# CUDA Driver API

## API Reference Manual

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# Chapter 1. Difference between the driver and runtime APIs

The driver and runtime APIs are very similar and can for the most part be used interchangeably. However, there are some key differences worth noting between the two.

## Complexity vs. control

The runtime API eases device code management by providing implicit primary context initialization and management, and implicit module management. This leads to simpler code, but it also lacks the level of control that the driver API has.

In comparison, the driver API offers more fine-grained control, especially over module loading. Kernel launches are much more complex to implement, as the execution configuration and kernel parameters must be specified with explicit function calls. However, unlike the runtime, where all the kernels are automatically loaded during initialization and stay loaded for as long as the program runs, with the driver API it is possible to only keep the modules that are currently needed loaded, or even dynamically reload modules. The driver API is also language-independent as it only deals with cubin objects.

## Context management

Unless an execution context cudaExecutionContext_t is specified, the runtime API decides itself which context to use for a thread: if a context has been made current to the calling thread through the driver API, the runtime will use that, but if there is no such context, it uses the device execution context which is a "primary context." Primary contexts are created as needed, one per device per process, are reference-counted, and are then destroyed when there are no more references to them. Within one process, all users of the runtime API will share the primary context, unless a context has been made current to each thread or an explicit execution context is specified to the runtime APIs.

Using the runtime API with primary contexts has its tradeoffs, however. It can cause trouble for users writing plug-ins for larger software packages, for example, because if all plug-ins run in the same process, they will all share a context but will likely have no way to communicate with each other. So, if one of them calls `cudaDeviceReset()` after finishing all its CUDA work, the other plug-ins will fail because the context they were using was destroyed without their knowledge. To avoid this issue, CUDA clients can use the driver API to create and set the current context, and then use the runtime API to work with it. However, contexts may consume significant resources, such as device memory, extra host threads, and performance costs of context switching on the device. This runtime-driver context

sharing is important when using the driver API in conjunction with libraries built on the runtime API, such as cuBLAS or cuFFT.

# Chapter 2. API synchronization behavior

The API provides memcpy/memset functions in both synchronous and asynchronous forms, the latter having an "Async" suffix. This is a misnomer as each function may exhibit synchronous or asynchronous behavior depending on the arguments passed to the function. The synchronous forms of these APIs issue these copies through the default stream.

Any CUDA API call may block or synchronize for various reasons such as contention for or unavailability of internal resources. Such behavior is subject to change and undocumented behavior should not be relied upon.

## Memcpy

In the reference documentation, each memcpy function is categorized as synchronous or asynchronous, corresponding to the definitions below.

Synchronous

1. For transfers from pageable host memory to device memory, a stream sync is performed before the copy is initiated. The function will return once the pageable buffer has been copied to the staging memory for DMA transfer to device memory, but the DMA to final destination may not have completed.
2. For transfers from pinned host memory to device memory, the function is synchronous with respect to the host.
3. For transfers from device to either pageable or pinned host memory, the function returns only once the copy has completed.
4. For transfers from device memory to device memory, no host-side synchronization is performed.
5. For transfers from any host memory to any host memory, the function is fully synchronous with respect to the host.

Asynchronous

1. For transfers between device memory and pageable host memory, the function might be synchronous with respect to host.
2. For transfers from any host memory to any host memory, the function is fully synchronous with respect to the host.

3. If pageable memory must first be staged to pinned memory, the driver may synchronize with the stream and stage the copy into pinned memory.
4. For all other transfers, the function should be fully asynchronous.

## Memset

The cudaMemset functions are asynchronous with respect to the host except when the target memory is pinned host memory. The Async versions are always asynchronous with respect to the host.

## Kernel Launches

Kernel launches are asynchronous with respect to the host. Details of concurrent kernel execution and data transfers can be found in the CUDA Programmers Guide.

# Chapter 3. Stream synchronization behavior

## Default stream

The default stream, used when `0` is passed as a `cudaStream_t` or by APIs that operate on a stream implicitly, can be configured to have either legacy or per-thread synchronization behavior as described below.

The behavior can be controlled per compilation unit with the `--default-stream` nvcc option. Alternatively, per-thread behavior can be enabled by defining the `CUDA_API_PER_THREAD_DEFAULT_STREAM` macro before including any CUDA headers. Either way, the `CUDA_API_PER_THREAD_DEFAULT_STREAM` macro will be defined in compilation units using per-thread synchronization behavior.

## Legacy default stream

The legacy default stream is an implicit stream which synchronizes with all other streams in the same `CUcontext` except for non-blocking streams, described below. (For applications using the runtime APIs only, there will be one context per device.) When an action is taken in the legacy stream such as a kernel launch or `cudaStreamWaitEvent()`, the legacy stream first waits on all blocking streams, the action is queued in the legacy stream, and then all blocking streams wait on the legacy stream.

For example, the following code launches a kernel `k_1` in stream `s`, then `k_2` in the legacy stream, then `k_3` in stream `s`:

```
k_1<<<1, 1, 0, s>>>();
k_2<<<1, 1>>>();
k_3<<<1, 1, 0, s>>>();
```

The resulting behavior is that `k_2` will block on `k_1` and `k_3` will block on `k_2`.

Non-blocking streams which do not synchronize with the legacy stream can be created using the `cudaStreamNonBlocking` flag with the stream creation APIs.

The legacy default stream can be used explicitly with the `CUstream` (`cudaStream_t`) handle `CU_STREAM_LEGACY` (`cudaStreamLegacy`).

## Per-thread default stream

The per-thread default stream is an implicit stream local to both the thread and the `CUcontext`, and which does not synchronize with other streams (just like explicitly created streams). The per-thread default stream is not a non-blocking stream and will synchronize with the legacy default stream if both are used in a program.

The per-thread default stream can be used explicitly with the `CUstream` (`cudaStream_t`) handle `CU_STREAM_PER_THREAD` (`cudaStreamPerThread`).

# Chapter 4. Graph object thread safety

Graph objects (`cudaGraph_t`, `CUgraph`) are not internally synchronized and must not be accessed concurrently from multiple threads. API calls accessing the same graph object must be serialized externally.

Note that this includes APIs which may appear to be read-only, such as `cudaGraphClone()` (`cuGraphClone()`) and `cudaGraphInstantiate()` (`cuGraphInstantiate()`). No API or pair of APIs is guaranteed to be safe to call on the same graph object from two different threads without serialization.

# Chapter 5. Rules for version mixing

1. Starting with CUDA 11.0, the ABI version for the CUDA runtime is bumped every major release. CUDA-defined types, whether opaque handles or structures like `cudaDeviceProp`, have their ABI tied to the major release of the CUDA runtime. It is unsafe to pass them from function A to function B if those functions have been compiled with different major versions of the toolkit and linked together into the same device executable.
2. The CUDA Driver API has a per-function ABI denoted with a _v* extension. CUDA-defined types (e.g structs) should not be passed across different ABI versions. For example, an application calling `cuMemcpy2D_v2(const CUDA_MEMCPY2D_v2 *pCopy)` and using the older version of the struct `CUDA_MEMCPY2D_v1` instead of `CUDA_MEMCPY2D_v2`.
3. Users should not arbitrarily mix different API versions during the lifetime of a resource. These resources include IPC handles, memory, streams, contexts, events, etc. For example, a user who wants to allocate CUDA memory using `cuMemAlloc_v2` should free the memory using `cuMemFree_v2` and not `cuMemFree`.

# Chapter 6. Modules

Here is a list of all modules:


- Data types used by CUDA driver
- Error Handling
- Initialization
- Version Management
- Device Management
- Device Management [DEPRECATED]
- Primary Context Management
- Context Management
- Context Management [DEPRECATED]
- Module Management
- Module Management [DEPRECATED]
- Library Management
- Memory Management
- Virtual Memory Management
- Stream Ordered Memory Allocator
- Multicast Object Management
- Logical Endpoint
- Unified Addressing
- Stream Management
- Event Management
- External Resource Interoperability
- Stream Memory Operations
- Execution Control
- Execution Control [DEPRECATED]
- Graph Management
- Occupancy

- Texture Reference Management [DEPRECATED]
- Surface Reference Management [DEPRECATED]
- Texture Object Management
- Surface Object Management
- Tensor Map Object Managment
- Peer Context Memory Access
- Graphics Interoperability
- Driver Entry Point Access
- Coredump Attributes Control API
- Green Contexts
- Error Log Management Functions
- CUDA Checkpointing
- Profiler Control [DEPRECATED]
- Profiler Control
- OpenGL Interoperability
  - OpenGL Interoperability [DEPRECATED]
- Direct3D 9 Interoperability
  - Direct3D 9 Interoperability [DEPRECATED]
- Direct3D 10 Interoperability
  - Direct3D 10 Interoperability [DEPRECATED]
- Direct3D 11 Interoperability
  - Direct3D 11 Interoperability [DEPRECATED]
- VDPAU Interoperability
- EGL Interoperability


## 6.1. Data types used by CUDA driver

struct CUaccessPolicyWindow_v1

struct CUarrayMapInfo_v1

struct CUasyncNotificationInfo

struct CUcheckpointCheckpointArgs

struct CUcheckpointGpuPair

struct CUcheckpointLockArgs

struct CUcheckpointRestoreArgs

struct CUcheckpointUnlockArgs

struct CUctxCigParam

struct CUctxCreateParams

struct CUDA_ARRAY3D_DESCRIPTOR_v2

struct CUDA_ARRAY_DESCRIPTOR_v2

struct CUDA_ARRAY_MEMORY_REQUIREMENTS_v1

struct CUDA_ARRAY_SPARSE_PROPERTIES_v1

struct CUDA_BATCH_MEM_OP_NODE_PARAMS_v1

struct CUDA_BATCH_MEM_OP_NODE_PARAMS_v2

struct CUDA_CHILD_GRAPH_NODE_PARAMS

struct CUDA_CONDITIONAL_NODE_PARAMS

struct CUDA_EVENT_RECORD_NODE_PARAMS

struct CUDA_EVENT_WAIT_NODE_PARAMS

struct CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v1

struct CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v2

struct CUDA_EXT_SEM_WAIT_NODE_PARAMS_v1

struct CUDA_EXT_SEM_WAIT_NODE_PARAMS_v2

struct CUDA_EXTERNAL_MEMORY_BUFFER_DESC_v1

struct CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1

struct CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_v

struct CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1

struct CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1

struct CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1

struct CUDA_GRAPH_INSTANTIATE_PARAMS

struct CUDA_HOST_NODE_PARAMS_v1

struct CUDA_HOST_NODE_PARAMS_v2

struct CUDA_KERNEL_NODE_PARAMS_v1

struct CUDA_KERNEL_NODE_PARAMS_v2

struct CUDA_KERNEL_NODE_PARAMS_v3

struct CUDA_LAUNCH_PARAMS_v1

struct CUDA_MEM_ALLOC_NODE_PARAMS_v1

struct CUDA_MEM_ALLOC_NODE_PARAMS_v2

struct CUDA_MEM_FREE_NODE_PARAMS

struct CUDA_MEMCPY2D_v2

struct CUDA_MEMCPY3D_PEER_v1

struct CUDA_MEMCPY3D_v2

struct CUDA_MEMCPY_NODE_PARAMS

struct CUDA_MEMSET_NODE_PARAMS_v1

struct CUDA_MEMSET_NODE_PARAMS_v2

struct CUDA_POINTER_ATTRIBUTE_P2P_TOKENS_v1

struct CUDA_RESOURCE_DESC_v1

struct CUDA_RESOURCE_VIEW_DESC_v1

struct CUDA_TEXTURE_DESC_v1

struct CUdevprop_v1

struct CUeglFrame_v1

struct CUexecAffinityParam_v1

struct CUexecAffinitySmCount_v1

struct CUextent3D_v1

struct CUgraphEdgeData

struct CUgraphExecUpdateResultInfo_v1

struct CUgraphNodeParams

struct CUipcEventHandle_v1

struct CUipcMemHandle_v1

struct CUlaunchAttribute

union CUlaunchAttributeValue

struct CUlaunchConfig

struct CUlaunchMemSyncDomainMap

struct CUmemAccessDesc_v1

struct CUmemAllocationProp_v1

struct CUmemcpy3DOperand_v1

struct CUmemcpyAttributes_v1

struct CUmemFabricHandle_v1

struct CUmemLocation_v1

struct CUmemPoolProps_v1

struct CUmemPoolPtrExportData_v1

struct CUmulticastObjectProp_v1

struct CUoffset3D_v1

union CUstreamBatchMemOpParams_v1

struct CUstreamCigCaptureParams

struct CUstreamCigParam

struct CUtensorMap

enum cl_context_flags

NVCL context scheduling flags

### Values

**NVCL_CTX_SCHED_AUTO = 0x00**
Automatic scheduling
**NVCL_CTX_SCHED_SPIN = 0x01**
Set spin as default scheduling
**NVCL_CTX_SCHED_YIELD = 0x02**
Set yield as default scheduling
**NVCL_CTX_SCHED_BLOCKING_SYNC = 0x04**
Set blocking synchronization as default scheduling

## enum cl_event_flags

NVCL event scheduling flags

### Values

**NVCL_EVENT_SCHED_AUTO = 0x00**
Automatic scheduling
**NVCL_EVENT_SCHED_SPIN = 0x01**
Set spin as default scheduling
**NVCL_EVENT_SCHED_YIELD = 0x02**
Set yield as default scheduling
**NVCL_EVENT_SCHED_BLOCKING_SYNC = 0x04**
Set blocking synchronization as default scheduling

## enum CUaccessProperty

Specifies performance hint with CUaccessPolicyWindow for hitProp and missProp members.

### Values

**CU_ACCESS_PROPERTY_NORMAL = 0**
Normal cache persistence.
**CU_ACCESS_PROPERTY_STREAMING = 1**
Streaming access is less likely to persit from cache.
**CU_ACCESS_PROPERTY_PERSISTING = 2**
Persisting access is more likely to persist in cache.

## enum CUaddress_mode

Texture reference addressing modes

### Values

**CU_TR_ADDRESS_MODE_WRAP = 0**
Wrapping address mode
**CU_TR_ADDRESS_MODE_CLAMP = 1**
Clamp to edge address mode
**CU_TR_ADDRESS_MODE_MIRROR = 2**
Mirror address mode
**CU_TR_ADDRESS_MODE_BORDER = 3**
Border address mode

## enum CUarray_cubemap_face

Array indices for cube faces

### Values

**CU_CUBEMAP_FACE_POSITIVE_X = 0x00**
Positive X face of cubemap
**CU_CUBEMAP_FACE_NEGATIVE_X = 0x01**
Negative X face of cubemap
**CU_CUBEMAP_FACE_POSITIVE_Y = 0x02**
Positive Y face of cubemap
**CU_CUBEMAP_FACE_NEGATIVE_Y = 0x03**
Negative Y face of cubemap
**CU_CUBEMAP_FACE_POSITIVE_Z = 0x04**
Positive Z face of cubemap
**CU_CUBEMAP_FACE_NEGATIVE_Z = 0x05**
Negative Z face of cubemap

## enum CUarray_format

Array formats

### Values

**CU_AD_FORMAT_UNSIGNED_INT8 = 0x01**
Unsigned 8-bit integers
**CU_AD_FORMAT_UNSIGNED_INT16 = 0x02**
Unsigned 16-bit integers
**CU_AD_FORMAT_UNSIGNED_INT32 = 0x03**
Unsigned 32-bit integers
**CU_AD_FORMAT_SIGNED_INT8 = 0x08**
Signed 8-bit integers
**CU_AD_FORMAT_SIGNED_INT16 = 0x09**

Signed 16-bit integers

**CU_AD_FORMAT_SIGNED_INT32 = 0x0a**

Signed 32-bit integers

**CU_AD_FORMAT_HALF = 0x10**

16-bit floating point

**CU_AD_FORMAT_FLOAT = 0x20**

32-bit floating point

**CU_AD_FORMAT_NV12 = 0xb0**

8-bit YUV planar format, with 4:2:0 sampling

**CU_AD_FORMAT_UNORM_INT8X1 = 0xc0**

1 channel unsigned 8-bit normalized integer

**CU_AD_FORMAT_UNORM_INT8X2 = 0xc1**

2 channel unsigned 8-bit normalized integer

**CU_AD_FORMAT_UNORM_INT8X4 = 0xc2**

4 channel unsigned 8-bit normalized integer

**CU_AD_FORMAT_UNORM_INT16X1 = 0xc3**

1 channel unsigned 16-bit normalized integer

**CU_AD_FORMAT_UNORM_INT16X2 = 0xc4**

2 channel unsigned 16-bit normalized integer

**CU_AD_FORMAT_UNORM_INT16X4 = 0xc5**

4 channel unsigned 16-bit normalized integer

**CU_AD_FORMAT_SNORM_INT8X1 = 0xc6**

1 channel signed 8-bit normalized integer

**CU_AD_FORMAT_SNORM_INT8X2 = 0xc7**

2 channel signed 8-bit normalized integer

**CU_AD_FORMAT_SNORM_INT8X4 = 0xc8**

4 channel signed 8-bit normalized integer

**CU_AD_FORMAT_SNORM_INT16X1 = 0xc9**

1 channel signed 16-bit normalized integer

**CU_AD_FORMAT_SNORM_INT16X2 = 0xca**

2 channel signed 16-bit normalized integer

**CU_AD_FORMAT_SNORM_INT16X4 = 0xcb**

4 channel signed 16-bit normalized integer

**CU_AD_FORMAT_BC1_UNORM = 0x91**

4 channel unsigned normalized block-compressed (BC1 compression) format

**CU_AD_FORMAT_BC1_UNORM_SRGB = 0x92**

4 channel unsigned normalized block-compressed (BC1 compression) format with sRGB encoding

**CU_AD_FORMAT_BC2_UNORM = 0x93**

4 channel unsigned normalized block-compressed (BC2 compression) format

**CU_AD_FORMAT_BC2_UNORM_SRGB = 0x94**

4 channel unsigned normalized block-compressed (BC2 compression) format with sRGB encoding

**CU_AD_FORMAT_BC3_UNORM = 0x95**

4 channel unsigned normalized block-compressed (BC3 compression) format

**CU_AD_FORMAT_BC3_UNORM_SRGB = 0x96**
4 channel unsigned normalized block-compressed (BC3 compression) format with sRGB encoding
**CU_AD_FORMAT_BC4_UNORM = 0x97**
1 channel unsigned normalized block-compressed (BC4 compression) format
**CU_AD_FORMAT_BC4_SNORM = 0x98**
1 channel signed normalized block-compressed (BC4 compression) format
**CU_AD_FORMAT_BC5_UNORM = 0x99**
2 channel unsigned normalized block-compressed (BC5 compression) format
**CU_AD_FORMAT_BC5_SNORM = 0x9a**
2 channel signed normalized block-compressed (BC5 compression) format
**CU_AD_FORMAT_BC6H_UF16 = 0x9b**
3 channel unsigned half-float block-compressed (BC6H compression) format
**CU_AD_FORMAT_BC6H_SF16 = 0x9c**
3 channel signed half-float block-compressed (BC6H compression) format
**CU_AD_FORMAT_BC7_UNORM = 0x9d**
4 channel unsigned normalized block-compressed (BC7 compression) format
**CU_AD_FORMAT_BC7_UNORM_SRGB = 0x9e**
4 channel unsigned normalized block-compressed (BC7 compression) format with sRGB encoding
**CU_AD_FORMAT_P010 = 0x9f**
10-bit YUV planar format, with 4:2:0 sampling
**CU_AD_FORMAT_P016 = 0xa1**
16-bit YUV planar format, with 4:2:0 sampling
**CU_AD_FORMAT_NV16 = 0xa2**
8-bit YUV planar format, with 4:2:2 sampling
**CU_AD_FORMAT_P210 = 0xa3**
10-bit YUV planar format, with 4:2:2 sampling
**CU_AD_FORMAT_P216 = 0xa4**
16-bit YUV planar format, with 4:2:2 sampling
**CU_AD_FORMAT_YUY2 = 0xa5**
2 channel, 8-bit YUV packed planar format, with 4:2:2 sampling
**CU_AD_FORMAT_Y210 = 0xa6**
2 channel, 10-bit YUV packed planar format, with 4:2:2 sampling
**CU_AD_FORMAT_Y216 = 0xa7**
2 channel, 16-bit YUV packed planar format, with 4:2:2 sampling
**CU_AD_FORMAT_AYUV = 0xa8**
4 channel, 8-bit YUV packed planar format, with 4:4:4 sampling
**CU_AD_FORMAT_Y410 = 0xa9**
10-bit YUV packed planar format, with 4:4:4 sampling
**CU_AD_FORMAT_Y416 = 0xb1**
4 channel, 12-bit YUV packed planar format, with 4:4:4 sampling
**CU_AD_FORMAT_Y444_PLANAR8 = 0xb2**
3 channel 8-bit YUV planar format, with 4:4:4 sampling
**CU_AD_FORMAT_Y444_PLANAR10 = 0xb3**

3 channel 10-bit YUV planar format, with 4:4:4 sampling

**CU_AD_FORMAT_YUV444_8bit_SemiPlanar = 0xb4**

3 channel 8-bit YUV semi-planar format, with 4:4:4 sampling

**CU_AD_FORMAT_YUV444_16bit_SemiPlanar = 0xb5**

3 channel 16-bit YUV semi-planar format, with 4:4:4 sampling

**CU_AD_FORMAT_UNORM_INT_101010_2 = 0x50**

4 channel unorm R10G10B10A2 RGB format

**CU_AD_FORMAT_UINT8_PACKED_422 = 0x51**

4 channel unsigned 8-bit YUV packed format, with 4:2:2 sampling

**CU_AD_FORMAT_UINT8_PACKED_444 = 0x52**

4 channel unsigned 8-bit YUV packed format, with 4:4:4 sampling

**CU_AD_FORMAT_UINT8_SEMIPLANAR_420 = 0x53**

3 channel unsigned 8-bit YUV semi-planar format, with 4:2:0 sampling

**CU_AD_FORMAT_UINT16_SEMIPLANAR_420 = 0x54**

3 channel unsigned 16-bit YUV semi-planar format, with 4:2:0 sampling

**CU_AD_FORMAT_UINT8_SEMIPLANAR_422 = 0x55**

3 channel unsigned 8-bit YUV semi-planar format, with 4:2:2 sampling

**CU_AD_FORMAT_UINT16_SEMIPLANAR_422 = 0x56**

3 channel unsigned 16-bit YUV semi-planar format, with 4:2:2 sampling

**CU_AD_FORMAT_UINT8_SEMIPLANAR_444 = 0x57**

3 channel unsigned 8-bit YUV semi-planar format, with 4:4:4 sampling

**CU_AD_FORMAT_UINT16_SEMIPLANAR_444 = 0x58**

3 channel unsigned 16-bit YUV semi-planar format, with 4:4:4 sampling

**CU_AD_FORMAT_UINT8_PLANAR_420 = 0x59**

3 channel unsigned 8-bit YUV planar format, with 4:2:0 sampling

**CU_AD_FORMAT_UINT16_PLANAR_420 = 0x5a**

3 channel unsigned 16-bit YUV planar format, with 4:2:0 sampling

**CU_AD_FORMAT_UINT8_PLANAR_422 = 0x5b**

3 channel unsigned 8-bit YUV planar format, with 4:2:2 sampling

**CU_AD_FORMAT_UINT16_PLANAR_422 = 0x5c**

3 channel unsigned 16-bit YUV planar format, with 4:2:2 sampling

**CU_AD_FORMAT_UINT8_PLANAR_444 = 0x5d**

3 channel unsigned 8-bit YUV planar format, with 4:4:4 sampling

**CU_AD_FORMAT_UINT16_PLANAR_444 = 0x5e**

3 channel unsigned 16-bit YUV planar format, with 4:4:4 sampling

**CU_AD_FORMAT_MAX = 0x7FFFFFFF**

## enum CUarraySparseSubresourceType

Sparse subresource types

### Values

**CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_SPARSE_LEVEL = 0**

**CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_MIPTAIL = 1**

# enum CUasyncNotificationType

Types of async notification that can be sent

## Values

**CU_ASYNC_NOTIFICATION_TYPE_OVER_BUDGET = 0x1**
Sent when the process has exceeded its device memory budget

# enum CUatomicOperation

CUDA-valid Atomic Operations

## Values

**CU_ATOMIC_OPERATION_INTEGER_ADD = 0**
**CU_ATOMIC_OPERATION_INTEGER_MIN = 1**
**CU_ATOMIC_OPERATION_INTEGER_MAX = 2**
**CU_ATOMIC_OPERATION_INTEGER_INCREMENT = 3**
**CU_ATOMIC_OPERATION_INTEGER_DECREMENT = 4**
**CU_ATOMIC_OPERATION_AND = 5**
**CU_ATOMIC_OPERATION_OR = 6**
**CU_ATOMIC_OPERATION_XOR = 7**
**CU_ATOMIC_OPERATION_EXCHANGE = 8**
**CU_ATOMIC_OPERATION_CAS = 9**
**CU_ATOMIC_OPERATION_FLOAT_ADD = 10**
**CU_ATOMIC_OPERATION_FLOAT_MIN = 11**
**CU_ATOMIC_OPERATION_FLOAT_MAX = 12**
**CU_ATOMIC_OPERATION_MAX**

# enum CUatomicOperationCapability

CUDA-valid Atomic Operation capabilities

## Values

**CU_ATOMIC_CAPABILITY_SIGNED = 1u<<0**
**CU_ATOMIC_CAPABILITY_UNSIGNED = 1u<<1**
**CU_ATOMIC_CAPABILITY_REDUCTION = 1u<<2**
**CU_ATOMIC_CAPABILITY_SCALAR_32 = 1u<<3**
**CU_ATOMIC_CAPABILITY_SCALAR_64 = 1u<<4**
**CU_ATOMIC_CAPABILITY_SCALAR_128 = 1u<<5**
**CU_ATOMIC_CAPABILITY_VECTOR_32x4 = 1u<<6**

# enum CUclusterSchedulingPolicy

Cluster scheduling policies. These may be passed to cuFuncSetAttribute or cuKernelSetAttribute

## Values

**CU_CLUSTER_SCHEDULING_POLICY_DEFAULT = 0**
the default policy

**CU_CLUSTER_SCHEDULING_POLICY_SPREAD = 1**
spread the blocks within a cluster to the SMs

**CU_CLUSTER_SCHEDULING_POLICY_LOAD_BALANCING = 2**
allow the hardware to load-balance the blocks in a cluster to the SMs

# enum CUcomputemode

Compute Modes

## Values

**CU_COMPUTEMODE_DEFAULT = 0**
Default compute mode (Multiple contexts allowed per device)

**CU_COMPUTEMODE_PROHIBITED = 2**
Compute-prohibited mode (No contexts can be created on this device at this time)

**CU_COMPUTEMODE_EXCLUSIVE_PROCESS = 3**
Compute-exclusive-process mode (Only one context used by a single process can be present on this device at a time)

# enum CUctx_flags

Context creation flags

## Values

**CU_CTX_SCHED_AUTO = 0x00**
Automatic scheduling

**CU_CTX_SCHED_SPIN = 0x01**
Set spin as default scheduling

**CU_CTX_SCHED_YIELD = 0x02**
Set yield as default scheduling

**CU_CTX_SCHED_BLOCKING_SYNC = 0x04**
Set blocking synchronization as default scheduling

**CU_CTX_BLOCKING_SYNC = 0x04**
Set blocking synchronization as default scheduling Deprecated This flag was deprecated as of CUDA 4.0 and was replaced with CU_CTX_SCHED_BLOCKING_SYNC.

**CU_CTX_SCHED_MASK = 0x07**

**CU_CTX_MAP_HOST = 0x08**
Deprecated This flag was deprecated as of CUDA 11.0 and it no longer has any effect. All contexts as of CUDA 3.2 behave as though the flag is enabled.

**CU_CTX_LMEM_RESIZE_TO_MAX = 0x10**
Keep local memory allocation after launch

**CU_CTX_COREDUMP_ENABLE = 0x20**
Trigger coredumps from exceptions in this context

**CU_CTX_USER_COREDUMP_ENABLE = 0x40**
Enable user pipe to trigger coredumps in this context

**CU_CTX_SYNC_MEMOPS = 0x80**
Ensure synchronous memory operations on this context will synchronize

**CU_CTX_FLAGS_MASK = 0xFF**

# enum CUDA_POINTER_ATTRIBUTE_ACCESS_FLAGS

Access flags that specify the level of access the current context's device has on the memory referenced.

## Values

**CU_POINTER_ATTRIBUTE_ACCESS_FLAG_NONE = 0x0**
No access, meaning the device cannot access this memory at all, thus must be staged through accessible memory in order to complete certain operations

**CU_POINTER_ATTRIBUTE_ACCESS_FLAG_READ = 0x1**
Read-only access, meaning writes to this memory are considered invalid accesses and thus return error in that case.

**CU_POINTER_ATTRIBUTE_ACCESS_FLAG_READWRITE = 0x3**
Read-write access, the device has full read-write access to the memory

# enum CUdevice_attribute

Device properties

## Values

**CU_DEVICE_ATTRIBUTE_MAX_THREADS_PER_BLOCK = 1**
Maximum number of threads per block

**CU_DEVICE_ATTRIBUTE_MAX_BLOCK_DIM_X = 2**
Maximum block dimension X

**CU_DEVICE_ATTRIBUTE_MAX_BLOCK_DIM_Y = 3**
Maximum block dimension Y

**CU_DEVICE_ATTRIBUTE_MAX_BLOCK_DIM_Z = 4**
Maximum block dimension Z

**CU_DEVICE_ATTRIBUTE_MAX_GRID_DIM_X = 5**
Maximum grid dimension X

**CU_DEVICE_ATTRIBUTE_MAX_GRID_DIM_Y = 6**

Maximum grid dimension Y

**CU_DEVICE_ATTRIBUTE_MAX_GRID_DIM_Z = 7**

Maximum grid dimension Z

**CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK = 8**

Maximum shared memory available per block in bytes

**CU_DEVICE_ATTRIBUTE_SHARED_MEMORY_PER_BLOCK = 8**

Deprecated, use CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK

**CU_DEVICE_ATTRIBUTE_TOTAL_CONSTANT_MEMORY = 9**

Memory available on device for __constant__ variables in a CUDA C kernel in bytes

**CU_DEVICE_ATTRIBUTE_WARP_SIZE = 10**

Warp size in threads

**CU_DEVICE_ATTRIBUTE_MAX_PITCH = 11**

Maximum pitch in bytes allowed by memory copies

**CU_DEVICE_ATTRIBUTE_MAX_REGISTERS_PER_BLOCK = 12**

Maximum number of 32-bit registers available per block

**CU_DEVICE_ATTRIBUTE_REGISTERS_PER_BLOCK = 12**

Deprecated, use CU_DEVICE_ATTRIBUTE_MAX_REGISTERS_PER_BLOCK

**CU_DEVICE_ATTRIBUTE_CLOCK_RATE = 13**

Typical clock frequency in kilohertz

**CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT = 14**

Alignment requirement for textures

**CU_DEVICE_ATTRIBUTE_GPU_OVERLAP = 15**

Device can possibly copy memory and execute a kernel concurrently. Deprecated. Use instead CU_DEVICE_ATTRIBUTE_ASYNC_ENGINE_COUNT.

**CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT = 16**

Number of multiprocessors on device

**CU_DEVICE_ATTRIBUTE_KERNEL_EXEC_TIMEOUT = 17**

Specifies whether there is a run time limit on kernels

**CU_DEVICE_ATTRIBUTE_INTEGRATED = 18**

Device is integrated with host memory

**CU_DEVICE_ATTRIBUTE_CAN_MAP_HOST_MEMORY = 19**

Device can map host memory into CUDA address space

**CU_DEVICE_ATTRIBUTE_COMPUTE_MODE = 20**

Compute mode (See CUcomputemode for details)

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_WIDTH = 21**

Maximum 1D texture width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_WIDTH = 22**

Maximum 2D texture width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_HEIGHT = 23**

Maximum 2D texture height

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_WIDTH = 24**

Maximum 3D texture width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_HEIGHT = 25**

Maximum 3D texture height

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_DEPTH = 26**

Maximum 3D texture depth

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_WIDTH = 27**

Maximum 2D layered texture width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_HEIGHT = 28**

Maximum 2D layered texture height

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_LAYERS = 29**

Maximum layers in a 2D layered texture

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_ARRAY_WIDTH = 27**

Deprecated, use CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_WIDTH

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_ARRAY_HEIGHT = 28**

Deprecated, use CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_HEIGHT

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_ARRAY_NUMSLICES = 29**

Deprecated, use CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LAYERED_LAYERS

**CU_DEVICE_ATTRIBUTE_SURFACE_ALIGNMENT = 30**

Alignment requirement for surfaces

**CU_DEVICE_ATTRIBUTE_CONCURRENT_KERNELS = 31**

Device can possibly execute multiple kernels concurrently

**CU_DEVICE_ATTRIBUTE_ECC_ENABLED = 32**

Device has ECC support enabled

**CU_DEVICE_ATTRIBUTE_PCI_BUS_ID = 33**

PCI bus ID of the device

**CU_DEVICE_ATTRIBUTE_PCI_DEVICE_ID = 34**

PCI device ID of the device

**CU_DEVICE_ATTRIBUTE_TCC_DRIVER = 35**

Device is using TCC driver model

**CU_DEVICE_ATTRIBUTE_MEMORY_CLOCK_RATE = 36**

Peak memory clock frequency in kilohertz

**CU_DEVICE_ATTRIBUTE_GLOBAL_MEMORY_BUS_WIDTH = 37**

Global memory bus width in bits

**CU_DEVICE_ATTRIBUTE_L2_CACHE_SIZE = 38**

Size of L2 cache in bytes

**CU_DEVICE_ATTRIBUTE_MAX_THREADS_PER_MULTIPROCESSOR = 39**

Maximum resident threads per multiprocessor

**CU_DEVICE_ATTRIBUTE_ASYNC_ENGINE_COUNT = 40**

Number of asynchronous engines

**CU_DEVICE_ATTRIBUTE_UNIFIED_ADDRESSING = 41**

Device shares a unified address space with the host

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LAYERED_WIDTH = 42**

Maximum 1D layered texture width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LAYERED_LAYERS = 43**

Maximum layers in a 1D layered texture

**CU_DEVICE_ATTRIBUTE_CAN_TEX2D_GATHER = 44**
Deprecated, do not use.
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_GATHER_WIDTH = 45**
Maximum 2D texture width if CUDA_ARRAY3D_TEXTURE_GATHER is set
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_GATHER_HEIGHT = 46**
Maximum 2D texture height if CUDA_ARRAY3D_TEXTURE_GATHER is set
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_WIDTH_ALTERNATE = 47**
Alternate maximum 3D texture width
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_HEIGHT_ALTERNATE = 48**
Alternate maximum 3D texture height
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE3D_DEPTH_ALTERNATE = 49**
Alternate maximum 3D texture depth
**CU_DEVICE_ATTRIBUTE_PCI_DOMAIN_ID = 50**
PCI domain ID of the device
**CU_DEVICE_ATTRIBUTE_TEXTURE_PITCH_ALIGNMENT = 51**
Pitch alignment requirement for textures
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURECUBEMAP_WIDTH = 52**
Maximum cubemap texture width/height
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURECUBEMAP_LAYERED_WIDTH = 53**
Maximum cubemap layered texture width/height
**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURECUBEMAP_LAYERED_LAYERS = 54**
Maximum layers in a cubemap layered texture
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE1D_WIDTH = 55**
Maximum 1D surface width
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_WIDTH = 56**
Maximum 2D surface width
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_HEIGHT = 57**
Maximum 2D surface height
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE3D_WIDTH = 58**
Maximum 3D surface width
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE3D_HEIGHT = 59**
Maximum 3D surface height
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE3D_DEPTH = 60**
Maximum 3D surface depth
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE1D_LAYERED_WIDTH = 61**
Maximum 1D layered surface width
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE1D_LAYERED_LAYERS = 62**
Maximum layers in a 1D layered surface
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_LAYERED_WIDTH = 63**
Maximum 2D layered surface width
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_LAYERED_HEIGHT = 64**
Maximum 2D layered surface height
**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACE2D_LAYERED_LAYERS = 65**

Maximum layers in a 2D layered surface

**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACECUBEMAP_WIDTH = 66**

Maximum cubemap surface width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACECUBEMAP_LAYERED_WIDTH = 67**

Maximum cubemap layered surface width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_SURFACECUBEMAP_LAYERED_LAYERS = 68**

Maximum layers in a cubemap layered surface

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LINEAR_WIDTH = 69**

Deprecated, do not use. Use cudaDeviceGetTexture1DLinearMaxWidth() or cuDeviceGetTexture1DLinearMaxWidth() instead.

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_WIDTH = 70**

Maximum 2D linear texture width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_HEIGHT = 71**

Maximum 2D linear texture height

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_PITCH = 72**

Maximum 2D linear texture pitch in bytes

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_MIPMAPPED_WIDTH = 73**

Maximum mipmapped 2D texture width

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_MIPMAPPED_HEIGHT = 74**

Maximum mipmapped 2D texture height

**CU_DEVICE_ATTRIBUTE_COMPUTE_CAPABILITY_MAJOR = 75**

Major compute capability version number

**CU_DEVICE_ATTRIBUTE_COMPUTE_CAPABILITY_MINOR = 76**

Minor compute capability version number

**CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_MIPMAPPED_WIDTH = 77**

Maximum mipmapped 1D texture width

**CU_DEVICE_ATTRIBUTE_STREAM_PRIORITIES_SUPPORTED = 78**

Device supports stream priorities

**CU_DEVICE_ATTRIBUTE_GLOBAL_L1_CACHE_SUPPORTED = 79**

Device supports caching globals in L1

**CU_DEVICE_ATTRIBUTE_LOCAL_L1_CACHE_SUPPORTED = 80**

Device supports caching locals in L1

**CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_MULTIPROCESSOR = 81**

Maximum shared memory available per multiprocessor in bytes

**CU_DEVICE_ATTRIBUTE_MAX_REGISTERS_PER_MULTIPROCESSOR = 82**

Maximum number of 32-bit registers available per multiprocessor

**CU_DEVICE_ATTRIBUTE_MANAGED_MEMORY = 83**

Device can allocate managed memory on this system

**CU_DEVICE_ATTRIBUTE_MULTI_GPU_BOARD = 84**

Device is on a multi-GPU board

**CU_DEVICE_ATTRIBUTE_MULTI_GPU_BOARD_GROUP_ID = 85**

Unique id for a group of devices on the same multi-GPU board

**CU_DEVICE_ATTRIBUTE_HOST_NATIVE_ATOMIC_SUPPORTED = 86**

Link between the device and the host supports all native atomic operations

**CU_DEVICE_ATTRIBUTE_SINGLE_TO_DOUBLE_PRECISION_PERF_RATIO = 87**

Ratio of single precision performance (in floating-point operations per second) to double precision performance

**CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS = 88**

Device supports coherently accessing pageable memory without calling cudaHostRegister on it

**CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS = 89**

Device can coherently access managed memory concurrently with the CPU

**CU_DEVICE_ATTRIBUTE_COMPUTE_PREEMPTION_SUPPORTED = 90**

Device supports compute preemption.

**CU_DEVICE_ATTRIBUTE_CAN_USE_HOST_POINTER_FOR_REGISTERED_MEM = 91**

Device can access host registered memory at the same virtual address as the CPU

**CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_MEM_OPS_V1 = 92**

Deprecated, along with v1 MemOps API, cuStreamBatchMemOp and related APIs are supported.

**CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS_V1 = 93**

Deprecated, along with v1 MemOps API, 64-bit operations are supported in cuStreamBatchMemOp and related APIs.

**CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR_V1 = 94**

Deprecated, along with v1 MemOps API, CU_STREAM_WAIT_VALUE_NOR is supported.

**CU_DEVICE_ATTRIBUTE_COOPERATIVE_LAUNCH = 95**

Device supports launching cooperative kernels via cuLaunchCooperativeKernel

**CU_DEVICE_ATTRIBUTE_COOPERATIVE_MULTI_DEVICE_LAUNCH = 96**

Deprecated, cuLaunchCooperativeKernelMultiDevice is deprecated.

**CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK_OPTIN = 97**

Maximum optin shared memory per block. That is shared memory that is available for dynamic allocation or static allocation (including architecture specific static shared memory) on this device but is not guaranteed to be portable.

**CU_DEVICE_ATTRIBUTE_CAN_FLUSH_REMOTE_WRITES = 98**

The CU_STREAM_WAIT_VALUE_FLUSH flag and the CU_STREAM_MEM_OP_FLUSH_REMOTE_WRITES MemOp are supported on the device. See Stream Memory Operations for additional details.

**CU_DEVICE_ATTRIBUTE_HOST_REGISTER_SUPPORTED = 99**

Device supports host memory registration via cudaHostRegister.

**CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES = 100**

Device accesses pageable memory via the host's page tables.

**CU_DEVICE_ATTRIBUTE_DIRECT_MANAGED_MEM_ACCESS_FROM_HOST = 101**

The host can directly access managed memory on the device without migration.

**CU_DEVICE_ATTRIBUTE_VIRTUAL_ADDRESS_MANAGEMENT_SUPPORTED = 102**

Deprecated, Use CU_DEVICE_ATTRIBUTE_VIRTUAL_MEMORY_MANAGEMENT_SUPPORTED

**CU_DEVICE_ATTRIBUTE_VIRTUAL_MEMORY_MANAGEMENT_SUPPORTED = 102**

Device supports virtual memory management APIs like cuMemAddressReserve, cuMemCreate, cuMemMap and related APIs

**CU_DEVICE_ATTRIBUTE_HANDLE_TYPE_POSIX_FILE_DESCRIPTOR_SUPPORTED = 103**

Device supports exporting memory to a posix file descriptor with cuMemExportToShareableHandle, if requested via cuMemCreate

**CU_DEVICE_ATTRIBUTE_HANDLE_TYPE_WIN32_HANDLE_SUPPORTED = 104**

Device supports exporting memory to a Win32 NT handle with cuMemExportToShareableHandle, if requested via cuMemCreate

**CU_DEVICE_ATTRIBUTE_HANDLE_TYPE_WIN32_KMT_HANDLE_SUPPORTED = 105**

Device supports exporting memory to a Win32 KMT handle with cuMemExportToShareableHandle, if requested via cuMemCreate

**CU_DEVICE_ATTRIBUTE_MAX_BLOCKS_PER_MULTIPROCESSOR = 106**

Maximum number of blocks per multiprocessor

**CU_DEVICE_ATTRIBUTE_GENERIC_COMPRESSION_SUPPORTED = 107**

Device supports compression of memory

**CU_DEVICE_ATTRIBUTE_MAX_PERSISTING_L2_CACHE_SIZE = 108**

Maximum L2 persisting lines capacity setting in bytes.

**CU_DEVICE_ATTRIBUTE_MAX_ACCESS_POLICY_WINDOW_SIZE = 109**

Maximum value of CUaccessPolicyWindow::num_bytes.

**CU_DEVICE_ATTRIBUTE_GPU_DIRECT_RDMA_WITH_CUDA_VMM_SUPPORTED = 110**

Device supports specifying the GPUDirect RDMA flag with cuMemCreate

**CU_DEVICE_ATTRIBUTE_RESERVED_SHARED_MEMORY_PER_BLOCK = 111**

Shared memory reserved by CUDA driver per block in bytes

**CU_DEVICE_ATTRIBUTE_SPARSE_CUDA_ARRAY_SUPPORTED = 112**

Device supports sparse CUDA arrays and sparse CUDA mipmapped arrays

**CU_DEVICE_ATTRIBUTE_READ_ONLY_HOST_REGISTER_SUPPORTED = 113**

Device supports using the cuMemHostRegister flag CU_MEMHOSTERGISTER_READ_ONLY to register memory that must be mapped as read-only to the GPU

**CU_DEVICE_ATTRIBUTE_TIMELINE_SEMAPHORE_INTEROP_SUPPORTED = 114**

External timeline semaphore interop is supported on the device

**CU_DEVICE_ATTRIBUTE_MEMORY_POOLS_SUPPORTED = 115**

Device supports using the cuMemAllocAsync and cuMemPool family of APIs

**CU_DEVICE_ATTRIBUTE_GPU_DIRECT_RDMA_SUPPORTED = 116**

Device supports GPUDirect RDMA APIs, like nvidia_p2p_get_pages (see https://docs.nvidia.com/cuda/gpudirect-rdma for more information)

**CU_DEVICE_ATTRIBUTE_GPU_DIRECT_RDMA_FLUSH_WRITES_OPTIONS = 117**

The returned attribute shall be interpreted as a bitmask, where the individual bits are described by the CUflushGPUDirectRDMAWritesOptions enum

**CU_DEVICE_ATTRIBUTE_GPU_DIRECT_RDMA_WRITES_ORDERING = 118**

GPUDirect RDMA writes to the device do not need to be flushed for consumers within the scope indicated by the returned attribute. See CUGPUDirectRDMAWritesOrdering for the numerical values returned here.

**CU_DEVICE_ATTRIBUTE_MEMPOOL_SUPPORTED_HANDLE_TYPES = 119**
Handle types supported with mempool based IPC

**CU_DEVICE_ATTRIBUTE_CLUSTER_LAUNCH = 120**
Indicates device supports cluster launch

**CU_DEVICE_ATTRIBUTE_DEFERRED_MAPPING_CUDA_ARRAY_SUPPORTED = 121**
Device supports deferred mapping CUDA arrays and CUDA mipmapped arrays

**CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS = 122**
64-bit operations are supported in cuStreamBatchMemOp and related MemOp APIs.

**CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR = 123**
CU_STREAM_WAIT_VALUE_NOR is supported by MemOp APIs.

**CU_DEVICE_ATTRIBUTE_DMA_BUF_SUPPORTED = 124**
Device supports buffer sharing with dma_buf mechanism.

**CU_DEVICE_ATTRIBUTE_IPC_EVENT_SUPPORTED = 125**
Device supports IPC Events.

**CU_DEVICE_ATTRIBUTE_MEM_SYNC_DOMAIN_COUNT = 126**
Number of memory domains the device supports.

**CU_DEVICE_ATTRIBUTE_TENSOR_MAP_ACCESS_SUPPORTED = 127**
Device supports accessing memory using Tensor Map.

**CU_DEVICE_ATTRIBUTE_HANDLE_TYPE_FABRIC_SUPPORTED = 128**
Device supports exporting memory to a fabric handle with cuMemExportToShareableHandle() or requested with cuMemCreate()

**CU_DEVICE_ATTRIBUTE_UNIFIED_FUNCTION_POINTERS = 129**
Device supports unified function pointers.

**CU_DEVICE_ATTRIBUTE_NUMA_CONFIG = 130**
NUMA configuration of a device: value is of type CUdeviceNumaConfig enum

**CU_DEVICE_ATTRIBUTE_NUMA_ID = 131**
NUMA node ID of the GPU memory

**CU_DEVICE_ATTRIBUTE_MULTICAST_SUPPORTED = 132**
Device supports switch multicast and reduction operations.

**CU_DEVICE_ATTRIBUTE_MPS_ENABLED = 133**
Indicates if contexts created on this device will be shared via MPS

**CU_DEVICE_ATTRIBUTE_HOST_NUMA_ID = 134**
NUMA ID of the host node closest to the device. Returns -1 when system does not support NUMA.

**CU_DEVICE_ATTRIBUTE_D3D12_CIG_SUPPORTED = 135**
Device supports CIG with D3D12.

**CU_DEVICE_ATTRIBUTE_MEM_DECOMPRESS_ALGORITHM_MASK = 136**
The returned valued shall be interpreted as a bitmask, where the individual bits are described by the CUmemDecompressAlgorithm enum.

**CU_DEVICE_ATTRIBUTE_MEM_DECOMPRESS_MAXIMUM_LENGTH = 137**

The returned valued is the maximum length in bytes of a single decompress operation that is allowed.

**CU_DEVICE_ATTRIBUTE_VULKAN_CIG_SUPPORTED = 138**

Device supports CIG with Vulkan.

**CU_DEVICE_ATTRIBUTE_GPU_PCI_DEVICE_ID = 139**

The combined 16-bit PCI device ID and 16-bit PCI vendor ID.

**CU_DEVICE_ATTRIBUTE_GPU_PCI_SUBSYSTEM_ID = 140**

The combined 16-bit PCI subsystem ID and 16-bit PCI subsystem vendor ID.

**CU_DEVICE_ATTRIBUTE_HOST_NUMA_VIRTUAL_MEMORY_MANAGEMENT_SUPPORTED = 141**

Device supports HOST_NUMA location with the virtual memory management APIs like cuMemCreate, cuMemMap and related APIs

**CU_DEVICE_ATTRIBUTE_HOST_NUMA_MEMORY_POOLS_SUPPORTED = 142**

Device supports HOST_NUMA location with the cuMemAllocAsync and cuMemPool family of APIs

**CU_DEVICE_ATTRIBUTE_HOST_NUMA_MULTINODE_IPC_SUPPORTED = 143**

Device supports HOST_NUMA location IPC between nodes in a multi-node system.

**CU_DEVICE_ATTRIBUTE_HOST_MEMORY_POOLS_SUPPORTED = 144**

Device suports HOST location with the cuMemAllocAsync and cuMemPool family of APIs

**CU_DEVICE_ATTRIBUTE_HOST_VIRTUAL_MEMORY_MANAGEMENT_SUPPORTED = 145**

Device supports HOST location with the virtual memory management APIs like cuMemCreate, cuMemMap and related APIs

**CU_DEVICE_ATTRIBUTE_HOST_ALLOC_DMA_BUF_SUPPORTED = 146**

Device supports page-locked host memory buffer sharing with dma_buf mechanism.

**CU_DEVICE_ATTRIBUTE_ONLY_PARTIAL_HOST_NATIVE_ATOMIC_SUPPORTED = 147**

Link between the device and the host supports only some native atomic operations

**CU_DEVICE_ATTRIBUTE_ATOMIC_REDUCTION_SUPPORTED = 148**

Device supports atomic reduction operations in stream batch memory operations

**CU_DEVICE_ATTRIBUTE_D3D12_CIG_STREAMS_SUPPORTED = 151**

Device supports CIG streams with D3D12

**CU_DEVICE_ATTRIBUTE_DMA_BUF_MMAP_SUPPORTED = 152**

Device supports mmap() of dmabuf file descriptors for CUDA device memory allocations

**CU_DEVICE_ATTRIBUTE_LOGICAL_ENDPOINT_UNICAST_SUPPORTED = 153**

Device supports unicast logical endpoints

**CU_DEVICE_ATTRIBUTE_LOGICAL_ENDPOINT_MULTICAST_SUPPORTED = 154**

Device supports multicast logical endpoints

**CU_DEVICE_ATTRIBUTE_LOGICAL_ENDPOINT_COUNTED_OPS_SUPPORTED = 155**

Device supports counted operations via logical endpoints

**CU_DEVICE_ATTRIBUTE_LOGICAL_ENDPOINT_UNICAST_ACCESS_ON_OWNER_DEVICE_SUPPOR = 156**

Device supports unicast logical endpoint access on the owner device

**CU_DEVICE_ATTRIBUTE_MAX**

## enum CUdevice_P2PAttribute

P2P Attributes

### Values

**CU_DEVICE_P2P_ATTRIBUTE_PERFORMANCE_RANK = 0x01**
A relative value indicating the performance of the link between two devices

**CU_DEVICE_P2P_ATTRIBUTE_ACCESS_SUPPORTED = 0x02**
P2P Access is enable

**CU_DEVICE_P2P_ATTRIBUTE_NATIVE_ATOMIC_SUPPORTED = 0x03**
All CUDA-valid atomic operation over the link are supported

**CU_DEVICE_P2P_ATTRIBUTE_ACCESS_ACCESS_SUPPORTED = 0x04**
Deprecated use CU_DEVICE_P2P_ATTRIBUTE_CUDA_ARRAY_ACCESS_SUPPORTED instead

**CU_DEVICE_P2P_ATTRIBUTE_CUDA_ARRAY_ACCESS_SUPPORTED = 0x04**
Accessing CUDA arrays over the link supported

**CU_DEVICE_P2P_ATTRIBUTE_ONLY_PARTIAL_NATIVE_ATOMIC_SUPPORTED = 0x05**
Only some CUDA-valid atomic operations over the link are supported.

## enum CUdeviceNumaConfig

CUDA device NUMA configuration

### Values

**CU_DEVICE_NUMA_CONFIG_NONE = 0**
The GPU is not a NUMA node

**CU_DEVICE_NUMA_CONFIG_NUMA_NODE**
The GPU is a NUMA node, CU_DEVICE_ATTRIBUTE_NUMA_ID contains its NUMA ID

## enum CUdriverProcAddress_flags

Flags to specify search options. For more details see cuGetProcAddress

### Values

**CU_GET_PROC_ADDRESS_DEFAULT = 0**
Default search mode for driver symbols.

**CU_GET_PROC_ADDRESS_LEGACY_STREAM = 1<<0**
Search for legacy versions of driver symbols.

**CU_GET_PROC_ADDRESS_PER_THREAD_DEFAULT_STREAM = 1<<1**
Search for per-thread versions of driver symbols.

# enum CUdriverProcAddressQueryResult

Flags to indicate search status. For more details see cuGetProcAddress

## Values

**CU_GET_PROC_ADDRESS_SUCCESS = 0**
Symbol was succesfully found

**CU_GET_PROC_ADDRESS_SYMBOL_NOT_FOUND = 1**
Symbol was not found in search

**CU_GET_PROC_ADDRESS_VERSION_NOT_SUFFICIENT = 2**
Symbol was found but version supplied was not sufficient

# enum CUeglColorFormat

CUDA EGL Color Format - The different planar and multiplanar formats currently supported for CUDA_EGL interops. Three channel formats are currently not supported for CU_EGL_FRAME_TYPE_ARRAY

## Values

**CU_EGL_COLOR_FORMAT_YUV420_PLANAR = 0x00**
Y, U, V in three surfaces, each in a separate surface, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YUV420_SEMIPLANAR = 0x01**
Y, UV in two surfaces (UV as one surface) with VU byte ordering, width, height ratio same as YUV420Planar.

**CU_EGL_COLOR_FORMAT_YUV422_PLANAR = 0x02**
Y, U, V each in a separate surface, U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YUV422_SEMIPLANAR = 0x03**
Y, UV in two surfaces with VU byte ordering, width, height ratio same as YUV422Planar.

**CU_EGL_COLOR_FORMAT_RGB = 0x04**
R/G/B three channels in one surface with BGR byte ordering. Only pitch linear format supported.

**CU_EGL_COLOR_FORMAT_BGR = 0x05**
R/G/B three channels in one surface with RGB byte ordering. Only pitch linear format supported.

**CU_EGL_COLOR_FORMAT_ARGB = 0x06**
R/G/B/A four channels in one surface with BGRA byte ordering.

**CU_EGL_COLOR_FORMAT_RGBA = 0x07**
R/G/B/A four channels in one surface with ABGR byte ordering.

**CU_EGL_COLOR_FORMAT_L = 0x08**
single luminance channel in one surface.

**CU_EGL_COLOR_FORMAT_R = 0x09**
single color channel in one surface.

**CU_EGL_COLOR_FORMAT_YUV444_PLANAR = 0x0A**

Y, U, V in three surfaces, each in a separate surface, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YUV444_SEMIPLANAR = 0x0B**

Y, UV in two surfaces (UV as one surface) with VU byte ordering, width, height ratio same as YUV444Planar.

**CU_EGL_COLOR_FORMAT_YUYV_422 = 0x0C**

Y, U, V in one surface, interleaved as UYVY in one channel.

**CU_EGL_COLOR_FORMAT_UYVY_422 = 0x0D**

Y, U, V in one surface, interleaved as YUYV in one channel.

**CU_EGL_COLOR_FORMAT_ABGR = 0x0E**

R/G/B/A four channels in one surface with RGBA byte ordering.

**CU_EGL_COLOR_FORMAT_BGRA = 0x0F**

R/G/B/A four channels in one surface with ARGB byte ordering.

**CU_EGL_COLOR_FORMAT_A = 0x10**

Alpha color format - one channel in one surface.

**CU_EGL_COLOR_FORMAT_RG = 0x11**

R/G color format - two channels in one surface with GR byte ordering

**CU_EGL_COLOR_FORMAT_AYUV = 0x12**

Y, U, V, A four channels in one surface, interleaved as VUYA.

**CU_EGL_COLOR_FORMAT_YVU444_SEMIPLANAR = 0x13**

Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU422_SEMIPLANAR = 0x14**

Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU420_SEMIPLANAR = 0x15**

Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_444_SEMIPLANAR = 0x16**

Y10, V10U10 in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_420_SEMIPLANAR = 0x17**

Y10, V10U10 in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y12V12U12_444_SEMIPLANAR = 0x18**

Y12, V12U12 in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y12V12U12_420_SEMIPLANAR = 0x19**

Y12, V12U12 in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_VYUY_ER = 0x1A**

Extended Range Y, U, V in one surface, interleaved as YVYU in one channel.

**CU_EGL_COLOR_FORMAT_UYVY_ER = 0x1B**

Extended Range Y, U, V in one surface, interleaved as YUYV in one channel.

**CU_EGL_COLOR_FORMAT_YUYV_ER = 0x1C**
Extended Range Y, U, V in one surface, interleaved as UYVY in one channel.

**CU_EGL_COLOR_FORMAT_YVYU_ER = 0x1D**
Extended Range Y, U, V in one surface, interleaved as VYUY in one channel.

**CU_EGL_COLOR_FORMAT_YUV_ER = 0x1E**
Extended Range Y, U, V three channels in one surface, interleaved as VUY. Only pitch linear format supported.

**CU_EGL_COLOR_FORMAT_YUVA_ER = 0x1F**
Extended Range Y, U, V, A four channels in one surface, interleaved as AVUY.

**CU_EGL_COLOR_FORMAT_AYUV_ER = 0x20**
Extended Range Y, U, V, A four channels in one surface, interleaved as VUYA.

**CU_EGL_COLOR_FORMAT_YUV444_PLANAR_ER = 0x21**
Extended Range Y, U, V in three surfaces, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YUV422_PLANAR_ER = 0x22**
Extended Range Y, U, V in three surfaces, U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YUV420_PLANAR_ER = 0x23**
Extended Range Y, U, V in three surfaces, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YUV444_SEMIPLANAR_ER = 0x24**
Extended Range Y, UV in two surfaces (UV as one surface) with VU byte ordering, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YUV422_SEMIPLANAR_ER = 0x25**
Extended Range Y, UV in two surfaces (UV as one surface) with VU byte ordering, U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YUV420_SEMIPLANAR_ER = 0x26**
Extended Range Y, UV in two surfaces (UV as one surface) with VU byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YVU444_PLANAR_ER = 0x27**
Extended Range Y, V, U in three surfaces, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU422_PLANAR_ER = 0x28**
Extended Range Y, V, U in three surfaces, U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU420_PLANAR_ER = 0x29**
Extended Range Y, V, U in three surfaces, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YVU444_SEMIPLANAR_ER = 0x2A**
Extended Range Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU422_SEMIPLANAR_ER = 0x2B**
Extended Range Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU420_SEMIPLANAR_ER = 0x2C**
Extended Range Y, VU in two surfaces (VU as one surface) with UV byte ordering, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_BAYER_RGGB = 0x2D**
Bayer format - one channel in one surface with interleaved RGGB ordering.

**CU_EGL_COLOR_FORMAT_BAYER_BGGR = 0x2E**
Bayer format - one channel in one surface with interleaved BGGR ordering.

**CU_EGL_COLOR_FORMAT_BAYER_GRBG = 0x2F**
Bayer format - one channel in one surface with interleaved GRBG ordering.

**CU_EGL_COLOR_FORMAT_BAYER_GBRG = 0x30**
Bayer format - one channel in one surface with interleaved GBRG ordering.

**CU_EGL_COLOR_FORMAT_BAYER10_RGGB = 0x31**
Bayer10 format - one channel in one surface with interleaved RGGB ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER10_BGGR = 0x32**
Bayer10 format - one channel in one surface with interleaved BGGR ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER10_GRBG = 0x33**
Bayer10 format - one channel in one surface with interleaved GRBG ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER10_GBRG = 0x34**
Bayer10 format - one channel in one surface with interleaved GBRG ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_RGGB = 0x35**
Bayer12 format - one channel in one surface with interleaved RGGB ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_BGGR = 0x36**
Bayer12 format - one channel in one surface with interleaved BGGR ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_GRBG = 0x37**
Bayer12 format - one channel in one surface with interleaved GRBG ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_GBRG = 0x38**
Bayer12 format - one channel in one surface with interleaved GBRG ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER14_RGGB = 0x39**
Bayer14 format - one channel in one surface with interleaved RGGB ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER14_BGGR = 0x3A**
Bayer14 format - one channel in one surface with interleaved BGGR ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER14_GRBG = 0x3B**
Bayer14 format - one channel in one surface with interleaved GRBG ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER14_GBRG = 0x3C**
Bayer14 format - one channel in one surface with interleaved GBRG ordering. Out of 16 bits, 14 bits used 2 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER20_RGGB = 0x3D**

Bayer20 format - one channel in one surface with interleaved RGGB ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER20_BGGR = 0x3E**

Bayer20 format - one channel in one surface with interleaved BGGR ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER20_GRBG = 0x3F**

Bayer20 format - one channel in one surface with interleaved GRBG ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER20_GBRG = 0x40**

Bayer20 format - one channel in one surface with interleaved GBRG ordering. Out of 32 bits, 20 bits used 12 bits No-op.

**CU_EGL_COLOR_FORMAT_YVU444_PLANAR = 0x41**

Y, V, U in three surfaces, each in a separate surface, U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU422_PLANAR = 0x42**

Y, V, U in three surfaces, each in a separate surface, U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_YVU420_PLANAR = 0x43**

Y, V, U in three surfaces, each in a separate surface, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_BAYER_ISP_RGGB = 0x44**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved RGGB ordering and mapped to opaque integer datatype.

**CU_EGL_COLOR_FORMAT_BAYER_ISP_BGGR = 0x45**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved BGGR ordering and mapped to opaque integer datatype.

**CU_EGL_COLOR_FORMAT_BAYER_ISP_GRBG = 0x46**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved GRBG ordering and mapped to opaque integer datatype.

**CU_EGL_COLOR_FORMAT_BAYER_ISP_GBRG = 0x47**

Nvidia proprietary Bayer ISP format - one channel in one surface with interleaved GBRG ordering and mapped to opaque integer datatype.

**CU_EGL_COLOR_FORMAT_BAYER_BCCR = 0x48**

Bayer format - one channel in one surface with interleaved BCCR ordering.

**CU_EGL_COLOR_FORMAT_BAYER_RCCB = 0x49**

Bayer format - one channel in one surface with interleaved RCCB ordering.

**CU_EGL_COLOR_FORMAT_BAYER_CRBC = 0x4A**

Bayer format - one channel in one surface with interleaved CRBC ordering.

**CU_EGL_COLOR_FORMAT_BAYER_CBRC = 0x4B**

Bayer format - one channel in one surface with interleaved CBRC ordering.

**CU_EGL_COLOR_FORMAT_BAYER10_CCCC = 0x4C**

Bayer10 format - one channel in one surface with interleaved CCCC ordering. Out of 16 bits, 10 bits used 6 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_BCCR = 0x4D**

Bayer12 format - one channel in one surface with interleaved BCCR ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_RCCB = 0x4E**

Bayer12 format - one channel in one surface with interleaved RCCB ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_CRBC = 0x4F**

Bayer12 format - one channel in one surface with interleaved CRBC ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_CBRC = 0x50**

Bayer12 format - one channel in one surface with interleaved CBRC ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_BAYER12_CCCC = 0x51**

Bayer12 format - one channel in one surface with interleaved CCCC ordering. Out of 16 bits, 12 bits used 4 bits No-op.

**CU_EGL_COLOR_FORMAT_Y = 0x52**

Color format for single Y plane.

**CU_EGL_COLOR_FORMAT_YUV420_SEMIPLANAR_2020 = 0x53**

Y, UV in two surfaces (UV as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YVU420_SEMIPLANAR_2020 = 0x54**

Y, VU in two surfaces (VU as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YUV420_PLANAR_2020 = 0x55**

Y, U, V each in a separate surface, U/V width = 1/2 Y width, U/V height= 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YVU420_PLANAR_2020 = 0x56**

Y, V, U each in a separate surface, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YUV420_SEMIPLANAR_709 = 0x57**

Y, UV in two surfaces (UV as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YVU420_SEMIPLANAR_709 = 0x58**

Y, VU in two surfaces (VU as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YUV420_PLANAR_709 = 0x59**

Y, U, V each in a separate surface, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_YVU420_PLANAR_709 = 0x5A**

Y, V, U each in a separate surface, U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_420_SEMIPLANAR_709 = 0x5B**

Y10, V10U10 in two surfaces (VU as one surface), U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_420_SEMIPLANAR_2020 = 0x5C**

Y10, V10U10 in two surfaces (VU as one surface), U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_422_SEMIPLANAR_2020 = 0x5D**

Y10, V10U10 in two surfaces(VU as one surface) U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_422_SEMIPLANAR = 0x5E**

Y10, V10U10 in two surfaces(VU as one surface) U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_422_SEMIPLANAR_709 = 0x5F**

Y10, V10U10 in two surfaces(VU as one surface) U/V width = 1/2 Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y_ER = 0x60**

Extended Range Color format for single Y plane.

**CU_EGL_COLOR_FORMAT_Y_709_ER = 0x61**

Extended Range Color format for single Y plane.

**CU_EGL_COLOR_FORMAT_Y10_ER = 0x62**

Extended Range Color format for single Y10 plane.

**CU_EGL_COLOR_FORMAT_Y10_709_ER = 0x63**

Extended Range Color format for single Y10 plane.

**CU_EGL_COLOR_FORMAT_Y12_ER = 0x64**

Extended Range Color format for single Y12 plane.

**CU_EGL_COLOR_FORMAT_Y12_709_ER = 0x65**

Extended Range Color format for single Y12 plane.

**CU_EGL_COLOR_FORMAT_YUVA = 0x66**

Y, U, V, A four channels in one surface, interleaved as AVUY.

**CU_EGL_COLOR_FORMAT_YUV = 0x67**

Y, U, V three channels in one surface, interleaved as VUY. Only pitch linear format supported.

**CU_EGL_COLOR_FORMAT_YVYU = 0x68**

Y, U, V in one surface, interleaved as YVYU in one channel.

**CU_EGL_COLOR_FORMAT_VYUY = 0x69**

Y, U, V in one surface, interleaved as VYUY in one channel.

**CU_EGL_COLOR_FORMAT_Y10V10U10_420_SEMIPLANAR_ER = 0x6A**

Extended Range Y10, V10U10 in two surfaces(VU as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_420_SEMIPLANAR_709_ER = 0x6B**

Extended Range Y10, V10U10 in two surfaces(VU as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_444_SEMIPLANAR_ER = 0x6C**

Extended Range Y10, V10U10 in two surfaces (VU as one surface) U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y10V10U10_444_SEMIPLANAR_709_ER = 0x6D**

Extended Range Y10, V10U10 in two surfaces (VU as one surface) U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y12V12U12_420_SEMIPLANAR_ER = 0x6E**

Extended Range Y12, V12U12 in two surfaces (VU as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y12V12U12_420_SEMIPLANAR_709_ER = 0x6F**

Extended Range Y12, V12U12 in two surfaces (VU as one surface) U/V width = 1/2 Y width, U/V height = 1/2 Y height.

**CU_EGL_COLOR_FORMAT_Y12V12U12_444_SEMIPLANAR_ER = 0x70**

Extended Range Y12, V12U12 in two surfaces (VU as one surface) U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_Y12V12U12_444_SEMIPLANAR_709_ER = 0x71**

Extended Range Y12, V12U12 in two surfaces (VU as one surface) U/V width = Y width, U/V height = Y height.

**CU_EGL_COLOR_FORMAT_UYVY_709 = 0x72**

Y, U, V in one surface, interleaved as UYVY in one channel.

**CU_EGL_COLOR_FORMAT_UYVY_709_ER = 0x73**

Extended Range Y, U, V in one surface, interleaved as UYVY in one channel.

**CU_EGL_COLOR_FORMAT_UYVY_2020 = 0x74**

Y, U, V in one surface, interleaved as UYVY in one channel.

**CU_EGL_COLOR_FORMAT_MAX**

# enum CUeglFrameType

CUDA EglFrame type - array or pointer

## Values

**CU_EGL_FRAME_TYPE_ARRAY = 0**

Frame type CUDA array

**CU_EGL_FRAME_TYPE_PITCH = 1**

Frame type pointer

# enum CUeglResourceLocationFlags

Resource location flags- sysmem or vidmem

For CUDA context on iGPU, since video and system memory are equivalent - these flags will not have an effect on the execution.

For CUDA context on dGPU, applications can use the flag CUeglResourceLocationFlags to give a hint about the desired location.

CU_EGL_RESOURCE_LOCATION_SYSMEM - the frame data is made resident on the system memory to be accessed by CUDA.

CU_EGL_RESOURCE_LOCATION_VIDMEM - the frame data is made resident on the dedicated video memory to be accessed by CUDA.

There may be an additional latency due to new allocation and data migration, if the frame is produced on a different memory.

## Values

**CU_EGL_RESOURCE_LOCATION_SYSMEM = 0x00**

Resource location sysmem

**CU_EGL_RESOURCE_LOCATION_VIDMEM = 0x01**

Resource location vidmem

## enum CUevent_flags

Event creation flags

### Values

**CU_EVENT_DEFAULT = 0x0**
Default event flag
**CU_EVENT_BLOCKING_SYNC = 0x1**
Event uses blocking synchronization
**CU_EVENT_DISABLE_TIMING = 0x2**
Event will not record timing data
**CU_EVENT_INTERPROCESS = 0x4**
Event is suitable for interprocess use. CU_EVENT_DISABLE_TIMING must be set

## enum CUevent_record_flags

Event record flags

### Values

**CU_EVENT_RECORD_DEFAULT = 0x0**
Default event record flag
**CU_EVENT_RECORD_EXTERNAL = 0x1**
When using stream capture, create an event record node instead of the default behavior. This flag is invalid when used outside of capture.

## enum CUevent_sched_flags

Event sched flags

### Values

**CU_EVENT_SCHED_AUTO = 0x00**
Automatic scheduling
**CU_EVENT_SCHED_SPIN = 0x01**
Set spin as default scheduling
**CU_EVENT_SCHED_YIELD = 0x02**
Set yield as default scheduling
**CU_EVENT_SCHED_BLOCKING_SYNC = 0x04**
Set blocking synchronization as default scheduling

## enum CUevent_wait_flags

Event wait flags

### Values

**CU_EVENT_WAIT_DEFAULT = 0x0**
Default event wait flag

**CU_EVENT_WAIT_EXTERNAL = 0x1**
When using stream capture, create an event wait node instead of the default behavior. This flag is invalid when used outside of capture.

## enum CUexecAffinityType

Execution Affinity Types

### Values

**CU_EXEC_AFFINITY_TYPE_SM_COUNT = 0**
Create a context with limited SMs.

**CU_EXEC_AFFINITY_TYPE_MAX**

## enum CUexternalMemoryHandleType

External memory handle types

### Values

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_FD = 1**
Handle is an opaque file descriptor

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32 = 2**
Handle is an opaque shared NT handle

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32_KMT = 3**
Handle is an opaque, globally shared handle

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_HEAP = 4**
Handle is a D3D12 heap object

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE = 5**
Handle is a D3D12 committed resource

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE = 6**
Handle is a shared NT handle to a D3D11 resource

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT = 7**
Handle is a globally shared handle to a D3D11 resource

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF = 8**
Handle is an NvSciBuf object

**CU_EXTERNAL_MEMORY_HANDLE_TYPE_DMABUF_FD = 9**
Handle is a dma_buf file descriptor

## enum CUexternalSemaphoreHandleType

External semaphore handle types

### Values

**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD = 1**
Handle is an opaque file descriptor
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32 = 2**
Handle is an opaque shared NT handle
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT = 3**
Handle is an opaque, globally shared handle
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE = 4**
Handle is a shared NT handle referencing a D3D12 fence object
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE = 5**
Handle is a shared NT handle referencing a D3D11 fence object
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC = 6**
Opaque handle to NvSciSync Object
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX = 7**
Handle is a shared NT handle referencing a D3D11 keyed mutex object
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT = 8**
Handle is a globally shared handle referencing a D3D11 keyed mutex object
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_FD = 9**
Handle is an opaque file descriptor referencing a timeline semaphore
**CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_WIN32 = 10**
Handle is an opaque shared NT handle referencing a timeline semaphore

## enum CUfilter_mode

Texture reference filtering modes

### Values

**CU_TR_FILTER_MODE_POINT = 0**
Point filter mode
**CU_TR_FILTER_MODE_LINEAR = 1**
Linear filter mode

## enum CUflushGPUDirectRDMAWritesOptions

Bitmasks for CU_DEVICE_ATTRIBUTE_GPU_DIRECT_RDMA_FLUSH_WRITES_OPTIONS

### Values

**CU_FLUSH_GPU_DIRECT_RDMA_WRITES_OPTION_HOST = 1<<0**

cuFlushGPUDirectRDMAWrites() and its CUDA Runtime API counterpart are supported on the device.

**CU_FLUSH_GPU_DIRECT_RDMA_WRITES_OPTION_MEMOPS = 1<<1**

The CU_STREAM_WAIT_VALUE_FLUSH flag and the CU_STREAM_MEM_OP_FLUSH_REMOTE_WRITES MemOp are supported on the device.

## enum CUflushGPUDirectRDMAWritesScope

The scopes for cuFlushGPUDirectRDMAWrites

### Values

**CU_FLUSH_GPU_DIRECT_RDMA_WRITES_TO_OWNER = 100**

Blocks until remote writes are visible to the CUDA device context owning the data.

**CU_FLUSH_GPU_DIRECT_RDMA_WRITES_TO_ALL_DEVICES = 200**

Blocks until remote writes are visible to all CUDA device contexts.

## enum CUflushGPUDirectRDMAWritesTarget

The targets for cuFlushGPUDirectRDMAWrites

### Values

**CU_FLUSH_GPU_DIRECT_RDMA_WRITES_TARGET_CURRENT_CTX = 0**

Sets the target for cuFlushGPUDirectRDMAWrites() to the currently active CUDA device context.

## enum CUfunc_cache

Function cache configurations

### Values

**CU_FUNC_CACHE_PREFER_NONE = 0x00**

no preference for shared memory or L1 (default)

**CU_FUNC_CACHE_PREFER_SHARED = 0x01**

prefer larger shared memory and smaller L1 cache

**CU_FUNC_CACHE_PREFER_L1 = 0x02**

prefer larger L1 cache and smaller shared memory

**CU_FUNC_CACHE_PREFER_EQUAL = 0x03**

prefer equal sized L1 cache and shared memory

## enum CUfunction_attribute

Function properties

## Values

**CU_FUNC_ATTRIBUTE_MAX_THREADS_PER_BLOCK = 0**
The maximum number of threads per block, beyond which a launch of the function would fail. This number depends on both the function and the device on which the function is currently loaded.

**CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES = 1**
The size in bytes of statically-allocated shared memory required by this function. This does not include dynamically-allocated shared memory requested by the user at runtime.

**CU_FUNC_ATTRIBUTE_CONST_SIZE_BYTES = 2**
The size in bytes of user-allocated constant memory required by this function.

**CU_FUNC_ATTRIBUTE_LOCAL_SIZE_BYTES = 3**
The size in bytes of local memory used by each thread of this function.

**CU_FUNC_ATTRIBUTE_NUM_REGS = 4**
The number of registers used by each thread of this function.

**CU_FUNC_ATTRIBUTE_PTX_VERSION = 5**
The PTX virtual architecture version for which the function was compiled. This value is the major PTX version * 10 + the minor PTX version, so a PTX version 1.3 function would return the value 13. Note that this may return the undefined value of 0 for cubins compiled prior to CUDA 3.0.

**CU_FUNC_ATTRIBUTE_BINARY_VERSION = 6**
The binary architecture version for which the function was compiled. This value is the major binary version * 10 + the minor binary version, so a binary version 1.3 function would return the value 13. Note that this will return a value of 10 for legacy cubins that do not have a properly-encoded binary architecture version.

**CU_FUNC_ATTRIBUTE_CACHE_MODE_CA = 7**
The attribute to indicate whether the function has been compiled with user specified option "-Xptxas --dlcm=ca" set .

**CU_FUNC_ATTRIBUTE_MAX_DYNAMIC_SHARED_SIZE_BYTES = 8**
The maximum size in bytes of dynamically-allocated shared memory that can be used by this function. If the user-specified dynamic shared memory size is larger than this value, the launch will fail. The default value of this attribute is CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK - CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES, except when CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES is greater than CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK, then the default value of this attribute is 0. The value can be increased to CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK_OPTIN - CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT = 9**
On devices where the L1 cache and shared memory use the same hardware resources, this sets the shared memory carveout preference, in percent of the total shared memory. Refer to CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_MULTIPROCESSOR. This

is only a hint, and the driver can choose a different ratio if required to execute the function. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_CLUSTER_SIZE_MUST_BE_SET = 10**

If this attribute is set, the kernel must launch with a valid cluster size specified. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_WIDTH = 11**

The required cluster width in blocks. The values must either all be 0 or all be positive. The validity of the cluster dimensions is otherwise checked at launch time.If the value is set during compile time, it cannot be set at runtime. Setting it at runtime will return CUDA_ERROR_NOT_PERMITTED. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_HEIGHT = 12**

The required cluster height in blocks. The values must either all be 0 or all be positive. The validity of the cluster dimensions is otherwise checked at launch time.If the value is set during compile time, it cannot be set at runtime. Setting it at runtime should return CUDA_ERROR_NOT_PERMITTED. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_DEPTH = 13**

The required cluster depth in blocks. The values must either all be 0 or all be positive. The validity of the cluster dimensions is otherwise checked at launch time.If the value is set during compile time, it cannot be set at runtime. Setting it at runtime should return CUDA_ERROR_NOT_PERMITTED. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_NON_PORTABLE_CLUSTER_SIZE_ALLOWED = 14**

Whether the function can be launched with non-portable cluster size. 1 is allowed, 0 is disallowed. A non-portable cluster size may only function on the specific SKUs the program is tested on. The launch might fail if the program is run on a different hardware platform.CUDA API provides cudaOccupancyMaxActiveClusters to assist with checking whether the desired size can be launched on the current device.Portable Cluster SizeA portable cluster size is guaranteed to be functional on all compute capabilities higher than the target compute capability. The portable cluster size for sm_90 is 8 blocks per cluster. This value may increase for future compute capabilities.The specific hardware unit may support higher cluster sizes that’s not guaranteed to be portable. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE = 15**

The block scheduling policy of a function. The value type is CUclusterSchedulingPolicy / cudaClusterSchedulingPolicy. See cuFuncSetAttribute, cuKernelSetAttribute

**CU_FUNC_ATTRIBUTE_DEVICE_NODE_UPDATE_SUPPORTED = 16**

Whether the function can be updated on device. 1 means device node update is supported, 0 is unsupported. See cuFuncGetAttribute.

**CU_FUNC_ATTRIBUTE_MAX**

## enum CUGPUDirectRDMAWritesOrdering

Platform native ordering for GPUDirect RDMA writes

### Values

**CU_GPU_DIRECT_RDMA_WRITES_ORDERING_NONE = 0**
The device does not natively support ordering of remote writes. cuFlushGPUDirectRDMAWrites() can be leveraged if supported.

**CU_GPU_DIRECT_RDMA_WRITES_ORDERING_OWNER = 100**
Natively, the device can consistently consume remote writes, although other CUDA devices may not.

**CU_GPU_DIRECT_RDMA_WRITES_ORDERING_ALL_DEVICES = 200**
Any CUDA device in the system can consistently consume remote writes to this device.

## enum CUgraphChildGraphNodeOwnership

Child graph node ownership

### Values

**CU_GRAPH_CHILD_GRAPH_OWNERSHIP_CLONE = 0**
Default behavior for a child graph node. Child graph is cloned into the parent and memory allocation/free nodes can't be present in the child graph.

**CU_GRAPH_CHILD_GRAPH_OWNERSHIP_MOVE = 1**
The child graph is moved to the parent. The handle to the child graph is owned by the parent and will be destroyed when the parent is destroyed.The following restrictions apply to child graphs after they have been moved: Cannot be independently instantiated or destroyed; Cannot be added as a child graph of a separate parent graph; Cannot be used as an argument to cuGraphExecUpdate; Cannot have additional memory allocation or free nodes added.

**CU_GRAPH_CHILD_GRAPH_OWNERSHIP_INVALID = -1**
Invalid ownership flag. Set when params are queried to prevent accidentally reusing the driver-owned graph object

## enum CUgraphConditionalNodeType

Conditional node types

### Values

**CU_GRAPH_COND_TYPE_IF = 0**
Conditional 'if/else' Node. Body[0] executed if condition is non-zero. If `size` == 2, an optional ELSE graph is created and this is executed if the condition is zero.

**CU_GRAPH_COND_TYPE_WHILE = 1**
Conditional 'while' Node. Body executed repeatedly while condition value is non-zero.

**CU_GRAPH_COND_TYPE_SWITCH = 2**
Conditional 'switch' Node. Body[n] is executed once, where 'n' is the value of the condition. If the condition does not match a body index, no body is launched.

# enum CUgraphDebugDot_flags

The additional write options for cuGraphDebugDotPrint

## Values

**CU_GRAPH_DEBUG_DOT_FLAGS_VERBOSE = 1<<0**
Output all debug data as if every debug flag is enabled

**CU_GRAPH_DEBUG_DOT_FLAGS_RUNTIME_TYPES = 1<<1**
Use CUDA Runtime structures for output

**CU_GRAPH_DEBUG_DOT_FLAGS_KERNEL_NODE_PARAMS = 1<<2**
Adds CUDA_KERNEL_NODE_PARAMS values to output

**CU_GRAPH_DEBUG_DOT_FLAGS_MEMCPY_NODE_PARAMS = 1<<3**
Adds CUDA_MEMCPY3D values to output

**CU_GRAPH_DEBUG_DOT_FLAGS_MEMSET_NODE_PARAMS = 1<<4**
Adds CUDA_MEMSET_NODE_PARAMS values to output

**CU_GRAPH_DEBUG_DOT_FLAGS_HOST_NODE_PARAMS = 1<<5**
Adds CUDA_HOST_NODE_PARAMS values to output

**CU_GRAPH_DEBUG_DOT_FLAGS_EVENT_NODE_PARAMS = 1<<6**
Adds CUevent handle from record and wait nodes to output

**CU_GRAPH_DEBUG_DOT_FLAGS_EXT_SEMAS_SIGNAL_NODE_PARAMS = 1<<7**
Adds CUDA_EXT_SEM_SIGNAL_NODE_PARAMS values to output

**CU_GRAPH_DEBUG_DOT_FLAGS_EXT_SEMAS_WAIT_NODE_PARAMS = 1<<8**
Adds CUDA_EXT_SEM_WAIT_NODE_PARAMS values to output

**CU_GRAPH_DEBUG_DOT_FLAGS_KERNEL_NODE_ATTRIBUTES = 1<<9**
Adds CUkernelNodeAttrValue values to output

**CU_GRAPH_DEBUG_DOT_FLAGS_HANDLES = 1<<10**
Adds node handles and every kernel function handle to output

**CU_GRAPH_DEBUG_DOT_FLAGS_MEM_ALLOC_NODE_PARAMS = 1<<11**
Adds memory alloc node parameters to output

**CU_GRAPH_DEBUG_DOT_FLAGS_MEM_FREE_NODE_PARAMS = 1<<12**
Adds memory free node parameters to output

**CU_GRAPH_DEBUG_DOT_FLAGS_BATCH_MEM_OP_NODE_PARAMS = 1<<13**
Adds batch mem op node parameters to output

**CU_GRAPH_DEBUG_DOT_FLAGS_EXTRA_TOPO_INFO = 1<<14**
Adds edge numbering information

**CU_GRAPH_DEBUG_DOT_FLAGS_CONDITIONAL_NODE_PARAMS = 1<<15**
Adds conditional node parameters to output

# enum CUgraphDependencyType

Type annotations that can be applied to graph edges as part of CUgraphEdgeData.

### Values

**CU_GRAPH_DEPENDENCY_TYPE_DEFAULT = 0**
This is an ordinary dependency.
**CU_GRAPH_DEPENDENCY_TYPE_PROGRAMMATIC = 1**
This dependency type allows the downstream node to use `cudaGridDependencySynchronize()`. It may only be used between kernel nodes, and must be used with either the CU_GRAPH_KERNEL_NODE_PORT_PROGRAMMATIC or CU_GRAPH_KERNEL_NODE_PORT_LAUNCH_ORDER outgoing port.

## enum CUgraphExecUpdateResult

CUDA Graph Update error types

### Values

**CU_GRAPH_EXEC_UPDATE_SUCCESS = 0x0**
The update succeeded
**CU_GRAPH_EXEC_UPDATE_ERROR = 0x1**
The update failed for an unexpected reason which is described in the return value of the function
**CU_GRAPH_EXEC_UPDATE_ERROR_TOPOLOGY_CHANGED = 0x2**
The update failed because the topology changed
**CU_GRAPH_EXEC_UPDATE_ERROR_NODE_TYPE_CHANGED = 0x3**
The update failed because a node type changed
**CU_GRAPH_EXEC_UPDATE_ERROR_FUNCTION_CHANGED = 0x4**
The update failed because the function of a kernel node changed (CUDA driver < 11.2)
**CU_GRAPH_EXEC_UPDATE_ERROR_PARAMETERS_CHANGED = 0x5**
The update failed because the parameters changed in a way that is not supported
**CU_GRAPH_EXEC_UPDATE_ERROR_NOT_SUPPORTED = 0x6**
The update failed because something about the node is not supported
**CU_GRAPH_EXEC_UPDATE_ERROR_UNSUPPORTED_FUNCTION_CHANGE = 0x7**
The update failed because the function of a kernel node changed in an unsupported way
**CU_GRAPH_EXEC_UPDATE_ERROR_ATTRIBUTES_CHANGED = 0x8**
The update failed because the node attributes changed in a way that is not supported

## enum CUgraphicsMapResourceFlags

Flags for mapping and unmapping interop resources

### Values

**CU_GRAPHICS_MAP_RESOURCE_FLAGS_NONE = 0x00**
**CU_GRAPHICS_MAP_RESOURCE_FLAGS_READ_ONLY = 0x01**
**CU_GRAPHICS_MAP_RESOURCE_FLAGS_WRITE_DISCARD = 0x02**

# enum CUgraphicsRegisterFlags

Flags to register a graphics resource

## Values

**CU_GRAPHICS_REGISTER_FLAGS_NONE = 0x00**
**CU_GRAPHICS_REGISTER_FLAGS_READ_ONLY = 0x01**
**CU_GRAPHICS_REGISTER_FLAGS_WRITE_DISCARD = 0x02**
**CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST = 0x04**
**CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER = 0x08**

# enum CUgraphInstantiate_flags

Flags for instantiating a graph

## Values

**CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH = 1**
Automatically free memory allocated in a graph before relaunching.
**CUDA_GRAPH_INSTANTIATE_FLAG_UPLOAD = 2**
Automatically upload the graph after instantiation. Only supported by cuGraphInstantiateWithParams. The upload will be performed using the stream provided in `instantiateParams`.
**CUDA_GRAPH_INSTANTIATE_FLAG_DEVICE_LAUNCH = 4**
Instantiate the graph to be launchable from the device. This flag can only be used on platforms which support unified addressing. This flag cannot be used in conjunction with CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH.
**CUDA_GRAPH_INSTANTIATE_FLAG_USE_NODE_PRIORITY = 8**
Run the graph using the per-node priority attributes rather than the priority of the stream it is launched into.

# enum CUgraphInstantiateResult

Graph instantiation results

## Values

**CUDA_GRAPH_INSTANTIATE_SUCCESS = 0**
Instantiation succeeded
**CUDA_GRAPH_INSTANTIATE_ERROR = 1**
Instantiation failed for an unexpected reason which is described in the return value of the function
**CUDA_GRAPH_INSTANTIATE_INVALID_STRUCTURE = 2**
Instantiation failed due to invalid structure, such as cycles
**CUDA_GRAPH_INSTANTIATE_NODE_OPERATION_NOT_SUPPORTED = 3**

Instantiation for device launch failed because the graph contained an unsupported operation

**CUDA_GRAPH_INSTANTIATE_MULTIPLE_CTXS_NOT_SUPPORTED = 4**

Instantiation for device launch failed due to the nodes belonging to different contexts

**CUDA_GRAPH_INSTANTIATE_CONDITIONAL_HANDLE_UNUSED = 5**

One or more conditional handles are not associated with conditional nodes

## enum CUgraphNodeType

Graph node types

### Values

**CU_GRAPH_NODE_TYPE_KERNEL = 0**

GPU kernel node

**CU_GRAPH_NODE_TYPE_MEMCPY = 1**

Memcpy node

**CU_GRAPH_NODE_TYPE_MEMSET = 2**

Memset node

**CU_GRAPH_NODE_TYPE_HOST = 3**

Host (executable) node

**CU_GRAPH_NODE_TYPE_GRAPH = 4**

Node which executes an embedded graph

**CU_GRAPH_NODE_TYPE_EMPTY = 5**

Empty (no-op) node

**CU_GRAPH_NODE_TYPE_WAIT_EVENT = 6**

External event wait node

**CU_GRAPH_NODE_TYPE_EVENT_RECORD = 7**

External event record node

**CU_GRAPH_NODE_TYPE_EXT_SEMAS_SIGNAL = 8**

External semaphore signal node

**CU_GRAPH_NODE_TYPE_EXT_SEMAS_WAIT = 9**

External semaphore wait node

**CU_GRAPH_NODE_TYPE_MEM_ALLOC = 10**

Memory Allocation Node

**CU_GRAPH_NODE_TYPE_MEM_FREE = 11**

Memory Free Node

**CU_GRAPH_NODE_TYPE_BATCH_MEM_OP = 12**

Batch MemOp Node See cuStreamBatchMemOp and CUstreamBatchMemOpType for what these nodes can do.

**CU_GRAPH_NODE_TYPE_CONDITIONAL = 13**

Conditional NodeMay be used to implement a conditional execution path or loop inside of a graph. The graph(s) contained within the body of the conditional node can be selectively executed or iterated upon based on the value of a conditional variable.Handles must be created in advance of creating the node using cuGraphConditionalHandleCreate.The following restrictions apply to graphs

which contain conditional nodes: The graph cannot be used in a child node. Only one instantiation of the graph may exist at any point in time. The graph cannot be cloned.To set the control value, supply a default value when creating the handle and/or call cudaGraphSetConditional from device code.

**CU_GRAPH_NODE_TYPE_RESERVED_16 = 16**
Reserved

# enum CUipcMem_flags

CUDA Ipc Mem Flags

## Values

**CU_IPC_MEM_LAZY_ENABLE_PEER_ACCESS = 0x1**
Automatically enable peer access between remote devices as needed

# enum CUjit_cacheMode

Caching modes for dlcm

## Values

**CU_JIT_CACHE_OPTION_NONE = 0**
Compile with no -dlcm flag specified

**CU_JIT_CACHE_OPTION_CG**
Compile with L1 cache disabled

**CU_JIT_CACHE_OPTION_CA**
Compile with L1 cache enabled

# enum CUjit_fallback

Cubin matching fallback strategies

## Values

**CU_PREFER_PTX = 0**
Prefer to compile ptx if exact binary match not found

**CU_PREFER_BINARY**
Prefer to fall back to compatible binary code if exact match not found

# enum CUjit_option

Online compiler and linker options

## Values

**CU_JIT_MAX_REGISTERS = 0**

Max number of registers that a thread may use. Option type: unsigned int Applies to: compiler only

**CU_JIT_THREADS_PER_BLOCK = 1**

IN: Specifies minimum number of threads per block to target compilation for OUT: Returns the number of threads the compiler actually targeted. This restricts the resource utilization of the compiler (e.g. max registers) such that a block with the given number of threads should be able to launch based on register limitations. Note, this option does not currently take into account any other resource limitations, such as shared memory utilization. Cannot be combined with CU_JIT_TARGET. Option type: unsigned int Applies to: compiler only

**CU_JIT_WALL_TIME = 2**

Overwrites the option value with the total wall clock time, in milliseconds, spent in the compiler and linker Option type: float Applies to: compiler and linker

**CU_JIT_INFO_LOG_BUFFER = 3**

Pointer to a buffer in which to print any log messages that are informational in nature (the buffer size is specified via option CU_JIT_INFO_LOG_BUFFER_SIZE_BYTES) Option type: char * Applies to: compiler and linker

**CU_JIT_INFO_LOG_BUFFER_SIZE_BYTES = 4**

IN: Log buffer size in bytes. Log messages will be capped at this size (including null terminator) OUT: Amount of log buffer filled with messages Option type: unsigned int Applies to: compiler and linker

**CU_JIT_ERROR_LOG_BUFFER = 5**

Pointer to a buffer in which to print any log messages that reflect errors (the buffer size is specified via option CU_JIT_ERROR_LOG_BUFFER_SIZE_BYTES) Option type: char * Applies to: compiler and linker

**CU_JIT_ERROR_LOG_BUFFER_SIZE_BYTES = 6**

IN: Log buffer size in bytes. Log messages will be capped at this size (including null terminator) OUT: Amount of log buffer filled with messages Option type: unsigned int Applies to: compiler and linker

**CU_JIT_OPTIMIZATION_LEVEL = 7**

Level of optimizations to apply to generated code (0 - 4), with 4 being the default and highest level of optimizations. Option type: unsigned int Applies to: compiler only

**CU_JIT_TARGET_FROM_CUCONTEXT = 8**

No option value required. Determines the target based on the current attached context (default) Option type: No option value needed Applies to: compiler and linker

**CU_JIT_TARGET = 9**

Target is chosen based on supplied CUjit_target. Cannot be combined with CU_JIT_THREADS_PER_BLOCK. Option type: unsigned int for enumerated type CUjit_target Applies to: compiler and linker

**CU_JIT_FALLBACK_STRATEGY = 10**

Specifies choice of fallback strategy if matching cubin is not found. Choice is based on supplied CUjit_fallback. This option cannot be used with cuLink* APIs as the linker requires exact matches. Option type: unsigned int for enumerated type CUjit_fallback Applies to: compiler only

**CU_JIT_GENERATE_DEBUG_INFO = 11**

Specifies whether to create debug information in output (-g) (0: false, default) Option type: int Applies to: compiler and linker

**CU_JIT_LOG_VERBOSE = 12**

Generate verbose log messages (0: false, default) Option type: int Applies to: compiler and linker

**CU_JIT_GENERATE_LINE_INFO = 13**

Generate line number information (-lineinfo) (0: false, default) Option type: int Applies to: compiler only

**CU_JIT_CACHE_MODE = 14**

Specifies whether to enable caching explicitly (-dlcm) Choice is based on supplied CUjit_cacheMode_enum. Option type: unsigned int for enumerated type CUjit_cacheMode_enum Applies to: compiler only

**CU_JIT_NEW_SM3X_OPT = 15**

Deprecated This jit option is deprecated and should not be used.

**CU_JIT_FAST_COMPILE = 16**

This jit option is used for internal purpose only.

**CU_JIT_GLOBAL_SYMBOL_NAMES = 17**

Array of device symbol names that will be relocated to the corresponding host addresses stored in CU_JIT_GLOBAL_SYMBOL_ADDRESSES. Must contain CU_JIT_GLOBAL_SYMBOL_COUNT entries. When loading a device module, driver will relocate all encountered unresolved symbols to the host addresses. It is only allowed to register symbols that correspond to unresolved global variables. It is illegal to register the same device symbol at multiple addresses. Option type: const char ** Applies to: dynamic linker only

**CU_JIT_GLOBAL_SYMBOL_ADDRESSES = 18**

Array of host addresses that will be used to relocate corresponding device symbols stored in CU_JIT_GLOBAL_SYMBOL_NAMES. Must contain CU_JIT_GLOBAL_SYMBOL_COUNT entries. Option type: void ** Applies to: dynamic linker only

**CU_JIT_GLOBAL_SYMBOL_COUNT = 19**

Number of entries in CU_JIT_GLOBAL_SYMBOL_NAMES and CU_JIT_GLOBAL_SYMBOL_ADDRESSES arrays. Option type: unsigned int Applies to: dynamic linker only

**CU_JIT_LTO = 20**

Deprecated Enable link-time optimization (-dlto) for device code (Disabled by default). This option is not supported on 32-bit platforms. Option type: int Applies to: compiler and linker Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_FTZ = 21**

Deprecated Control single-precision denormals (-ftz) support (0: false, default). 1 : flushes denormal values to zero 0 : preserves denormal values Option type: int Applies to: link-time optimization specified with CU_JIT_LTO Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_PREC_DIV = 22**

Deprecated Control single-precision floating-point division and reciprocals (-prec-div) support (1: true, default). 1 : Enables the IEEE round-to-nearest mode 0 : Enables the fast approximation mode Option type: int Applies to: link-time optimization specified with CU_JIT_LTO Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_PREC_SQRT = 23**

Deprecated Control single-precision floating-point square root (-prec-sqrt) support (1: true, default). 1 : Enables the IEEE round-to-nearest mode 0 : Enables the fast approximation mode Option type: int Applies to: link-time optimization specified with CU_JIT_LTO Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_FMA = 24**

Deprecated Enable/Disable the contraction of floating-point multiplies and adds/subtracts into floating-point multiply-add (-fma) operations (1: Enable, default; 0: Disable). Option type: int Applies to: link-time optimization specified with CU_JIT_LTO Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_REFERENCED_KERNEL_NAMES = 25**

Deprecated Array of kernel names that should be preserved at link time while others can be removed. Must contain CU_JIT_REFERENCED_KERNEL_COUNT entries. Note that kernel names can be mangled by the compiler in which case the mangled name needs to be specified. Wildcard "*" can be used to represent zero or more characters instead of specifying the full or mangled name. It is important to note that the wildcard "*" is also added implicitly. For example, specifying "foo" will match "foobaz", "barfoo", "barfoobaz" and thus preserve all kernels with those names. This can be avoided by providing a more specific name like "barfoobaz". Option type: const char ** Applies to: dynamic linker only Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_REFERENCED_KERNEL_COUNT = 26**

Deprecated Number of entries in CU_JIT_REFERENCED_KERNEL_NAMES array. Option type: unsigned int Applies to: dynamic linker only Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_REFERENCED_VARIABLE_NAMES = 27**

Deprecated Array of variable names (__device__ and/or __constant__) that should be preserved at link time while others can be removed. Must contain CU_JIT_REFERENCED_VARIABLE_COUNT entries. Note that variable names can be mangled by the compiler in which case the mangled name needs to be specified. Wildcard "*" can be used to represent zero or more characters instead of specifying the full or mangled name. It is important to note that the wildcard "*" is also added implicitly. For example, specifying "foo" will match "foobaz", "barfoo", "barfoobaz" and thus preserve all variables with those names. This can be avoided by providing a more specific name like "barfoobaz". Option type: const char ** Applies to: link-time optimization specified with CU_JIT_LTO Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_REFERENCED_VARIABLE_COUNT = 28**

Deprecated Number of entries in CU_JIT_REFERENCED_VARIABLE_NAMES array. Option type: unsigned int Applies to: link-time optimization specified with CU_JIT_LTO Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_OPTIMIZE_UNUSED_DEVICE_VARIABLES = 29**

Deprecated This option serves as a hint to enable the JIT compiler/linker to remove constant (__constant__) and device (__device__) variables unreferenced in device code (Disabled by default). Note that host references to constant and device variables using APIs like

cuModuleGetGlobal() with this option specified may result in undefined behavior unless the variables are explicitly specified using CU_JIT_REFERENCED_VARIABLE_NAMES. Option type: int Applies to: link-time optimization specified with CU_JIT_LTO Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_POSITION_INDEPENDENT_CODE = 30**

Generate position independent code (0: false) Option type: int Applies to: compiler only

**CU_JIT_MIN_CTA_PER_SM = 31**

This option hints to the JIT compiler the minimum number of CTAs from the kernel's grid to be mapped to a SM. This option is ignored when used together with CU_JIT_MAX_REGISTERS or CU_JIT_THREADS_PER_BLOCK. Optimizations based on this option need CU_JIT_MAX_THREADS_PER_BLOCK to be specified as well. For kernels already using PTX directive .minnctapersm, this option will be ignored by default. Use CU_JIT_OVERRIDE_DIRECTIVE_VALUES to let this option take precedence over the PTX directive. Option type: unsigned int Applies to: compiler only

**CU_JIT_MAX_THREADS_PER_BLOCK = 32**

Maximum number threads in a thread block, computed as the product of the maximum extent specifed for each dimension of the block. This limit is guaranteed not to be exeeded in any invocation of the kernel. Exceeding the the maximum number of threads results in runtime error or kernel launch failure. For kernels already using PTX directive .maxntid, this option will be ignored by default. Use CU_JIT_OVERRIDE_DIRECTIVE_VALUES to let this option take precedence over the PTX directive. Option type: int Applies to: compiler only

**CU_JIT_OVERRIDE_DIRECTIVE_VALUES = 33**

This option lets the values specified using CU_JIT_MAX_REGISTERS, CU_JIT_THREADS_PER_BLOCK, CU_JIT_MAX_THREADS_PER_BLOCK and CU_JIT_MIN_CTA_PER_SM take precedence over any PTX directives. (0: Disable, default; 1: Enable) Option type: int Applies to: compiler only

**CU_JIT_SPLIT_COMPILE = 34**

This option specifies the maximum number of concurrent threads to use when running compiler optimizations. If the specified value is 1, the option will be ignored. If the specified value is 0, the number of threads will match the number of CPUs on the underlying machine. Otherwise, if the option is N, then up to N threads will be used. Option type: unsigned int Applies to: compiler only

**CU_JIT_BINARY_LOADER_THREAD_COUNT = 35**

This option specifies the maximum number of concurrent threads to use when compiling device code. If the specified value is 1, the option will be ignored. If the specified value is 0, the number of threads will match the number of CPUs on the underlying machine. Otherwise, if the option is N, then up to N threads will be used. This option is ignored if the env var CUDA_BINARY_LOADER_THREAD_COUNT is set. Option type: unsigned int Applies to: compiler and linker

**CU_JIT_NUM_OPTIONS**

## enum CUjit_target

Online compilation targets

## Values

**CU_TARGET_COMPUTE_30 = 30**
Compute device class 3.0
**CU_TARGET_COMPUTE_32 = 32**
Compute device class 3.2
**CU_TARGET_COMPUTE_35 = 35**
Compute device class 3.5
**CU_TARGET_COMPUTE_37 = 37**
Compute device class 3.7
**CU_TARGET_COMPUTE_50 = 50**
Compute device class 5.0
**CU_TARGET_COMPUTE_52 = 52**
Compute device class 5.2
**CU_TARGET_COMPUTE_53 = 53**
Compute device class 5.3
**CU_TARGET_COMPUTE_60 = 60**
Compute device class 6.0.
**CU_TARGET_COMPUTE_61 = 61**
Compute device class 6.1.
**CU_TARGET_COMPUTE_62 = 62**
Compute device class 6.2.
**CU_TARGET_COMPUTE_70 = 70**
Compute device class 7.0.
**CU_TARGET_COMPUTE_72 = 72**
Compute device class 7.2.
**CU_TARGET_COMPUTE_75 = 75**
Compute device class 7.5.
**CU_TARGET_COMPUTE_80 = 80**
Compute device class 8.0.
**CU_TARGET_COMPUTE_86 = 86**
Compute device class 8.6.
**CU_TARGET_COMPUTE_87 = 87**
Compute device class 8.7.
**CU_TARGET_COMPUTE_89 = 89**
Compute device class 8.9.
**CU_TARGET_COMPUTE_90 = 90**
Compute device class 9.0.
**CU_TARGET_COMPUTE_100 = 100**
Compute device class 10.0.
**CU_TARGET_COMPUTE_110 = 110**
Compute device class 11.0.
**CU_TARGET_COMPUTE_103 = 103**

Compute device class 10.3.

**CU_TARGET_COMPUTE_120 = 120**

Compute device class 12.0.

**CU_TARGET_COMPUTE_121 = 121**

Compute device class 12.1. Compute device class 9.0. with accelerated features.

**CU_TARGET_COMPUTE_90A = CU_COMPUTE_ACCELERATED_TARGET_BASE +CU_TARGET_COMPUTE_90**

Compute device class 10.0. with accelerated features.

**CU_TARGET_COMPUTE_100A = CU_COMPUTE_ACCELERATED_TARGET_BASE +CU_TARGET_COMPUTE_100**

Compute device class 11.0 with accelerated features.

**CU_TARGET_COMPUTE_110A = CU_COMPUTE_ACCELERATED_TARGET_BASE +CU_TARGET_COMPUTE_110**

Compute device class 10.3. with accelerated features.

**CU_TARGET_COMPUTE_103A = CU_COMPUTE_ACCELERATED_TARGET_BASE +CU_TARGET_COMPUTE_103**

Compute device class 12.0. with accelerated features.

**CU_TARGET_COMPUTE_120A = CU_COMPUTE_ACCELERATED_TARGET_BASE +CU_TARGET_COMPUTE_120**

Compute device class 12.1. with accelerated features.

**CU_TARGET_COMPUTE_121A = CU_COMPUTE_ACCELERATED_TARGET_BASE +CU_TARGET_COMPUTE_121**

Compute device class 10.x with family features.

**CU_TARGET_COMPUTE_100F = CU_COMPUTE_FAMILY_TARGET_BASE +CU_TARGET_COMPUTE_100**

Compute device class 11.0 with family features.

**CU_TARGET_COMPUTE_110F = CU_COMPUTE_FAMILY_TARGET_BASE +CU_TARGET_COMPUTE_110**

Compute device class 10.3. with family features.

**CU_TARGET_COMPUTE_103F = CU_COMPUTE_FAMILY_TARGET_BASE +CU_TARGET_COMPUTE_103**

Compute device class 12.0. with family features.

**CU_TARGET_COMPUTE_120F = CU_COMPUTE_FAMILY_TARGET_BASE +CU_TARGET_COMPUTE_120**

Compute device class 12.1. with family features.

**CU_TARGET_COMPUTE_121F = CU_COMPUTE_FAMILY_TARGET_BASE +CU_TARGET_COMPUTE_121**

## enum CUjitInputType

Device code formats

### Values

**CU_JIT_INPUT_CUBIN = 0**
Compiled device-class-specific device code Applicable options: none

**CU_JIT_INPUT_PTX = 1**
PTX source code Applicable options: PTX compiler options

**CU_JIT_INPUT_FATBINARY = 2**
Bundle of multiple cubins and/or PTX of some device code Applicable options: PTX compiler options, CU_JIT_FALLBACK_STRATEGY

**CU_JIT_INPUT_OBJECT = 3**
Host object with embedded device code Applicable options: PTX compiler options, CU_JIT_FALLBACK_STRATEGY

**CU_JIT_INPUT_LIBRARY = 4**
Archive of host objects with embedded device code Applicable options: PTX compiler options, CU_JIT_FALLBACK_STRATEGY

**CU_JIT_INPUT_NVVM = 5**
Deprecated High-level intermediate code for link-time optimization Applicable options: NVVM compiler options, PTX compiler options Only valid with LTO-IR compiled with toolkits prior to CUDA 12.0

**CU_JIT_NUM_INPUT_TYPES = 6**

## enum CUlaunchAttributeID

Launch attributes enum; used as id field of CUlaunchAttribute

### Values

**CU_LAUNCH_ATTRIBUTE_IGNORE = 0**
Ignored entry, for convenient composition

**CU_LAUNCH_ATTRIBUTE_ACCESS_POLICY_WINDOW = 1**
Valid for streams, graph nodes, launches. See CUlaunchAttributeValue::accessPolicyWindow.

**CU_LAUNCH_ATTRIBUTE_COOPERATIVE = 2**
Valid for graph nodes, launches. See CUlaunchAttributeValue::cooperative.

**CU_LAUNCH_ATTRIBUTE_SYNCHRONIZATION_POLICY = 3**
Valid for streams. See CUlaunchAttributeValue::syncPolicy.

**CU_LAUNCH_ATTRIBUTE_CLUSTER_DIMENSION = 4**
Valid for graph nodes, launches. See CUlaunchAttributeValue::clusterDim.

**CU_LAUNCH_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE = 5**
Valid for graph nodes, launches. See CUlaunchAttributeValue::clusterSchedulingPolicyPreference.

**CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_STREAM_SERIALIZATION = 6**
Valid for launches. Setting CUlaunchAttributeValue::programmaticStreamSerializationAllowed to non-0 signals that the kernel will use programmatic means to resolve its stream dependency, so that the CUDA runtime should opportunistically allow the grid's execution to overlap with the previous kernel in the stream, if that kernel requests the overlap. The dependent launches can choose to wait

on the dependency using the programmatic sync (cudaGridDependencySynchronize() or equivalent PTX instructions).

**CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_EVENT = 7**

Valid for launches. Set CUlaunchAttributeValue::programmaticEvent to record the event. Event recorded through this launch attribute is guaranteed to only trigger after all block in the associated kernel trigger the event. A block can trigger the event through PTX launchdep.release or CUDA builtin function cudaTriggerProgrammaticLaunchCompletion(). A trigger can also be inserted at the beginning of each block's execution if triggerAtBlockStart is set to non-0. The dependent launches can choose to wait on the dependency using the programmatic sync (cudaGridDependencySynchronize() or equivalent PTX instructions). Note that dependents (including the CPU thread calling cuEventSynchronize()) are not guaranteed to observe the release precisely when it is released. For example, cuEventSynchronize() may only observe the event trigger long after the associated kernel has completed. This recording type is primarily meant for establishing programmatic dependency between device tasks. Note also this type of dependency allows, but does not guarantee, concurrent execution of tasks. The event supplied must not be an interprocess or interop event. The event must disable timing (i.e. must be created with the CU_EVENT_DISABLE_TIMING flag set).

**CU_LAUNCH_ATTRIBUTE_PRIORITY = 8**

Valid for streams, graph nodes, launches. See CUlaunchAttributeValue::priority.

**CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN_MAP = 9**

Valid for streams, graph nodes, launches. See CUlaunchAttributeValue::memSyncDomainMap.

**CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN = 10**

Valid for streams, graph nodes, launches. See CUlaunchAttributeValue::memSyncDomain.

**CU_LAUNCH_ATTRIBUTE_PREFERRED_CLUSTER_DIMENSION = 11**

Valid for graph nodes, launches. Set CUlaunchAttributeValue::preferredClusterDim to allow the kernel launch to specify a preferred substitute cluster dimension. Blocks may be grouped according to either the dimensions specified with this attribute (grouped into a "preferred substitute cluster"), or the one specified with CU_LAUNCH_ATTRIBUTE_CLUSTER_DIMENSION attribute (grouped into a "regular cluster"). The cluster dimensions of a "preferred substitute cluster" shall be an integer multiple greater than zero of the regular cluster dimensions. The device will attempt - on a best-effort basis - to group thread blocks into preferred clusters over grouping them into regular clusters. When it deems necessary (primarily when the device temporarily runs out of physical resources to launch the larger preferred clusters), the device may switch to launch the regular clusters instead to attempt to utilize as much of the physical device resources as possible. Each type of cluster will have its enumeration / coordinate setup as if the grid consists solely of its type of cluster. For example, if the preferred substitute cluster dimensions double the regular cluster dimensions, there might be simultaneously a regular cluster indexed at (1,0,0), and a preferred cluster indexed at (1,0,0). In this example, the preferred substitute cluster (1,0,0) replaces regular clusters (2,0,0) and (3,0,0) and groups their blocks. This attribute will only take effect when a regular cluster dimension has been specified. The preferred substitute cluster dimension must be an integer multiple greater than zero of the regular cluster dimension and must divide the grid. It must also be no more than `maxBlocksPerCluster`, if it is set in the kernel's `__launch_bounds__`.

Otherwise it must be less than the maximum value the driver can support. Otherwise, setting this attribute to a value physically unable to fit on any particular device is permitted.

**CU_LAUNCH_ATTRIBUTE_LAUNCH_COMPLETION_EVENT = 12**

Valid for launches. Set CUlaunchAttributeValue::launchCompletionEvent to record the event. Nominally, the event is triggered once all blocks of the kernel have begun execution. Currently this is a best effort. If a kernel B has a launch completion dependency on a kernel A, B may wait until A is complete. Alternatively, blocks of B may begin before all blocks of A have begun, for example if B can claim execution resources unavailable to A (e.g. they run on different GPUs) or if B is a higher priority than A. Exercise caution if such an ordering inversion could lead to deadlock. A launch completion event is nominally similar to a programmatic event with `triggerAtBlockStart` set except that it is not visible to `cudaGridDependencySynchronize()` and can be used with compute capability less than 9.0. The event supplied must not be an interprocess or interop event. The event must disable timing (i.e. must be created with the CU_EVENT_DISABLE_TIMING flag set).

**CU_LAUNCH_ATTRIBUTE_DEVICE_UPDATABLE_KERNEL_NODE = 13**

Valid for graph nodes, launches. This attribute is graphs-only, and passing it to a launch in a non-capturing stream will result in an error. CUlaunchAttributeValue::deviceUpdatableKernelNode::deviceUpdatable can only be set to 0 or 1. Setting the field to 1 indicates that the corresponding kernel node should be device-updatable. On success, a handle will be returned via CUlaunchAttributeValue::deviceUpdatableKernelNode::devNode which can be passed to the various device-side update functions to update the node's kernel parameters from within another kernel. For more information on the types of device updates that can be made, as well as the relevant limitations thereof, see cudaGraphKernelNodeUpdatesApply. Nodes which are device-updatable have additional restrictions compared to regular kernel nodes. Firstly, device-updatable nodes cannot be removed from their graph via cuGraphDestroyNode. Additionally, once opted-in to this functionality, a node cannot opt out, and any attempt to set the deviceUpdatable attribute to 0 will result in an error. Device-updatable kernel nodes also cannot have their attributes copied to/from another kernel node via cuGraphKernelNodeCopyAttributes. Graphs containing one or more device-updatable nodes also do not allow multiple instantiation, and neither the graph nor its instantiated version can be passed to cuGraphExecUpdate. If a graph contains device-updatable nodes and updates those nodes from the device from within the graph, the graph must be uploaded with cuGraphUpload before it is launched. For such a graph, if host-side executable graph updates are made to the device-updatable nodes, the graph must be uploaded before it is launched again.

**CU_LAUNCH_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT = 14**

Valid for launches. On devices where the L1 cache and shared memory use the same hardware resources, setting CUlaunchAttributeValue::sharedMemCarveout to a percentage between 0-100 signals the CUDA driver to set the shared memory carveout preference, in percent of the total shared memory for that kernel launch. This attribute takes precedence over CU_FUNC_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT. This is only a hint, and the CUDA driver can choose a different configuration if required for the launch.

**CU_LAUNCH_ATTRIBUTE_NVLINK_UTIL_CENTRIC_SCHEDULING = 16**

Valid for streams, graph nodes, launches. This attribute is a hint to the CUDA runtime that the launch should attempt to make the kernel maximize its NVLINK utilization. When possible to honor this hint, CUDA will assume each block in the grid launch will carry out an even amount of NVLINK traffic, and make a best-effort attempt to adjust the kernel launch based on that assumption. This attribute is a hint only. CUDA makes no functional or performance guarantee. Its applicability can be affected by many different factors, including driver version (i.e. CUDA doesn't guarantee the performance characteristics will be maintained between driver versions or a driver update could alter or regress previously observed perf characteristics.) It also doesn't guarantee a successful result, i.e. applying the attribute may not improve the performance of either the targeted kernel or the encapsulating application. Valid values for CUlaunchAttributeValue::nvlinkUtilCentricScheduling are 0 (disabled) and 1 (enabled).

**CU_LAUNCH_ATTRIBUTE_PORTABLE_CLUSTER_SIZE_MODE = 17**

Valid for graph nodes, launches. This controls whether the kernel launch is allowed to use a non-portable cluster size. Valid values for CUlaunchAttributeValue::portableClusterSizeMode are described in CUlaunchAttributePortableClusterMode. Any other value will return CUDA_ERROR_INVALID_VALUE

**CU_LAUNCH_ATTRIBUTE_SHARED_MEMORY_MODE = 18**

Valid for graph nodes, launches. This indicates if the kernel is allowed to use a non-portable dynamic shared memory mode.

## enum CUlaunchAttributePortableClusterMode

Enum for defining applicability of portable cluster size, used with cuLaunchKernelEx

### Values

**CU_LAUNCH_PORTABLE_CLUSTER_MODE_DEFAULT = 0**

The default to use for allowing non-portable cluster size on launch - uses current function attribute for CU_FUNC_ATTRIBUTE_NON_PORTABLE_CLUSTER_SIZE_ALLOWED

**CU_LAUNCH_PORTABLE_CLUSTER_MODE_REQUIRE_PORTABLE = 1**

Specifies that the cluster size requested must be a portable size

**CU_LAUNCH_PORTABLE_CLUSTER_MODE_ALLOW_NON_PORTABLE = 2**

Specifies that the cluster size requested may be a non-portable size

## enum CUlaunchMemSyncDomain

Memory Synchronization Domain

A kernel can be launched in a specified memory synchronization domain that affects all memory operations issued by that kernel. A memory barrier issued in one domain will only order memory operations in that domain, thus eliminating latency increase from memory barriers ordering unrelated traffic.

By default, kernels are launched in domain 0. Kernel launched with CU_LAUNCH_MEM_SYNC_DOMAIN_REMOTE will have a different domain ID. User may also alter the domain ID with CUlaunchMemSyncDomainMap for a specific stream / graph node /

kernel launch. See CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN, cuStreamSetAttribute, cuLaunchKernelEx, cuGraphKernelNodeSetAttribute.

Memory operations done in kernels launched in different domains are considered system-scope distanced. In other words, a GPU scoped memory synchronization is not sufficient for memory order to be observed by kernels in another memory synchronization domain even if they are on the same GPU.

### Values

**CU_LAUNCH_MEM_SYNC_DOMAIN_DEFAULT = 0**
Launch kernels in the default domain

**CU_LAUNCH_MEM_SYNC_DOMAIN_REMOTE = 1**
Launch kernels in the remote domain

## enum CUlibraryOption

Library options to be specified with cuLibraryLoadData() or cuLibraryLoadFromFile()

### Values

**CU_LIBRARY_HOST_UNIVERSAL_FUNCTION_AND_DATA_TABLE = 0**

**CU_LIBRARY_BINARY_IS_PRESERVED = 1**
Specifes that the argument `code` passed to cuLibraryLoadData() will be preserved. Specifying this option will let the driver know that `code` can be accessed at any point until cuLibraryUnload(). The default behavior is for the driver to allocate and maintain its own copy of `code`. Note that this is only a memory usage optimization hint and the driver can choose to ignore it if required. Specifying this option with cuLibraryLoadFromFile() is invalid and will return CUDA_ERROR_INVALID_VALUE.

**CU_LIBRARY_NUM_OPTIONS**

## enum CUlimit

Limits

### Values

**CU_LIMIT_STACK_SIZE = 0x00**
GPU thread stack size

**CU_LIMIT_PRINTF_FIFO_SIZE = 0x01**
GPU printf FIFO size

**CU_LIMIT_MALLOC_HEAP_SIZE = 0x02**
GPU malloc heap size

**CU_LIMIT_DEV_RUNTIME_SYNC_DEPTH = 0x03**
GPU device runtime launch synchronize depth

**CU_LIMIT_DEV_RUNTIME_PENDING_LAUNCH_COUNT = 0x04**
GPU device runtime pending launch count

**CU_LIMIT_MAX_L2_FETCH_GRANULARITY = 0x05**

A value between 0 and 128 that indicates the maximum fetch granularity of L2 (in Bytes). This is a hint

**CU_LIMIT_PERSISTING_L2_CACHE_SIZE = 0x06**

A size in bytes for L2 persisting lines cache size

**CU_LIMIT_SHMEM_SIZE = 0x07**

A maximum size in bytes of shared memory available to CUDA kernels on a CIG context. Can only be queried, cannot be set

**CU_LIMIT_CIG_ENABLED = 0x08**

A non-zero value indicates this CUDA context is a CIG-enabled context. Can only be queried, cannot be set

**CU_LIMIT_CIG_SHMEM_FALLBACK_ENABLED = 0x09**

When set to zero, CUDA will fail to launch a kernel on a CIG context, instead of using the fallback path, if the kernel uses more shared memory than available

**CU_LIMIT_MAX**

# enum CUmem_advise

Memory advise values

## Values

**CU_MEM_ADVISE_SET_READ_MOSTLY = 1**

Data will mostly be read and only occasionally be written to

**CU_MEM_ADVISE_UNSET_READ_MOSTLY = 2**

Undo the effect of CU_MEM_ADVISE_SET_READ_MOSTLY

**CU_MEM_ADVISE_SET_PREFERRED_LOCATION = 3**

Set the preferred location for the data as the specified device

**CU_MEM_ADVISE_UNSET_PREFERRED_LOCATION = 4**

Clear the preferred location for the data

**CU_MEM_ADVISE_SET_ACCESSED_BY = 5**

Data will be accessed by the specified device, so prevent page faults as much as possible

**CU_MEM_ADVISE_UNSET_ACCESSED_BY = 6**

Let the Unified Memory subsystem decide on the page faulting policy for the specified device

# enum CUmemAccess_flags

Specifies the memory protection flags for mapping.

## Values

**CU_MEM_ACCESS_FLAGS_PROT_NONE = 0x0**

Default, make the address range not accessible

**CU_MEM_ACCESS_FLAGS_PROT_READ = 0x1**

Make the address range read accessible

**CU_MEM_ACCESS_FLAGS_PROT_READWRITE = 0x3**

Make the address range read-write accessible

**CU_MEM_ACCESS_FLAGS_PROT_MAX = 0x7FFFFFFF**

## enum CUmemAllocationCompType

Specifies compression attribute for an allocation.

### Values

**CU_MEM_ALLOCATION_COMP_NONE = 0x0**

Allocating non-compressible memory

**CU_MEM_ALLOCATION_COMP_GENERIC = 0x1**

Allocating compressible memory

## enum CUmemAllocationGranularity_flags

Flag for requesting different optimal and required granularities for an allocation.

### Values

**CU_MEM_ALLOC_GRANULARITY_MINIMUM = 0x0**

Minimum required granularity for allocation

**CU_MEM_ALLOC_GRANULARITY_RECOMMENDED = 0x1**

Recommended granularity for allocation for best performance

## enum CUmemAllocationHandleType

Flags for specifying particular handle types

### Values

**CU_MEM_HANDLE_TYPE_NONE = 0x0**

Does not allow any export mechanism. >

**CU_MEM_HANDLE_TYPE_POSIX_FILE_DESCRIPTOR = 0x1**

Allows a file descriptor to be used for exporting. Permitted only on POSIX systems. (int)

**CU_MEM_HANDLE_TYPE_WIN32 = 0x2**

Allows a Win32 NT handle to be used for exporting. (HANDLE)

**CU_MEM_HANDLE_TYPE_WIN32_KMT = 0x4**

Allows a Win32 KMT handle to be used for exporting. (D3DKMT_HANDLE)

**CU_MEM_HANDLE_TYPE_FABRIC = 0x8**

Allows a fabric handle to be used for exporting. (CUmemFabricHandle)

**CU_MEM_HANDLE_TYPE_MAX = 0x7FFFFFFF**

## enum CUmemAllocationType

Defines the allocation types available

### Values

**CU_MEM_ALLOCATION_TYPE_INVALID = 0x0**

**CU_MEM_ALLOCATION_TYPE_PINNED = 0x1**

This allocation type is 'pinned', i.e. cannot migrate from its current location while the application is actively using it

**CU_MEM_ALLOCATION_TYPE_MANAGED = 0x2**

This allocation type is managed memory

**CU_MEM_ALLOCATION_TYPE_MAX = 0x7FFFFFFF**

## enum CUmemAttach_flags

CUDA Mem Attach Flags

### Values

**CU_MEM_ATTACH_GLOBAL = 0x1**

Memory can be accessed by any stream on any device

**CU_MEM_ATTACH_HOST = 0x2**

Memory cannot be accessed by any stream on any device

**CU_MEM_ATTACH_SINGLE = 0x4**

Memory can only be accessed by a single stream on the associated device

## enum CUmemcpy3DOperandType

These flags allow applications to convey the operand type for individual copies specified in cuMemcpy3DBatchAsync.

### Values

**CU_MEMCPY_OPERAND_TYPE_POINTER = 0x1**

Memcpy operand is a valid pointer.

**CU_MEMCPY_OPERAND_TYPE_ARRAY = 0x2**

Memcpy operand is a CUarray.

**CU_MEMCPY_OPERAND_TYPE_MAX = 0x7FFFFFFF**

## enum CUmemcpyFlags

Flags to specify for copies within a batch. For more details see cuMemcpyBatchAsync.

### Values

**CU_MEMCPY_FLAG_DEFAULT = 0x0**

**CU_MEMCPY_FLAG_PREFER_OVERLAP_WITH_COMPUTE = 0x1**

Hint to the driver to try and overlap the copy with compute work on the SMs.

## enum CUmemcpySrcAccessOrder

These flags allow applications to convey the source access ordering CUDA must maintain. The destination will always be accessed in stream order.

### Values

**CU_MEMCPY_SRC_ACCESS_ORDER_INVALID = 0x0**
Default invalid.

**CU_MEMCPY_SRC_ACCESS_ORDER_STREAM = 0x1**
Indicates that access to the source pointer must be in stream order.

**CU_MEMCPY_SRC_ACCESS_ORDER_DURING_API_CALL = 0x2**
Indicates that access to the source pointer can be out of stream order and all accesses must be complete before the API call returns. This flag is suited for ephemeral sources (ex., stack variables) when it's known that no prior operations in the stream can be accessing the memory and also that the lifetime of the memory is limited to the scope that the source variable was declared in. Specifying this flag allows the driver to optimize the copy and removes the need for the user to synchronize the stream after the API call.

**CU_MEMCPY_SRC_ACCESS_ORDER_ANY = 0x3**
Indicates that access to the source pointer can be out of stream order and the accesses can happen even after the API call returns. This flag is suited for host pointers allocated outside CUDA (ex., via malloc) when it's known that no prior operations in the stream can be accessing the memory. Specifying this flag allows the driver to optimize the copy on certain platforms.

**CU_MEMCPY_SRC_ACCESS_ORDER_MAX = 0x7FFFFFFF**

## enum CUmemHandleType

Memory handle types

### Values

**CU_MEM_HANDLE_TYPE_GENERIC = 0**

## enum CUmemLocationType

Specifies the type of location

### Values

**CU_MEM_LOCATION_TYPE_INVALID = 0x0**

**CU_MEM_LOCATION_TYPE_NONE = 0x0**
Location is unspecified. This is used when creating a managed memory pool to indicate no preferred location for the pool

**CU_MEM_LOCATION_TYPE_DEVICE = 0x1**
Location is a device location, thus id is a device ordinal

**CU_MEM_LOCATION_TYPE_HOST = 0x2**
Location is host, id is ignored
**CU_MEM_LOCATION_TYPE_HOST_NUMA = 0x3**
Location is a host NUMA node, thus id is a host NUMA node id
**CU_MEM_LOCATION_TYPE_HOST_NUMA_CURRENT = 0x4**
Location is a host NUMA node of the current thread, id is ignored
**CU_MEM_LOCATION_TYPE_INVISIBLE = 0x5**
Location is not visible but device is accessible, id is always CU_DEVICE_INVALID
**CU_MEM_LOCATION_TYPE_MAX = 0x7FFFFFFF**

## enum CUmemOperationType

Memory operation types

### Values

**CU_MEM_OPERATION_TYPE_MAP = 1**
**CU_MEM_OPERATION_TYPE_UNMAP = 2**

## enum CUmemorytype

Memory types

### Values

**CU_MEMORYTYPE_HOST = 0x01**
Host memory
**CU_MEMORYTYPE_DEVICE = 0x02**
Device memory
**CU_MEMORYTYPE_ARRAY = 0x03**
Array memory
**CU_MEMORYTYPE_UNIFIED = 0x04**
Unified device or host memory

## enum CUmemPool_attribute

CUDA memory pool attributes

### Values

**CU_MEMPOOL_ATTR_REUSE_FOLLOW_EVENT_DEPENDENCIES = 1**
(value type = int) Allow cuMemAllocAsync to use memory asynchronously freed in another streams as long as a stream ordering dependency of the allocating stream on the free action exists. Cuda events and null stream interactions can create the required stream ordered dependencies. (default enabled)
**CU_MEMPOOL_ATTR_REUSE_ALLOW_OPPORTUNISTIC**

(value type = int) Allow reuse of already completed frees when there is no dependency between the free and allocation. (default enabled)

**CU_MEMPOOL_ATTR_REUSE_ALLOW_INTERNAL_DEPENDENCIES**

(value type = int) Allow cuMemAllocAsync to insert new stream dependencies in order to establish the stream ordering required to reuse a piece of memory released by cuMemFreeAsync (default enabled).

**CU_MEMPOOL_ATTR_RELEASE_THRESHOLD**

(value type = cuuint64_t) Amount of reserved memory in bytes to hold onto before trying to release memory back to the OS. When more than the release threshold bytes of memory are held by the memory pool, the allocator will try to release memory back to the OS on the next call to stream, event or context synchronize. (default 0)

**CU_MEMPOOL_ATTR_RESERVED_MEM_CURRENT**

(value type = cuuint64_t) Amount of backing memory currently allocated for the mempool.

**CU_MEMPOOL_ATTR_RESERVED_MEM_HIGH**

(value type = cuuint64_t) High watermark of backing memory allocated for the mempool since the last time it was reset. High watermark can only be reset to zero.

**CU_MEMPOOL_ATTR_USED_MEM_CURRENT**

(value type = cuuint64_t) Amount of memory from the pool that is currently in use by the application.

**CU_MEMPOOL_ATTR_USED_MEM_HIGH**

(value type = cuuint64_t) High watermark of the amount of memory from the pool that was in use by the application since the last time it was reset. High watermark can only be reset to zero.

**CU_MEMPOOL_ATTR_ALLOCATION_TYPE**

(value type = CUmemAllocationType) The allocation type of the mempool

**CU_MEMPOOL_ATTR_EXPORT_HANDLE_TYPES**

(value type = CUmemAllocationHandleType) Available export handle types for the mempool. For imported pools this value is always CU_MEM_HANDLE_TYPE_NONE as an imported pool cannot be re-exported

**CU_MEMPOOL_ATTR_LOCATION_ID**

(value type = int) The location id for the mempool. If the location type for this pool is CU_MEM_LOCATION_TYPE_INVISIBLE then ID will be CU_DEVICE_INVALID.

**CU_MEMPOOL_ATTR_LOCATION_TYPE**

(value type = CUmemLocationType) The location type for the mempool. For imported memory pools where the device is not directly visible to the importing process or pools imported via fabric handles across nodes this will be CU_MEM_LOCATION_TYPE_INVISIBLE.

**CU_MEMPOOL_ATTR_MAX_POOL_SIZE**

(value type = cuuint64_t) Maximum size of the pool in bytes, this value may be higher than what was initially passed to cuMemPoolCreate due to alignment requirements. A value of 0 indicates no maximum size. For CU_MEM_ALLOCATION_TYPE_MANAGED and IPC imported pools this value will be system dependent.

**CU_MEMPOOL_ATTR_HW_DECOMPRESS_ENABLED**

(value type = int) Indicates whether the pool has hardware compresssion enabled

## enum CUmemRangeFlags

Flag for requesting handle type for address range.

### Values

**CU_MEM_RANGE_FLAG_DMA_BUF_MAPPING_TYPE_PCIE = 0x1**
Indicates that DMA_BUF handle should be mapped via PCIe BAR1

## enum CUmemRangeHandleType

Specifies the handle type for address range

### Values

**CU_MEM_RANGE_HANDLE_TYPE_DMA_BUF_FD = 0x1**
**CU_MEM_RANGE_HANDLE_TYPE_MAX = 0x7FFFFFFF**

## enum CUmulticastGranularity_flags

Flags for querying different granularities for a multicast object

### Values

**CU_MULTICAST_GRANULARITY_MINIMUM = 0x0**
Minimum required granularity
**CU_MULTICAST_GRANULARITY_RECOMMENDED = 0x1**
Recommended granularity for best performance

## enum CUoccupancy_flags

Occupancy calculator flag

### Values

**CU_OCCUPANCY_DEFAULT = 0x0**
Default behavior
**CU_OCCUPANCY_DISABLE_CACHING_OVERRIDE = 0x1**
Assume global caching is enabled and cannot be automatically turned off

## enum CUpointer_attribute

Pointer information

### Values

**CU_POINTER_ATTRIBUTE_CONTEXT = 1**

The CUcontext on which a pointer was allocated or registered

**CU_POINTER_ATTRIBUTE_MEMORY_TYPE = 2**

The CUmemorytype describing the physical location of a pointer

**CU_POINTER_ATTRIBUTE_DEVICE_POINTER = 3**

The address at which a pointer's memory may be accessed on the device

**CU_POINTER_ATTRIBUTE_HOST_POINTER = 4**

The address at which a pointer's memory may be accessed on the host

**CU_POINTER_ATTRIBUTE_P2P_TOKENS = 5**

A pair of tokens for use with the nv-p2p.h Linux kernel interface

**CU_POINTER_ATTRIBUTE_SYNC_MEMOPS = 6**

Synchronize every synchronous memory operation initiated on this region

**CU_POINTER_ATTRIBUTE_BUFFER_ID = 7**

A process-wide unique ID for an allocated memory region

**CU_POINTER_ATTRIBUTE_IS_MANAGED = 8**

Indicates if the pointer points to managed memory

**CU_POINTER_ATTRIBUTE_DEVICE_ORDINAL = 9**

A device ordinal of a device on which a pointer was allocated or registered

**CU_POINTER_ATTRIBUTE_IS_LEGACY_CUDA_IPC_CAPABLE = 10**

1 if this pointer maps to an allocation that is suitable for cudaIpcGetMemHandle, 0 otherwise

**CU_POINTER_ATTRIBUTE_RANGE_START_ADDR = 11**

Starting address for this requested pointer

**CU_POINTER_ATTRIBUTE_RANGE_SIZE = 12**

Size of the address range for this requested pointer

**CU_POINTER_ATTRIBUTE_MAPPED = 13**

1 if this pointer is in a valid address range that is mapped to a backing allocation, 0 otherwise

**CU_POINTER_ATTRIBUTE_ALLOWED_HANDLE_TYPES = 14**

Bitmask of allowed CUmemAllocationHandleType for this allocation

**CU_POINTER_ATTRIBUTE_IS_GPU_DIRECT_RDMA_CAPABLE = 15**

1 if the memory this pointer is referencing can be used with the GPUDirect RDMA API

**CU_POINTER_ATTRIBUTE_ACCESS_FLAGS = 16**

Returns the access flags the device associated with the current context has on the corresponding memory referenced by the pointer given

**CU_POINTER_ATTRIBUTE_MEMPOOL_HANDLE = 17**

Returns the mempool handle for the allocation if it was allocated from a mempool. Otherwise returns NULL.

**CU_POINTER_ATTRIBUTE_MAPPING_SIZE = 18**

Size of the actual underlying mapping that the pointer belongs to

**CU_POINTER_ATTRIBUTE_MAPPING_BASE_ADDR = 19**

The start address of the mapping that the pointer belongs to

**CU_POINTER_ATTRIBUTE_MEMORY_BLOCK_ID = 20**

A process-wide unique id corresponding to the physical allocation the pointer belongs to

**CU_POINTER_ATTRIBUTE_IS_HW_DECOMPRESS_CAPABLE = 21**

Returns in `*data` a boolean that indicates whether the pointer points to memory that is capable to be used for hardware accelerated decompression.

## enum CUprocessState

CUDA Process States

### Values

**CU_PROCESS_STATE_RUNNING = 0**
Default process state

**CU_PROCESS_STATE_LOCKED**
CUDA API locks are taken so further CUDA API calls will block

**CU_PROCESS_STATE_CHECKPOINTED**
Application memory contents have been checkpointed and underlying allocations and device handles have been released

**CU_PROCESS_STATE_FAILED**
Application entered an uncorrectable error during the checkpoint/restore process

## enum CUresourcetype

Resource types

### Values

**CU_RESOURCE_TYPE_ARRAY = 0x00**
Array resource

**CU_RESOURCE_TYPE_MIPMAPPED_ARRAY = 0x01**
Mipmapped array resource

**CU_RESOURCE_TYPE_LINEAR = 0x02**
Linear resource

**CU_RESOURCE_TYPE_PITCH2D = 0x03**
Pitch 2D resource

## enum CUresourceViewFormat

Resource view format

### Values

**CU_RES_VIEW_FORMAT_NONE = 0x00**
No resource view format (use underlying resource format)

**CU_RES_VIEW_FORMAT_UINT_1X8 = 0x01**
1 channel unsigned 8-bit integers

**CU_RES_VIEW_FORMAT_UINT_2X8 = 0x02**
2 channel unsigned 8-bit integers

**CU_RES_VIEW_FORMAT_UINT_4X8 = 0x03**
4 channel unsigned 8-bit integers
**CU_RES_VIEW_FORMAT_SINT_1X8 = 0x04**
1 channel signed 8-bit integers
**CU_RES_VIEW_FORMAT_SINT_2X8 = 0x05**
2 channel signed 8-bit integers
**CU_RES_VIEW_FORMAT_SINT_4X8 = 0x06**
4 channel signed 8-bit integers
**CU_RES_VIEW_FORMAT_UINT_1X16 = 0x07**
1 channel unsigned 16-bit integers
**CU_RES_VIEW_FORMAT_UINT_2X16 = 0x08**
2 channel unsigned 16-bit integers
**CU_RES_VIEW_FORMAT_UINT_4X16 = 0x09**
4 channel unsigned 16-bit integers
**CU_RES_VIEW_FORMAT_SINT_1X16 = 0x0a**
1 channel signed 16-bit integers
**CU_RES_VIEW_FORMAT_SINT_2X16 = 0x0b**
2 channel signed 16-bit integers
**CU_RES_VIEW_FORMAT_SINT_4X16 = 0x0c**
4 channel signed 16-bit integers
**CU_RES_VIEW_FORMAT_UINT_1X32 = 0x0d**
1 channel unsigned 32-bit integers
**CU_RES_VIEW_FORMAT_UINT_2X32 = 0x0e**
2 channel unsigned 32-bit integers
**CU_RES_VIEW_FORMAT_UINT_4X32 = 0x0f**
4 channel unsigned 32-bit integers
**CU_RES_VIEW_FORMAT_SINT_1X32 = 0x10**
1 channel signed 32-bit integers
**CU_RES_VIEW_FORMAT_SINT_2X32 = 0x11**
2 channel signed 32-bit integers
**CU_RES_VIEW_FORMAT_SINT_4X32 = 0x12**
4 channel signed 32-bit integers
**CU_RES_VIEW_FORMAT_FLOAT_1X16 = 0x13**
1 channel 16-bit floating point
**CU_RES_VIEW_FORMAT_FLOAT_2X16 = 0x14**
2 channel 16-bit floating point
**CU_RES_VIEW_FORMAT_FLOAT_4X16 = 0x15**
4 channel 16-bit floating point
**CU_RES_VIEW_FORMAT_FLOAT_1X32 = 0x16**
1 channel 32-bit floating point
**CU_RES_VIEW_FORMAT_FLOAT_2X32 = 0x17**
2 channel 32-bit floating point
**CU_RES_VIEW_FORMAT_FLOAT_4X32 = 0x18**

4 channel 32-bit floating point

**CU_RES_VIEW_FORMAT_UNSIGNED_BC1 = 0x19**

Block compressed 1

**CU_RES_VIEW_FORMAT_UNSIGNED_BC2 = 0x1a**

Block compressed 2

**CU_RES_VIEW_FORMAT_UNSIGNED_BC3 = 0x1b**

Block compressed 3

**CU_RES_VIEW_FORMAT_UNSIGNED_BC4 = 0x1c**

Block compressed 4 unsigned

**CU_RES_VIEW_FORMAT_SIGNED_BC4 = 0x1d**

Block compressed 4 signed

**CU_RES_VIEW_FORMAT_UNSIGNED_BC5 = 0x1e**

Block compressed 5 unsigned

**CU_RES_VIEW_FORMAT_SIGNED_BC5 = 0x1f**

Block compressed 5 signed

**CU_RES_VIEW_FORMAT_UNSIGNED_BC6H = 0x20**

Block compressed 6 unsigned half-float

**CU_RES_VIEW_FORMAT_SIGNED_BC6H = 0x21**

Block compressed 6 signed half-float

**CU_RES_VIEW_FORMAT_UNSIGNED_BC7 = 0x22**

Block compressed 7

# enum CUresult

Error codes

## Values

**CUDA_SUCCESS = 0**

The API call returned with no errors. In the case of query calls, this also means that the operation being queried is complete (see cuEventQuery() and cuStreamQuery()).

**CUDA_ERROR_INVALID_VALUE = 1**

This indicates that one or more of the parameters passed to the API call is not within an acceptable range of values.

**CUDA_ERROR_OUT_OF_MEMORY = 2**

The API call failed because it was unable to allocate enough memory or other resources to perform the requested operation.

**CUDA_ERROR_NOT_INITIALIZED = 3**

This indicates that the CUDA driver has not been initialized with cuInit() or that initialization has failed.

**CUDA_ERROR_DEINITIALIZED = 4**

This indicates that the CUDA driver is in the process of shutting down.

**CUDA_ERROR_PROFILER_DISABLED = 5**

This indicates profiler is not initialized for this run. This can happen when the application is running with external profiling tools like visual profiler.

**CUDA_ERROR_PROFILER_NOT_INITIALIZED = 6**

Deprecated This error return is deprecated as of CUDA 5.0. It is no longer an error to attempt to enable/disable the profiling via cuProfilerStart or cuProfilerStop without initialization.

**CUDA_ERROR_PROFILER_ALREADY_STARTED = 7**

Deprecated This error return is deprecated as of CUDA 5.0. It is no longer an error to call cuProfilerStart() when profiling is already enabled.

**CUDA_ERROR_PROFILER_ALREADY_STOPPED = 8**

Deprecated This error return is deprecated as of CUDA 5.0. It is no longer an error to call cuProfilerStop() when profiling is already disabled.

**CUDA_ERROR_STUB_LIBRARY = 34**

This indicates that the CUDA driver that the application has loaded is a stub library. Applications that run with the stub rather than a real driver loaded will result in CUDA API returning this error.

**CUDA_ERROR_CALL_REQUIRES_NEWER_DRIVER = 36**

This indicates that the API call requires a newer CUDA driver than the one currently installed. Users should install an updated NVIDIA CUDA driver to allow the API call to succeed.

**CUDA_ERROR_DEVICE_UNAVAILABLE = 46**

This indicates that requested CUDA device is unavailable at the current time. Devices are often unavailable due to use of CU_COMPUTEMODE_EXCLUSIVE_PROCESS or CU_COMPUTEMODE_PROHIBITED.

**CUDA_ERROR_NO_DEVICE = 100**

This indicates that no CUDA-capable devices were detected by the installed CUDA driver.

**CUDA_ERROR_INVALID_DEVICE = 101**

This indicates that the device ordinal supplied by the user does not correspond to a valid CUDA device or that the action requested is invalid for the specified device.

**CUDA_ERROR_DEVICE_NOT_LICENSED = 102**

This error indicates that the Grid license is not applied.

**CUDA_ERROR_INVALID_IMAGE = 200**

This indicates that the device kernel image is invalid. This can also indicate an invalid CUDA module.

**CUDA_ERROR_INVALID_CONTEXT = 201**

This most frequently indicates that there is no context bound to the current thread. This can also be returned if the context passed to an API call is not a valid handle (such as a context that has had cuCtxDestroy() invoked on it). This can also be returned if a user mixes different API versions (i.e. 3010 context with 3020 API calls). See cuCtxGetApiVersion() for more details. This can also be returned if the green context passed to an API call was not converted to a CUcontext using cuCtxFromGreenCtx API.

**CUDA_ERROR_CONTEXT_ALREADY_CURRENT = 202**

This indicated that the context being supplied as a parameter to the API call was already the active context. Deprecated This error return is deprecated as of CUDA 3.2. It is no longer an error to attempt to push the active context via cuCtxPushCurrent().

**CUDA_ERROR_MAP_FAILED = 205**

This indicates that a map or register operation has failed.

**CUDA_ERROR_UNMAP_FAILED = 206**

This indicates that an unmap or unregister operation has failed.

**CUDA_ERROR_ARRAY_IS_MAPPED = 207**

This indicates that the specified array is currently mapped and thus cannot be destroyed.

**CUDA_ERROR_ALREADY_MAPPED = 208**

This indicates that the resource is already mapped.

**CUDA_ERROR_NO_BINARY_FOR_GPU = 209**

This indicates that there is no kernel image available that is suitable for the device. This can occur when a user specifies code generation options for a particular CUDA source file that do not include the corresponding device configuration.

**CUDA_ERROR_ALREADY_ACQUIRED = 210**

This indicates that a resource has already been acquired.

**CUDA_ERROR_NOT_MAPPED = 211**

This indicates that a resource is not mapped.

**CUDA_ERROR_NOT_MAPPED_AS_ARRAY = 212**

This indicates that a mapped resource is not available for access as an array.

**CUDA_ERROR_NOT_MAPPED_AS_POINTER = 213**

This indicates that a mapped resource is not available for access as a pointer.

**CUDA_ERROR_ECC_UNCORRECTABLE = 214**

This indicates that an uncorrectable ECC error was detected during execution.

**CUDA_ERROR_UNSUPPORTED_LIMIT = 215**

This indicates that the CUlimit passed to the API call is not supported by the active device.

**CUDA_ERROR_CONTEXT_ALREADY_IN_USE = 216**

This indicates that the CUcontext passed to the API call can only be bound to a single CPU thread at a time but is already bound to a CPU thread.

**CUDA_ERROR_PEER_ACCESS_UNSUPPORTED = 217**

This indicates that peer access is not supported across the given devices.

**CUDA_ERROR_INVALID_PTX = 218**

This indicates that a PTX JIT compilation failed.

**CUDA_ERROR_INVALID_GRAPHICS_CONTEXT = 219**

This indicates an error with OpenGL or DirectX context.

**CUDA_ERROR_NVLINK_UNCORRECTABLE = 220**

This indicates that an uncorrectable NVLink error was detected during the execution.

**CUDA_ERROR_JIT_COMPILER_NOT_FOUND = 221**

This indicates that the PTX JIT compiler library was not found.

**CUDA_ERROR_UNSUPPORTED_PTX_VERSION = 222**

This indicates that the provided PTX was compiled with an unsupported toolchain.

**CUDA_ERROR_JIT_COMPILATION_DISABLED = 223**

This indicates that the PTX JIT compilation was disabled.

**CUDA_ERROR_UNSUPPORTED_EXEC_AFFINITY = 224**

This indicates that the CUexecAffinityType passed to the API call is not supported by the active device.

**CUDA_ERROR_UNSUPPORTED_DEVSIDE_SYNC = 225**
This indicates that the code to be compiled by the PTX JIT contains unsupported call to cudaDeviceSynchronize.

**CUDA_ERROR_CONTAINED = 226**
This indicates that an exception occurred on the device that is now contained by the GPU's error containment capability. Common causes are - a. Certain types of invalid accesses of peer GPU memory over nvlink b. Certain classes of hardware errors This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_INVALID_SOURCE = 300**
This indicates that the device kernel source is invalid. This includes compilation/linker errors encountered in device code or user error.

**CUDA_ERROR_FILE_NOT_FOUND = 301**
This indicates that the file specified was not found.

**CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND = 302**
This indicates that a link to a shared object failed to resolve.

**CUDA_ERROR_SHARED_OBJECT_INIT_FAILED = 303**
This indicates that initialization of a shared object failed.

**CUDA_ERROR_OPERATING_SYSTEM = 304**
This indicates that an OS call failed.

**CUDA_ERROR_INVALID_HANDLE = 400**
This indicates that a resource handle passed to the API call was not valid. Resource handles are opaque types like CUstream and CUevent.

**CUDA_ERROR_ILLEGAL_STATE = 401**
This indicates that a resource required by the API call is not in a valid state to perform the requested operation.

**CUDA_ERROR_LOSSY_QUERY = 402**
This indicates an attempt was made to introspect an object in a way that would discard semantically important information. This is either due to the object using funtionality newer than the API version used to introspect it or omission of optional return arguments.

**CUDA_ERROR_NOT_FOUND = 500**
This indicates that a named symbol was not found. Examples of symbols are global/constant variable names, driver function names, texture names, and surface names.

**CUDA_ERROR_NOT_READY = 600**
This indicates that asynchronous operations issued previously have not completed yet. This result is not actually an error, but must be indicated differently than CUDA_SUCCESS (which indicates completion). Calls that may return this value include cuEventQuery() and cuStreamQuery().

**CUDA_ERROR_ILLEGAL_ADDRESS = 700**
While executing a kernel, the device encountered a load or store instruction on an invalid memory address. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES = 701**

This indicates that a launch did not occur because it did not have appropriate resources. This error usually indicates that the user has attempted to pass too many arguments to the device kernel, or the kernel launch specifies too many threads for the kernel's register count. Passing arguments of the wrong size (i.e. a 64-bit pointer when a 32-bit int is expected) is equivalent to passing too many arguments and can also result in this error.

**CUDA_ERROR_LAUNCH_TIMEOUT = 702**

This indicates that the device kernel took too long to execute. This can only occur if timeouts are enabled - see the device attribute CU_DEVICE_ATTRIBUTE_KERNEL_EXEC_TIMEOUT for more information. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING = 703**

This error indicates a kernel launch that uses an incompatible texturing mode.

**CUDA_ERROR_PEER_ACCESS_ALREADY_ENABLED = 704**

This error indicates that a call to cuCtxEnablePeerAccess() is trying to re-enable peer access to a context which has already had peer access to it enabled.

**CUDA_ERROR_PEER_ACCESS_NOT_ENABLED = 705**

This error indicates that cuCtxDisablePeerAccess() is trying to disable peer access which has not been enabled yet via cuCtxEnablePeerAccess().

**CUDA_ERROR_PRIMARY_CONTEXT_ACTIVE = 708**

This error indicates that the primary context for the specified device has already been initialized.

**CUDA_ERROR_CONTEXT_IS_DESTROYED = 709**

This error indicates that the context current to the calling thread has been destroyed using cuCtxDestroy, or is a primary context which has not yet been initialized.

**CUDA_ERROR_ASSERT = 710**

A device-side assert triggered during kernel execution. The context cannot be used anymore, and must be destroyed. All existing device memory allocations from this context are invalid and must be reconstructed if the program is to continue using CUDA.

**CUDA_ERROR_TOO_MANY_PEERS = 711**

This error indicates that the hardware resources required to enable peer access have been exhausted for one or more of the devices passed to cuCtxEnablePeerAccess().

**CUDA_ERROR_HOST_MEMORY_ALREADY_REGISTERED = 712**

This error indicates that the memory range passed to cuMemHostRegister() has already been registered.

**CUDA_ERROR_HOST_MEMORY_NOT_REGISTERED = 713**

This error indicates that the pointer passed to cuMemHostUnregister() does not correspond to any currently registered memory region.

**CUDA_ERROR_HARDWARE_STACK_ERROR = 714**

While executing a kernel, the device encountered a stack error. This can be due to stack corruption or exceeding the stack size limit. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_ILLEGAL_INSTRUCTION = 715**

While executing a kernel, the device encountered an illegal instruction. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_MISALIGNED_ADDRESS = 716**

While executing a kernel, the device encountered a load or store instruction on a memory address which is not aligned. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_INVALID_ADDRESS_SPACE = 717**

While executing a kernel, the device encountered an instruction which can only operate on memory locations in certain address spaces (global, shared, or local), but was supplied a memory address not belonging to an allowed address space. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_INVALID_PC = 718**

While executing a kernel, the device program counter wrapped its address space. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_LAUNCH_FAILED = 719**

An exception occurred on the device while executing a kernel. Common causes include dereferencing an invalid device pointer and accessing out of bounds shared memory. Less common cases can be system specific - more information about these cases can be found in the system specific user guide. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_COOPERATIVE_LAUNCH_TOO_LARGE = 720**

This error indicates that the number of blocks launched per grid for a kernel that was launched via either cuLaunchCooperativeKernel or cuLaunchCooperativeKernelMultiDevice exceeds the maximum number of blocks as allowed by cuOccupancyMaxActiveBlocksPerMultiprocessor or cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags times the number of multiprocessors as specified by the device attribute CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT.

**CUDA_ERROR_TENSOR_MEMORY_LEAK = 721**

An exception occurred on the device while exiting a kernel using tensor memory: the tensor memory was not completely deallocated. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_NOT_PERMITTED = 800**

This error indicates that the attempted operation is not permitted.

**CUDA_ERROR_NOT_SUPPORTED = 801**

This error indicates that the attempted operation is not supported on the current system or device.

**CUDA_ERROR_SYSTEM_NOT_READY = 802**

This error indicates that the system is not yet ready to start any CUDA work. To continue using CUDA, verify the system configuration is in a valid state and all required driver daemons are actively running. More information about this error can be found in the system specific user guide.

**CUDA_ERROR_SYSTEM_DRIVER_MISMATCH = 803**
This error indicates that there is a mismatch between the versions of the display driver and the CUDA driver. Refer to the compatibility documentation for supported versions.

**CUDA_ERROR_COMPAT_NOT_SUPPORTED_ON_DEVICE = 804**
This error indicates that the system was upgraded to run with forward compatibility but the visible hardware detected by CUDA does not support this configuration. Refer to the compatibility documentation for the supported hardware matrix or ensure that only supported hardware is visible during initialization via the CUDA_VISIBLE_DEVICES environment variable.

**CUDA_ERROR_MPS_CONNECTION_FAILED = 805**
This error indicates that the MPS client failed to connect to the MPS control daemon or the MPS server.

**CUDA_ERROR_MPS_RPC_FAILURE = 806**
This error indicates that the remote procedural call between the MPS server and the MPS client failed.

**CUDA_ERROR_MPS_SERVER_NOT_READY = 807**
This error indicates that the MPS server is not ready to accept new MPS client requests. This error can be returned when the MPS server is in the process of recovering from a fatal failure.

**CUDA_ERROR_MPS_MAX_CLIENTS_REACHED = 808**
This error indicates that the hardware resources required to create MPS client have been exhausted.

**CUDA_ERROR_MPS_MAX_CONNECTIONS_REACHED = 809**
This error indicates the the hardware resources required to support device connections have been exhausted.

**CUDA_ERROR_MPS_CLIENT_TERMINATED = 810**
This error indicates that the MPS client has been terminated by the server. To continue using CUDA, the process must be terminated and relaunched.

**CUDA_ERROR_CDP_NOT_SUPPORTED = 811**
This error indicates that the module is using CUDA Dynamic Parallelism, but the current configuration, like MPS, does not support it.

**CUDA_ERROR_CDP_VERSION_MISMATCH = 812**
This error indicates that a module contains an unsupported interaction between different versions of CUDA Dynamic Parallelism.

**CUDA_ERROR_STREAM_CAPTURE_UNSUPPORTED = 900**
This error indicates that the operation is not permitted when the stream is capturing.

**CUDA_ERROR_STREAM_CAPTURE_INVALIDATED = 901**
This error indicates that the current capture sequence on the stream has been invalidated due to a previous error.

**CUDA_ERROR_STREAM_CAPTURE_MERGE = 902**
This error indicates that the operation would have resulted in a merge of two independent capture sequences.

**CUDA_ERROR_STREAM_CAPTURE_UNMATCHED = 903**
This error indicates that the capture was not initiated in this stream.

**CUDA_ERROR_STREAM_CAPTURE_UNJOINED = 904**

This error indicates that the capture sequence contains a fork that was not joined to the primary stream.

**CUDA_ERROR_STREAM_CAPTURE_ISOLATION = 905**

This error indicates that a dependency would have been created which crosses the capture sequence boundary. Only implicit in-stream ordering dependencies are allowed to cross the boundary.

**CUDA_ERROR_STREAM_CAPTURE_IMPLICIT = 906**

This error indicates a disallowed implicit dependency on a current capture sequence from cudaStreamLegacy.

**CUDA_ERROR_CAPTURED_EVENT = 907**

This error indicates that the operation is not permitted on an event which was last recorded in a capturing stream.

**CUDA_ERROR_STREAM_CAPTURE_WRONG_THREAD = 908**

A stream capture sequence not initiated with the CU_STREAM_CAPTURE_MODE_RELAXED argument to cuStreamBeginCapture was passed to cuStreamEndCapture in a different thread.

**CUDA_ERROR_TIMEOUT = 909**

This error indicates that the timeout specified for the wait operation has lapsed.

**CUDA_ERROR_GRAPH_EXEC_UPDATE_FAILURE = 910**

This error indicates that the graph update was not performed because it included changes which violated constraints specific to instantiated graph update.

**CUDA_ERROR_EXTERNAL_DEVICE = 911**

This indicates that an error has occurred in a device outside of GPU. It can be a synchronous error w.r.t. CUDA API or an asynchronous error from the external device. In case of asynchronous error, it means that if cuda was waiting for an external device's signal before consuming shared data, the external device signaled an error indicating that the data is not valid for consumption. This leaves the process in an inconsistent state and any further CUDA work will return the same error. To continue using CUDA, the process must be terminated and relaunched. In case of synchronous error, it means that one or more external devices have encountered an error and cannot complete the operation.

**CUDA_ERROR_INVALID_CLUSTER_SIZE = 912**

Indicates a kernel launch error due to cluster misconfiguration.

**CUDA_ERROR_FUNCTION_NOT_LOADED = 913**

Indiciates a function handle is not loaded when calling an API that requires a loaded function.

**CUDA_ERROR_INVALID_RESOURCE_TYPE = 914**

This error indicates one or more resources passed in are not valid resource types for the operation.

**CUDA_ERROR_INVALID_RESOURCE_CONFIGURATION = 915**

This error indicates one or more resources are insufficient or non-applicable for the operation.

**CUDA_ERROR_KEY_ROTATION = 916**

This error indicates that an error happened during the key rotation sequence.

**CUDA_ERROR_STREAM_DETACHED = 917**

This error indicates that the requested operation is not permitted because the stream is in a detached state. This can occur if the green context associated with the stream has been destroyed, limiting the stream's operational capabilities.

**CUDA_ERROR_GRAPH_RECAPTURE_FAILURE = 918**

This error indicates that a graph recapture failed and had to be terminated.

**CUDA_ERROR_UNKNOWN = 999**

This indicates that an unknown internal error has occurred.

## enum CUshared_carveout

Shared memory carveout configurations. These may be passed to cuFuncSetAttribute or cuKernelSetAttribute

### Values

**CU_SHAREDMEM_CARVEOUT_DEFAULT = -1**

No preference for shared memory or L1 (default)

**CU_SHAREDMEM_CARVEOUT_MAX_SHARED = 100**

Prefer maximum available shared memory, minimum L1 cache

**CU_SHAREDMEM_CARVEOUT_MAX_L1 = 0**

Prefer maximum available L1 cache, minimum shared memory

## enum CUsharedconfig

Deprecated

Shared memory configurations

### Values

**CU_SHARED_MEM_CONFIG_DEFAULT_BANK_SIZE = 0x00**

set default shared memory bank size

**CU_SHARED_MEM_CONFIG_FOUR_BYTE_BANK_SIZE = 0x01**

set shared memory bank width to four bytes

**CU_SHARED_MEM_CONFIG_EIGHT_BYTE_BANK_SIZE = 0x02**

set shared memory bank width to eight bytes

## enum CUsharedMemoryMode

Shared memory related attributes for use with cuLaunchKernelEx

### Values

**CU_SHARED_MEMORY_MODE_DEFAULT = 0**

The default to use for shared memory on launch - uses current function attribute for CU_FUNC_ATTRIBUTE_MAX_DYNAMIC_SHARED_SIZE_BYTES

**CU_SHARED_MEMORY_MODE_REQUIRE_PORTABLE = 1**

Specifies that the dynamic shared size bytes requested must be a portable size within the bounds of CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK

**CU_SHARED_MEMORY_MODE_ALLOW_NON_PORTABLE = 2**

Specifies that the dynamic shared size bytes requested may be a non-portable size but still within the bounds of CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK_OPTIN

## enum CUstream_flags

Stream creation flags

### Values

**CU_STREAM_DEFAULT = 0x0**
Default stream flag
**CU_STREAM_NON_BLOCKING = 0x1**
Stream does not synchronize with stream 0 (the NULL stream)

## enum CUstreamAtomicReductionDataType

Atomic reduction data types for CUstreamBatchMemOpParams::atomicReduction::dataType

### Values

**CU_STREAM_ATOMIC_REDUCTION_UNSIGNED_32 = CU_ATOMIC_CAPABILITY_UNSIGNED|CU_ATOMIC_CAPABILITY_SCALAR_32|CU_ATOMIC_CAPABILITY_REDUCTION**
**CU_STREAM_ATOMIC_REDUCTION_UNSIGNED_64 = CU_ATOMIC_CAPABILITY_UNSIGNED|CU_ATOMIC_CAPABILITY_SCALAR_64|CU_ATOMIC_CAPABILITY_REDUCTION**

## enum CUstreamAtomicReductionOpType

Atomic reduction operation types for CUstreamBatchMemOpParams::atomicReduction::reductionOp

### Values

**CU_STREAM_ATOMIC_REDUCTION_OP_OR = CU_ATOMIC_OPERATION_OR**
Performs an atomic OR: *(address) = *(address) | value
**CU_STREAM_ATOMIC_REDUCTION_OP_AND = CU_ATOMIC_OPERATION_AND**
Performs an atomic AND: *(address) = *(address) & value
**CU_STREAM_ATOMIC_REDUCTION_OP_ADD = CU_ATOMIC_OPERATION_INTEGER_ADD**
Performs an atomic ADD: *(address) = *(address) + value

## enum CUstreamBatchMemOpType

Operations for cuStreamBatchMemOp

### Values

**CU_STREAM_MEM_OP_WAIT_VALUE_32 = 1**
Represents a cuStreamWaitValue32 operation
**CU_STREAM_MEM_OP_WRITE_VALUE_32 = 2**
Represents a cuStreamWriteValue32 operation
**CU_STREAM_MEM_OP_WAIT_VALUE_64 = 4**
Represents a cuStreamWaitValue64 operation
**CU_STREAM_MEM_OP_WRITE_VALUE_64 = 5**
Represents a cuStreamWriteValue64 operation
**CU_STREAM_MEM_OP_BARRIER = 6**
Insert a memory barrier of the specified type
**CU_STREAM_MEM_OP_ATOMIC_REDUCTION = 8**
Perform a atomic reduction. See CUstreamBatchMemOpParams::atomicReduction
**CU_STREAM_MEM_OP_FLUSH_REMOTE_WRITES = 3**
This has the same effect as CU_STREAM_WAIT_VALUE_FLUSH, but as a standalone operation.

## enum CUstreamCaptureMode

Possible modes for stream capture thread interactions. For more details see cuStreamBeginCapture and cuThreadExchangeStreamCaptureMode

### Values

**CU_STREAM_CAPTURE_MODE_GLOBAL = 0**
**CU_STREAM_CAPTURE_MODE_THREAD_LOCAL = 1**
**CU_STREAM_CAPTURE_MODE_RELAXED = 2**

## enum CUstreamCaptureStatus

Possible stream capture statuses returned by cuStreamIsCapturing

### Values

**CU_STREAM_CAPTURE_STATUS_NONE = 0**
Stream is not capturing
**CU_STREAM_CAPTURE_STATUS_ACTIVE = 1**
Stream is actively capturing
**CU_STREAM_CAPTURE_STATUS_INVALIDATED = 2**
Stream is part of a capture sequence that has been invalidated, but not terminated

## enum CUstreamMemoryBarrier_flags

Flags for CUstreamBatchMemOpParams::memoryBarrier

### Values

**CU_STREAM_MEMORY_BARRIER_TYPE_SYS = 0x0**
System-wide memory barrier.

**CU_STREAM_MEMORY_BARRIER_TYPE_GPU = 0x1**
Limit memory barrier scope to the GPU.

## enum CUstreamUpdateCaptureDependencies_flags

Flags for cuStreamUpdateCaptureDependencies

### Values

**CU_STREAM_ADD_CAPTURE_DEPENDENCIES = 0x0**
Add new nodes to the dependency set

**CU_STREAM_SET_CAPTURE_DEPENDENCIES = 0x1**
Replace the dependency set with the new nodes

## enum CUstreamWaitValue_flags

Flags for cuStreamWaitValue32 and cuStreamWaitValue64

### Values

**CU_STREAM_WAIT_VALUE_GEQ = 0x0**
Wait until (int32_t)(*addr - value) >= 0 (or int64_t for 64 bit values). Note this is a cyclic comparison which ignores wraparound. (Default behavior.)

**CU_STREAM_WAIT_VALUE_EQ = 0x1**
Wait until *addr == value.

**CU_STREAM_WAIT_VALUE_AND = 0x2**
Wait until (*addr & value) != 0.

**CU_STREAM_WAIT_VALUE_NOR = 0x3**
Wait until ~(*addr | value) != 0. Support for this operation can be queried with cuDeviceGetAttribute() and CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR.

**CU_STREAM_WAIT_VALUE_FLUSH = 1<<30**
Follow the wait operation with a flush of outstanding remote writes. This means that, if a remote write operation is guaranteed to have reached the device before the wait can be satisfied, that write is guaranteed to be visible to downstream device work. The device is permitted to reorder remote writes internally. For example, this flag would be required if two remote writes arrive in a defined order, the wait is satisfied by the second write, and downstream work needs to observe the first write. Support for this operation is restricted to selected platforms and can be queried with CU_DEVICE_ATTRIBUTE_CAN_FLUSH_REMOTE_WRITES.

# enum CUstreamWriteValue_flags

Flags for cuStreamWriteValue32

## Values

**CU_STREAM_WRITE_VALUE_DEFAULT = 0x0**
Default behavior

**CU_STREAM_WRITE_VALUE_NO_MEMORY_BARRIER = 0x1**
Permits the write to be reordered with writes which were issued before it, as a performance optimization. Normally, cuStreamWriteValue32 will provide a memory fence before the write, which has similar semantics to __threadfence_system() but is scoped to the stream rather than a CUDA thread. This flag is not supported in the v2 API.

# enum CUtensorMapDataType

Tensor map data type

## Values

**CU_TENSOR_MAP_DATA_TYPE_UINT8 = 0**
**CU_TENSOR_MAP_DATA_TYPE_UINT16**
**CU_TENSOR_MAP_DATA_TYPE_UINT32**
**CU_TENSOR_MAP_DATA_TYPE_INT32**
**CU_TENSOR_MAP_DATA_TYPE_UINT64**
**CU_TENSOR_MAP_DATA_TYPE_INT64**
**CU_TENSOR_MAP_DATA_TYPE_FLOAT16**
**CU_TENSOR_MAP_DATA_TYPE_FLOAT32**
**CU_TENSOR_MAP_DATA_TYPE_FLOAT64**
**CU_TENSOR_MAP_DATA_TYPE_BFLOAT16**
**CU_TENSOR_MAP_DATA_TYPE_FLOAT32_FTZ**
**CU_TENSOR_MAP_DATA_TYPE_TFLOAT32**
**CU_TENSOR_MAP_DATA_TYPE_TFLOAT32_FTZ**
**CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B**
**CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B**
**CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B**

# enum CUtensorMapFloatOOBfill

Tensor map out-of-bounds fill type

## Values

**CU_TENSOR_MAP_FLOAT_OOB_FILL_NONE = 0**
**CU_TENSOR_MAP_FLOAT_OOB_FILL_NAN_REQUEST_ZERO_FMA**

## enum CUtensorMapIm2ColWideMode

Tensor map Im2Col wide mode

### Values

**CU_TENSOR_MAP_IM2COL_WIDE_MODE_W = 0**
**CU_TENSOR_MAP_IM2COL_WIDE_MODE_W128**

## enum CUtensorMapInterleave

Tensor map interleave layout type

### Values

**CU_TENSOR_MAP_INTERLEAVE_NONE = 0**
**CU_TENSOR_MAP_INTERLEAVE_16B**
**CU_TENSOR_MAP_INTERLEAVE_32B**

## enum CUtensorMapL2promotion

Tensor map L2 promotion type

### Values

**CU_TENSOR_MAP_L2_PROMOTION_NONE = 0**
**CU_TENSOR_MAP_L2_PROMOTION_L2_64B**
**CU_TENSOR_MAP_L2_PROMOTION_L2_128B**
**CU_TENSOR_MAP_L2_PROMOTION_L2_256B**

## enum CUtensorMapSwizzle

Tensor map swizzling mode of shared memory banks

### Values

**CU_TENSOR_MAP_SWIZZLE_NONE = 0**
**CU_TENSOR_MAP_SWIZZLE_32B**
**CU_TENSOR_MAP_SWIZZLE_64B**
**CU_TENSOR_MAP_SWIZZLE_128B**
**CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B**
**CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B_FLIP_8B**
**CU_TENSOR_MAP_SWIZZLE_128B_ATOM_64B**

## enum CUuserObject_flags

Flags for user objects for graphs

### Values

**CU_USER_OBJECT_NO_DESTRUCTOR_SYNC = 1**
Indicates the destructor execution is not synchronized by any CUDA handle.

## enum CUuserObjectRetain_flags

Flags for retaining user object references for graphs

### Values

**CU_GRAPH_USER_OBJECT_MOVE = 1**
Transfer references from the caller rather than creating new references.

## typedef CUaccessPolicyWindow

Access policy window

## typedef struct CUarray_st *CUarray

CUDA array

## typedef (*CUasyncCallback) (CUasyncNotificationInfo* info, void* userData, CUasyncCallbackHandle callback)

CUDA async notification callback

## typedef struct CUasyncCallbackEntry_st *CUasyncCallbackHandle

CUDA async notification callback handle

## typedef struct CUctx_st *CUcontext

A regular context handle

## typedef CUdevice

CUDA device

## typedef int CUdevice_v1

CUDA device

## typedef CUdeviceptr

CUDA device pointer

## typedef unsigned int CUdeviceptr_v2

CUDA device pointer CUdeviceptr is defined as an unsigned integer type whose size matches the size of a pointer on the target platform.

## typedef struct CUeglStreamConnection_st *CUeglStreamConnection

CUDA EGLSream Connection

## typedef struct CUevent_st *CUevent

CUDA event

## typedef CUexecAffinityParam

Execution Affinity Parameters

## typedef struct CUextMemory_st *CUexternalMemory

CUDA external memory

## typedef struct CUextSemaphore_st *CUexternalSemaphore

CUDA external semaphore

## typedef struct CUfunc_st *CUfunction

CUDA function

## typedef struct CUgraph_st *CUgraph

CUDA graph

## typedef cuuint64_t CUgraphConditionalHandle

CUDA graph conditional handle

## typedef struct CUgraphDeviceUpdatableNode_st *CUgraphDeviceNode

CUDA graph device node handle

## typedef struct CUgraphExec_st *CUgraphExec

CUDA executable graph

## typedef struct CUgraphicsResource_st *CUgraphicsResource

CUDA graphics interop resource

## typedef struct CUgraphNode_st *CUgraphNode

CUDA graph node

## typedef struct CUgreenCtx_st *CUgreenCtx

A green context handle. This handle can be used safely from only one CPU thread at a time. Created via cuGreenCtxCreate

## typedef void (CUDA_CB *CUhostFn) (void* userData)

CUDA host function

## typedef struct CUkern_st *CUkernel

CUDA kernel

## typedef struct CUlib_st *CUlibrary

CUDA library

## typedef struct CUmemPoolHandle_st *CUmemoryPool

CUDA memory pool

## typedef struct CUmipmappedArray_st *CUmipmappedArray

CUDA mipmapped array

## typedef struct CUmod_st *CUmodule

CUDA module

## typedef size_t (CUDA_CB *CUoccupancyB2DSize) (int blockSize)

Block size to per-block dynamic shared memory mapping for a certain kernel

## typedef struct CUstream_st *CUstream

CUDA stream

## typedef void (CUDA_CB *CUstreamCallback) (CUstream hStream, CUresult status, void* userData)

CUDA stream callback

## typedef CUsurfObject

An opaque value that represents a CUDA surface object

## typedef unsigned long long CUsurfObject_v1

An opaque value that represents a CUDA surface object

## typedef struct CUsurfref_st *CUsurfref

CUDA surface reference

## typedef CUtexObject

An opaque value that represents a CUDA texture object

## typedef unsigned long long CUtexObject_v1

An opaque value that represents a CUDA texture object

## typedef struct CUtexref_st *CUtexref

CUDA texture reference

## typedef struct CUuserObject_st *CUuserObject

CUDA user object for graphs

## #define CU_ARRAY_SPARSE_PROPERTIES_SINGLE_MIPTAIL 0x1

Indicates that the layered sparse CUDA array or CUDA mipmapped array has a single mip tail region for all layers

## #define CU_DEVICE_CPU ((CUdevice)-1)

Device that represents the CPU

## #define CU_DEVICE_INVALID ((CUdevice)-2)

Device that represents an invalid device

## #define CU_GRAPH_COND_ASSIGN_DEFAULT 0x1

Conditional node handle flags Default value is applied when graph is launched.

## #define CU_GRAPH_KERNEL_NODE_PORT_DEFAULT 0

This port activates when the kernel has finished executing.

## #define CU_GRAPH_KERNEL_NODE_PORT_LAUNCH_ORDER 2

This port activates when all blocks of the kernel have begun execution. See also CU_LAUNCH_ATTRIBUTE_LAUNCH_COMPLETION_EVENT.

## #define CU_GRAPH_KERNEL_NODE_PORT_PROGRAMMATIC 1

This port activates when all blocks of the kernel have performed cudaTriggerProgrammaticLaunchCompletion() or have terminated. It must be used with edge type CU_GRAPH_DEPENDENCY_TYPE_PROGRAMMATIC. See also CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_EVENT.

## #define CU_IPC_HANDLE_SIZE 64

CUDA IPC handle size

## #define CU_LAUNCH_KERNEL_REQUIRED_BLOCK_DIM 1

Launch with the required block dimension.

## #define CU_LAUNCH_PARAM_BUFFER_POINTER ((void*)CU_LAUNCH_PARAM_BUFFER_POINTER_AS_INT)

Indicator that the next value in the `extra` parameter to cuLaunchKernel will be a pointer to a buffer containing all kernel parameters used for launching kernel `f`. This buffer needs to honor all alignment/padding requirements of the individual parameters. If CU_LAUNCH_PARAM_BUFFER_SIZE is not also specified in the `extra` array, then CU_LAUNCH_PARAM_BUFFER_POINTER will have no effect.

## #define CU_LAUNCH_PARAM_BUFFER_POINTER_AS_INT 0x01

C++ compile time constant for CU_LAUNCH_PARAM_BUFFER_POINTER

## #define CU_LAUNCH_PARAM_BUFFER_SIZE ((void*)CU_LAUNCH_PARAM_BUFFER_SIZE_AS_INT)

Indicator that the next value in the `extra` parameter to cuLaunchKernel will be a pointer to a size_t which contains the size of the buffer specified with CU_LAUNCH_PARAM_BUFFER_POINTER. It is required that CU_LAUNCH_PARAM_BUFFER_POINTER also be specified in the `extra` array if the value associated with CU_LAUNCH_PARAM_BUFFER_SIZE is not zero.

## #define CU_LAUNCH_PARAM_BUFFER_SIZE_AS_INT 0x02

C++ compile time constant for CU_LAUNCH_PARAM_BUFFER_SIZE

## #define CU_LAUNCH_PARAM_END ((void*)CU_LAUNCH_PARAM_END_AS_INT)

End of array terminator for the `extra` parameter to cuLaunchKernel

## #define CU_LAUNCH_PARAM_END_AS_INT 0x00

C++ compile time constant for CU_LAUNCH_PARAM_END

## #define CU_MEM_CREATE_USAGE_HW_DECOMPRESS 0x2

This flag, if set, indicates that the memory will be used as a buffer for hardware accelerated decompression.

## #define CU_MEM_CREATE_USAGE_TILE_POOL 0x1

This flag if set indicates that the memory will be used as a tile pool.

## #define CU_MEM_POOL_CREATE_USAGE_HW_DECOMPRESS 0x2

This flag, if set, indicates that the memory will be used as a buffer for hardware accelerated decompression.

## #define CU_MEMHOSTALLOC_DEVICEMAP 0x02

If set, host memory is mapped into CUDA address space and cuMemHostGetDevicePointer() may be called on the host pointer. Flag for cuMemHostAlloc()

## #define CU_MEMHOSTALLOC_PORTABLE 0x01

If set, host memory is portable between CUDA contexts. Flag for cuMemHostAlloc()

## #define CU_MEMHOSTALLOC_WRITECOMBINED 0x04

If set, host memory is allocated as write-combined - fast to write, faster to DMA, slow to read except via SSE4 streaming load instruction (MOVNTDQA). Flag for cuMemHostAlloc()

## #define CU_MEMHOSTREGISTER_DEVICEMAP 0x02

If set, host memory is mapped into CUDA address space and cuMemHostGetDevicePointer() may be called on the host pointer. Flag for cuMemHostRegister()

## #define CU_MEMHOSTREGISTER_IOMEMORY 0x04

If set, the passed memory pointer is treated as pointing to some memory-mapped I/O space, e.g. belonging to a third-party PCIe device. On Windows the flag is a no-op. On Linux that memory is marked as non cache-coherent for the GPU and is expected to be physically contiguous. It may return CUDA_ERROR_NOT_PERMITTED if run as an unprivileged user, CUDA_ERROR_NOT_SUPPORTED on older Linux kernel versions. On all other platforms, it is not supported and CUDA_ERROR_NOT_SUPPORTED is returned. Flag for cuMemHostRegister()

## #define CU_MEMHOSTREGISTER_PORTABLE 0x01

If set, host memory is portable between CUDA contexts. Flag for cuMemHostRegister()

## #define CU_MEMHOSTREGISTER_READ_ONLY 0x08

If set, the passed memory pointer is treated as pointing to memory that is considered read-only by the device. On platforms without CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES, this flag is required in order to register memory mapped to the CPU as read-only. Support for the use of this flag can be queried from the device attribute CU_DEVICE_ATTRIBUTE_READ_ONLY_HOST_REGISTER_SUPPORTED. Using this flag with a current context associated with a device that does not have this attribute set will cause cuMemHostRegister to error with CUDA_ERROR_NOT_SUPPORTED.

## #define CU_PARAM_TR_DEFAULT -1

For texture references loaded into the module, use default texunit from texture reference.

## #define CU_STREAM_LEGACY ((CUstream)0x1)

Legacy stream handle

Stream handle that can be passed as a CUstream to use an implicit stream with legacy synchronization behavior.

See details of the synchronization behavior.

## #define CU_STREAM_PER_THREAD ((CUstream)0x2)

Per-thread stream handle

Stream handle that can be passed as a CUstream to use an implicit stream with per-thread synchronization behavior.

See details of the synchronization behavior.

## #define CU_TENSOR_MAP_NUM_QWORDS 16

Size of tensor map descriptor

## #define CU_TRSA_OVERRIDE_FORMAT 0x01

Override the texref format with a format inferred from the array. Flag for cuTexRefSetArray()

## #define CU_TRSF_DISABLE_TRILINEAR_OPTIMIZATION 0x20

Disable any trilinear filtering optimizations. Flag for cuTexRefSetFlags() and cuTexObjectCreate()

## #define CU_TRSF_NORMALIZED_COORDINATES 0x02

Use normalized texture coordinates in the range [0,1) instead of [0,dim). Flag for cuTexRefSetFlags() and cuTexObjectCreate()

## #define CU_TRSF_READ_AS_INTEGER 0x01

Read the texture as integers rather than promoting the values to floats in the range [0,1]. Flag for cuTexRefSetFlags() and cuTexObjectCreate()

## #define CU_TRSF_SEAMLESS_CUBEMAP 0x40

Enable seamless cube map filtering. Flag for cuTexObjectCreate()

## #define CU_TRSF_SRGB 0x10

Perform sRGB->linear conversion during texture read. Flag for cuTexRefSetFlags() and cuTexObjectCreate()

## #define CUDA_ARRAY3D_2DARRAY 0x01

Deprecated, use CUDA_ARRAY3D_LAYERED

## #define CUDA_ARRAY3D_COLOR_ATTACHMENT 0x20

This flag indicates that the CUDA array may be bound as a color target in an external graphics API

## #define CUDA_ARRAY3D_CUBEMAP 0x04

If set, the CUDA array is a collection of six 2D arrays, representing faces of a cube. The width of such a CUDA array must be equal to its height, and Depth must be six. If CUDA_ARRAY3D_LAYERED flag is also set, then the CUDA array is a collection of cubemaps and Depth must be a multiple of six.

## #define CUDA_ARRAY3D_DEFERRED_MAPPING 0x80

This flag if set indicates that the CUDA array or CUDA mipmapped array will allow deferred memory mapping

## #define CUDA_ARRAY3D_DEPTH_TEXTURE 0x10

This flag if set indicates that the CUDA array is a DEPTH_TEXTURE.

## #define CUDA_ARRAY3D_LAYERED 0x01

If set, the CUDA array is a collection of layers, where each layer is either a 1D or a 2D array and the Depth member of CUDA_ARRAY3D_DESCRIPTOR specifies the number of layers, not the depth of a 3D array.

## #define CUDA_ARRAY3D_SPARSE 0x40

This flag if set indicates that the CUDA array or CUDA mipmapped array is a sparse CUDA array or CUDA mipmapped array respectively

## #define CUDA_ARRAY3D_SURFACE_LDST 0x02

This flag must be set in order to bind a surface reference to the CUDA array

## #define CUDA_ARRAY3D_TEXTURE_GATHER 0x08

This flag must be set in order to perform texture gather operations on a CUDA array.

## #define CUDA_ARRAY3D_VIDEO_ENCODE_DECODE 0x100

This flag indicates that the CUDA array will be used for hardware accelerated video encode/decode operations.

## #define CUDA_COOPERATIVE_LAUNCH_MULTI_DEVICE_NO_POST_ 0x02

If set, any subsequent work pushed in a stream that participated in a call to cuLaunchCooperativeKernelMultiDevice will only wait for the kernel launched on the GPU corresponding to that stream to complete before it begins execution.

## #define CUDA_COOPERATIVE_LAUNCH_MULTI_DEVICE_NO_PRE_L 0x01

If set, each kernel launched as part of cuLaunchCooperativeKernelMultiDevice only waits for prior work in the stream corresponding to that GPU to complete before the kernel begins execution.

## #define CUDA_EGL_INFINITE_TIMEOUT 0xFFFFFFFF

Indicates that timeout for cuEGLStreamConsumerAcquireFrame is infinite.

## #define CUDA_EXTERNAL_MEMORY_DEDICATED 0x1

Indicates that the external memory object is a dedicated resource

## #define CUDA_EXTERNAL_SEMAPHORE_SIGNAL_SKIP_NVSCIBUF_ 0x01

When the `flags` parameter of CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS contains this flag, it indicates that signaling an external semaphore object should skip performing appropriate memory synchronization operations over all the external memory objects that are imported as CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF, which otherwise are performed by default to ensure data coherency with other importers of the same NvSciBuf memory objects.

## #define CUDA_EXTERNAL_SEMAPHORE_WAIT_SKIP_NVSCIBUF_M 0x02

When the `flags` parameter of CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS contains this flag, it indicates that waiting on an external semaphore object should skip performing appropriate memory synchronization operations over all the external memory objects that are imported as CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF, which otherwise are performed by default to ensure data coherency with other importers of the same NvSciBuf memory objects.

## #define CUDA_NVSCISYNC_ATTR_SIGNAL 0x1

When `flags` of cuDeviceGetNvSciSyncAttributes is set to this, it indicates that application needs signaler specific NvSciSyncAttr to be filled by cuDeviceGetNvSciSyncAttributes.

## #define CUDA_NVSCISYNC_ATTR_WAIT 0x2

When `flags` of cuDeviceGetNvSciSyncAttributes is set to this, it indicates that application needs waiter specific NvSciSyncAttr to be filled by cuDeviceGetNvSciSyncAttributes.

## #define CUDA_VERSION 13030

CUDA API version number

## #define MAX_PLANES 3

Maximum number of planes per frame

# 6.2. Error Handling

This section describes the error handling functions of the low-level CUDA driver application programming interface.

# CUresult cuGetErrorName (CUresult error, const char **pStr)

Gets the string representation of an error code enum name.

## Parameters

**error**
- Error code to convert to string

**pStr**
- Address of the string pointer.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Sets `*pStr` to the address of a NULL-terminated string representation of the name of the enum error code `error`. If the error code is not recognized, CUDA_ERROR_INVALID_VALUE will be returned and `*pStr` will be set to the NULL address.

See also:

CUresult, cudaGetErrorName

# CUresult cuGetErrorString (CUresult error, const char **pStr)

Gets the string description of an error code.

## Parameters

**error**
- Error code to convert to string

**pStr**
- Address of the string pointer.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Sets `*pStr` to the address of a NULL-terminated string description of the error code `error`. If the error code is not recognized, CUDA_ERROR_INVALID_VALUE will be returned and `*pStr` will be set to the NULL address.

See also:

CUresult, cudaGetErrorString

# 6.3. Initialization

This section describes the initialization functions of the low-level CUDA driver application programming interface.

## CUresult cuInit (unsigned int Flags)

Initialize the CUDA driver API Initializes the driver API and must be called before any other function from the driver API in the current process. Currently, the `Flags` parameter must be 0. If cuInit() has not been called, any function from the driver API will return CUDA_ERROR_NOT_INITIALIZED.

### Parameters

**Flags**

- Initialization flag for CUDA.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_SYSTEM_DRIVER_MISMATCH, CUDA_ERROR_COMPAT_NOT_SUPPORTED_ON_DEVICE

### Description

Note: cuInit preloads various libraries needed for JIT compilation. To opt-out of this behavior, set the environment variable CUDA_FORCE_PRELOAD_LIBRARIES=0. CUDA will lazily load JIT libraries as needed. To disable JIT entirely, set the environment variable CUDA_DISABLE_JIT=1.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

# 6.4. Version Management

This section describes the version management functions of the low-level CUDA driver application programming interface.

## CUresult cuDriverGetVersion (int *driverVersion)

Returns the latest CUDA version supported by driver.

### Parameters

**driverVersion**
- Returns the CUDA driver version

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

Returns in `*driverVersion` the version of CUDA supported by the driver. The version is returned as (1000 * major + 10 * minor). For example, CUDA 9.2 would be represented by 9020.

This function automatically returns CUDA_ERROR_INVALID_VALUE if `driverVersion` is NULL.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cudaDriverGetVersion, cudaRuntimeGetVersion

# 6.5. Device Management

This section describes the device management functions of the low-level CUDA driver application programming interface.

## CUresult cuDeviceGet (CUdevice *device, int ordinal)

Returns a handle to a compute device.

### Parameters

**device**
- Returned device handle

**ordinal**
- Device number to get handle for

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

### Description

Returns in `*device` a device handle given an ordinal in the range [0, cuDeviceGetCount()-1].

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGetLuid, cuDeviceTotalMem, cuDeviceGetExecAffinitySupport

## CUresult cuDeviceGetAttribute (int *pi, CUdevice_attribute attrib, CUdevice dev)

Returns information about the device.

### Parameters

**pi**
- Returned device attribute value

**attrib**
- Device attribute to query

**dev**
- Device handle

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

### Description

Returns in `*pi` the integer value of the attribute `attrib` on device `dev`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGet, cuDeviceTotalMem, cuDeviceGetExecAffinitySupport, cudaDeviceGetAttribute, cudaGetDeviceProperties

# CUresult cuDeviceGetCount (int *count)

Returns the number of compute-capable devices.

## Parameters

**count**

- Returned number of compute-capable devices

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `*count` the number of devices with compute capability greater than or equal to 2.0 that are available for execution. If there is no such device, cuDeviceGetCount() returns 0.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGetLuid, cuDeviceGet, cuDeviceTotalMem, cuDeviceGetExecAffinitySupport, cudaGetDeviceCount

# CUresult cuDeviceGetDefaultMemPool (CUmemoryPool *pool_out, CUdevice dev)

Returns the default mempool of a device.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_SUPPORTED

### Description

The default mempool of a device contains device memory from that device.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemAllocAsync, cuMemPoolTrimTo, cuMemPoolGetAttribute, cuMemPoolSetAttribute, cuMemPoolSetAccess, cuDeviceGetMemPool, cuMemPoolCreate

## CUresult cuDeviceGetExecAffinitySupport (int *pi, CUexecAffinityType type, CUdevice dev)

Returns information about the execution affinity support of the device.

### Parameters

**pi**

- 1 if the execution affinity type `type` is supported by the device, or 0 if not

**type**

- Execution affinity type to query

**dev**

- Device handle

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

### Description

Returns in `*pi` whether execution affinity type `type` is supported by device `dev`. The supported types are:

- CU_EXEC_AFFINITY_TYPE_SM_COUNT: 1 if context with limited SMs is supported by the device, or 0 if not;

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGet, cuDeviceTotalMem

# CUresult cuDeviceGetHostAtomicCapabilities (unsigned int *capabilities, const CUatomicOperation *operations, unsigned int count, CUdevice dev)

Queries details about atomic operations supported between the device and host.

## Parameters

**capabilities**
- Returned capability details of each requested operation

**operations**
- Requested operations

**count**
- Count of requested operations and size of capabilities

**dev**
- Device handle

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `*capabilities` the details about requested atomic `*operations` over the the link between `dev` and the host. The allocated size of `*operations` and `*capabilities` must be `count`.

For each CUatomicOperation in `*operations`, the corresponding result in `*capabilities` will be a bitmask indicating which of CUatomicOperationCapability the link supports natively.

Returns CUDA_ERROR_INVALID_DEVICE if `dev` is not valid.

Returns CUDA_ERROR_INVALID_VALUE if `*capabilities` or `*operations` is NULL, if `count` is 0, or if any of `*operations` is not valid.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetP2PAtomicCapabilities, cudaDeviceGeHostAtomicCapabilities

# CUresult cuDeviceGetLuid (char *luid, unsigned int *deviceNodeMask, CUdevice dev)

Return an LUID and device node mask for the device.

## Parameters

**luid**
- Returned LUID

**deviceNodeMask**
- Returned device node mask

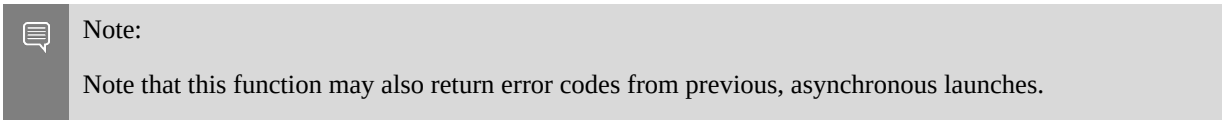
**dev**
- Device to get identifier string for

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Return identifying information (`luid` and `deviceNodeMask`) to allow matching device with graphics APIs.




See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGet, cuDeviceTotalMem, cuDeviceGetExecAffinitySupport, cudaGetDeviceProperties

# CUresult cuDeviceGetMemPool (CUmemoryPool *pool, CUdevice dev)

Gets the current mempool for a device.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

Returns the last pool provided to cuDeviceSetMemPool for this device or the device's default memory pool if cuDeviceSetMemPool has never been called. By default the current mempool is the default mempool for a device. Otherwise the returned pool must have been set with cuDeviceSetMemPool.

See also:

cuDeviceGetDefaultMemPool, cuMemPoolCreate, cuDeviceSetMemPool

## CUresult cuDeviceGetName (char *name, int len, CUdevice dev)

Returns an identifier string for the device.

### Parameters

**name**
- Returned identifier string for the device

**len**
- Maximum length of string to store in `name`

**dev**
- Device to get identifier string for

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

### Description

Returns an ASCII string identifying the device `dev` in the NULL-terminated string pointed to by `name`. `len` specifies the maximum length of the string that may be returned. `name` is shortened to the specified `len`, if `len` is less than the device name

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetUuid, cuDeviceGetLuid, cuDeviceGetCount, cuDeviceGet, cuDeviceTotalMem, cuDeviceGetExecAffinitySupport, cudaGetDeviceProperties

# CUresult cuDeviceGetNvSciSyncAttributes (void *nvSciSyncAttrList, CUdevice dev, int flags)

Return NvSciSync attributes that this device can support.

## Parameters

**nvSciSyncAttrList**
- Return NvSciSync attributes supported.

**dev**
- Valid Cuda Device to get NvSciSync attributes for.

**flags**
- flags describing NvSciSync usage.

## Description

Returns in `nvSciSyncAttrList`, the properties of NvSciSync that this CUDA device, `dev` can support. The returned `nvSciSyncAttrList` can be used to create an NvSciSync object that matches this device's capabilities.

If NvSciSyncAttrKey_RequiredPerm field in `nvSciSyncAttrList` is already set this API will return CUDA_ERROR_INVALID_VALUE.

The applications should set `nvSciSyncAttrList` to a valid NvSciSyncAttrList failing which this API will return CUDA_ERROR_INVALID_HANDLE.

The `flags` controls how applications intends to use the NvSciSync created from the `nvSciSyncAttrList`. The valid flags are:

- CUDA_NVSCISYNC_ATTR_SIGNAL, specifies that the applications intends to signal an NvSciSync on this CUDA device.
- CUDA_NVSCISYNC_ATTR_WAIT, specifies that the applications intends to wait on an NvSciSync on this CUDA device.

At least one of these flags must be set, failing which the API returns CUDA_ERROR_INVALID_VALUE. Both the flags are orthogonal to one another: a developer may set both these flags that allows to set both wait and signal specific attributes in the same `nvSciSyncAttrList`.

Note that this API updates the input `nvSciSyncAttrList` with values equivalent to the following public attribute key-values: NvSciSyncAttrKey_RequiredPerm is set to

- NvSciSyncAccessPerm_SignalOnly if CUDA_NVSCISYNC_ATTR_SIGNAL is set in `flags`.
- NvSciSyncAccessPerm_WaitOnly if CUDA_NVSCISYNC_ATTR_WAIT is set in `flags`.
- NvSciSyncAccessPerm_WaitSignal if both CUDA_NVSCISYNC_ATTR_WAIT and CUDA_NVSCISYNC_ATTR_SIGNAL are set in `flags`. NvSciSyncAttrKey_PrimitiveInfo is set to

- NvSciSyncAttrValPrimitiveType_SysmemSemaphore on any valid `device`.
- NvSciSyncAttrValPrimitiveType_Syncpoint if `device` is a Tegra device.
- NvSciSyncAttrValPrimitiveType_SysmemSemaphorePayload64b if `device` is GA10X+. NvSciSyncAttrKey_GpuId is set to the same UUID that is returned for this `device` from cuDeviceGetUuid.

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY

See also:

cuImportExternalSemaphore, cuDestroyExternalSemaphore, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync

# CUresult cuDeviceGetTexture1DLinearMaxWidth (size_t *maxWidthInElements, CUarray_format format, unsigned numChannels, CUdevice dev)

Returns the maximum number of elements allocatable in a 1D linear texture for a given texture element size.

## Parameters

**maxWidthInElements**
- Returned maximum number of texture elements allocatable for given `format` and `numChannels`.

**format**
- Texture format.

**numChannels**
- Number of channels per texture element.

**dev**
- Device handle.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Returns in `maxWidthInElements` the maximum number of texture elements allocatable in a 1D linear texture for given `format` and `numChannels`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGet, cudaMemGetInfo, cuDeviceTotalMem

# CUresult cuDeviceGetUuid (CUuuid *uuid, CUdevice dev)

Return an UUID for the device.

## Parameters

**uuid**

- Returned UUID

**dev**

- Device to get identifier string for

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Returns 16-octets identifying the device `dev` in the structure pointed by the `uuid`. If the device is in MIG mode, returns its MIG UUID which uniquely identifies the subscribed MIG compute instance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetLuid, cuDeviceGet, cuDeviceTotalMem, cudaGetDeviceProperties

# CUresult cuDeviceSetMemPool (CUdevice dev, CUmemoryPool pool)

Sets the current memory pool of a device.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

The memory pool must be local to the specified device. cuMemAllocAsync allocates from the current mempool of the provided stream's device. By default, a device's current memory pool is its default memory pool.

Note:

Use cuMemAllocFromPoolAsync to specify asynchronous allocations from a device different than the one the stream runs on.

See also:

cuDeviceGetDefaultMemPool, cuDeviceGetMemPool, cuMemPoolCreate, cuMemPoolDestroy, cuMemAllocFromPoolAsync

# CUresult cuDeviceTotalMem (size_t *bytes, CUdevice dev)

Returns the total amount of memory on the device.

## Parameters

**bytes**
- Returned memory available on device in bytes

**dev**
- Device handle

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Returns in `*bytes` the total amount of memory available on the device `dev` in bytes.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGet, cuDeviceGetExecAffinitySupport, cudaMemGetInfo

# CUresult cuFlushGPUDirectRDMAWrites (CUflushGPUDirectRDMAWritesTarget target, CUflushGPUDirectRDMAWritesScope scope)

Blocks until remote writes are visible to the specified scope.

## Parameters

**target**

- The target of the operation, see CUflushGPUDirectRDMAWritesTarget

**scope**

- The scope of the operation, see CUflushGPUDirectRDMAWritesScope

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE,

## Description

Blocks until GPUDirect RDMA writes to the target context via mappings created through APIs like nvidia_p2p_get_pages (see https://docs.nvidia.com/cuda/gpudirect-rdma for more information), are visible to the specified scope.

If the scope equals or lies within the scope indicated by CU_DEVICE_ATTRIBUTE_GPU_DIRECT_RDMA_WRITES_ORDERING, the call will be a no-op and can be safely omitted for performance. This can be determined by comparing the numerical values between the two enums, with smaller scopes having smaller values.

On platforms that support GPUDirect RDMA writes via more than one path in hardware (see CU_MEM_RANGE_FLAG_DMA_BUF_MAPPING_TYPE_PCIE), the user should consider those paths as belonging to separate ordering domains. Note that in such cases CUDA driver will report both RDMA writes ordering and RDMA write scope as ALL_DEVICES and a call to cuFlushGPUDirectRDMA will be a no-op, but when these multiple paths are used simultaneously, it is the user's responsibility to ensure ordering by using mechanisms outside the scope of CUDA.

Users may query support for this API via CU_DEVICE_ATTRIBUTE_FLUSH_FLUSH_GPU_DIRECT_RDMA_OPTIONS.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

# 6.6. Device Management [DEPRECATED]

This section describes the device management functions of the low-level CUDA driver application programming interface.

## CUresult cuDeviceComputeCapability (int *major, int *minor, CUdevice dev)

Returns the compute capability of the device.

### Parameters

**major**
- Major revision number

**minor**
- Minor revision number

**dev**
- Device handle

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

### Description

Deprecated

This function was deprecated as of CUDA 5.0 and its functionality superseded by cuDeviceGetAttribute().

Returns in `*major` and `*minor` the major and minor revision numbers that define the compute capability of the device `dev`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGet, cuDeviceTotalMem

# CUresult cuDeviceGetProperties (CUdevprop *prop, CUdevice dev)

Returns properties for a selected device.

## Parameters

**prop**
- Returned properties of device

**dev**
- Device to get properties for

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Deprecated

This function was deprecated as of CUDA 5.0 and replaced by cuDeviceGetAttribute().

Returns in `*prop` the properties of device `dev`. The CUdevprop structure is defined as:

```
typedef struct CUdevprop_st {
     int maxThreadsPerBlock;
     int maxThreadsDim[3];
     int maxGridSize[3];
     int sharedMemPerBlock;
     int totalConstantMemory;
     int SIMDWidth;
     int memPitch;
     int regsPerBlock;
     int clockRate;
     int textureAlign
   } CUdevprop;
```

where:

- maxThreadsPerBlock is the maximum number of threads per block;
- maxThreadsDim[3] is the maximum sizes of each dimension of a block;
- maxGridSize[3] is the maximum sizes of each dimension of a grid;
- sharedMemPerBlock is the total amount of shared memory available per block in bytes;
- totalConstantMemory is the total amount of constant memory available on the device in bytes;

- SIMDWidth is the warp size;
- memPitch is the maximum pitch allowed by the memory copy functions that involve memory regions allocated through cuMemAllocPitch();
- regsPerBlock is the total number of registers available per block;
- clockRate is the clock frequency in kilohertz;
- textureAlign is the alignment requirement; texture base addresses that are aligned to textureAlign bytes do not need an offset applied to texture fetches.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetAttribute, cuDeviceGetCount, cuDeviceGetName, cuDeviceGetUuid, cuDeviceGet, cuDeviceTotalMem

# 6.7. Primary Context Management

This section describes the primary context management functions of the low-level CUDA driver application programming interface.

The primary context is unique per device and shared with the CUDA runtime API. These functions allow integration with other libraries using CUDA.

## CUresult cuDevicePrimaryCtxGetState (CUdevice dev, unsigned int *flags, int *active)

Get the state of the primary context.

### Parameters

**dev**
- Device to get primary context flags for

**flags**
- Pointer to store flags

**active**
- Pointer to store context state; 0 = inactive, 1 = active

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE,

### Description

Returns in `*flags` the flags for the primary context of `dev`, and in `*active` whether it is active. See cuDevicePrimaryCtxSetFlags for flag values.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDevicePrimaryCtxSetFlags, cuCtxGetFlags, cuCtxSetFlags, cudaGetDeviceFlags

## CUresult cuDevicePrimaryCtxRelease (CUdevice dev)

Release the primary context on the GPU.

### Parameters

**dev**

- Device which primary context is released

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_CONTEXT

### Description

Releases the primary context interop on the device. A retained context should always be released once the user is done using it. The context is automatically reset once the last reference to it is released. This behavior is different when the primary context was retained by the CUDA runtime from CUDA 4.0 and earlier. In this case, the primary context remains always active.

Releasing a primary context that has not been previously retained will fail with CUDA_ERROR_INVALID_CONTEXT.

Please note that unlike cuCtxDestroy() this method does not pop the context from stack in any circumstances.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDevicePrimaryCtxRetain, cuCtxDestroy, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetCacheConfig, cuCtxSetLimit, cuCtxSynchronize

# CUresult cuDevicePrimaryCtxReset (CUdevice dev)

Destroy all allocations and reset all state on the primary context.

## Parameters

**dev**

- Device for which primary context is destroyed

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_PRIMARY_CONTEXT_ACTIVE

## Description

Explicitly destroys and cleans up all resources associated with the current device in the current process.

Note that it is responsibility of the calling function to ensure that no other module in the process is using the device any more. For that reason it is recommended to use cuDevicePrimaryCtxRelease() in most cases. However it is safe for other modules to call cuDevicePrimaryCtxRelease() even after resetting the device. Resetting the primary context does not release it, an application that has retained the primary context should explicitly release its usage.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDevicePrimaryCtxRetain, cuDevicePrimaryCtxRelease, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetCacheConfig, cuCtxSetLimit, cuCtxSynchronize, cudaDeviceReset

# CUresult cuDevicePrimaryCtxRetain (CUcontext *pctx, CUdevice dev)

Retain the primary context on the GPU.

## Parameters

**pctx**

- Returned context handle of the new context

**dev**
- Device for which primary context is requested

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

### Description

Retains the primary context on the device. Once the user successfully retains the primary context, the primary context will be active and available to the user until the user releases it with cuDevicePrimaryCtxRelease() or resets it with cuDevicePrimaryCtxReset(). Unlike cuCtxCreate() the newly retained context is not pushed onto the stack.

Retaining the primary context for the first time will fail with CUDA_ERROR_UNKNOWN if the compute mode of the device is CU_COMPUTEMODE_PROHIBITED. The function cuDeviceGetAttribute() can be used with CU_DEVICE_ATTRIBUTE_COMPUTE_MODE to determine the compute mode of the device. The nvidia-smi tool can be used to set the compute mode for devices. Documentation for nvidia-smi can be obtained by passing a -h option to it.

Please note that the primary context always supports pinned allocations. Other flags can be specified by cuDevicePrimaryCtxSetFlags().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDevicePrimaryCtxRelease, cuDevicePrimaryCtxSetFlags, cuCtxCreate, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetCacheConfig, cuCtxSetLimit, cuCtxSynchronize

## CUresult cuDevicePrimaryCtxSetFlags (CUdevice dev, unsigned int flags)

Set flags for the primary context.

### Parameters

**dev**
- Device for which the primary context flags are set

**flags**
- New flags for the device

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE,

## Description

Sets the flags for the primary context on the device overwriting perviously set ones.

The three LSBs of the `flags` parameter can be used to control how the OS thread, which owns the CUDA context at the time of an API call, interacts with the OS scheduler when waiting for results from the GPU. Only one of the scheduling flags can be set when creating a context.

- CU_CTX_SCHED_SPIN: Instruct CUDA to actively spin when waiting for results from the GPU. This can decrease latency when waiting for the GPU, but may lower the performance of CPU threads if they are performing work in parallel with the CUDA thread.
- CU_CTX_SCHED_YIELD: Instruct CUDA to yield its thread when waiting for results from the GPU. This can increase latency when waiting for the GPU, but can increase the performance of CPU threads performing work in parallel with the GPU.
- CU_CTX_SCHED_BLOCKING_SYNC: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the GPU to finish work.
- CU_CTX_BLOCKING_SYNC: Instruct CUDA to block the CPU thread on a synchronization primitive when waiting for the GPU to finish work.

  Deprecated: This flag was deprecated as of CUDA 4.0 and was replaced with CU_CTX_SCHED_BLOCKING_SYNC.
- CU_CTX_SCHED_AUTO: The default value if the `flags` parameter is zero, uses a heuristic based on the number of active CUDA contexts in the process C and the number of logical processors in the system P. If C > P, then CUDA will yield to other OS threads when waiting for the GPU (CU_CTX_SCHED_YIELD), otherwise CUDA will not yield while waiting for results and actively spin on the processor (CU_CTX_SCHED_SPIN). Additionally, on Tegra devices, CU_CTX_SCHED_AUTO uses a heuristic based on the power profile of the platform and may choose CU_CTX_SCHED_BLOCKING_SYNC for low-powered devices.
- CU_CTX_LMEM_RESIZE_TO_MAX: Instruct CUDA to not reduce local memory after resizing local memory for a kernel. This can prevent thrashing by local memory allocations when launching many kernels with high local memory usage at the cost of potentially increased memory usage.

  Deprecated: This flag is deprecated and the behavior enabled by this flag is now the default and cannot be disabled.
- CU_CTX_COREDUMP_ENABLE: If GPU coredumps have not been enabled globally with cuCoredumpSetAttributeGlobal or environment variables, this flag can be set during context

creation to instruct CUDA to create a coredump if this context raises an exception during execution. These environment variables are described in the CUDA-GDB user guide under the "GPU core dump support" section. The initial settings will be taken from the global settings at the time of context creation. The other settings that control coredump output can be modified by calling cuCoredumpSetAttribute from the created context after it becomes current.

- CU_CTX_USER_COREDUMP_ENABLE: If user-triggered GPU coredumps have not been enabled globally with cuCoredumpSetAttributeGlobal or environment variables, this flag can be set during context creation to instruct CUDA to create a coredump if data is written to a certain pipe that is present in the OS space. These environment variables are described in the CUDA-GDB user guide under the "GPU core dump support" section. It is important to note that the pipe name *must* be set with cuCoredumpSetAttributeGlobal before creating the context if this flag is used. Setting this flag implies that CU_CTX_COREDUMP_ENABLE is set. The initial settings will be taken from the global settings at the time of context creation. The other settings that control coredump output can be modified by calling cuCoredumpSetAttribute from the created context after it becomes current.
- CU_CTX_SYNC_MEMOPS: Ensures that synchronous memory operations initiated on this context will always synchronize. See further documentation in the section titled "API Synchronization behavior" to learn more about cases when synchronous memory operations can exhibit asynchronous behavior.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDevicePrimaryCtxRetain, cuDevicePrimaryCtxGetState, cuCtxCreate, cuCtxGetFlags, cuCtxSetFlags, cudaSetDeviceFlags

# 6.9. Context Management [DEPRECATED]

This section describes the deprecated context management functions of the low-level CUDA driver application programming interface.

# CUresult cuCtxAttach (CUcontext *pctx, unsigned int flags)

Increment a context's usage-count.

## Parameters

**pctx**
- Returned context handle of the current context

**flags**
- Context attach flags (must be 0)

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

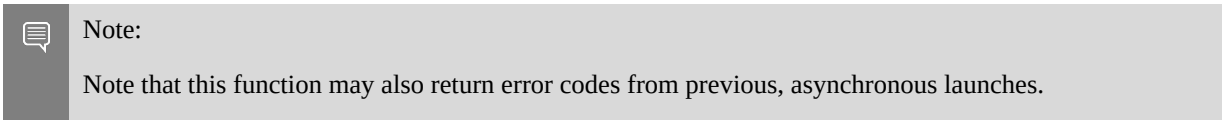
## Description

Deprecated

Note that this function is deprecated and should not be used.

Increments the usage count of the context and passes back a context handle in `*pctx` that must be passed to cuCtxDetach() when the application is done with the context. cuCtxAttach() fails if there is no context current to the thread.

Currently, the `flags` parameter must be 0.




See also:

cuCtxCreate, cuCtxDestroy, cuCtxDetach, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetCacheConfig, cuCtxSetLimit, cuCtxSynchronize

# CUresult cuCtxDetach (CUcontext ctx)

Decrement a context's usage-count.

## Parameters

**ctx**
- Context to destroy

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT

### Description

Deprecated

Note that this function is deprecated and should not be used.

Decrements the usage count of the context `ctx`, and destroys the context if the usage count goes to 0. The context must be a handle that was passed back by cuCtxCreate() or cuCtxAttach(), and must be current to the calling thread.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxCreate, cuCtxDestroy, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetCacheConfig, cuCtxSetLimit, cuCtxSynchronize

## CUresult cuCtxGetSharedMemConfig (CUsharedconfig *pConfig)

Returns the current shared memory configuration for the current context.

### Parameters

**pConfig**
- returned shared memory configuration

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

This function will return in `pConfig` the current size of shared memory banks in the current context. On devices with configurable shared memory banks, cuCtxSetSharedMemConfig can be used to change this setting, so that all subsequent kernel launches will by default use the new bank size. When

cuCtxGetSharedMemConfig is called on devices without configurable shared memory, it will return the fixed bank size of the hardware.

The returned bank configurations can be either:

- CU_SHARED_MEM_CONFIG_FOUR_BYTE_BANK_SIZE: shared memory bank width is four bytes.
- CU_SHARED_MEM_CONFIG_EIGHT_BYTE_BANK_SIZE: shared memory bank width will eight bytes.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxCreate, cuCtxDestroy, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetLimit, cuCtxSynchronize, cuCtxGetSharedMemConfig, cuFuncSetCacheConfig, cudaDeviceGetSharedMemConfig

# CUresult cuCtxSetSharedMemConfig (CUsharedconfig config)

Sets the shared memory configuration for the current context.

## Parameters

**config**

- requested shared memory configuration

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

On devices with configurable shared memory banks, this function will set the context's shared memory bank size which is used for subsequent kernel launches.

Changed the shared memory configuration between launches may insert a device side synchronization point between those launches.

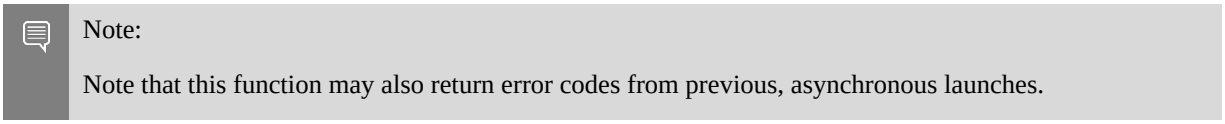
Changing the shared memory bank size will not increase shared memory usage or affect occupancy of kernels, but may have major effects on performance. Larger bank sizes will allow for greater potential

bandwidth to shared memory, but will change what kinds of accesses to shared memory will result in bank conflicts.

This function will do nothing on devices with fixed shared memory bank size.

The supported bank configurations are:

- CU_SHARED_MEM_CONFIG_DEFAULT_BANK_SIZE: set bank width to the default initial setting (currently, four bytes).
- CU_SHARED_MEM_CONFIG_FOUR_BYTE_BANK_SIZE: set shared memory bank width to be natively four bytes.
- CU_SHARED_MEM_CONFIG_EIGHT_BYTE_BANK_SIZE: set shared memory bank width to be natively eight bytes.




See also:

cuCtxCreate, cuCtxDestroy, cuCtxGetApiVersion, cuCtxGetCacheConfig, cuCtxGetDevice, cuCtxGetFlags, cuCtxGetLimit, cuCtxPopCurrent, cuCtxPushCurrent, cuCtxSetLimit, cuCtxSynchronize, cuCtxGetSharedMemConfig, cuFuncSetCacheConfig, cudaDeviceSetSharedMemConfig

# 6.10. Module Management

This section describes the module management functions of the low-level CUDA driver application programming interface.

## enum CUmoduleLoadingMode

CUDA Lazy Loading status

### Values

**CU_MODULE_EAGER_LOADING = 0x1**
Lazy Kernel Loading is not enabled

**CU_MODULE_LAZY_LOADING = 0x2**
Lazy Kernel Loading is enabled

# CUresult cuLinkAddData (CUlinkState state, CUjitInputType type, void *data, size_t size, const char *name, unsigned int numOptions, CUjit_option *options, void **optionValues)

Add an input to a pending linker invocation.

## Parameters

**state**
A pending linker action.

**type**
The type of the input data.

**data**
The input data. PTX must be NULL-terminated.

**size**
The length of the input data.

**name**
An optional name for this input in log messages.

**numOptions**
Size of options.

**options**
Options to be applied only for this input (overrides options from cuLinkCreate).

**optionValues**
Array of option values, each cast to void *.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_IMAGE, CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NO_BINARY_FOR_GPU

## Description

Ownership of `data` is retained by the caller. No reference is retained to any inputs after this call returns.

This method accepts only compiler options, which are used if the data must be compiled from PTX, and does not accept any of CU_JIT_WALL_TIME, CU_JIT_INFO_LOG_BUFFER, CU_JIT_ERROR_LOG_BUFFER, CU_JIT_TARGET_FROM_CUCONTEXT, or CU_JIT_TARGET.

Note:

For LTO-IR input, only LTO-IR compiled with toolkits prior to CUDA 12.0 will be accepted

See also:

cuLinkCreate, cuLinkAddFile, cuLinkComplete, cuLinkDestroy

# CUresult cuLinkAddFile (CUlinkState state, CUjitInputType type, const char *path, unsigned int numOptions, CUjit_option *options, void **optionValues)

Add a file input to a pending linker invocation.

## Parameters

**state**
A pending linker action
**type**
The type of the input data
**path**
Path to the input file
**numOptions**
Size of options
**options**
Options to be applied only for this input (overrides options from cuLinkCreate)
**optionValues**
Array of option values, each cast to void *

## Returns

CUDA_SUCCESS, CUDA_ERROR_FILE_NOT_FOUND CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_IMAGE, CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NO_BINARY_FOR_GPU

## Description

No reference is retained to any inputs after this call returns.

This method accepts only compiler options, which are used if the input must be compiled from PTX, and does not accept any of CU_JIT_WALL_TIME, CU_JIT_INFO_LOG_BUFFER, CU_JIT_ERROR_LOG_BUFFER, CU_JIT_TARGET_FROM_CUCONTEXT, or CU_JIT_TARGET.

This method is equivalent to invoking cuLinkAddData on the contents of the file.

Note:

For LTO-IR input, only LTO-IR compiled with toolkits prior to CUDA 12.0 will be accepted

See also:

cuLinkCreate, cuLinkAddData, cuLinkComplete, cuLinkDestroy

# CUresult cuLinkComplete (CUlinkState state, void **cubinOut, size_t *sizeOut)

Complete a pending linker invocation.

## Parameters

**state**
A pending linker invocation
**cubinOut**
On success, this will point to the output image
**sizeOut**
Optional parameter to receive the size of the generated image

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Completes the pending linker action and returns the cubin image for the linked device code, which can be used with cuModuleLoadData. The cubin is owned by `state`, so it should be loaded before `state` is destroyed via cuLinkDestroy. This call does not destroy `state`.

See also:

cuLinkCreate, cuLinkAddData, cuLinkAddFile, cuLinkDestroy, cuModuleLoadData

# CUresult cuLinkCreate (unsigned int numOptions, CUjit_option *options, void **optionValues, CUlinkState *stateOut)

Creates a pending JIT linker invocation.

## Parameters

**numOptions**
Size of options arrays
**options**
Array of linker and compiler options

**optionValues**
Array of option values, each cast to void *
**stateOut**
On success, this will contain a CUlinkState to specify and complete this action

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_JIT_COMPILER_NOT_FOUND

### Description

If the call is successful, the caller owns the returned CUlinkState, which should eventually be destroyed with cuLinkDestroy. The device code machine size (32 or 64 bit) will match the calling application.

Both linker and compiler options may be specified. Compiler options will be applied to inputs to this linker action which must be compiled from PTX. The options CU_JIT_WALL_TIME, CU_JIT_INFO_LOG_BUFFER_SIZE_BYTES, and CU_JIT_ERROR_LOG_BUFFER_SIZE_BYTES will accumulate data until the CUlinkState is destroyed.

The data passed in via cuLinkAddData and cuLinkAddFile will be treated as relocatable (-rdc=true to nvcc) when linking the final cubin during cuLinkComplete and will have similar consequences as offline relocatable device code linking.

`optionValues` must remain valid for the life of the CUlinkState if output options are used. No other references to inputs are maintained after this call returns.

Note:

For LTO-IR input, only LTO-IR compiled with toolkits prior to CUDA 12.0 will be accepted

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuLinkAddData, cuLinkAddFile, cuLinkComplete, cuLinkDestroy

## CUresult cuLinkDestroy (CUlinkState state)

Destroys state for a JIT linker invocation.

### Parameters

**state**
State object for the linker invocation

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE

### Description

See also:

cuLinkCreate

## CUresult cuModuleEnumerateFunctions (CUfunction *functions, unsigned int numFunctions, CUmodule mod)

Returns the function handles within a module.

### Parameters

**functions**
- Buffer where the function handles are returned to

**numFunctions**
- Maximum number of function handles may be returned to the buffer

**mod**
- Module to query from

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

### Description

Returns in `functions` a maximum number of `numFunctions` function handles within `mod`. When function loading mode is set to LAZY the function retrieved may be partially loaded. The loading state of a function can be queried using cuFunctionIsLoaded. CUDA APIs may load the function automatically when called with partially loaded function handle which may incur additional latency. Alternatively, cuFunctionLoad can be used to explicitly load a function. The returned function handles become invalid when the module is unloaded.

See also:

cuModuleGetFunction, cuModuleGetFunctionCount, cuFuncIsLoaded, cuFuncLoad

# CUresult cuModuleGetFunction (CUfunction *hfunc, CUmodule hmod, const char *name)

Returns a function handle.

## Parameters

**hfunc**
- Returned function handle

**hmod**
- Module to retrieve function from

**name**
- Name of function to retrieve

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND

## Description

Returns in `*hfunc` the handle of the function of name `name` located in module `hmod`. If no function of that name exists, cuModuleGetFunction() returns CUDA_ERROR_NOT_FOUND.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetGlobal, cuModuleGetTexRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx, cuModuleLoadFatBinary, cuModuleUnload

# CUresult cuModuleGetFunctionCount (unsigned int *count, CUmodule mod)

Returns the number of functions within a module.

## Parameters

**count**
- Number of functions found within the module

**mod**
- Module to query

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

### Description

Returns in `count` the number of functions in `mod`.

## CUresult cuModuleGetGlobal (CUdeviceptr *dptr, size_t *bytes, CUmodule hmod, const char *name)

Returns a global pointer from a module.

### Parameters

**dptr**
- Returned global device pointer

**bytes**
- Returned global size in bytes

**hmod**
- Module to retrieve global from

**name**
- Name of global to retrieve

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND

### Description

Returns in `*dptr` and `*bytes` the base pointer and size of the global of name `name` located in module `hmod`. If no variable of that name exists, cuModuleGetGlobal() returns CUDA_ERROR_NOT_FOUND. One of the parameters `dptr` or `bytes` (not both) can be NULL in which case it is ignored.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetFunction, cuModuleGetTexRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx, cuModuleLoadFatBinary, cuModuleUnload, cudaGetSymbolAddress, cudaGetSymbolSize

# CUresult cuModuleGetLoadingMode (CUmoduleLoadingMode *mode)

Query lazy loading mode.

## Parameters

**mode**
- Returns the lazy loading mode

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Returns lazy loading mode Module loading mode is controlled by CUDA_MODULE_LOADING env variable

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleLoad,

# CUresult cuModuleLoad (CUmodule *module, const char *fname)

Loads a compute module.

## Parameters

**module**
- Returned module

**fname**
- Filename of module to load

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE,

CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_FILE_NOT_FOUND, CUDA_ERROR_NO_BINARY_FOR_GPU, CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_JIT_COMPILER_NOT_FOUND

### Description

Takes a filename `fname` and loads the corresponding module `module` into the current context. The CUDA driver API does not attempt to lazily allocate the resources needed by a module; if the memory for functions and data (constant and global) needed by the module cannot be allocated, cuModuleLoad() fails. The file should be a cubin file as output by nvcc, or a PTX file either as output by nvcc or handwritten, or a fatbin file as output by nvcc from toolchain 4.0 or later, or a Tile IR file.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetTexRef, cuModuleLoadData, cuModuleLoadDataEx, cuModuleLoadFatBinary, cuModuleUnload

## CUresult cuModuleLoadData (CUmodule *module, const void *image)

Load a module's data.

### Parameters

**module**

- Returned module

**image**

- Module data to load

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NO_BINARY_FOR_GPU, CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_JIT_COMPILER_NOT_FOUND

### Description

Takes a pointer `image` and loads the corresponding module `module` into the current context. The `image` may be a cubin or fatbin as output by nvcc, or a NULL-terminated PTX, either as output by nvcc or hand-written, or Tile IR data.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetTexRef, cuModuleLoad, cuModuleLoadDataEx, cuModuleLoadFatBinary, cuModuleUnload

## CUresult cuModuleLoadDataEx (CUmodule *module, const void *image, unsigned int numOptions, CUjit_option *options, void **optionValues)

Load a module's data with options.

### Parameters

**module**
- Returned module

**image**
- Module data to load

**numOptions**
- Number of options

**options**
- Options for JIT

**optionValues**
- Option values for JIT

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NO_BINARY_FOR_GPU, CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_JIT_COMPILER_NOT_FOUND

### Description

Takes a pointer `image` and loads the corresponding module `module` into the current context. The `image` may be a cubin or fatbin as output by nvcc, or a NULL-terminated PTX, either as output by nvcc or hand-written, or Tile IR data.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetTexRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadFatBinary, cuModuleUnload

## CUresult cuModuleLoadFatBinary (CUmodule *module, const void *fatCubin)

Load a module's data.

### Parameters

**module**
- Returned module

**fatCubin**
- Fat binary to load

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NO_BINARY_FOR_GPU, CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_JIT_COMPILER_NOT_FOUND

### Description

Takes a pointer `fatCubin` and loads the corresponding module `module` into the current context. The pointer represents a fat binary object, which is a collection of different cubin and/or PTX files, all representing the same device code, but compiled and optimized for different architectures.

Prior to CUDA 4.0, there was no documented API for constructing and using fat binary objects by programmers. Starting with CUDA 4.0, fat binary objects can be constructed by providing the -fatbin option to nvcc. More information can be found in the nvcc document.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetTexRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx, cuModuleUnload

# CUresult cuModuleUnload (CUmodule hmod)

Unloads a module.

## Parameters

**hmod**

- Module to unload

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_PERMITTED

## Description

Unloads a module `hmod` from the current context. Attempting to unload a module which was obtained from the Library Management API such as cuLibraryGetModule will return CUDA_ERROR_NOT_PERMITTED.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- Use of the handle after this call is undefined behavior.

See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetTexRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx, cuModuleLoadFatBinary

# 6.11. Module Management [DEPRECATED]

This section describes the deprecated module management functions of the low-level CUDA driver application programming interface.

## CUresult cuModuleGetSurfRef (CUsurfref *pSurfRef, CUmodule hmod, const char *name)

Returns a handle to a surface reference.

### Parameters

**pSurfRef**
- Returned surface reference

**hmod**
- Module to retrieve surface reference from

**name**
- Name of surface reference to retrieve

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND

### Description

Deprecated

Returns in `*pSurfRef` the handle of the surface reference of name `name` in the module `hmod`. If no surface reference of that name exists, cuModuleGetSurfRef() returns CUDA_ERROR_NOT_FOUND.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetTexRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx, cuModuleLoadFatBinary, cuModuleUnload

## CUresult cuModuleGetTexRef (CUtexref *pTexRef, CUmodule hmod, const char *name)

Returns a handle to a texture reference.

### Parameters

**pTexRef**
- Returned texture reference

**hmod**
- Module to retrieve texture reference from

**name**
- Name of texture reference to retrieve

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND

### Description

Deprecated

Returns in `*pTexRef` the handle of the texture reference of name `name` in the module `hmod`. If no texture reference of that name exists, cuModuleGetTexRef() returns CUDA_ERROR_NOT_FOUND. This texture reference handle should not be destroyed, since it will be destroyed when the module is unloaded.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuModuleGetFunction, cuModuleGetGlobal, cuModuleGetSurfRef, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx, cuModuleLoadFatBinary, cuModuleUnload

# 6.12. Library Management

This section describes the library management functions of the low-level CUDA driver application programming interface.

# CUresult cuKernelGetAttribute (int *pi, CUfunction_attribute attrib, CUkernel kernel, CUdevice dev)

Returns information about a kernel.

## Parameters

**pi**
- Returned attribute value

**attrib**
- Attribute requested

**kernel**
- Kernel to query attribute of

**dev**
- Device to query attribute of

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Returns in `*pi` the integer value of the attribute `attrib` for the kernel `kernel` for the requested device `dev`. The supported attributes are:

- CU_FUNC_ATTRIBUTE_MAX_THREADS_PER_BLOCK: The maximum number of threads per block, beyond which a launch of the kernel would fail. This number depends on both the kernel and the requested device.
- CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES: The size in bytes of statically-allocated shared memory per block required by this kernel. This does not include dynamically-allocated shared memory requested by the user at runtime.
- CU_FUNC_ATTRIBUTE_CONST_SIZE_BYTES: The size in bytes of user-allocated constant memory required by this kernel.
- CU_FUNC_ATTRIBUTE_LOCAL_SIZE_BYTES: The size in bytes of local memory used by each thread of this kernel.
- CU_FUNC_ATTRIBUTE_NUM_REGS: The number of registers used by each thread of this kernel.
- CU_FUNC_ATTRIBUTE_PTX_VERSION: The PTX virtual architecture version for which the kernel was compiled. This value is the major PTX version * 10 + the minor PTX version, so a PTX version 1.3 function would return the value 13. Note that this may return the undefined value of 0 for cubins compiled prior to CUDA 3.0.

- CU_FUNC_ATTRIBUTE_BINARY_VERSION: The binary architecture version for which the kernel was compiled. This value is the major binary version * 10 + the minor binary version, so a binary version 1.3 function would return the value 13. Note that this will return a value of 10 for legacy cubins that do not have a properly-encoded binary architecture version.
- CU_FUNC_CACHE_MODE_CA: The attribute to indicate whether the kernel has been compiled with user specified option "-Xptxas --dlcm=ca" set.
- CU_FUNC_ATTRIBUTE_MAX_DYNAMIC_SHARED_SIZE_BYTES: The maximum size in bytes of dynamically-allocated shared memory.
- CU_FUNC_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT: Preferred shared memory-L1 cache split ratio in percent of total shared memory.
- CU_FUNC_ATTRIBUTE_CLUSTER_SIZE_MUST_BE_SET: If this attribute is set, the kernel must launch with a valid cluster size specified.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_WIDTH: The required cluster width in blocks.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_HEIGHT: The required cluster height in blocks.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_DEPTH: The required cluster depth in blocks.
- CU_FUNC_ATTRIBUTE_NON_PORTABLE_CLUSTER_SIZE_ALLOWED: Indicates whether the function can be launched with non-portable cluster size. 1 is allowed, 0 is disallowed. A non-portable cluster size may only function on the specific SKUs the program is tested on. The launch might fail if the program is run on a different hardware platform. CUDA API provides cudaOccupancyMaxActiveClusters to assist with checking whether the desired size can be launched on the current device. A portable cluster size is guaranteed to be functional on all compute capabilities higher than the target compute capability. The portable cluster size for sm_90 is 8 blocks per cluster. This value may increase for future compute capabilities. The specific hardware unit may support higher cluster sizes that’s not guaranteed to be portable.
- CU_FUNC_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE: The block scheduling policy of a function. The value type is CUclusterSchedulingPolicy.

Note:

If another thread is trying to set the same attribute on the same device using cuKernelSetAttribute() simultaneously, the attribute query will give the old or new value depending on the interleavings chosen by the OS scheduler and memory consistency.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuKernelSetAttribute, cuLibraryGetKernel, cuLaunchKernel, cuKernelGetFunction, cuLibraryGetModule, cuModuleGetFunction, cuFuncGetAttribute

# CUresult cuKernelGetFunction (CUfunction *pFunc, CUkernel kernel)

Returns a function handle.

## Parameters

**pFunc**
- Returned function handle

**kernel**
- Kernel to retrieve function for the requested context

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_CONTEXT_IS_DESTROYED

## Description

Returns in `pFunc` the handle of the function for the requested kernel `kernel` and the current context. If function handle is not found, the call returns CUDA_ERROR_NOT_FOUND.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuLibraryGetKernel, cuLibraryGetModule, cuModuleGetFunction

# CUresult cuKernelGetLibrary (CUlibrary *pLib, CUkernel kernel)

Returns a library handle.

## Parameters

**pLib**
- Returned library handle

**kernel**
- Kernel to retrieve library handle

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_FOUND

### Description

Returns in `pLib` the handle of the library for the requested kernel `kernel`

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuLibraryGetKernel

## CUresult cuKernelGetName (const char **name, CUkernel hfunc)

Returns the function name for a CUkernel handle.

### Parameters

**name**
- The returned name of the function

**hfunc**
- The function handle to retrieve the name for

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

Returns in `**name` the function name associated with the kernel handle `hfunc` . The function name is returned as a null-terminated string. The returned name is only valid when the kernel handle is valid. If the library is unloaded or reloaded, one must call the API again to get the updated name. This API may return a mangled name if the function is not declared as having C linkage. If either `**name` or `hfunc` is NULL, CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

## CUresult cuKernelGetParamCount (CUkernel kernel, size_t *paramCount)

Returns the number of parameters used by the kernel.

### Parameters

**kernel**
- The kernel to query

**paramCount**
- Returns the number of parameters used by the function

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

Queries the number of kernel parameters used by `kernel` and returns it in `paramCount`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuKernelGetParamInfo

## CUresult cuKernelGetParamInfo (CUkernel kernel, size_t paramIndex, size_t *paramOffset, size_t *paramSize)

Returns the offset and size of a kernel parameter in the device-side parameter layout.

### Parameters

**kernel**
- The kernel to query

**paramIndex**
- The parameter index to query

**paramOffset**
- Returns the offset into the device-side parameter layout at which the parameter resides

**paramSize**
- Optionally returns the size of the parameter in the device-side parameter layout

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

### Description

Queries the kernel parameter at `paramIndex` into `kernel`'s list of parameters, and returns in `paramOffset` and `paramSize` the offset and size, respectively, where the parameter will reside in the device-side parameter layout. This information can be used to update kernel node parameters from the device via cudaGraphKernelNodeSetParam() and cudaGraphKernelNodeUpdatesApply(). `paramIndex` must be less than the number of parameters that `kernel` takes. `paramSize` can be set to NULL if only the parameter offset is desired.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncGetParamInfo

# CUresult cuKernelSetAttribute (CUfunction_attribute attrib, int val, CUkernel kernel, CUdevice dev)

Sets information about a kernel.

## Parameters

**attrib**
- Attribute requested

**val**
- Value to set

**kernel**
- Kernel to set attribute of

**dev**
- Device to set attribute of

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_OUT_OF_MEMORY

## Description

This call sets the value of a specified attribute `attrib` on the kernel `kernel` for the requested device `dev` to an integer value specified by `val`. This function returns CUDA_SUCCESS if the new value of the attribute could be successfully set. If the set fails, this call will return an error. Not all attributes can have values set. Attempting to set a value on a read-only attribute will result in an error (CUDA_ERROR_INVALID_VALUE)

Note that attributes set using cuFuncSetAttribute() will override the attribute set by this API irrespective of whether the call to cuFuncSetAttribute() is made before or after this API call. However, cuKernelGetAttribute() will always return the attribute value set by this API.

Supported attributes are:

- CU_FUNC_ATTRIBUTE_MAX_DYNAMIC_SHARED_SIZE_BYTES: This is the maximum size in bytes of dynamically-allocated shared memory. The value should contain the requested

maximum size of dynamically-allocated shared memory. The sum of this value and the function attribute CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES cannot exceed the device attribute CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK_OPTIN. The maximal size of requestable dynamic shared memory may differ by GPU architecture.

- CU_FUNC_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT: On devices where the L1 cache and shared memory use the same hardware resources, this sets the shared memory carveout preference, in percent of the total shared memory. See CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_MULTIPROCESSOR This is only a hint, and the driver can choose a different ratio if required to execute the function.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_WIDTH: The required cluster width in blocks. The width, height, and depth values must either all be 0 or all be positive. The validity of the cluster dimensions is checked at launch time. If the value is set during compile time, it cannot be set at runtime. Setting it at runtime will return CUDA_ERROR_NOT_PERMITTED.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_HEIGHT: The required cluster height in blocks. The width, height, and depth values must either all be 0 or all be positive. The validity of the cluster dimensions is checked at launch time. If the value is set during compile time, it cannot be set at runtime. Setting it at runtime will return CUDA_ERROR_NOT_PERMITTED.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_DEPTH: The required cluster depth in blocks. The width, height, and depth values must either all be 0 or all be positive. The validity of the cluster dimensions is checked at launch time. If the value is set during compile time, it cannot be set at runtime. Setting it at runtime will return CUDA_ERROR_NOT_PERMITTED.
- CU_FUNC_ATTRIBUTE_NON_PORTABLE_CLUSTER_SIZE_ALLOWED: Indicates whether the function can be launched with non-portable cluster size. 1 is allowed, 0 is disallowed.
- CU_FUNC_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE: The block scheduling policy of a function. The value type is CUclusterSchedulingPolicy.

Note:

The API has stricter locking requirements in comparison to its legacy counterpart cuFuncSetAttribute() due to device-wide semantics. If multiple threads are trying to set the same attribute on the same device simultaneously, the attribute setting will depend on the interleavings chosen by the OS scheduler and memory consistency.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuKernelGetAttribute, cuLibraryGetKernel, cuLaunchKernel, cuKernelGetFunction, cuLibraryGetModule, cuModuleGetFunction, cuFuncSetAttribute

# CUresult cuKernelSetCacheConfig (CUkernel kernel, CUfunc_cache config, CUdevice dev)

Sets the preferred cache configuration for a device kernel.

## Parameters

**kernel**
- Kernel to configure cache for

**config**
- Requested cache configuration

**dev**
- Device to set attribute of

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_OUT_OF_MEMORY

## Description

On devices where the L1 cache and shared memory use the same hardware resources, this sets through `config` the preferred cache configuration for the device kernel `kernel` on the requested device `dev`. This is only a preference. The driver will use the requested configuration if possible, but it is free to choose a different configuration if required to execute `kernel`. Any context-wide preference set via cuCtxSetCacheConfig() will be overridden by this per-kernel setting.

Note that attributes set using cuFuncSetCacheConfig() will override the attribute set by this API irrespective of whether the call to cuFuncSetCacheConfig() is made before or after this API call.

This setting does nothing on devices where the size of the L1 cache and shared memory are fixed.

Launching a kernel with a different preference than the most recent preference setting may insert a device-side synchronization point.

The supported cache configurations are:

- CU_FUNC_CACHE_PREFER_NONE: no preference for shared memory or L1 (default)
- CU_FUNC_CACHE_PREFER_SHARED: prefer larger shared memory and smaller L1 cache
- CU_FUNC_CACHE_PREFER_L1: prefer larger L1 cache and smaller shared memory
- CU_FUNC_CACHE_PREFER_EQUAL: prefer equal sized L1 cache and shared memory

Note:

The API has stricter locking requirements in comparison to its legacy counterpart cuFuncSetCacheConfig() due to device-wide semantics. If multiple threads are trying to set a config on

the same device simultaneously, the cache config setting will depend on the interleavings chosen by the OS scheduler and memory consistency.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuLibraryGetKernel, cuKernelGetFunction, cuLibraryGetModule, cuModuleGetFunction, cuFuncSetCacheConfig, cuCtxSetCacheConfig, cuLaunchKernel

# CUresult cuLibraryEnumerateKernels (CUkernel *kernels, unsigned int numKernels, CUlibrary lib)

Retrieve the kernel handles within a library.

## Parameters

**kernels**
- Buffer where the kernel handles are returned to

**numKernels**
- Maximum number of kernel handles may be returned to the buffer

**lib**
- Library to query from

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `kernels` a maximum number of `numKernels` kernel handles within `lib`. The returned kernel handle becomes invalid when the library is unloaded.

See also:

cuLibraryGetKernelCount

# CUresult cuLibraryGetGlobal (CUdeviceptr *dptr, size_t *bytes, CUlibrary library, const char *name)

Returns a global device pointer.

## Parameters

**dptr**
- Returned global device pointer for the requested context

**bytes**
- Returned global size in bytes

**library**
- Library to retrieve global from

**name**
- Name of global to retrieve

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_CONTEXT_IS_DESTROYED

### Description

Returns in `*dptr` and `*bytes` the base pointer and size of the global with name `name` for the requested library `library` and the current context. If no global for the requested name `name` exists, the call returns CUDA_ERROR_NOT_FOUND. One of the parameters `dptr` or `bytes` (not both) can be NULL in which case it is ignored.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuLibraryGetModule, cuModuleGetGlobal

## CUresult cuLibraryGetKernel (CUkernel *pKernel, CUlibrary library, const char *name)

Returns a kernel handle.

### Parameters

**pKernel**
- Returned kernel handle

**library**
- Library to retrieve kernel from

**name**
- Name of kernel to retrieve

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_FOUND

### Description

Returns in `pKernel` the handle of the kernel with name `name` located in library `library`. If kernel handle is not found, the call returns CUDA_ERROR_NOT_FOUND.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuKernelGetFunction, cuLibraryGetModule, cuModuleGetFunction

## CUresult cuLibraryGetKernelCount (unsigned int *count, CUlibrary lib)

Returns the number of kernels within a library.

### Parameters

**count**
- Number of kernels found within the library

**lib**
- Library to query

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

### Description

Returns in `count` the number of kernels in `lib`.

## CUresult cuLibraryGetManaged (CUdeviceptr *dptr, size_t *bytes, CUlibrary library, const char *name)

Returns a pointer to managed memory.

### Parameters

**dptr**
- Returned pointer to the managed memory

**bytes**
- Returned memory size in bytes

**library**
- Library to retrieve managed memory from

**name**
- Name of managed memory to retrieve

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_FOUND

### Description

Returns in `*dptr` and `*bytes` the base pointer and size of the managed memory with name `name` for the requested library `library`. If no managed memory with the requested name `name` exists, the call returns CUDA_ERROR_NOT_FOUND. One of the parameters `dptr` or `bytes` (not both) can be NULL in which case it is ignored. Note that managed memory for library `library` is shared across devices and is registered when the library is loaded into atleast one context.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload

## CUresult cuLibraryGetModule (CUmodule *pMod, CUlibrary library)

Returns a module handle.

### Parameters

**pMod**
- Returned module handle

**library**
- Library to retrieve module from

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_CONTEXT_IS_DESTROYED

### Description

Returns in `pMod` the module handle associated with the current context located in library `library`. If module handle is not found, the call returns CUDA_ERROR_NOT_FOUND.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload, cuModuleGetFunction

# CUresult cuLibraryGetUnifiedFunction (void **fptr, CUlibrary library, const char *symbol)

Returns a pointer to a unified function.

## Parameters

**fptr**
- Returned pointer to a unified function

**library**
- Library to retrieve function pointer memory from

**symbol**
- Name of function pointer to retrieve

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_FOUND

## Description

Returns in `*fptr` the function pointer to a unified function denoted by `symbol`. If no unified function with name `symbol` exists, the call returns CUDA_ERROR_NOT_FOUND. If there is no device with attribute CU_DEVICE_ATTRIBUTE_UNIFIED_FUNCTION_POINTERS present in the system, the call may return CUDA_ERROR_NOT_FOUND.

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuLibraryUnload

# CUresult cuLibraryLoadData (CUlibrary *library, const void *code, CUjit_option *jitOptions, void **jitOptionsValues, unsigned int numJitOptions, CUlibraryOption *libraryOptions, void **libraryOptionValues, unsigned int numLibraryOptions)

Load a library with specified code and options.

## Parameters

**library**
- Returned library

**code**
- Code to load

**jitOptions**
- Options for JIT

**jitOptionsValues**
- Option values for JIT

**numJitOptions**
- Number of options

**libraryOptions**
- Options for loading

**libraryOptionValues**
- Option values for loading

**numLibraryOptions**
- Number of options for loading

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NO_BINARY_FOR_GPU, CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_JIT_COMPILER_NOT_FOUND, CUDA_ERROR_NOT_SUPPORTED

## Description

Takes a pointer `code` and loads the corresponding library `library` based on the application defined library loading mode:

- If module loading is set to EAGER, via the environment variables described in "Module loading", `library` is loaded eagerly into all contexts at the time of the call and future contexts at the time of creation until the library is unloaded with cuLibraryUnload().
- If the environment variables are set to LAZY, `library` is not immediately loaded onto all existent contexts and will only be loaded when a function is needed for that context, such as a kernel launch.

These environment variables are described in the CUDA programming guide under the "CUDA environment variables" section.

The `code` may be a cubin or fatbin as output by nvcc, or a NULL-terminated PTX, either as output by nvcc or hand-written, or Tile IR data. A fatbin should also contain relocatable code when doing separate compilation.

Options are passed as an array via `jitOptions` and any corresponding parameters are passed in `jitOptionsValues`. The number of total JIT options is supplied via `numJitOptions`. Any outputs will be returned via `jitOptionsValues`.

Library load options are passed as an array via `libraryOptions` and any corresponding parameters are passed in `libraryOptionValues`. The number of total library load options is supplied via `numLibraryOptions`.

Note:

If the library contains managed variables and no device in the system supports managed variables this call is expected to return CUDA_ERROR_NOT_SUPPORTED

See also:

cuLibraryLoadFromFile, cuLibraryUnload, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx

# CUresult cuLibraryLoadFromFile (CUlibrary *library, const char *fileName, CUjit_option *jitOptions, void **jitOptionsValues, unsigned int numJitOptions, CUlibraryOption *libraryOptions, void **libraryOptionValues, unsigned int numLibraryOptions)

Load a library with specified file and options.

## Parameters

**library**
- Returned library

**fileName**
- File to load from

**jitOptions**
- Options for JIT

**jitOptionsValues**
- Option values for JIT

**numJitOptions**
- Number of options

**libraryOptions**
- Options for loading

**libraryOptionValues**
- Option values for loading

**numLibraryOptions**
- Number of options for loading

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_PTX, CUDA_ERROR_UNSUPPORTED_PTX_VERSION, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NO_BINARY_FOR_GPU, CUDA_ERROR_SHARED_OBJECT_SYMBOL_NOT_FOUND, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_JIT_COMPILER_NOT_FOUND, CUDA_ERROR_NOT_SUPPORTED

## Description

Takes a pointer `code` and loads the corresponding library `library` based on the application defined library loading mode:

- If module loading is set to EAGER, via the environment variables described in "Module loading", `library` is loaded eagerly into all contexts at the time of the call and future contexts at the time of creation until the library is unloaded with cuLibraryUnload().
- If the environment variables are set to LAZY, `library` is not immediately loaded onto all existent contexts and will only be loaded when a function is needed for that context, such as a kernel launch.

These environment variables are described in the CUDA programming guide under the "CUDA environment variables" section.

The file should be a cubin file as output by nvcc, or a PTX file either as output by nvcc or handwritten, or a fatbin file as output by nvcc or hand-written, or Tile IR file. A fatbin should also contain relocatable code when doing separate compilation.

Options are passed as an array via `jitOptions` and any corresponding parameters are passed in `jitOptionsValues`. The number of total options is supplied via `numJitOptions`. Any outputs will be returned via `jitOptionsValues`.

Library load options are passed as an array via `libraryOptions` and any corresponding parameters are passed in `libraryOptionValues`. The number of total library load options is supplied via `numLibraryOptions`.

Note:

If the library contains managed variables and no device in the system supports managed variables this call is expected to return CUDA_ERROR_NOT_SUPPORTED

See also:

cuLibraryLoadData, cuLibraryUnload, cuModuleLoad, cuModuleLoadData, cuModuleLoadDataEx

## CUresult cuLibraryUnload (CUlibrary library)

Unloads a library.

### Parameters

**library**
- Library to unload

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Unloads the library specified with `library`

See also:

cuLibraryLoadData, cuLibraryLoadFromFile, cuModuleUnload

# 6.13. Memory Management

This section describes the memory management functions of the low-level CUDA driver application programming interface.

## struct CUmemDecompressParams

Structure describing the parameters that compose a single decompression operation.

## enum CUmemDecompressAlgorithm

Bitmasks for CU_DEVICE_ATTRIBUTE_MEM_DECOMPRESS_ALGORITHM_MASK.

### Values

**CU_MEM_DECOMPRESS_UNSUPPORTED = 0**
Decompression is unsupported.

**CU_MEM_DECOMPRESS_ALGORITHM_DEFLATE = 1<<0**
Deflate is supported.

**CU_MEM_DECOMPRESS_ALGORITHM_SNAPPY = 1<<1**
Snappy is supported.

**CU_MEM_DECOMPRESS_ALGORITHM_LZ4 = 1<<2**
LZ4 is supported.

# CUresult cuArray3DCreate (CUarray *pHandle, const CUDA_ARRAY3D_DESCRIPTOR *pAllocateArray)

Creates a 3D CUDA array.

## Parameters

**pHandle**
- Returned array

**pAllocateArray**
- 3D array descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Creates a CUDA array according to the CUDA_ARRAY3D_DESCRIPTOR structure `pAllocateArray` and returns a handle to the new CUDA array in `*pHandle`. The CUDA_ARRAY3D_DESCRIPTOR is defined as:

```
typedef struct {
          unsigned int Width;
          unsigned int Height;
          unsigned int Depth;
          CUarray_format Format;
          unsigned int NumChannels;
          unsigned int Flags;
      } CUDA_ARRAY3D_DESCRIPTOR;
```

where:

- `Width`, `Height`, and `Depth` are the width, height, and depth of the CUDA array (in elements); the following types of CUDA arrays can be allocated:
  - A 1D array is allocated if `Height` and `Depth` extents are both zero.
  - A 2D array is allocated if only `Depth` extent is zero.
  - A 3D array is allocated if all three extents are non-zero.
  - A 1D layered CUDA array is allocated if only `Height` is zero and the CUDA_ARRAY3D_LAYERED flag is set. Each layer is a 1D array. The number of layers is determined by the depth extent.
  - A 2D layered CUDA array is allocated if all three extents are non-zero and the CUDA_ARRAY3D_LAYERED flag is set. Each layer is a 2D array. The number of layers is determined by the depth extent.
  - A cubemap CUDA array is allocated if all three extents are non-zero and the CUDA_ARRAY3D_CUBEMAP flag is set. `Width` must be equal to `Height`, and `Depth`

must be six. A cubemap is a special type of 2D layered CUDA array, where the six layers represent the six faces of a cube. The order of the six layers in memory is the same as that listed in CUarray_cubemap_face.

- A cubemap layered CUDA array is allocated if all three extents are non-zero, and both, CUDA_ARRAY3D_CUBEMAP and CUDA_ARRAY3D_LAYERED flags are set. `Width` must be equal to `Height`, and `Depth` must be a multiple of six. A cubemap layered CUDA array is a special type of 2D layered CUDA array that consists of a collection of cubemaps. The first six layers represent the first cubemap, the next six layers form the second cubemap, and so on.

- Format specifies the format of the elements; CUarray_format is defined as:

```
typedef enum CUarray_format_enum {
    CU_AD_FORMAT_UNSIGNED_INT8 = 0x01,
    CU_AD_FORMAT_UNSIGNED_INT16 = 0x02,
    CU_AD_FORMAT_UNSIGNED_INT32 = 0x03,
    CU_AD_FORMAT_SIGNED_INT8 = 0x08,
    CU_AD_FORMAT_SIGNED_INT16 = 0x09,
    CU_AD_FORMAT_SIGNED_INT32 = 0x0a,
    CU_AD_FORMAT_HALF = 0x10,
    CU_AD_FORMAT_FLOAT = 0x20,
    CU_AD_FORMAT_NV12 = 0xb0,
    CU_AD_FORMAT_UNORM_INT8X1 = 0xc0,
    CU_AD_FORMAT_UNORM_INT8X2 = 0xc1,
    CU_AD_FORMAT_UNORM_INT8X4 = 0xc2,
    CU_AD_FORMAT_UNORM_INT16X1 = 0xc3,
    CU_AD_FORMAT_UNORM_INT16X2 = 0xc4,
    CU_AD_FORMAT_UNORM_INT16X4 = 0xc5,
    CU_AD_FORMAT_SNORM_INT8X1 = 0xc6,
    CU_AD_FORMAT_SNORM_INT8X2 = 0xc7,
    CU_AD_FORMAT_SNORM_INT8X4 = 0xc8,
    CU_AD_FORMAT_SNORM_INT16X1 = 0xc9,
    CU_AD_FORMAT_SNORM_INT16X2 = 0xca,
    CU_AD_FORMAT_SNORM_INT16X4 = 0xcb,
    CU_AD_FORMAT_BC1_UNORM = 0x91,
    CU_AD_FORMAT_BC1_UNORM_SRGB = 0x92,
    CU_AD_FORMAT_BC2_UNORM = 0x93,
    CU_AD_FORMAT_BC2_UNORM_SRGB = 0x94,
    CU_AD_FORMAT_BC3_UNORM = 0x95,
    CU_AD_FORMAT_BC3_UNORM_SRGB = 0x96,
    CU_AD_FORMAT_BC4_UNORM = 0x97,
    CU_AD_FORMAT_BC4_SNORM = 0x98,
    CU_AD_FORMAT_BC5_UNORM = 0x99,
    CU_AD_FORMAT_BC5_SNORM = 0x9a,
    CU_AD_FORMAT_BC6H_UF16 = 0x9b,
    CU_AD_FORMAT_BC6H_SF16 = 0x9c,
    CU_AD_FORMAT_BC7_UNORM = 0x9d,
    CU_AD_FORMAT_BC7_UNORM_SRGB = 0x9e,
    CU_AD_FORMAT_P010 = 0x9f,
    CU_AD_FORMAT_P016 = 0xa1,
    CU_AD_FORMAT_NV16 = 0xa2,
    CU_AD_FORMAT_P210 = 0xa3,
    CU_AD_FORMAT_P216 = 0xa4,
    CU_AD_FORMAT_YUY2 = 0xa5,
    CU_AD_FORMAT_Y210 = 0xa6,
    CU_AD_FORMAT_Y216 = 0xa7,
    CU_AD_FORMAT_AYUV = 0xa8,
    CU_AD_FORMAT_Y410 = 0xa9,
    CU_AD_FORMAT_Y416 = 0xb1,
    CU_AD_FORMAT_Y444_PLANAR8 = 0xb2,
    CU_AD_FORMAT_Y444_PLANAR10 = 0xb3,
    CU_AD_FORMAT_YUV444_8bit_SemiPlanar = 0xb4,
    CU_AD_FORMAT_YUV444_16bit_SemiPlanar = 0xb5,
```

```
    CU_AD_FORMAT_UNORM_INT_101010_2 = 0x50,
} CUarray_format;
```

- `NumChannels` specifies the number of packed components per CUDA array element; it may be 1, 2, or 4;
- Flags may be set to
  - CUDA_ARRAY3D_LAYERED to enable creation of layered CUDA arrays. If this flag is set, `Depth` specifies the number of layers, not the depth of a 3D array.
  - CUDA_ARRAY3D_SURFACE_LDST to enable surface references to be bound to the CUDA array. If this flag is not set, cuSurfRefSetArray will fail when attempting to bind the CUDA array to a surface reference.
  - CUDA_ARRAY3D_CUBEMAP to enable creation of cubemaps. If this flag is set, `Width` must be equal to `Height`, and `Depth` must be six. If the CUDA_ARRAY3D_LAYERED flag is also set, then `Depth` must be a multiple of six.
  - CUDA_ARRAY3D_TEXTURE_GATHER to indicate that the CUDA array will be used for texture gather. Texture gather can only be performed on 2D CUDA arrays.

`Width`, `Height` and `Depth` must meet certain size requirements as listed in the following table. All values are specified in elements. Note that for brevity's sake, the full name of the device attribute is not specified. For ex., TEXTURE1D_WIDTH refers to the device attribute CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_WIDTH.

Note that 2D CUDA arrays have different size requirements if the CUDA_ARRAY3D_TEXTURE_GATHER flag is set. `Width` and `Height` must not be greater than CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_GATHER_WIDTH and CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_GATHER_HEIGHT respectively, in that case.

| CUDA array type | Valid extents that must always be met {(width range in elements), (height range), (depth range)} | Valid extents with CUDA_ARRAY3D_SURFACE_LDST set {(width range in elements), (height range), (depth range)} |
|---|---|---|
| 1D | { (1,TEXTURE1D_WIDTH), 0, 0 } | { (1,SURFACE1D_WIDTH), 0, 0 } |
| 2D | { (1,TEXTURE2D_WIDTH), (1,TEXTURE2D_HEIGHT), 0 } | { (1,SURFACE2D_WIDTH), (1,SURFACE2D_HEIGHT), 0 } |
| 3D | { (1,TEXTURE3D_WIDTH), (1,TEXTURE3D_HEIGHT), (1,TEXTURE3D_DEPTH) } OR { (1,TEXTURE3D_WIDTH_ALTERNATE), (1,TEXTURE3D_HEIGHT_ALTERNATE), (1,TEXTURE3D_DEPTH_ALTERNATE) } | { (1,SURFACE3D_WIDTH), (1,SURFACE3D_HEIGHT), (1,SURFACE3D_DEPTH) } |

| | | |
|---|---|---|
| 1D Layered | { (1,TEXTURE1D_LAYERED_WIDTH), 0, (1,TEXTURE1D_LAYERED_LAYERS) } | { (1,SURFACE1D_LAYERED_WIDTH), 0, (1,SURFACE1D_LAYERED_LAYERS) } |
| 2D Layered | { (1,TEXTURE2D_LAYERED_WIDTH), (1,TEXTURE2D_LAYERED_HEIGHT), (1,TEXTURE2D_LAYERED_LAYERS) } | { (1,SURFACE2D_LAYERED_WIDTH), (1,SURFACE2D_LAYERED_HEIGHT), (1,SURFACE2D_LAYERED_LAYERS) } |
| Cubemap | { (1,TEXTURECUBEMAP_WIDTH), (1,TEXTURECUBEMAP_WIDTH), 6 } | { (1,SURFACECUBEMAP_WIDTH), (1,SURFACECUBEMAP_WIDTH), 6 } |
| Cubemap Layered | { (1,TEXTURECUBEMAP_LAYERED_WIDTH), (1,TEXTURECUBEMAP_LAYERED_WIDTH), (1,TEXTURECUBEMAP_LAYERED_LAYERS) } | { (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,SURFACECUBEMAP_LAYERED_LAYERS) } |

Here are examples of CUDA array descriptions:

Description for a CUDA array of 2048 floats:

```
CUDA_ARRAY3D_DESCRIPTOR desc;
desc.Format = CU_AD_FORMAT_FLOAT;
desc.NumChannels = 1;
desc.Width = 2048;
desc.Height = 0;
desc.Depth = 0;
```

Description for a 64 x 64 CUDA array of floats:

```
CUDA_ARRAY3D_DESCRIPTOR desc;
desc.Format = CU_AD_FORMAT_FLOAT;
desc.NumChannels = 1;
desc.Width = 64;
desc.Height = 64;
desc.Depth = 0;
```

Description for a `width` x `height` x `depth` CUDA array of 64-bit, 4x16-bit float16's:

```
CUDA_ARRAY3D_DESCRIPTOR desc;
desc.Format = CU_AD_FORMAT_HALF;
desc.NumChannels = 4;
desc.Width = width;
desc.Height = height;
desc.Depth = depth;
```

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync,

cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMalloc3DArray

# CUresult cuArray3DGetDescriptor (CUDA_ARRAY3D_DESCRIPTOR *pArrayDescriptor, CUarray hArray)

Get a 3D CUDA array descriptor.

## Parameters

**pArrayDescriptor**
- Returned 3D array descriptor

**hArray**
- 3D array to get descriptor of

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_CONTEXT_IS_DESTROYED

## Description

Returns in `*pArrayDescriptor` a descriptor containing information on the format and dimensions of the CUDA array `hArray`. It is useful for subroutines that have been passed a CUDA array, but need to know the CUDA array parameters for validation or other purposes.

This function may be called on 1D and 2D arrays, in which case the `Height` and/or `Depth` members of the descriptor struct will be set to 0.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo,

cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaArrayGetInfo

# CUresult cuArrayCreate (CUarray *pHandle, const CUDA_ARRAY_DESCRIPTOR *pAllocateArray)

Creates a 1D or 2D CUDA array.

## Parameters

**pHandle**
- Returned array

**pAllocateArray**
- Array descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Creates a CUDA array according to the CUDA_ARRAY_DESCRIPTOR structure `pAllocateArray` and returns a handle to the new CUDA array in `*pHandle`. The CUDA_ARRAY_DESCRIPTOR is defined as:

```
typedef struct {
        unsigned int Width;
        unsigned int Height;
        CUarray_format Format;
        unsigned int NumChannels;
    } CUDA_ARRAY_DESCRIPTOR;
```

where:

- `Width`, and `Height` are the width, and height of the CUDA array (in elements); the CUDA array is one-dimensional if height is 0, two-dimensional otherwise;
- Format specifies the format of the elements; CUarray_format is defined as:

```
typedef enum CUarray_format_enum {
        CU_AD_FORMAT_UNSIGNED_INT8 = 0x01,
        CU_AD_FORMAT_UNSIGNED_INT16 = 0x02,
        CU_AD_FORMAT_UNSIGNED_INT32 = 0x03,
        CU_AD_FORMAT_SIGNED_INT8 = 0x08,
        CU_AD_FORMAT_SIGNED_INT16 = 0x09,
        CU_AD_FORMAT_SIGNED_INT32 = 0x0a,
        CU_AD_FORMAT_HALF = 0x10,
        CU_AD_FORMAT_FLOAT = 0x20,
        CU_AD_FORMAT_NV12 = 0xb0,
        CU_AD_FORMAT_UNORM_INT8X1 = 0xc0,
        CU_AD_FORMAT_UNORM_INT8X2 = 0xc1,
        CU_AD_FORMAT_UNORM_INT8X4 = 0xc2,
        CU_AD_FORMAT_UNORM_INT16X1 = 0xc3,
        CU_AD_FORMAT_UNORM_INT16X2 = 0xc4,
        CU_AD_FORMAT_UNORM_INT16X4 = 0xc5,
```

```
        CU_AD_FORMAT_SNORM_INT8X1 = 0xc6,
        CU_AD_FORMAT_SNORM_INT8X2 = 0xc7,
        CU_AD_FORMAT_SNORM_INT8X4 = 0xc8,
        CU_AD_FORMAT_SNORM_INT16X1 = 0xc9,
        CU_AD_FORMAT_SNORM_INT16X2 = 0xca,
        CU_AD_FORMAT_SNORM_INT16X4 = 0xcb,
        CU_AD_FORMAT_BC1_UNORM = 0x91,
        CU_AD_FORMAT_BC1_UNORM_SRGB = 0x92,
        CU_AD_FORMAT_BC2_UNORM = 0x93,
        CU_AD_FORMAT_BC2_UNORM_SRGB = 0x94,
        CU_AD_FORMAT_BC3_UNORM = 0x95,
        CU_AD_FORMAT_BC3_UNORM_SRGB = 0x96,
        CU_AD_FORMAT_BC4_UNORM = 0x97,
        CU_AD_FORMAT_BC4_SNORM = 0x98,
        CU_AD_FORMAT_BC5_UNORM = 0x99,
        CU_AD_FORMAT_BC5_SNORM = 0x9a,
        CU_AD_FORMAT_BC6H_UF16 = 0x9b,
        CU_AD_FORMAT_BC6H_SF16 = 0x9c,
        CU_AD_FORMAT_BC7_UNORM = 0x9d,
        CU_AD_FORMAT_BC7_UNORM_SRGB = 0x9e,
        CU_AD_FORMAT_P010 = 0x9f,
        CU_AD_FORMAT_P016 = 0xa1,
        CU_AD_FORMAT_NV16 = 0xa2,
        CU_AD_FORMAT_P210 = 0xa3,
        CU_AD_FORMAT_P216 = 0xa4,
        CU_AD_FORMAT_YUY2 = 0xa5,
        CU_AD_FORMAT_Y210 = 0xa6,
        CU_AD_FORMAT_Y216 = 0xa7,
        CU_AD_FORMAT_AYUV = 0xa8,
        CU_AD_FORMAT_Y410 = 0xa9,
        CU_AD_FORMAT_Y416 = 0xb1,
        CU_AD_FORMAT_Y444_PLANAR8 = 0xb2,
        CU_AD_FORMAT_Y444_PLANAR10 = 0xb3,
        CU_AD_FORMAT_YUV444_8bit_SemiPlanar = 0xb4,
        CU_AD_FORMAT_YUV444_16bit_SemiPlanar = 0xb5,
        CU_AD_FORMAT_UNORM_INT_101010_2 = 0x50,
        CU_AD_FORMAT_UINT8_PACKED_422 = 0x51,
        CU_AD_FORMAT_UINT8_PACKED_444 = 0x52,
        CU_AD_FORMAT_UINT8_SEMIPLANAR_420 = 0x53,
        CU_AD_FORMAT_UINT16_SEMIPLANAR_420 = 0x54,
        CU_AD_FORMAT_UINT8_SEMIPLANAR_422 = 0x55,
        CU_AD_FORMAT_UINT16_SEMIPLANAR_422 = 0x56,
        CU_AD_FORMAT_UINT8_SEMIPLANAR_444 = 0x57,
        CU_AD_FORMAT_UINT16_SEMIPLANAR_444 = 0x58,
        CU_AD_FORMAT_UINT8_PLANAR_420 = 0x59,
        CU_AD_FORMAT_UINT16_PLANAR_420 = 0x5a,
        CU_AD_FORMAT_UINT8_PLANAR_422 = 0x5b,
        CU_AD_FORMAT_UINT16_PLANAR_422 = 0x5c,
        CU_AD_FORMAT_UINT8_PLANAR_444 = 0x5d,
        CU_AD_FORMAT_UINT16_PLANAR_444 = 0x5e,
    } CUarray_format;
```

- `NumChannels` specifies the number of packed components per CUDA array element; it may be 1, 2, or 4;

Here are examples of CUDA array descriptions:

Description for a CUDA array of 2048 floats:

```
CUDA_ARRAY_DESCRIPTOR desc;
desc.Format = CU_AD_FORMAT_FLOAT;
desc.NumChannels = 1;
desc.Width = 2048;
desc.Height = 1;
```

Description for a 64 x 64 CUDA array of floats:

```
CUDA_ARRAY_DESCRIPTOR desc;
```

```
        desc.Format = CU_AD_FORMAT_FLOAT;
        desc.NumChannels = 1;
        desc.Width = 64;
        desc.Height = 64;
```

Description for a `width` x `height` CUDA array of 64-bit, 4x16-bit float16's:

```
    CUDA_ARRAY_DESCRIPTOR desc;
        desc.Format = CU_AD_FORMAT_HALF;
        desc.NumChannels = 4;
        desc.Width = width;
        desc.Height = height;
```

Description for a `width` x `height` CUDA array of 16-bit elements, each of which is two 8-bit unsigned chars:

```
    CUDA_ARRAY_DESCRIPTOR arrayDesc;
        desc.Format = CU_AD_FORMAT_UNSIGNED_INT8;
        desc.NumChannels = 2;
        desc.Width = width;
        desc.Height = height;
```

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMallocArray

# CUresult cuArrayDestroy (CUarray hArray)

Destroys a CUDA array.

## Parameters

**hArray**

- Array to destroy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ARRAY_IS_MAPPED, CUDA_ERROR_CONTEXT_IS_DESTROYED

### Description

Destroys the CUDA array `hArray`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaFreeArray

## CUresult cuArrayGetDescriptor (CUDA_ARRAY_DESCRIPTOR *pArrayDescriptor, CUarray hArray)

Get a 1D or 2D CUDA array descriptor.

### Parameters

**pArrayDescriptor**

- Returned array descriptor

**hArray**

- Array to get descriptor of

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Returns in `*pArrayDescriptor` a descriptor containing information on the format and dimensions of the CUDA array `hArray`. It is useful for subroutines that have been passed a CUDA array, but need to know the CUDA array parameters for validation or other purposes.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaArrayGetInfo

# CUresult cuArrayGetMemoryRequirements (CUDA_ARRAY_MEMORY_REQUIREMENTS *memoryRequirements, CUarray array, CUdevice device)

Returns the memory requirements of a CUDA array.

## Parameters

**memoryRequirements**
- Pointer to CUDA_ARRAY_MEMORY_REQUIREMENTS

**array**
- CUDA array to get the memory requirements of

**device**
- Device to get the memory requirements for

## Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## Description

Returns the memory requirements of a CUDA array in `memoryRequirements` If the CUDA array is not allocated with flag CUDA_ARRAY3D_DEFERRED_MAPPING CUDA_ERROR_INVALID_VALUE will be returned.

The returned value in CUDA_ARRAY_MEMORY_REQUIREMENTS::size represents the total size of the CUDA array. The returned value in CUDA_ARRAY_MEMORY_REQUIREMENTS::alignment represents the alignment necessary for mapping the CUDA array.

See also:

cuMipmappedArrayGetMemoryRequirements, cuMemMapArrayAsync

# CUresult cuArrayGetPlane (CUarray *pPlaneArray, CUarray hArray, unsigned int planeIdx)

Gets a CUDA array plane from a CUDA array.

## Parameters

**pPlaneArray**
- Returned CUDA array referenced by the `planeIdx`

**hArray**
- Multiplanar CUDA array

**planeIdx**
- Plane index

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Returns in `pPlaneArray` a CUDA array that represents a single format plane of the CUDA array `hArray`.

If `planeIdx` is greater than the maximum number of planes in this array or if the array does not have a multi-planar format e.g: CU_AD_FORMAT_NV12, then CUDA_ERROR_INVALID_VALUE is returned.

Note that if the `hArray` has format CU_AD_FORMAT_NV12, then passing in 0 for `planeIdx` returns a CUDA array of the same size as `hArray` but with one channel and CU_AD_FORMAT_UNSIGNED_INT8 as its format. If 1 is passed for `planeIdx`, then the returned CUDA array has half the height and width of `hArray` with two channels and CU_AD_FORMAT_UNSIGNED_INT8 as its format.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArrayCreate, cudaArrayGetPlane

# CUresult cuArrayGetSparseProperties (CUDA_ARRAY_SPARSE_PROPERTIES *sparseProperties, CUarray array)

Returns the layout properties of a sparse CUDA array.

## Parameters

**sparseProperties**
- Pointer to CUDA_ARRAY_SPARSE_PROPERTIES

**array**
- CUDA array to get the sparse properties of

## Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## Description

Returns the layout properties of a sparse CUDA array in `sparseProperties` If the CUDA array is not allocated with flag CUDA_ARRAY3D_SPARSE CUDA_ERROR_INVALID_VALUE will be returned.

If the returned value in CUDA_ARRAY_SPARSE_PROPERTIES::flags contains CU_ARRAY_SPARSE_PROPERTIES_SINGLE_MIPTAIL, then CUDA_ARRAY_SPARSE_PROPERTIES::miptailSize represents the total size of the array. Otherwise, it will be zero. Also, the returned value in CUDA_ARRAY_SPARSE_PROPERTIES::miptailFirstLevel is always zero. Note that the `array` must have been allocated using cuArrayCreate or cuArray3DCreate. For CUDA arrays obtained using cuMipmappedArrayGetLevel, CUDA_ERROR_INVALID_VALUE will be returned. Instead, cuMipmappedArrayGetSparseProperties must be used to obtain the sparse properties of the entire CUDA mipmapped array to which `array` belongs to.

See also:

cuMipmappedArrayGetSparseProperties, cuMemMapArrayAsync

# CUresult cuDeviceGetByPCIBusId (CUdevice *dev, const char *pciBusId)

Returns a handle to a compute device.

## Parameters

**dev**
- Returned device handle

**pciBusId**

- String in one of the following forms: [domain]:[bus]:[device].[function] [domain]:[bus]:[device] [bus]:[device].[function] where `domain`, `bus`, `device`, and `function` are all hexadecimal values

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

### Description

Returns in `*device` a device handle given a PCI bus ID string.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGet, cuDeviceGetAttribute, cuDeviceGetPCIBusId, cudaDeviceGetByPCIBusId

## CUresult cuDeviceGetPCIBusId (char *pciBusId, int len, CUdevice dev)

Returns a PCI Bus Id string for the device.

### Parameters

**pciBusId**

- Returned identifier string for the device in the following format [domain]:[bus]:[device].[function] where `domain`, `bus`, `device`, and `function` are all hexadecimal values. pciBusId should be large enough to store 13 characters including the NULL-terminator.

**len**

- Maximum length of string to store in `name`

**dev**

- Device to get identifier string for

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

### Description

Returns an ASCII string identifying the device `dev` in the NULL-terminated string pointed to by `pciBusId`. `len` specifies the maximum length of the string that may be returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGet, cuDeviceGetAttribute, cuDeviceGetByPCIBusId, cudaDeviceGetPCIBusId

# CUresult cuDeviceRegisterAsyncNotification (CUdevice device, CUasyncCallback callbackFunc, void *userData, CUasyncCallbackHandle *callback)

Registers a callback function to receive async notifications.

## Parameters

**device**
- The device on which to register the callback

**callbackFunc**
- The function to register as a callback

**userData**
- A generic pointer to user data. This is passed into the callback function.

**callback**
- A handle representing the registered callback instance

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_UNKNOWN

## Description

Registers `callbackFunc` to receive async notifications.

The `userData` parameter is passed to the callback function at async notification time. Likewise, `callback` is also passed to the callback function to distinguish between multiple registered callbacks.

The callback function being registered should be designed to return quickly (~10ms). Any long running tasks should be queued for execution on an application thread.

Callbacks may not call cuDeviceRegisterAsyncNotification or cuDeviceUnregisterAsyncNotification. Doing so will result in CUDA_ERROR_NOT_PERMITTED. Async notification callbacks execute in an undefined order and may be serialized.

Returns in `*callback` a handle representing the registered callback instance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceUnregisterAsyncNotification

## CUresult cuDeviceUnregisterAsyncNotification (CUdevice device, CUasyncCallbackHandle callback)

Unregisters an async notification callback.

### Parameters

**device**

- The device from which to remove `callback`.

**callback**

- The callback instance to unregister from receiving async notifications.

### Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_UNKNOWN

### Description

Unregisters `callback` so that the corresponding callback function will stop receiving async notifications.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceRegisterAsyncNotification

# CUresult cuIpcCloseMemHandle (CUdeviceptr dptr)

Attempts to close memory mapped with cuIpcOpenMemHandle.

## Parameters

**dptr**

- Device pointer returned by cuIpcOpenMemHandle

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_MAP_FAILED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

## Description

Decrements the reference count of the memory returned by cuIpcOpenMemHandle by 1. When the reference count reaches 0, this API unmaps the memory. The original allocation in the exporting process as well as imported mappings in other processes will be unaffected.

Any resources used to enable peer access will be freed if this is the last mapping using them.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is supported for compatibility purposes but not recommended as it comes with performance cost. Users can test their device for IPC functionality by calling cuapiDeviceGetAttribute with CU_DEVICE_ATTRIBUTE_IPC_EVENT_SUPPORTED

See also:

cuMemAlloc, cuMemFree, cuIpcGetEventHandle, cuIpcOpenEventHandle, cuIpcGetMemHandle, cuIpcOpenMemHandle, cudaIpcCloseMemHandle

# CUresult cuIpcGetEventHandle (CUipcEventHandle *pHandle, CUevent event)

Gets an interprocess handle for a previously allocated event.

## Parameters

**pHandle**

- Pointer to a user allocated CUipcEventHandle in which to return the opaque event handle

**event**

- Event allocated with CU_EVENT_INTERPROCESS and CU_EVENT_DISABLE_TIMING flags.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_MAP_FAILED, CUDA_ERROR_INVALID_VALUE

### Description

Takes as input a previously allocated event. This event must have been created with the CU_EVENT_INTERPROCESS and CU_EVENT_DISABLE_TIMING flags set. This opaque handle may be copied into other processes and opened with cuIpcOpenEventHandle to allow efficient hardware synchronization between GPU work in different processes.

After the event has been opened in the importing process, cuEventRecord, cuEventSynchronize, cuStreamWaitEvent and cuEventQuery may be used in either process. Performing operations on the imported event after the exported event has been freed with cuEventDestroy will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is supported for compatibility purposes but not recommended as it comes with performance cost. Users can test their device for IPC functionality by calling cuDeviceGetAttribute with CU_DEVICE_ATTRIBUTE_IPC_EVENT_SUPPORTED

See also:

cuEventCreate, cuEventDestroy, cuEventSynchronize, cuEventQuery, cuStreamWaitEvent, cuIpcOpenEventHandle, cuIpcGetMemHandle, cuIpcOpenMemHandle, cuIpcCloseMemHandle, cudaIpcGetEventHandle

## CUresult cuIpcGetMemHandle (CUipcMemHandle *pHandle, CUdeviceptr dptr)

Gets an interprocess memory handle for an existing device memory allocation.

### Parameters

**pHandle**

- Pointer to user allocated CUipcMemHandle to return the handle in.

**dptr**

- Base pointer to previously allocated device memory

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_MAP_FAILED, CUDA_ERROR_INVALID_VALUE

### Description

Takes a pointer to the base of an existing device memory allocation created with cuMemAlloc and exports it for use in another process. This is a lightweight operation and may be called multiple times on an allocation without adverse effects.

If a region of memory is freed with cuMemFree and a subsequent call to cuMemAlloc returns memory with the same device address, cuIpcGetMemHandle will return a unique handle for the new memory.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is supported for compatibility purposes but not recommended as it comes with performance cost. Users can test their device for IPC functionality by calling cuapiDeviceGetAttribute with CU_DEVICE_ATTRIBUTE_IPC_EVENT_SUPPORTED

See also:

cuMemAlloc, cuMemFree, cuIpcGetEventHandle, cuIpcOpenEventHandle, cuIpcOpenMemHandle, cuIpcCloseMemHandle, cudaIpcGetMemHandle

## CUresult cuIpcOpenEventHandle (CUevent *phEvent, CUipcEventHandle handle)

Opens an interprocess event handle for use in the current process.

### Parameters

**phEvent**
- Returns the imported event

**handle**
- Interprocess handle to open

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_MAP_FAILED, CUDA_ERROR_PEER_ACCESS_UNSUPPORTED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

### Description

Opens an interprocess event handle exported from another process with cuIpcGetEventHandle. This function returns a CUevent that behaves like a locally created event with the CU_EVENT_DISABLE_TIMING flag specified. This event must be freed with cuEventDestroy.

Performing operations on the imported event after the exported event has been freed with cuEventDestroy will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is supported for compatibility purposes but not

recommended as it comes with performance cost. Users can test their device for IPC functionality by calling cuapiDeviceGetAttribute with CU_DEVICE_ATTRIBUTE_IPC_EVENT_SUPPORTED

See also:

cuEventCreate, cuEventDestroy, cuEventSynchronize, cuEventQuery, cuStreamWaitEvent, cuIpcGetEventHandle, cuIpcGetMemHandle, cuIpcOpenMemHandle, cuIpcCloseMemHandle, cudaIpcOpenEventHandle

# CUresult cuIpcOpenMemHandle (CUdeviceptr *pdptr, CUipcMemHandle handle, unsigned int Flags)

Opens an interprocess memory handle exported from another process and returns a device pointer usable in the local process.

## Parameters

**pdptr**
- Returned device pointer

**handle**
- CUipcMemHandle to open

**Flags**
- Flags for this operation. Must be specified as CU_IPC_MEM_LAZY_ENABLE_PEER_ACCESS

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_MAP_FAILED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_TOO_MANY_PEERS, CUDA_ERROR_INVALID_VALUE

## Description

Maps memory exported from another process with cuIpcGetMemHandle into the current device address space. For contexts on different devices cuIpcOpenMemHandle can attempt to enable peer access between the devices as if the user called cuCtxEnablePeerAccess. This behavior is controlled by the CU_IPC_MEM_LAZY_ENABLE_PEER_ACCESS flag. cuDeviceCanAccessPeer can determine if a mapping is possible.

Contexts that may open CUipcMemHandles are restricted in the following way. CUipcMemHandles from each CUdevice in a given process may only be opened by one CUcontext per CUdevice per other process.

If the memory handle has already been opened by the current context, the reference count on the handle is incremented by 1 and the existing device pointer is returned.

Memory returned from cuIpcOpenMemHandle must be freed with cuIpcCloseMemHandle.

Calling cuMemFree on an exported memory region before calling cuIpcCloseMemHandle in the importing context will result in undefined behavior.

IPC functionality is restricted to devices with support for unified addressing on Linux and Windows operating systems. IPC functionality on Windows is supported for compatibility purposes but not recommended as it comes with performance cost. Users can test their device for IPC functionality by calling cuapiDeviceGetAttribute with CU_DEVICE_ATTRIBUTE_IPC_EVENT_SUPPORTED

Note:

No guarantees are made about the address returned in `*pdptr`. In particular, multiple processes may not receive the same address for the same `handle`.

See also:

cuMemAlloc, cuMemFree, cuIpcGetEventHandle, cuIpcOpenEventHandle, cuIpcGetMemHandle, cuIpcCloseMemHandle, cuCtxEnablePeerAccess, cuDeviceCanAccessPeer, cudaIpcOpenMemHandle

# CUresult cuMemAlloc (CUdeviceptr *dptr, size_t bytesize)

Allocates device memory.

## Parameters

**dptr**

- Returned device pointer

**bytesize**

- Requested allocation size in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY CUDA_ERROR_EXTERNAL_DEVICE

## Description

Allocates `bytesize` bytes of linear memory on the device and returns in `*dptr` a pointer to the allocated memory. The allocated memory is suitably aligned for any kind of variable. The memory is not cleared. If `bytesize` is 0, cuMemAlloc() returns CUDA_ERROR_INVALID_VALUE.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMalloc

# CUresult cuMemAllocHost (void **pp, size_t bytesize)

Allocates page-locked host memory.

## Parameters

**pp**
- Returned pointer to host memory

**bytesize**
- Requested allocation size in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY CUDA_ERROR_EXTERNAL_DEVICE

## Description

Allocates `bytesize` bytes of host memory that is page-locked and accessible to the device. The driver tracks the virtual memory ranges allocated with this function and automatically accelerates calls to functions such as cuMemcpy(). Since the memory can be accessed directly by the device, it can be read or written with much higher bandwidth than pageable memory obtained with functions such as malloc().

On systems where CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES is true, cuMemAllocHost may not page-lock the allocated memory.

Page-locking excessive amounts of memory with cuMemAllocHost() may degrade system performance, since it reduces the amount of memory available to the system for paging. As a result, this function is best used sparingly to allocate staging areas for data exchange between host and device.

Note all host memory allocated using cuMemAllocHost() will automatically be immediately accessible to all contexts on all devices which support unified addressing (as may be queried using CU_DEVICE_ATTRIBUTE_UNIFIED_ADDRESSING). The device pointer that may be used to access this host memory from those contexts is always equal to the returned host pointer `*pp`. See Unified Addressing for additional details.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMallocHost

# CUresult cuMemAllocManaged (CUdeviceptr *dptr, size_t bytesize, unsigned int flags)

Allocates memory that will be automatically managed by the Unified Memory system.

## Parameters

**dptr**
- Returned device pointer

**bytesize**
- Requested allocation size in bytes

**flags**
- Must be one of CU_MEM_ATTACH_GLOBAL or CU_MEM_ATTACH_HOST

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Allocates `bytesize` bytes of managed memory on the device and returns in `*dptr` a pointer to the allocated memory. If the device doesn't support allocating managed memory, CUDA_ERROR_NOT_SUPPORTED is returned. Support for managed memory can be queried using the device attribute CU_DEVICE_ATTRIBUTE_MANAGED_MEMORY. The allocated memory is suitably aligned for any kind of variable. The memory is not cleared. If `bytesize` is 0, cuMemAllocManaged returns CUDA_ERROR_INVALID_VALUE. The pointer is valid on the CPU and on all GPUs in the system that support managed memory. All accesses to this pointer must obey the Unified Memory programming model.

`flags` specifies the default stream association for this allocation. `flags` must be one of CU_MEM_ATTACH_GLOBAL or CU_MEM_ATTACH_HOST. If CU_MEM_ATTACH_GLOBAL is specified, then this memory is accessible from any stream on any device. If CU_MEM_ATTACH_HOST is specified, then the allocation should not be accessed from devices that have a zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS; an explicit call to cuStreamAttachMemAsync will be required to enable access on such devices.

If the association is later changed via cuStreamAttachMemAsync to a single stream, the default association as specified during cuMemAllocManaged is restored when that stream is destroyed. For __managed__ variables, the default association is always CU_MEM_ATTACH_GLOBAL. Note that destroying a stream is an asynchronous operation, and as a result, the change to default association won't happen until all work in the stream has completed.

Memory allocated with cuMemAllocManaged should be released with cuMemFree.

Device memory oversubscription is possible for GPUs that have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. Managed memory on such GPUs may be evicted from device memory to host memory at any time by the Unified Memory driver in order to make room for other allocations.

In a system where all GPUs have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS, managed memory may not be populated when this API returns and instead may be populated on access. In such systems, managed memory can migrate to any processor's memory at any time. The Unified Memory driver will employ heuristics to maintain data locality and prevent excessive page faults to the extent possible. The application can also guide the driver about memory usage patterns via cuMemAdvise. The application can also explicitly migrate memory to a desired processor's memory via cuMemPrefetchAsync.

In a multi-GPU system where all of the GPUs have a zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS and all the GPUs have peer-to-peer support with each other, the physical storage for managed memory is created on the GPU which is active at the time cuMemAllocManaged is called. All other GPUs will reference the data at reduced bandwidth via peer mappings over the PCIe bus. The Unified Memory driver does not migrate memory among such GPUs.

In a multi-GPU system where not all GPUs have peer-to-peer support with each other and where the value of the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS is zero for at least one of those GPUs, the location chosen for physical storage of managed memory is system-dependent.

- On Linux, the location chosen will be device memory as long as the current set of active contexts are on devices that either have peer-to-peer support with each other or have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. If there is an active context on a GPU that does not have a non-zero value for that device attribute and it does not have peer-to-peer support with the other devices that have active contexts on them, then the location for physical storage will be 'zero-copy' or host memory. Note that this means that managed memory that is located in device memory is migrated to host memory if a new

context is created on a GPU that doesn't have a non-zero value for the device attribute and does not support peer-to-peer with at least one of the other devices that has an active context. This in turn implies that context creation may fail if there is insufficient host memory to migrate all managed allocations.

- On Windows, the physical storage is always created in 'zero-copy' or host memory. All GPUs will reference the data at reduced bandwidth over the PCIe bus. In these circumstances, use of the environment variable CUDA_VISIBLE_DEVICES is recommended to restrict CUDA to only use those GPUs that have peer-to-peer support. Alternatively, users can also set CUDA_MANAGED_FORCE_DEVICE_ALLOC to a non-zero value to force the driver to always use device memory for physical storage. When this environment variable is set to a non-zero value, all contexts created in that process on devices that support managed memory have to be peer-to-peer compatible with each other. Context creation will fail if a context is created on a device that supports managed memory and is not peer-to-peer compatible with any of the other managed memory supporting devices on which contexts were previously created, even if those contexts have been destroyed. These environment variables are described in the CUDA programming guide under the "CUDA environment variables" section.
- On ARM, managed memory is not available on discrete gpu with Drive PX-2.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cuDeviceGetAttribute, cuStreamAttachMemAsync, cudaMallocManaged

# CUresult cuMemAllocPitch (CUdeviceptr *dptr, size_t *pPitch, size_t WidthInBytes, size_t Height, unsigned int ElementSizeBytes)

Allocates pitched device memory.

## Parameters

**dptr**
- Returned device pointer

**pPitch**
- Returned pitch of allocation in bytes

**WidthInBytes**
- Requested allocation width in bytes

**Height**
- Requested allocation height in rows

**ElementSizeBytes**
- Size of largest reads/writes for range

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Allocates at least `WidthInBytes` * `Height` bytes of linear memory on the device and returns in `*dptr` a pointer to the allocated memory. The function may pad the allocation to ensure that corresponding pointers in any given row will continue to meet the alignment requirements for coalescing as the address is updated from row to row. `ElementSizeBytes` specifies the size of the largest reads and writes that will be performed on the memory range. `ElementSizeBytes` may be 4, 8 or 16 (since coalesced memory transactions are not possible on other data sizes). If `ElementSizeBytes` is smaller than the actual read/write size of a kernel, the kernel will run correctly, but possibly at reduced speed. The pitch returned in `*pPitch` by cuMemAllocPitch() is the width in bytes of the allocation. The intended usage of pitch is as a separate parameter of the allocation, used to compute addresses within the 2D array. Given the row and column of an array element of type T, the address is computed as:

```
T* pElement = (T*)((char*)BaseAddress + Row * Pitch) + Column;
```

The pitch returned by cuMemAllocPitch() is guaranteed to work with cuMemcpy2D() under all circumstances. For allocations of 2D arrays, it is recommended that programmers consider performing pitch allocations using cuMemAllocPitch(). Due to alignment restrictions in the hardware, this is especially true if the application will be performing 2D memory copies between different regions of device memory (whether linear memory or CUDA arrays).

The byte alignment of the pitch returned by cuMemAllocPitch() is guaranteed to match or exceed the alignment requirement for texture binding with cuTexRefSetAddress2D().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMallocPitch

# CUresult cuMemBatchDecompressAsync (CUmemDecompressParams *paramsArray, size_t count, unsigned int flags, size_t *errorIndex, CUstream stream)

Submit a batch of `count` independent decompression operations.

## Parameters

**paramsArray**
The array of structures describing the independent decompression operations.

**count**
The number of entries in `paramsArray` array.

**flags**
Must be 0.

**errorIndex**
The index into `paramsArray` of the decompression operation for which the error returned by this function pertains to. If `index` is SIZE_MAX and the value returned is not CUDA_SUCCESS, then the error returned by this function should be considered a general error that does not pertain to a particular decompression operation. May be `NULL`, in which case, no index will be recorded in the event of error.

**stream**
The stream where the work will be enqueued.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Each of the `count` decompression operations is described by a single entry in the `paramsArray` array. Once the batch has been submitted, the function will return, and decompression will happen asynchronously w.r.t. the CPU. To the work completion tracking mechanisms in the CUDA driver, the batch will be considered a single unit of work and processed according to stream semantics, i.e., it is not possible to query the completion of individual decompression operations within a batch.

The memory pointed to by each of CUmemDecompressParams.src, CUmemDecompressParams.dst, and CUmemDecompressParams.dstActBytes, must be capable of usage with the hardware decompress feature. That is, for each of said pointers, the pointer attribute CU_POINTER_ATTRIBUTE_IS_HW_DECOMPRESS_CAPABLE should give a non-zero value. To ensure this, the memory backing the pointers should have been allocated using one of the following CUDA memory allocators: * cuMemAlloc() * cuMemCreate() with the usage flag CU_MEM_CREATE_USAGE_HW_DECOMPRESS * cuMemAllocFromPoolAsync() from a pool that was created with the usage flag CU_MEM_POOL_CREATE_USAGE_HW_DECOMPRESS Additionally, CUmemDecompressParams.src, CUmemDecompressParams.dst, and CUmemDecompressParams.dstActBytes, must all be accessible from the device associated with the context where `stream` was created. For information on how to ensure this, see the documentation for the allocator of interest.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuMemAlloc, cuMemPoolCreate, cuMemAllocFromPoolAsync

# CUresult cuMemcpy (CUdeviceptr dst, CUdeviceptr src, size_t ByteCount)

Copies memory.

## Parameters

**dst**

- Destination unified virtual address space pointer

**src**

- Source unified virtual address space pointer

**ByteCount**

- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies data between two pointers. `dst` and `src` are base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy. Note that this function infers the type of the transfer (host to host, host to device, device to device, or device to host) from the pointer values. This function is only allowed in contexts which support unified addressing.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc,

cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy, cudaMemcpyToSymbol, cudaMemcpyFromSymbol

# CUresult cuMemcpy2D (const CUDA_MEMCPY2D *pCopy)

Copies memory for 2D arrays.

## Parameters

**pCopy**
- Parameters for the memory copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Perform a 2D memory copy according to the parameters specified in `pCopy`. The CUDA_MEMCPY2D structure is defined as:

```
typedef struct CUDA_MEMCPY2D_st {
        unsigned int srcXInBytes, srcY;
        CUmemorytype srcMemoryType;
            const void *srcHost;
            CUdeviceptr srcDevice;
            CUarray srcArray;
            unsigned int srcPitch;

        unsigned int dstXInBytes, dstY;
        CUmemorytype dstMemoryType;
            void *dstHost;
            CUdeviceptr dstDevice;
            CUarray dstArray;
            unsigned int dstPitch;

        unsigned int WidthInBytes;
        unsigned int Height;
    } CUDA_MEMCPY2D;
```

where:

- srcMemoryType and dstMemoryType specify the type of memory of the source and destination, respectively; CUmemorytype_enum is defined as:

```
typedef enum CUmemorytype_enum {
        CU_MEMORYTYPE_HOST = 0x01,
        CU_MEMORYTYPE_DEVICE = 0x02,
        CU_MEMORYTYPE_ARRAY = 0x03,
        CU_MEMORYTYPE_UNIFIED = 0x04
    } CUmemorytype;
```

If srcMemoryType is CU_MEMORYTYPE_UNIFIED, srcDevice and srcPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. srcArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If srcMemoryType is CU_MEMORYTYPE_HOST, srcHost and srcPitch specify the (host) base address of the source data and the bytes per row to apply. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_DEVICE, srcDevice and srcPitch specify the (device) base address of the source data and the bytes per row to apply. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_ARRAY, srcArray specifies the handle of the source data. srcHost, srcDevice and srcPitch are ignored.

If dstMemoryType is CU_MEMORYTYPE_HOST, dstHost and dstPitch specify the (host) base address of the destination data and the bytes per row to apply. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_UNIFIED, dstDevice and dstPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. dstArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If dstMemoryType is CU_MEMORYTYPE_DEVICE, dstDevice and dstPitch specify the (device) base address of the destination data and the bytes per row to apply. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_ARRAY, dstArray specifies the handle of the destination data. dstHost, dstDevice and dstPitch are ignored.

- srcXInBytes and srcY specify the base address of the source data for the copy.

For host pointers, the starting address is

```
void* Start = (void*)((char*)srcHost+srcY*srcPitch + srcXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr Start = srcDevice+srcY*srcPitch+srcXInBytes;
```

For CUDA arrays, srcXInBytes must be evenly divisible by the array element size.

- dstXInBytes and dstY specify the base address of the destination data for the copy.

For host pointers, the base address is

```
void* dstStart = (void*)((char*)dstHost+dstY*dstPitch + dstXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr dstStart = dstDevice+dstY*dstPitch+dstXInBytes;
```

For CUDA arrays, dstXInBytes must be evenly divisible by the array element size.

- WidthInBytes and Height specify the width (in bytes) and height of the 2D copy being performed.
- If specified, srcPitch must be greater than or equal to WidthInBytes + srcXInBytes, and dstPitch must be greater than or equal to WidthInBytes + dstXInBytes.

cuMemcpy2D() returns an error if any pitch is greater than the maximum allowed (CU_DEVICE_ATTRIBUTE_MAX_PITCH). cuMemAllocPitch() passes back pitches that always work with cuMemcpy2D(). On intra-device memory copies (device to device, CUDA array to

device, CUDA array to CUDA array), cuMemcpy2D() may fail for pitches not computed by cuMemAllocPitch(). cuMemcpy2DUnaligned() does not have this restriction, but may run significantly slower in the cases where cuMemcpy2D() would have returned an error code.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy2D, cudaMemcpy2DToArray, cudaMemcpy2DFromArray

# CUresult cuMemcpy2DAsync (const CUDA_MEMCPY2D *pCopy, CUstream hStream)

Copies memory for 2D arrays.

## Parameters

**pCopy**
- Parameters for the memory copy

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Perform a 2D memory copy according to the parameters specified in `pCopy`. The CUDA_MEMCPY2D structure is defined as:

```
typedef struct CUDA_MEMCPY2D_st {
        unsigned int srcXInBytes, srcY;
        CUmemorytype srcMemoryType;
```

```
            const void *srcHost;
            CUdeviceptr srcDevice;
            CUarray srcArray;
            unsigned int srcPitch;
            unsigned int dstXInBytes, dstY;
            CUmemorytype dstMemoryType;
            void *dstHost;
            CUdeviceptr dstDevice;
            CUarray dstArray;
            unsigned int dstPitch;
            unsigned int WidthInBytes;
            unsigned int Height;
        } CUDA_MEMCPY2D;
```

where:

- srcMemoryType and dstMemoryType specify the type of memory of the source and destination, respectively; CUmemorytype_enum is defined as:

```
    typedef enum CUmemorytype_enum {
            CU_MEMORYTYPE_HOST = 0x01,
            CU_MEMORYTYPE_DEVICE = 0x02,
            CU_MEMORYTYPE_ARRAY = 0x03,
            CU_MEMORYTYPE_UNIFIED = 0x04
        } CUmemorytype;
```

If srcMemoryType is CU_MEMORYTYPE_HOST, srcHost and srcPitch specify the (host) base address of the source data and the bytes per row to apply. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_UNIFIED, srcDevice and srcPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. srcArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If srcMemoryType is CU_MEMORYTYPE_DEVICE, srcDevice and srcPitch specify the (device) base address of the source data and the bytes per row to apply. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_ARRAY, srcArray specifies the handle of the source data. srcHost, srcDevice and srcPitch are ignored.

If dstMemoryType is CU_MEMORYTYPE_UNIFIED, dstDevice and dstPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. dstArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If dstMemoryType is CU_MEMORYTYPE_HOST, dstHost and dstPitch specify the (host) base address of the destination data and the bytes per row to apply. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_DEVICE, dstDevice and dstPitch specify the (device) base address of the destination data and the bytes per row to apply. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_ARRAY, dstArray specifies the handle of the destination data. dstHost, dstDevice and dstPitch are ignored.

- srcXInBytes and srcY specify the base address of the source data for the copy.

For host pointers, the starting address is

```
void* Start = (void*)((char*)srcHost+srcY*srcPitch + srcXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr Start = srcDevice+srcY*srcPitch+srcXInBytes;
```

For CUDA arrays, srcXInBytes must be evenly divisible by the array element size.

- dstXInBytes and dstY specify the base address of the destination data for the copy.

For host pointers, the base address is

```
void* dstStart = (void*)((char*)dstHost+dstY*dstPitch + dstXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr dstStart = dstDevice+dstY*dstPitch+dstXInBytes;
```

For CUDA arrays, dstXInBytes must be evenly divisible by the array element size.

- WidthInBytes and Height specify the width (in bytes) and height of the 2D copy being performed.
- If specified, srcPitch must be greater than or equal to WidthInBytes + srcXInBytes, and dstPitch must be greater than or equal to WidthInBytes + dstXInBytes.
- If specified, srcPitch must be greater than or equal to WidthInBytes + srcXInBytes, and dstPitch must be greater than or equal to WidthInBytes + dstXInBytes.
- If specified, srcHeight must be greater than or equal to Height + srcY, and dstHeight must be greater than or equal to Height + dstY.

cuMemcpy2DAsync() returns an error if any pitch is greater than the maximum allowed (CU_DEVICE_ATTRIBUTE_MAX_PITCH). cuMemAllocPitch() passes back pitches that always work with cuMemcpy2D(). On intra-device memory copies (device to device, CUDA array to device, CUDA array to CUDA array), cuMemcpy2DAsync() may fail for pitches not computed by cuMemAllocPitch().

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo,

cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpy2DAsync, cudaMemcpy2DToArrayAsync, cudaMemcpy2DFromArrayAsync

# CUresult cuMemcpy2DUnaligned (const CUDA_MEMCPY2D *pCopy)

Copies memory for 2D arrays.

## Parameters

**pCopy**

- Parameters for the memory copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Perform a 2D memory copy according to the parameters specified in `pCopy`. The CUDA_MEMCPY2D structure is defined as:

```
typedef struct CUDA_MEMCPY2D_st {
        unsigned int srcXInBytes, srcY;
        CUmemorytype srcMemoryType;
        const void *srcHost;
        CUdeviceptr srcDevice;
        CUarray srcArray;
        unsigned int srcPitch;
        unsigned int dstXInBytes, dstY;
        CUmemorytype dstMemoryType;
        void *dstHost;
        CUdeviceptr dstDevice;
        CUarray dstArray;
        unsigned int dstPitch;
        unsigned int WidthInBytes;
        unsigned int Height;
    } CUDA_MEMCPY2D;
```

where:

- srcMemoryType and dstMemoryType specify the type of memory of the source and destination, respectively; CUmemorytype_enum is defined as:

```
typedef enum CUmemorytype_enum {
        CU_MEMORYTYPE_HOST = 0x01,
        CU_MEMORYTYPE_DEVICE = 0x02,
        CU_MEMORYTYPE_ARRAY = 0x03,
        CU_MEMORYTYPE_UNIFIED = 0x04
    } CUmemorytype;
```

If srcMemoryType is CU_MEMORYTYPE_UNIFIED, srcDevice and srcPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. srcArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If srcMemoryType is CU_MEMORYTYPE_HOST, srcHost and srcPitch specify the (host) base address of the source data and the bytes per row to apply. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_DEVICE, srcDevice and srcPitch specify the (device) base address of the source data and the bytes per row to apply. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_ARRAY, srcArray specifies the handle of the source data. srcHost, srcDevice and srcPitch are ignored.

If dstMemoryType is CU_MEMORYTYPE_UNIFIED, dstDevice and dstPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. dstArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If dstMemoryType is CU_MEMORYTYPE_HOST, dstHost and dstPitch specify the (host) base address of the destination data and the bytes per row to apply. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_DEVICE, dstDevice and dstPitch specify the (device) base address of the destination data and the bytes per row to apply. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_ARRAY, dstArray specifies the handle of the destination data. dstHost, dstDevice and dstPitch are ignored.

- srcXInBytes and srcY specify the base address of the source data for the copy.

For host pointers, the starting address is

```
void* Start = (void*)((char*)srcHost+srcY*srcPitch + srcXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr Start = srcDevice+srcY*srcPitch+srcXInBytes;
```

For CUDA arrays, srcXInBytes must be evenly divisible by the array element size.

- dstXInBytes and dstY specify the base address of the destination data for the copy.

For host pointers, the base address is

```
void* dstStart = (void*)((char*)dstHost+dstY*dstPitch + dstXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr dstStart = dstDevice+dstY*dstPitch+dstXInBytes;
```

For CUDA arrays, dstXInBytes must be evenly divisible by the array element size.

- WidthInBytes and Height specify the width (in bytes) and height of the 2D copy being performed.
- If specified, srcPitch must be greater than or equal to WidthInBytes + srcXInBytes, and dstPitch must be greater than or equal to WidthInBytes + dstXInBytes.

cuMemcpy2D() returns an error if any pitch is greater than the maximum allowed (CU_DEVICE_ATTRIBUTE_MAX_PITCH). cuMemAllocPitch() passes back pitches that always work with cuMemcpy2D(). On intra-device memory copies (device to device, CUDA array to device, CUDA array to CUDA array), cuMemcpy2D() may fail for pitches not computed by cuMemAllocPitch(). cuMemcpy2DUnaligned() does not have this restriction, but may run significantly slower in the cases where cuMemcpy2D() would have returned an error code.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy2D, cudaMemcpy2DToArray, cudaMemcpy2DFromArray

# CUresult cuMemcpy3D (const CUDA_MEMCPY3D *pCopy)

Copies memory for 3D arrays.

## Parameters

**pCopy**
- Parameters for the memory copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. The CUDA_MEMCPY3D structure is defined as:

```
typedef struct CUDA_MEMCPY3D_st {

        unsigned int srcXInBytes, srcY, srcZ;
```

```
                unsigned int srcLOD;
                CUmemorytype srcMemoryType;
                    const void *srcHost;
                    CUdeviceptr srcDevice;
                    CUarray srcArray;
                    unsigned int srcPitch;  // ignored when src is array
                    unsigned int srcHeight; // ignored when src is array; may be 0
if Depth==1

                unsigned int dstXInBytes, dstY, dstZ;
                unsigned int dstLOD;
                CUmemorytype dstMemoryType;
                    void *dstHost;
                    CUdeviceptr dstDevice;
                    CUarray dstArray;
                    unsigned int dstPitch;  // ignored when dst is array
                    unsigned int dstHeight; // ignored when dst is array; may be 0
if Depth==1

                unsigned int WidthInBytes;
                unsigned int Height;
                unsigned int Depth;
            } CUDA_MEMCPY3D;
```

where:

- srcMemoryType and dstMemoryType specify the type of memory of the source and destination, respectively; CUmemorytype_enum is defined as:

```
typedef enum CUmemorytype_enum {
        CU_MEMORYTYPE_HOST = 0x01,
        CU_MEMORYTYPE_DEVICE = 0x02,
        CU_MEMORYTYPE_ARRAY = 0x03,
        CU_MEMORYTYPE_UNIFIED = 0x04
    } CUmemorytype;
```

If srcMemoryType is CU_MEMORYTYPE_UNIFIED, srcDevice and srcPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. srcArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If srcMemoryType is CU_MEMORYTYPE_HOST, srcHost, srcPitch and srcHeight specify the (host) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_DEVICE, srcDevice, srcPitch and srcHeight specify the (device) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_ARRAY, srcArray specifies the handle of the source data. srcHost, srcDevice, srcPitch and srcHeight are ignored.

If dstMemoryType is CU_MEMORYTYPE_UNIFIED, dstDevice and dstPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. dstArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If dstMemoryType is CU_MEMORYTYPE_HOST, dstHost and dstPitch specify the (host) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_DEVICE, dstDevice and dstPitch specify the (device) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_ARRAY, dstArray specifies the handle of the destination data. dstHost, dstDevice, dstPitch and dstHeight are ignored.

- srcXInBytes, srcY and srcZ specify the base address of the source data for the copy.

For host pointers, the starting address is

```
void* Start = (void*)((char*)srcHost+(srcZ*srcHeight+srcY)*srcPitch +
srcXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr Start = srcDevice+(srcZ*srcHeight+srcY)*srcPitch+srcXInBytes;
```

For CUDA arrays, srcXInBytes must be evenly divisible by the array element size.

- dstXInBytes, dstY and dstZ specify the base address of the destination data for the copy.

For host pointers, the base address is

```
void* dstStart = (void*)((char*)dstHost+(dstZ*dstHeight+dstY)*dstPitch +
dstXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr dstStart = dstDevice+(dstZ*dstHeight+dstY)*dstPitch+dstXInBytes;
```

For CUDA arrays, dstXInBytes must be evenly divisible by the array element size.

- WidthInBytes, Height and Depth specify the width (in bytes), height and depth of the 3D copy being performed.
- If specified, srcPitch must be greater than or equal to WidthInBytes + srcXInBytes, and dstPitch must be greater than or equal to WidthInBytes + dstXInBytes.
- If specified, srcHeight must be greater than or equal to Height + srcY, and dstHeight must be greater than or equal to Height + dstY.

cuMemcpy3D() returns an error if any pitch is greater than the maximum allowed (CU_DEVICE_ATTRIBUTE_MAX_PITCH).

The srcLOD and dstLOD members of the CUDA_MEMCPY3D structure must be set to 0.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.

- This function exhibits synchronous behavior for most use cases.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy3D

# CUresult cuMemcpy3DAsync (const CUDA_MEMCPY3D *pCopy, CUstream hStream)

Copies memory for 3D arrays.

## Parameters

**pCopy**

- Parameters for the memory copy

**hStream**

- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. The CUDA_MEMCPY3D structure is defined as:

```
typedef struct CUDA_MEMCPY3D_st {

    unsigned int srcXInBytes, srcY, srcZ;
    unsigned int srcLOD;
    CUmemorytype srcMemoryType;
        const void *srcHost;
        CUdeviceptr srcDevice;
        CUarray srcArray;
        unsigned int srcPitch;  // ignored when src is array
        unsigned int srcHeight; // ignored when src is array; may be 0
if Depth==1

    unsigned int dstXInBytes, dstY, dstZ;
    unsigned int dstLOD;
    CUmemorytype dstMemoryType;
        void *dstHost;
```

```
                    CUdeviceptr dstDevice;
                    CUarray dstArray;
                    unsigned int dstPitch;  // ignored when dst is array
                    unsigned int dstHeight; // ignored when dst is array; may be 0
 if Depth==1

                unsigned int WidthInBytes;
                unsigned int Height;
                unsigned int Depth;
            } CUDA_MEMCPY3D;
```

where:

- srcMemoryType and dstMemoryType specify the type of memory of the source and destination, respectively; CUmemorytype_enum is defined as:

```
    typedef enum CUmemorytype_enum {
            CU_MEMORYTYPE_HOST = 0x01,
            CU_MEMORYTYPE_DEVICE = 0x02,
            CU_MEMORYTYPE_ARRAY = 0x03,
            CU_MEMORYTYPE_UNIFIED = 0x04
        } CUmemorytype;
```

If srcMemoryType is CU_MEMORYTYPE_UNIFIED, srcDevice and srcPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. srcArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If srcMemoryType is CU_MEMORYTYPE_HOST, srcHost, srcPitch and srcHeight specify the (host) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_DEVICE, srcDevice, srcPitch and srcHeight specify the (device) base address of the source data, the bytes per row, and the height of each 2D slice of the 3D array. srcArray is ignored.

If srcMemoryType is CU_MEMORYTYPE_ARRAY, srcArray specifies the handle of the source data. srcHost, srcDevice, srcPitch and srcHeight are ignored.

If dstMemoryType is CU_MEMORYTYPE_UNIFIED, dstDevice and dstPitch specify the (unified virtual address space) base address of the source data and the bytes per row to apply. dstArray is ignored. This value may be used only if unified addressing is supported in the calling context.

If dstMemoryType is CU_MEMORYTYPE_HOST, dstHost and dstPitch specify the (host) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_DEVICE, dstDevice and dstPitch specify the (device) base address of the destination data, the bytes per row, and the height of each 2D slice of the 3D array. dstArray is ignored.

If dstMemoryType is CU_MEMORYTYPE_ARRAY, dstArray specifies the handle of the destination data. dstHost, dstDevice, dstPitch and dstHeight are ignored.

- srcXInBytes, srcY and srcZ specify the base address of the source data for the copy.

For host pointers, the starting address is

```
void* Start = (void*)((char*)srcHost+(srcZ*srcHeight+srcY)*srcPitch +
srcXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr Start = srcDevice+(srcZ*srcHeight+srcY)*srcPitch+srcXInBytes;
```

For CUDA arrays, srcXInBytes must be evenly divisible by the array element size.

- dstXInBytes, dstY and dstZ specify the base address of the destination data for the copy.

For host pointers, the base address is

```
void* dstStart = (void*)((char*)dstHost+(dstZ*dstHeight+dstY)*dstPitch +
dstXInBytes);
```

For device pointers, the starting address is

```
CUdeviceptr dstStart = dstDevice+(dstZ*dstHeight+dstY)*dstPitch+dstXInBytes;
```

For CUDA arrays, dstXInBytes must be evenly divisible by the array element size.

- WidthInBytes, Height and Depth specify the width (in bytes), height and depth of the 3D copy being performed.
- If specified, srcPitch must be greater than or equal to WidthInBytes + srcXInBytes, and dstPitch must be greater than or equal to WidthInBytes + dstXInBytes.
- If specified, srcHeight must be greater than or equal to Height + srcY, and dstHeight must be greater than or equal to Height + dstY.

cuMemcpy3DAsync() returns an error if any pitch is greater than the maximum allowed (CU_DEVICE_ATTRIBUTE_MAX_PITCH).

The srcLOD and dstLOD members of the CUDA_MEMCPY3D structure must be set to 0.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8,

cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpy3DAsync

# CUresult cuMemcpy3DBatchAsync (size_t numOps, CUDA_MEMCPY3D_BATCH_OP *opList, unsigned long long flags, CUstream hStream)

Performs a batch of 3D memory copies asynchronously.

## Parameters

**numOps**
- Total number of memcpy operations.

**opList**
- Array of size `numOps` containing the actual memcpy operations.

**flags**
- Flags for future use, must be zero now.

**hStream**
- The stream to enqueue the operations in. Must not be default NULL stream.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Performs a batch of memory copies. The batch as a whole executes in stream order but copies within a batch are not guaranteed to execute in any specific order. Note that this means specifying any dependent copies within a batch will result in undefined behavior.

Performs memory copies as specified in the `opList` array. The length of this array is specified in `numOps`. Each entry in this array describes a copy operation. This includes among other things, the source and destination operands for the copy as specified in CUDA_MEMCPY3D_BATCH_OP::src and CUDA_MEMCPY3D_BATCH_OP::dst respectively. The source and destination operands of a copy can either be a pointer or a CUDA array. The width, height and depth of a copy is specified in CUDA_MEMCPY3D_BATCH_OP::extent. The width, height and depth of a copy are specified in elements and must not be zero. For pointer-to-pointer copies, the element size is considered to be 1. For pointer to CUDA array or vice versa copies, the element size is determined by the CUDA array. For CUDA array to CUDA array copies, the element size of the two CUDA arrays must match.

For a given operand, if CUmemcpy3DOperand::type is specified as CU_MEMCPY_OPERAND_TYPE_POINTER, then CUmemcpy3DOperand::op::ptr will be used. The CUmemcpy3DOperand::op::ptr::ptr field must contain the pointer where the copy should begin. The CUmemcpy3DOperand::op::ptr::rowLength field specifies the length of each row in elements and must either be zero or be greater than or equal to the width of the copy specified in

CUDA_MEMCPY3D_BATCH_OP::extent::width. The CUmemcpy3DOperand::op::ptr::layerHeight field specifies the height of each layer and must either be zero or be greater than or equal to the height of the copy specified in CUDA_MEMCPY3D_BATCH_OP::extent::height. When either of these values is zero, that aspect of the operand is considered to be tightly packed according to the copy extent. For managed memory pointers on devices where CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS is true or system-allocated pageable memory on devices where CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS is true, the CUmemcpy3DOperand::op::ptr::locHint field can be used to hint the location of the operand.

If an operand's type is specified as CU_MEMCPY_OPERAND_TYPE_ARRAY, then CUmemcpy3DOperand::op::array will be used. The CUmemcpy3DOperand::op::array::array field specifies the CUDA array and CUmemcpy3DOperand::op::array::offset specifies the 3D offset into that array where the copy begins.

The CUmemcpyAttributes::srcAccessOrder indicates the source access ordering to be observed for copies associated with the attribute. If the source access order is set to CU_MEMCPY_SRC_ACCESS_ORDER_STREAM, then the source will be accessed in stream order. If the source access order is set to CU_MEMCPY_SRC_ACCESS_ORDER_DURING_API_CALL then it indicates that access to the source pointer can be out of stream order and all accesses must be complete before the API call returns. This flag is suited for ephemeral sources (ex., stack variables) when it's known that no prior operations in the stream can be accessing the memory and also that the lifetime of the memory is limited to the scope that the source variable was declared in. Specifying this flag allows the driver to optimize the copy and removes the need for the user to synchronize the stream after the API call. If the source access order is set to CU_MEMCPY_SRC_ACCESS_ORDER_ANY then it indicates that access to the source pointer can be out of stream order and the accesses can happen even after the API call returns. This flag is suited for host pointers allocated outside CUDA (ex., via malloc) when it's known that no prior operations in the stream can be accessing the memory. Specifying this flag allows the driver to optimize the copy on certain platforms. Each memcopy operation in `opList` must have a valid srcAccessOrder setting, otherwise this API will return CUDA_ERROR_INVALID_VALUE.

The CUmemcpyAttributes::flags field can be used to specify certain flags for copies. Setting the CU_MEMCPY_FLAG_PREFER_OVERLAP_WITH_COMPUTE flag indicates that the associated copies should preferably overlap with any compute work. Note that this flag is a hint and can be ignored depending on the platform and other parameters of the copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations

that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

# CUresult cuMemcpy3DPeer (const CUDA_MEMCPY3D_PEER *pCopy)

Copies memory between contexts.

## Parameters

**pCopy**
- Parameters for the memory copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. See the definition of the CUDA_MEMCPY3D_PEER structure for documentation of its parameters.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuMemcpyDtoD, cuMemcpyPeer, cuMemcpyDtoDAsync, cuMemcpyPeerAsync, cuMemcpy3DPeerAsync, cudaMemcpy3DPeer

# CUresult cuMemcpy3DPeerAsync (const CUDA_MEMCPY3D_PEER *pCopy, CUstream hStream)

Copies memory between contexts asynchronously.

## Parameters

**pCopy**
- Parameters for the memory copy

**hStream**
- Stream identifier

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Perform a 3D memory copy according to the parameters specified in `pCopy`. See the definition of the CUDA_MEMCPY3D_PEER structure for documentation of its parameters.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuMemcpyDtoD, cuMemcpyPeer, cuMemcpyDtoDAsync, cuMemcpyPeerAsync, cuMemcpy3DPeerAsync, cudaMemcpy3DPeerAsync

## CUresult cuMemcpy3DWithAttributesAsync (CUDA_MEMCPY3D_BATCH_OP *op, unsigned long long flags, CUstream hStream)

### Parameters

**op**
- Operation to perform

**flags**
- Flags for the copy, must be zero now.

**hStream**
- Stream to enqueue the operation in

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Performs 3D memory copy with attributes asynchronously

Performs the copy operation specified in `op`. `flags` specifies the flags for the copy and `hStream` specifies the stream to enqueue the operation in.

For more information regarding the operation, please refer to CUDA_MEMCPY3D_BATCH_OP and it's usage desciption in::cuMemcpy3DBatchAsync

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuMemcpy3DBatchAsync

## CUresult cuMemcpyAsync (CUdeviceptr dst, CUdeviceptr src, size_t ByteCount, CUstream hStream)

Copies memory asynchronously.

### Parameters

**dst**
- Destination unified virtual address space pointer

**src**
- Source unified virtual address space pointer

**ByteCount**
- Size of memory copy in bytes

**hStream**
- Stream identifier

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Copies data between two pointers. `dst` and `src` are base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy. Note that this function infers the type

of the transfer (host to host, host to device, device to device, or device to host) from the pointer values. This function is only allowed in contexts which support unified addressing.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyAsync, cudaMemcpyToSymbolAsync, cudaMemcpyFromSymbolAsync

## CUresult cuMemcpyAtoA (CUarray dstArray, size_t dstOffset, CUarray srcArray, size_t srcOffset, size_t ByteCount)

Copies memory from Array to Array.

### Parameters

**dstArray**
- Destination array

**dstOffset**
- Offset in bytes of destination array

**srcArray**
- Source array

**srcOffset**
- Offset in bytes of source array

**ByteCount**
- Size of memory copy in bytes

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Copies from one 1D CUDA array to another. `dstArray` and `srcArray` specify the handles of the destination and source CUDA arrays for the copy, respectively. `dstOffset` and `srcOffset` specify the destination and source offsets in bytes into the CUDA arrays. `ByteCount` is the number of bytes to be copied. The size of the elements in the CUDA arrays need not be the same format, but the elements must be the same size; and count must be evenly divisible by that size.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpyArrayToArray

## CUresult cuMemcpyAtoD (CUdeviceptr dstDevice, CUarray srcArray, size_t srcOffset, size_t ByteCount)

Copies memory from Array to Device.

### Parameters

**dstDevice**
- Destination device pointer

**srcArray**
- Source array

**srcOffset**
- Offset in bytes of source array

**ByteCount**
- Size of memory copy in bytes

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Copies from one 1D CUDA array to device memory. `dstDevice` specifies the base pointer of the destination and must be naturally aligned with the CUDA array elements. `srcArray` and `srcOffset` specify the CUDA array handle and the offset in bytes into the array where the copy is to begin. `ByteCount` specifies the number of bytes to copy and must be evenly divisible by the array element size.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpyFromArray

## CUresult cuMemcpyAtoH (void *dstHost, CUarray srcArray, size_t srcOffset, size_t ByteCount)

Copies memory from Array to Host.

### Parameters

**dstHost**
- Destination device pointer

**srcArray**
- Source array

**srcOffset**
- Offset in bytes of source array

**ByteCount**
- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies from one 1D CUDA array to host memory. `dstHost` specifies the base pointer of the destination. `srcArray` and `srcOffset` specify the CUDA array handle and starting offset in bytes of the source data. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpyFromArray

# CUresult cuMemcpyAtoHAsync (void *dstHost, CUarray srcArray, size_t srcOffset, size_t ByteCount, CUstream hStream)

Copies memory from Array to Host.

## Parameters

**dstHost**
- Destination pointer

**srcArray**
- Source array

**srcOffset**
- Offset in bytes of source array

**ByteCount**
- Size of memory copy in bytes

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Copies from one 1D CUDA array to host memory. `dstHost` specifies the base pointer of the destination. `srcArray` and `srcOffset` specify the CUDA array handle and starting offset in bytes of the source data. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyFromArrayAsync

# CUresult cuMemcpyBatchAsync (CUdeviceptr *dsts, CUdeviceptr *srcs, size_t *sizes, size_t count, CUmemcpyAttributes *attrs, size_t *attrsIdxs, size_t numAttrs, CUstream hStream)

Performs a batch of memory copies asynchronously.

## Parameters

**dsts**
- Array of destination pointers.

**srcs**
- Array of memcpy source pointers.

**sizes**
- Array of sizes for memcpy operations.

**count**
- Size of `dsts`, `srcs` and `sizes` arrays

**attrs**
- Array of memcpy attributes.

**attrsIdxs**
- Array of indices to specify which copies each entry in the `attrs` array applies to. The attributes specified in attrs[k] will be applied to copies starting from attrsIdxs[k] through attrsIdxs[k+1] - 1. Also attrs[numAttrs-1] will apply to copies starting from attrsIdxs[numAttrs-1] through count - 1.

**numAttrs**
- Size of `attrs` and `attrsIdxs` arrays.

**hStream**
- The stream to enqueue the operations in. Must not be legacy NULL stream.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Performs a batch of memory copies. The batch as a whole executes in stream order but copies within a batch are not guaranteed to execute in any specific order. This API only supports pointer-to-pointer copies. For copies involving CUDA arrays, please see cuMemcpy3DBatchAsync.

Performs memory copies from source buffers specified in `srcs` to destination buffers specified in `dsts`. The size of each copy is specified in `sizes`. All three arrays must be of the same length as specified by `count`. Since there are no ordering guarantees for copies within a batch, specifying any dependent copies within a batch will result in undefined behavior.

Every copy in the batch has to be associated with a set of attributes specified in the `attrs` array. Each entry in this array can apply to more than one copy. This can be done by specifying in the `attrsIdxs` array, the index of the first copy that the corresponding entry in the `attrs` array applies to. Both `attrs` and `attrsIdxs` must be of the same length as specified by `numAttrs`. For example, if a batch has 10 copies listed in dst/src/sizes, the first 6 of which have one set of attributes and the remaining 4 another, then `numAttrs` will be 2, `attrsIdxs` will be {0, 6} and `attrs` will contains the two sets of attributes. Note that the first entry in `attrsIdxs` must always be 0. Also, each entry must be greater than the previous entry and the last entry should be less than `count`. Furthermore, `numAttrs` must be lesser than or equal to `count`.

The CUmemcpyAttributes::srcAccessOrder indicates the source access ordering to be observed for copies associated with the attribute. If the source access order is set to CU_MEMCPY_SRC_ACCESS_ORDER_STREAM, then the source will be accessed in stream order. If the source access order is set to CU_MEMCPY_SRC_ACCESS_ORDER_DURING_API_CALL then it indicates that access to the source pointer can be out of stream order and all accesses must be complete before the API call returns. This flag is suited for ephemeral sources (ex., stack variables) when it's known that no prior operations in the stream can be accessing the memory and also that the lifetime of the memory is limited to the scope that the source variable was declared in. Specifying this flag allows the driver to optimize the copy and removes the need for the user to synchronize the stream after the API call. If the source access order is set to CU_MEMCPY_SRC_ACCESS_ORDER_ANY then it indicates that access to the source pointer can be out of stream order and the accesses can happen even after the API call returns. This flag is suited for host pointers allocated outside CUDA (ex., via malloc) when it's known that no prior operations in the stream can be accessing the memory. Specifying this flag allows the driver to optimize the copy on certain platforms. Each memcpy operation in the batch must have a valid CUmemcpyAttributes corresponding to it including the appropriate srcAccessOrder setting, otherwise the API will return CUDA_ERROR_INVALID_VALUE.

The CUmemcpyAttributes::srcLocHint and CUmemcpyAttributes::dstLocHint allows applications to specify hint locations for operands of a copy when the operand doesn't have a fixed location. That is, these hints are only applicable for managed memory pointers on devices where CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS is true or system-allocated pageable memory on devices where CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS is true. For other cases, these hints are ignored.

The CUmemcpyAttributes::flags field can be used to specify certain flags for copies. Setting the CU_MEMCPY_FLAG_PREFER_OVERLAP_WITH_COMPUTE flag indicates that the associated copies should preferably overlap with any compute work. Note that this flag is a hint and can be ignored depending on the platform and other parameters of the copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.

- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

# CUresult cuMemcpyDtoA (CUarray dstArray, size_t dstOffset, CUdeviceptr srcDevice, size_t ByteCount)

Copies memory from Device to Array.

## Parameters

**dstArray**
- Destination array

**dstOffset**
- Offset in bytes of destination array

**srcDevice**
- Source device pointer

**ByteCount**
- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies from device memory to a 1D CUDA array. `dstArray` and `dstOffset` specify the CUDA array handle and starting index of the destination data. `srcDevice` specifies the base pointer of the source. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo,

cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpyToArray

# CUresult cuMemcpyDtoD (CUdeviceptr dstDevice, CUdeviceptr srcDevice, size_t ByteCount)

Copies memory from Device to Device.

## Parameters

**dstDevice**
- Destination device pointer

**srcDevice**
- Source device pointer

**ByteCount**
- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies from device memory to device memory. `dstDevice` and `srcDevice` are the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy, cudaMemcpyToSymbol, cudaMemcpyFromSymbol

# CUresult cuMemcpyDtoDAsync (CUdeviceptr dstDevice, CUdeviceptr srcDevice, size_t ByteCount, CUstream hStream)

Copies memory from Device to Device.

## Parameters

**dstDevice**
- Destination device pointer

**srcDevice**
- Source device pointer

**ByteCount**
- Size of memory copy in bytes

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Copies from device memory to device memory. `dstDevice` and `srcDevice` are the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8,

cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyAsync, cudaMemcpyToSymbolAsync, cudaMemcpyFromSymbolAsync

# CUresult cuMemcpyDtoH (void *dstHost, CUdeviceptr srcDevice, size_t ByteCount)

Copies memory from Device to Host.

## Parameters

**dstHost**
- Destination host pointer

**srcDevice**
- Source device pointer

**ByteCount**
- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies from device to host memory. `dstHost` and `srcDevice` specify the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8,

cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy, cudaMemcpyFromSymbol

# CUresult cuMemcpyDtoHAsync (void *dstHost, CUdeviceptr srcDevice, size_t ByteCount, CUstream hStream)

Copies memory from Device to Host.

## Parameters

**dstHost**
- Destination host pointer

**srcDevice**
- Source device pointer

**ByteCount**
- Size of memory copy in bytes

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Copies from device to host memory. `dstHost` and `srcDevice` specify the base pointers of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyAsync, cudaMemcpyFromSymbolAsync

# CUresult cuMemcpyHtoA (CUarray dstArray, size_t dstOffset, const void *srcHost, size_t ByteCount)

Copies memory from Host to Array.

## Parameters

**dstArray**
- Destination array

**dstOffset**
- Offset in bytes of destination array

**srcHost**
- Source host pointer

**ByteCount**
- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies from host memory to a 1D CUDA array. `dstArray` and `dstOffset` specify the CUDA array handle and starting offset in bytes of the destination data. `pSrc` specifies the base address of the source. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations

that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpyToArray

# CUresult cuMemcpyHtoAAsync (CUarray dstArray, size_t dstOffset, const void *srcHost, size_t ByteCount, CUstream hStream)

Copies memory from Host to Array.

## Parameters

**dstArray**
- Destination array

**dstOffset**
- Offset in bytes of destination array

**srcHost**
- Source host pointer

**ByteCount**
- Size of memory copy in bytes

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Copies from host memory to a 1D CUDA array. `dstArray` and `dstOffset` specify the CUDA array handle and starting offset in bytes of the destination data. `srcHost` specifies the base address of the source. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyToArrayAsync

# CUresult cuMemcpyHtoD (CUdeviceptr dstDevice, const void *srcHost, size_t ByteCount)

Copies memory from Host to Device.

## Parameters

**dstDevice**
- Destination device pointer

**srcHost**
- Source host pointer

**ByteCount**
- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies from host memory to device memory. `dstDevice` and `srcHost` are the base addresses of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemcpy, cudaMemcpyToSymbol

# CUresult cuMemcpyHtoDAsync (CUdeviceptr dstDevice, const void *srcHost, size_t ByteCount, CUstream hStream)

Copies memory from Host to Device.

## Parameters

**dstDevice**
- Destination device pointer

**srcHost**
- Source host pointer

**ByteCount**
- Size of memory copy in bytes

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Copies from host memory to device memory. `dstDevice` and `srcHost` are the base addresses of the destination and source, respectively. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemcpyAsync, cudaMemcpyToSymbolAsync

# CUresult cuMemcpyPeer (CUdeviceptr dstDevice, CUcontext dstContext, CUdeviceptr srcDevice, CUcontext srcContext, size_t ByteCount)

Copies device memory between two contexts.

## Parameters

**dstDevice**
- Destination device pointer

**dstContext**
- Destination context

**srcDevice**
- Source device pointer

**srcContext**
- Source context

**ByteCount**
- Size of memory copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Copies from device memory in one context to device memory in another context. `dstDevice` is the base device pointer of the destination memory and `dstContext` is the destination context. `srcDevice` is the base device pointer of the source memory and `srcContext` is the source pointer. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuMemcpyDtoD, cuMemcpy3DPeer, cuMemcpyDtoDAsync, cuMemcpyPeerAsync, cuMemcpy3DPeerAsync, cudaMemcpyPeer

# CUresult cuMemcpyPeerAsync (CUdeviceptr dstDevice, CUcontext dstContext, CUdeviceptr srcDevice, CUcontext srcContext, size_t ByteCount, CUstream hStream)

Copies device memory between two contexts asynchronously.

## Parameters

**dstDevice**
- Destination device pointer

**dstContext**
- Destination context

**srcDevice**
- Source device pointer

**srcContext**
- Source context

**ByteCount**
- Size of memory copy in bytes

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Copies from device memory in one context to device memory in another context. `dstDevice` is the base device pointer of the destination memory and `dstContext` is the destination context. `srcDevice` is the base device pointer of the source memory and `srcContext` is the source pointer. `ByteCount` specifies the number of bytes to copy.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuMemcpyDtoD, cuMemcpyPeer, cuMemcpy3DPeer, cuMemcpyDtoDAsync, cuMemcpy3DPeerAsync, cudaMemcpyPeerAsync

# CUresult cuMemcpyWithAttributesAsync (CUdeviceptr dst, CUdeviceptr src, size_t size, CUmemcpyAttributes *attr, CUstream hStream)

## Parameters

**dst**
- Destination device pointer

**src**
- Source device pointer

**size**
- Number of bytes to copy

**attr**
- Attributes for the copy

**hStream**
- Stream to enqueue the operation in

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Performs asynchronous memory copy operation with the specified attributes.

Performs asynchronous memory copy operation where `dst` and `src` are the destination and source pointers respectively. `size` specifies the number of bytes to copy. `attr` specifies the attributes for the copy and `hStream` specifies the stream to enqueue the operation in.

For more information regarding the attributes, please refer to CUmemcpyAttributes and it's usage desciption in::cuMemcpyBatchAsync

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- Memory regions requested must be either entirely registered with CUDA, or in the case of host pageable transfers, not registered at all. Memory regions spanning over allocations that are both registered and not registered with CUDA are not supported and will return CUDA_ERROR_INVALID_VALUE.

See also:

cuMemcpyBatchAsync

# CUresult cuMemFree (CUdeviceptr dptr)

Frees device memory.

## Parameters

**dptr**

- Pointer to memory to free

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Frees the memory space pointed to by `dptr`, which must have been returned by a previous call to one of the following memory allocation APIs - cuMemAlloc(), cuMemAllocPitch(), cuMemAllocManaged(), cuMemAllocAsync(), cuMemAllocFromPoolAsync()

Note - This API will not perform any implict synchronization when the pointer was allocated with cuMemAllocAsync or cuMemAllocFromPoolAsync. Callers must ensure that all accesses to these pointer have completed before invoking cuMemFree. For best performance and memory reuse, users should use cuMemFreeAsync to free memory allocated via the stream ordered memory allocator. For all other pointers, this API may perform implicit synchronization.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemAllocManaged, cuMemAllocAsync, cuMemAllocFromPoolAsync, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemFreeAsync, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaFree

# CUresult cuMemFreeHost (void *p)

Frees page-locked host memory.

## Parameters

**p**
- Pointer to memory to free

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Frees the memory space pointed to by `p`, which must have been returned by a previous call to cuMemAllocHost().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaFreeHost

# CUresult cuMemGetAddressRange (CUdeviceptr *pbase, size_t *psize, CUdeviceptr dptr)

Get information on memory allocations.

## Parameters

**pbase**
- Returned base address

**psize**
- Returned size of device memory allocation

**dptr**
- Device pointer to query

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_INVALID_VALUE

### Description

Returns the base address in `*pbase` and size in `*psize` of the allocation that contains the input pointer `dptr`. Both parameters `pbase` and `psize` are optional. If one of them is NULL, it is ignored.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32

## CUresult cuMemGetHandleForAddressRange (void *handle, CUdeviceptr dptr, size_t size, CUmemRangeHandleType handleType, unsigned long long flags)

Retrieve handle for an address range.

### Parameters

**handle**
- Pointer to the location where the returned handle will be stored.

**dptr**
- Pointer to a valid CUDA device allocation. Must be aligned to host page size.

**size**
- Length of the address range. Must be aligned to host page size.

**handleType**

- Type of handle requested (defines type and size of the `handle` output parameter)

**flags**

- When requesting CUmemRangeHandleType::CU_MEM_RANGE_HANDLE_TYPE_DMA_BUF_FD the value could be CU_MEM_RANGE_FLAG_DMA_BUF_MAPPING_TYPE_PCIE, otherwise 0.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

Get a handle of the specified type to an address range. When requesting CUmemRangeHandleType::CU_MEM_RANGE_HANDLE_TYPE_DMA_BUF_FD, address range obtained by a prior call to either cuMemAlloc or cuMemAddressReserve is supported if the CU_DEVICE_ATTRIBUTE_DMA_BUF_SUPPORTED device attribute returns true. If the address range was obtained via cuMemAddressReserve, it must also be fully mapped via cuMemMap. Address range obtained by a prior call to either cuMemAllocHost or cuMemHostAlloc is supported if the CU_DEVICE_ATTRIBUTE_HOST_ALLOC_DMA_BUF_SUPPORTED device attribute returns true.

As of CUDA 13.0, querying support for address range obtained by calling cuMemAllocHost or cuMemHostAlloc using the CU_DEVICE_ATTRIBUTE_DMA_BUF_SUPPORTED device attribute is deprecated.

Users must ensure the `dptr` and `size` are aligned to the host page size.

The `handle` will be interpreted as a pointer to an integer to store the dma_buf file descriptor. Users must ensure the entire address range is backed and mapped when the address range is allocated by cuMemAddressReserve. All the physical allocations backing the address range must be resident on the same device and have identical allocation properties. Users are also expected to retrieve a new handle every time the underlying physical allocation(s) corresponding to a previously queried VA range are changed.

For CUmemRangeHandleType::CU_MEM_RANGE_HANDLE_TYPE_DMA_BUF_FD, users may set flags to CU_MEM_RANGE_FLAG_DMA_BUF_MAPPING_TYPE_PCIE. Which when set on a supported platform, will give a DMA_BUF handle mapped via PCIE BAR1 or will return an error otherwise.

If the device attribute CU_DEVICE_ATTRIBUTE_DMA_BUF_MMAP_SUPPORTED is set and a CUmemRangeHandleType::CU_MEM_RANGE_HANDLE_TYPE_DMA_BUF_FD is requested for a device memory range then the returned dmabuf file descriptor may be passed as the file descriptor argument to the mmap() system call.

For device memory on x86 systems the mapping will be a write combined mapping. On coherent ARM platforms these mappings will be regular cached memory. On all other platforms these mappings will be uncached.

# CUresult cuMemGetInfo (size_t *free, size_t *total)

Gets free and total memory.

## Parameters

**free**

- Returned free memory in bytes

**total**

- Returned total memory in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `*total` the total amount of memory available to the the current context. Returns in `*free` the amount of memory on the device that is free according to the OS. CUDA is not guaranteed to be able to allocate all of the memory that the OS reports as free. In a multi-tenet situation, free estimate returned is prone to race condition where a new allocation/free done by a different process or a different thread in the same process between the time when free memory was estimated and reported, will result in deviation in free value reported and actual free memory.

The integrated GPU on Tegra shares memory with CPU and other component of the SoC. The free and total values returned by the API excludes the SWAP memory space maintained by the OS on some platforms. The OS may move some of the memory pages into swap area as the GPU or CPU allocate or access memory. See Tegra app note on how to calculate total and free memory on Tegra.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaMemGetInfo

# CUresult cuMemHostAlloc (void **pp, size_t bytesize, unsigned int Flags)

Allocates page-locked host memory.

## Parameters

**pp**
- Returned pointer to host memory

**bytesize**
- Requested allocation size in bytes

**Flags**
- Flags for allocation request

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY CUDA_ERROR_EXTERNAL_DEVICE

## Description

Allocates `bytesize` bytes of host memory that is page-locked and accessible to the device. The driver tracks the virtual memory ranges allocated with this function and automatically accelerates calls to functions such as cuMemcpyHtoD(). Since the memory can be accessed directly by the device, it can be read or written with much higher bandwidth than pageable memory obtained with functions such as malloc().

On systems where CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES is true, cuMemHostAlloc may not page-lock the allocated memory.

Page-locking excessive amounts of memory may degrade system performance, since it reduces the amount of memory available to the system for paging. As a result, this function is best used sparingly to allocate staging areas for data exchange between host and device.

The `Flags` parameter enables different options to be specified that affect the allocation, as follows.

- CU_MEMHOSTALLOC_PORTABLE: The memory returned by this call will be considered as pinned memory by all CUDA contexts, not just the one that performed the allocation.
- CU_MEMHOSTALLOC_DEVICEMAP: Maps the allocation into the CUDA address space. The device pointer to the memory may be obtained by calling cuMemHostGetDevicePointer().
- CU_MEMHOSTALLOC_WRITECOMBINED: Allocates the memory as write-combined (WC). WC memory can be transferred across the PCI Express bus more quickly on some system configurations, but cannot be read efficiently by most CPUs. WC memory is a good option for

buffers that will be written by the CPU and read by the GPU via mapped pinned memory or host->device transfers.

All of these flags are orthogonal to one another: a developer may allocate memory that is portable, mapped and/or write-combined with no restrictions.

The CU_MEMHOSTALLOC_DEVICEMAP flag may be specified on CUDA contexts for devices that do not support mapped pinned memory. The failure is deferred to cuMemHostGetDevicePointer() because the memory may be mapped into other CUDA contexts via the CU_MEMHOSTALLOC_PORTABLE flag.

The memory allocated by this function must be freed with cuMemFreeHost().

Note all host memory allocated using cuMemHostAlloc() will automatically be immediately accessible to all contexts on all devices which support unified addressing (as may be queried using CU_DEVICE_ATTRIBUTE_UNIFIED_ADDRESSING). Unless the flag CU_MEMHOSTALLOC_WRITECOMBINED is specified, the device pointer that may be used to access this host memory from those contexts is always equal to the returned host pointer `*pp`. If the flag CU_MEMHOSTALLOC_WRITECOMBINED is specified, then the function cuMemHostGetDevicePointer() must be used to query the device pointer, even if the context supports unified addressing. See Unified Addressing for additional details.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaHostAlloc

# CUresult cuMemHostGetDevicePointer (CUdeviceptr *pdptr, void *p, unsigned int Flags)

Passes back device pointer of mapped pinned memory.

## Parameters

**pdptr**

- Returned device pointer

**p**
- Host pointer

**Flags**
- Options (must be 0)

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Passes back the device pointer `pdptr` corresponding to the mapped, pinned host buffer `p` allocated by cuMemHostAlloc.

cuMemHostGetDevicePointer() will fail if the CU_MEMHOSTALLOC_DEVICEMAP flag was not specified at the time the memory was allocated, or if the function is called on a GPU that does not support mapped pinned memory.

For devices that have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CAN_USE_HOST_POINTER_FOR_REGISTERED_MEM, the memory can also be accessed from the device using the host pointer `p`. The device pointer returned by cuMemHostGetDevicePointer() may or may not match the original host pointer `p` and depends on the devices visible to the application. If all devices visible to the application have a non-zero value for the device attribute, the device pointer returned by cuMemHostGetDevicePointer() will match the original pointer `p`. If any device visible to the application has a zero value for the device attribute, the device pointer returned by cuMemHostGetDevicePointer() will not match the original host pointer `p`, but it will be suitable for use on all devices provided Unified Virtual Addressing is enabled. In such systems, it is valid to access the memory using either pointer on devices that have a non-zero value for the device attribute. Note however that such devices should access the memory using only one of the two pointers and not both.

`Flags` provides for future releases. For now, it must be set to 0.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo,

cuMemHostAlloc, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD8, cuMemsetD16, cuMemsetD32, cudaHostGetDevicePointer

# CUresult cuMemHostGetFlags (unsigned int *pFlags, void *p)

Passes back flags that were used for a pinned allocation.

## Parameters

**pFlags**
- Returned flags word

**p**
- Host pointer

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Passes back the flags `pFlags` that were specified when allocating the pinned host buffer `p` allocated by cuMemHostAlloc.

cuMemHostGetFlags() will fail if the pointer does not reside in an allocation performed by cuMemAllocHost() or cuMemHostAlloc().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemAllocHost, cuMemHostAlloc, cudaHostGetFlags

# CUresult cuMemHostRegister (void *p, size_t bytesize, unsigned int Flags)

Registers an existing host memory range for use by CUDA.

## Parameters

**p**
- Host pointer to memory to page-lock

**bytesize**
- Size in bytes of the address range to page-lock

**Flags**
- Flags for allocation request

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_HOST_MEMORY_ALREADY_REGISTERED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED CUDA_ERROR_EXTERNAL_DEVICE

## Description

Page-locks the memory range specified by `p` and `bytesize` and maps it for the device(s) as specified by `Flags`. This memory range also is added to the same tracking mechanism as cuMemHostAlloc to automatically accelerate calls to functions such as cuMemcpyHtoD(). Since the memory can be accessed directly by the device, it can be read or written with much higher bandwidth than pageable memory that has not been registered. Page-locking excessive amounts of memory may degrade system performance, since it reduces the amount of memory available to the system for paging. As a result, this function is best used sparingly to register staging areas for data exchange between host and device.

On systems where CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES is true, cuMemHostRegister will not page-lock the memory range specified by `ptr` but only populate unpopulated pages.

The `Flags` parameter enables different options to be specified that affect the allocation, as follows.

- CU_MEMHOSTREGISTER_PORTABLE: The memory returned by this call will be considered as pinned memory by all CUDA contexts, not just the one that performed the allocation.
- CU_MEMHOSTREGISTER_DEVICEMAP: Maps the allocation into the CUDA address space. The device pointer to the memory may be obtained by calling cuMemHostGetDevicePointer().
- CU_MEMHOSTREGISTER_IOMEMORY: The pointer is treated as pointing to some I/O memory space, e.g. the PCI Express resource of a 3rd party device.
- CU_MEMHOSTREGISTER_READ_ONLY: The pointer is treated as pointing to memory that is considered read-only by the device. On platforms without CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES, this flag is required in order to register memory mapped to the CPU as read-only. Support for the use of this flag can be queried from the device attribute CU_DEVICE_ATTRIBUTE_READ_ONLY_HOST_REGISTER_SUPPORTED. Using this flag with a current context associated with a device that does not have this attribute set will cause cuMemHostRegister to error with CUDA_ERROR_NOT_SUPPORTED.

All of these flags are orthogonal to one another: a developer may page-lock memory that is portable or mapped with no restrictions.

The CU_MEMHOSTREGISTER_DEVICEMAP flag may be specified on CUDA contexts for devices that do not support mapped pinned memory. The failure is deferred to cuMemHostGetDevicePointer() because the memory may be mapped into other CUDA contexts via the CU_MEMHOSTREGISTER_PORTABLE flag.

For devices that have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CAN_USE_HOST_POINTER_FOR_REGISTERED_MEM, the memory can also be accessed from the device using the host pointer `p`. The device pointer returned by cuMemHostGetDevicePointer() may or may not match the original host pointer `ptr` and depends on the devices visible to the application. If all devices visible to the application have a non-zero value for the device attribute, the device pointer returned by cuMemHostGetDevicePointer() will match the original pointer `ptr`. If any device visible to the application has a zero value for the device attribute, the device pointer returned by cuMemHostGetDevicePointer() will not match the original host pointer `ptr`, but it will be suitable for use on all devices provided Unified Virtual Addressing is enabled. In such systems, it is valid to access the memory using either pointer on devices that have a non-zero value for the device attribute. Note however that such devices should access the memory using only of the two pointers and not both.

The memory page-locked by this function must be unregistered with cuMemHostUnregister().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemHostUnregister, cuMemHostGetFlags, cuMemHostGetDevicePointer, cudaHostRegister

# CUresult cuMemHostUnregister (void *p)

Unregisters a memory range that was registered with cuMemHostRegister.

## Parameters

**p**

- Host pointer to memory to unregister

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_HOST_MEMORY_NOT_REGISTERED,

### Description

Unmaps the memory range whose base address is specified by `p`, and makes it pageable again.

The base address must be the same one specified to cuMemHostRegister().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemHostRegister, cudaHostUnregister

## CUresult cuMemsetD16 (CUdeviceptr dstDevice, unsigned short us, size_t N)

Initializes device memory.

### Parameters

**dstDevice**
- Destination device pointer

**us**
- Value to set

**N**
- Number of elements

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Sets the memory range of `N` 16-bit values to the specified value `us`. The `dstDevice` pointer must be two byte aligned.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset

# CUresult cuMemsetD16Async (CUdeviceptr dstDevice, unsigned short us, size_t N, CUstream hStream)

Sets device memory.

## Parameters

**dstDevice**
- Destination device pointer

**us**
- Value to set

**N**
- Number of elements

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the memory range of `N` 16-bit values to the specified value `us`. The `dstDevice` pointer must be two byte aligned.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD32, cuMemsetD32Async, cudaMemsetAsync

# CUresult cuMemsetD2D16 (CUdeviceptr dstDevice, size_t dstPitch, unsigned short us, size_t Width, size_t Height)

Initializes device memory.

## Parameters

**dstDevice**
- Destination device pointer

**dstPitch**
- Pitch of destination device pointer(Unused if `Height` is 1)

**us**
- Value to set

**Width**
- Width of row

**Height**
- Number of rows

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the 2D memory range of `Width` 16-bit values to the specified value `us`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. The `dstDevice` pointer and `dstPitch` offset must be two byte aligned. This function performs fastest when the pitch is one that has been passed back by cuMemAllocPitch().

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset2D

# CUresult cuMemsetD2D16Async (CUdeviceptr dstDevice, size_t dstPitch, unsigned short us, size_t Width, size_t Height, CUstream hStream)

Sets device memory.

## Parameters

**dstDevice**
- Destination device pointer

**dstPitch**
- Pitch of destination device pointer(Unused if `Height` is 1)

**us**
- Value to set

**Width**
- Width of row

**Height**
- Number of rows

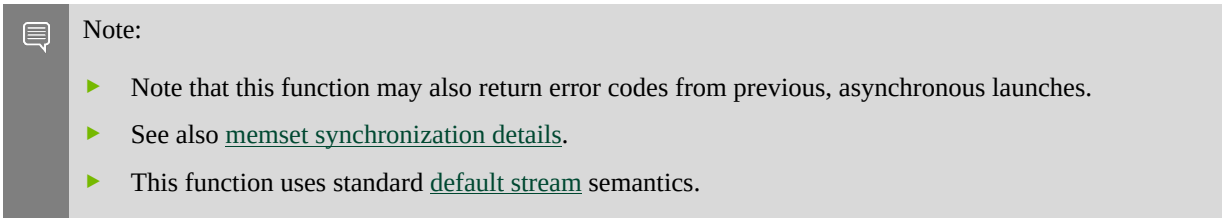
**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the 2D memory range of `Width` 16-bit values to the specified value `us`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. The `dstDevice` pointer and `dstPitch` offset must be two byte aligned. This function performs fastest when the pitch is one that has been passed back by cuMemAllocPitch().



Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset2DAsync

# CUresult cuMemsetD2D32 (CUdeviceptr dstDevice, size_t dstPitch, unsigned int ui, size_t Width, size_t Height)

Initializes device memory.

## Parameters

**dstDevice**
- Destination device pointer

**dstPitch**
- Pitch of destination device pointer(Unused if `Height` is 1)

**ui**
- Value to set

**Width**
- Width of row

**Height**
- Number of rows

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the 2D memory range of `Width` 32-bit values to the specified value `ui`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. The

`dstDevice` pointer and `dstPitch` offset must be four byte aligned. This function performs fastest when the pitch is one that has been passed back by cuMemAllocPitch().

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset2D

# CUresult cuMemsetD2D32Async (CUdeviceptr dstDevice, size_t dstPitch, unsigned int ui, size_t Width, size_t Height, CUstream hStream)

Sets device memory.

## Parameters

**dstDevice**
- Destination device pointer

**dstPitch**
- Pitch of destination device pointer(Unused if `Height` is 1)

**ui**
- Value to set

**Width**
- Width of row

**Height**
- Number of rows

**hStream**
- Stream identifier

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Sets the 2D memory range of `Width` 32-bit values to the specified value `ui`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. The `dstDevice` pointer and `dstPitch` offset must be four byte aligned. This function performs fastest when the pitch is one that has been passed back by cuMemAllocPitch().

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset2DAsync

## CUresult cuMemsetD2D8 (CUdeviceptr dstDevice, size_t dstPitch, unsigned char uc, size_t Width, size_t Height)

Initializes device memory.

### Parameters

**dstDevice**
- Destination device pointer

**dstPitch**
- Pitch of destination device pointer(Unused if `Height` is 1)

**uc**
- Value to set

**Width**
- Width of row

**Height**
- Number of rows

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Sets the 2D memory range of `Width` 8-bit values to the specified value `uc`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. This function performs fastest when the pitch is one that has been passed back by cuMemAllocPitch().

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset2D

## CUresult cuMemsetD2D8Async (CUdeviceptr dstDevice, size_t dstPitch, unsigned char uc, size_t Width, size_t Height, CUstream hStream)

Sets device memory.

### Parameters

**dstDevice**
- Destination device pointer

**dstPitch**
- Pitch of destination device pointer(Unused if `Height` is 1)

**uc**
- Value to set

**Width**
- Width of row

**Height**
- Number of rows

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the 2D memory range of `Width` 8-bit values to the specified value `uc`. `Height` specifies the number of rows to set, and `dstPitch` specifies the number of bytes between each row. This function performs fastest when the pitch is one that has been passed back by cuMemAllocPitch().

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset2DAsync

# CUresult cuMemsetD32 (CUdeviceptr dstDevice, unsigned int ui, size_t N)

Initializes device memory.

## Parameters

**dstDevice**
- Destination device pointer

**ui**
- Value to set

**N**
- Number of elements

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the memory range of `N` 32-bit values to the specified value `ui`. The `dstDevice` pointer must be four byte aligned.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32Async, cudaMemset

# CUresult cuMemsetD32Async (CUdeviceptr dstDevice, unsigned int ui, size_t N, CUstream hStream)

Sets device memory.

## Parameters

**dstDevice**
- Destination device pointer

**ui**
- Value to set

**N**
- Number of elements

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the memory range of `N` 32-bit values to the specified value `ui`. The `dstDevice` pointer must be four byte aligned.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cudaMemsetAsync

# CUresult cuMemsetD8 (CUdeviceptr dstDevice, unsigned char uc, size_t N)

Initializes device memory.

## Parameters

**dstDevice**
- Destination device pointer

**uc**
- Value to set

**N**
- Number of elements

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the memory range of `N` 8-bit values to the specified value `uc`.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8Async, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemset

# CUresult cuMemsetD8Async (CUdeviceptr dstDevice, unsigned char uc, size_t N, CUstream hStream)

Sets device memory.

## Parameters

**dstDevice**
- Destination device pointer

**uc**
- Value to set

**N**
- Number of elements

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Sets the memory range of `N` 8-bit values to the specified value `uc`.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- See also memset synchronization details.
- This function uses standard default stream semantics.

See also:

cuArray3DCreate, cuArray3DGetDescriptor, cuArrayCreate, cuArrayDestroy, cuArrayGetDescriptor, cuMemAlloc, cuMemAllocHost, cuMemAllocPitch, cuMemcpy2D, cuMemcpy2DAsync, cuMemcpy2DUnaligned, cuMemcpy3D, cuMemcpy3DAsync, cuMemcpyAtoA, cuMemcpyAtoD, cuMemcpyAtoH, cuMemcpyAtoHAsync, cuMemcpyDtoA, cuMemcpyDtoD, cuMemcpyDtoDAsync, cuMemcpyDtoH, cuMemcpyDtoHAsync, cuMemcpyHtoA, cuMemcpyHtoAAsync, cuMemcpyHtoD, cuMemcpyHtoDAsync, cuMemFree, cuMemFreeHost, cuMemGetAddressRange, cuMemGetInfo, cuMemHostAlloc, cuMemHostGetDevicePointer, cuMemsetD2D8, cuMemsetD2D8Async, cuMemsetD2D16, cuMemsetD2D16Async, cuMemsetD2D32, cuMemsetD2D32Async, cuMemsetD8, cuMemsetD16, cuMemsetD16Async, cuMemsetD32, cuMemsetD32Async, cudaMemsetAsync

# CUresult cuMipmappedArrayCreate (CUmipmappedArray *pHandle, const CUDA_ARRAY3D_DESCRIPTOR *pMipmappedArrayDesc, unsigned int numMipmapLevels)

Creates a CUDA mipmapped array.

## Parameters

**pHandle**
- Returned mipmapped array

**pMipmappedArrayDesc**
- mipmapped array descriptor

**numMipmapLevels**
- Number of mipmap levels

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Creates a CUDA mipmapped array according to the CUDA_ARRAY3D_DESCRIPTOR structure `pMipmappedArrayDesc` and returns a handle to the new CUDA mipmapped array in `*pHandle`. `numMipmapLevels` specifies the number of mipmap levels to be allocated. This value is clamped to the range [1, 1 + floor(log2(max(width, height, depth)))].

The CUDA_ARRAY3D_DESCRIPTOR is defined as:

```
typedef struct {
          unsigned int Width;
          unsigned int Height;
          unsigned int Depth;
          CUarray_format Format;
          unsigned int NumChannels;
          unsigned int Flags;
      } CUDA_ARRAY3D_DESCRIPTOR;
```

where:

- `Width`, `Height`, and `Depth` are the width, height, and depth of the CUDA array (in elements); the following types of CUDA arrays can be allocated:
  - A 1D mipmapped array is allocated if `Height` and `Depth` extents are both zero.
  - A 2D mipmapped array is allocated if only `Depth` extent is zero.
  - A 3D mipmapped array is allocated if all three extents are non-zero.
  - A 1D layered CUDA mipmapped array is allocated if only `Height` is zero and the CUDA_ARRAY3D_LAYERED flag is set. Each layer is a 1D array. The number of layers is determined by the depth extent.

- A 2D layered CUDA mipmapped array is allocated if all three extents are non-zero and the CUDA_ARRAY3D_LAYERED flag is set. Each layer is a 2D array. The number of layers is determined by the depth extent.
- A cubemap CUDA mipmapped array is allocated if all three extents are non-zero and the CUDA_ARRAY3D_CUBEMAP flag is set. `Width` must be equal to `Height`, and `Depth` must be six. A cubemap is a special type of 2D layered CUDA array, where the six layers represent the six faces of a cube. The order of the six layers in memory is the same as that listed in CUarray_cubemap_face.
- A cubemap layered CUDA mipmapped array is allocated if all three extents are non-zero, and both, CUDA_ARRAY3D_CUBEMAP and CUDA_ARRAY3D_LAYERED flags are set. `Width` must be equal to `Height`, and `Depth` must be a multiple of six. A cubemap layered CUDA array is a special type of 2D layered CUDA array that consists of a collection of cubemaps. The first six layers represent the first cubemap, the next six layers form the second cubemap, and so on.

- Format specifies the format of the elements; CUarray_format is defined as:

```
typedef enum CUarray_format_enum {
    CU_AD_FORMAT_UNSIGNED_INT8 = 0x01,
    CU_AD_FORMAT_UNSIGNED_INT16 = 0x02,
    CU_AD_FORMAT_UNSIGNED_INT32 = 0x03,
    CU_AD_FORMAT_SIGNED_INT8 = 0x08,
    CU_AD_FORMAT_SIGNED_INT16 = 0x09,
    CU_AD_FORMAT_SIGNED_INT32 = 0x0a,
    CU_AD_FORMAT_HALF = 0x10,
    CU_AD_FORMAT_FLOAT = 0x20,
    CU_AD_FORMAT_NV12 = 0xb0,
    CU_AD_FORMAT_UNORM_INT8X1 = 0xc0,
    CU_AD_FORMAT_UNORM_INT8X2 = 0xc1,
    CU_AD_FORMAT_UNORM_INT8X4 = 0xc2,
    CU_AD_FORMAT_UNORM_INT16X1 = 0xc3,
    CU_AD_FORMAT_UNORM_INT16X2 = 0xc4,
    CU_AD_FORMAT_UNORM_INT16X4 = 0xc5,
    CU_AD_FORMAT_SNORM_INT8X1 = 0xc6,
    CU_AD_FORMAT_SNORM_INT8X2 = 0xc7,
    CU_AD_FORMAT_SNORM_INT8X4 = 0xc8,
    CU_AD_FORMAT_SNORM_INT16X1 = 0xc9,
    CU_AD_FORMAT_SNORM_INT16X2 = 0xca,
    CU_AD_FORMAT_SNORM_INT16X4 = 0xcb,
    CU_AD_FORMAT_BC1_UNORM = 0x91,
    CU_AD_FORMAT_BC1_UNORM_SRGB = 0x92,
    CU_AD_FORMAT_BC2_UNORM = 0x93,
    CU_AD_FORMAT_BC2_UNORM_SRGB = 0x94,
    CU_AD_FORMAT_BC3_UNORM = 0x95,
    CU_AD_FORMAT_BC3_UNORM_SRGB = 0x96,
    CU_AD_FORMAT_BC4_UNORM = 0x97,
    CU_AD_FORMAT_BC4_SNORM = 0x98,
    CU_AD_FORMAT_BC5_UNORM = 0x99,
    CU_AD_FORMAT_BC5_SNORM = 0x9a,
    CU_AD_FORMAT_BC6H_UF16 = 0x9b,
    CU_AD_FORMAT_BC6H_SF16 = 0x9c,
    CU_AD_FORMAT_BC7_UNORM = 0x9d,
    CU_AD_FORMAT_BC7_UNORM_SRGB = 0x9e,
    CU_AD_FORMAT_P010 = 0x9f,
    CU_AD_FORMAT_P016 = 0xa1,
    CU_AD_FORMAT_NV16 = 0xa2,
    CU_AD_FORMAT_P210 = 0xa3,
    CU_AD_FORMAT_P216 = 0xa4,
    CU_AD_FORMAT_YUY2 = 0xa5,
```

```
        CU_AD_FORMAT_Y210 = 0xa6,
        CU_AD_FORMAT_Y216 = 0xa7,
        CU_AD_FORMAT_AYUV = 0xa8,
        CU_AD_FORMAT_Y410 = 0xa9,
        CU_AD_FORMAT_Y416 = 0xb1,
        CU_AD_FORMAT_Y444_PLANAR8 = 0xb2,
        CU_AD_FORMAT_Y444_PLANAR10 = 0xb3,
        CU_AD_FORMAT_YUV444_8bit_SemiPlanar = 0xb4,
        CU_AD_FORMAT_YUV444_16bit_SemiPlanar = 0xb5,
        CU_AD_FORMAT_UNORM_INT_101010_2 = 0x50,
        CU_AD_FORMAT_UINT8_PACKED_422 = 0x51,
        CU_AD_FORMAT_UINT8_PACKED_444 = 0x52,
        CU_AD_FORMAT_UINT8_SEMIPLANAR_420 = 0x53,
        CU_AD_FORMAT_UINT16_SEMIPLANAR_420 = 0x54,
        CU_AD_FORMAT_UINT8_SEMIPLANAR_422 = 0x55,
        CU_AD_FORMAT_UINT16_SEMIPLANAR_422 = 0x56,
        CU_AD_FORMAT_UINT8_SEMIPLANAR_444 = 0x57,
        CU_AD_FORMAT_UINT16_SEMIPLANAR_444 = 0x58,
        CU_AD_FORMAT_UINT8_PLANAR_420 = 0x59,
        CU_AD_FORMAT_UINT16_PLANAR_420 = 0x5a,
        CU_AD_FORMAT_UINT8_PLANAR_422 = 0x5b,
        CU_AD_FORMAT_UINT16_PLANAR_422 = 0x5c,
        CU_AD_FORMAT_UINT8_PLANAR_444 = 0x5d,
        CU_AD_FORMAT_UINT16_PLANAR_444 = 0x5e,
    } CUarray_format;
```

- `NumChannels` specifies the number of packed components per CUDA array element; it may be 1, 2, or 4;
- Flags may be set to
  - CUDA_ARRAY3D_LAYERED to enable creation of layered CUDA mipmapped arrays. If this flag is set, `Depth` specifies the number of layers, not the depth of a 3D array.
  - CUDA_ARRAY3D_SURFACE_LDST to enable surface references to be bound to individual mipmap levels of the CUDA mipmapped array. If this flag is not set, cuSurfRefSetArray will fail when attempting to bind a mipmap level of the CUDA mipmapped array to a surface reference.
  - CUDA_ARRAY3D_CUBEMAP to enable creation of mipmapped cubemaps. If this flag is set, `Width` must be equal to `Height`, and `Depth` must be six. If the CUDA_ARRAY3D_LAYERED flag is also set, then `Depth` must be a multiple of six.
  - CUDA_ARRAY3D_TEXTURE_GATHER to indicate that the CUDA mipmapped array will be used for texture gather. Texture gather can only be performed on 2D CUDA mipmapped arrays.

`Width`, `Height` and `Depth` must meet certain size requirements as listed in the following table. All values are specified in elements. Note that for brevity's sake, the full name of the device attribute is not specified. For ex., TEXTURE1D_MIPMAPPED_WIDTH refers to the device attribute CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_MIPMAPPED_WIDTH.

| CUDA array type | Valid extents that must always be met {(width range in elements), (height range), (depth range)} | Valid extents with CUDA_ARRAY3D_SURFACE_LDST set {(width range in elements), (height range), (depth range)} |
|---|---|---|

| | | |
|---|---|---|
| 1D | { (1,TEXTURE1D_MIPMAPPED_WIDTH), 0, 0 } | { (1,SURFACE1D_WIDTH), 0, 0 } |
| 2D | { (1,TEXTURE2D_MIPMAPPED_WIDTH), (1,TEXTURE2D_MIPMAPPED_HEIGHT), 0 } | { (1,SURFACE2D_WIDTH), (1,SURFACE2D_HEIGHT), 0 } |
| 3D | { (1,TEXTURE3D_WIDTH), (1,TEXTURE3D_HEIGHT), (1,TEXTURE3D_DEPTH) } OR { (1,TEXTURE3D_WIDTH_ALTERNATE), (1,TEXTURE3D_HEIGHT_ALTERNATE), (1,TEXTURE3D_DEPTH_ALTERNATE) } | { (1,SURFACE3D_WIDTH), (1,SURFACE3D_HEIGHT), (1,SURFACE3D_DEPTH) } |
| 1D Layered | { (1,TEXTURE1D_LAYERED_WIDTH), 0, (1,TEXTURE1D_LAYERED_LAYERS) } | { (1,SURFACE1D_LAYERED_WIDTH), 0, (1,SURFACE1D_LAYERED_LAYERS) } |
| 2D Layered | { (1,TEXTURE2D_LAYERED_WIDTH), (1,TEXTURE2D_LAYERED_HEIGHT), (1,TEXTURE2D_LAYERED_LAYERS) } | { (1,SURFACE2D_LAYERED_WIDTH), (1,SURFACE2D_LAYERED_HEIGHT), (1,SURFACE2D_LAYERED_LAYERS) } |
| Cubemap | { (1,TEXTURECUBEMAP_WIDTH), (1,TEXTURECUBEMAP_WIDTH), 6 } | { (1,SURFACECUBEMAP_WIDTH), (1,SURFACECUBEMAP_WIDTH), 6 } |
| Cubemap Layered | { (1,TEXTURECUBEMAP_LAYERED_WIDTH), (1,TEXTURECUBEMAP_LAYERED_LAYERS) } | { (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,SURFACECUBEMAP_LAYERED_WIDTH), (1,SURFACECUBEMAP_LAYERED_LAYERS) } |

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMipmappedArrayDestroy, cuMipmappedArrayGetLevel, cuArrayCreate, cudaMallocMipmappedArray

# CUresult cuMipmappedArrayDestroy (CUmipmappedArray hMipmappedArray)

Destroys a CUDA mipmapped array.

## Parameters

**hMipmappedArray**
- Mipmapped array to destroy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ARRAY_IS_MAPPED, CUDA_ERROR_CONTEXT_IS_DESTROYED

## Description

Destroys the CUDA mipmapped array `hMipmappedArray`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMipmappedArrayCreate, cuMipmappedArrayGetLevel, cuArrayCreate, cudaFreeMipmappedArray

# CUresult cuMipmappedArrayGetLevel (CUarray *pLevelArray, CUmipmappedArray hMipmappedArray, unsigned int level)

Gets a mipmap level of a CUDA mipmapped array.

## Parameters

**pLevelArray**
- Returned mipmap level CUDA array

**hMipmappedArray**
- CUDA mipmapped array

**level**
- Mipmap level

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Returns in `*pLevelArray` a CUDA array that represents a single mipmap level of the CUDA mipmapped array `hMipmappedArray`.

If `level` is greater than the maximum number of levels in this mipmapped array, CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMipmappedArrayCreate, cuMipmappedArrayDestroy, cuArrayCreate, cudaGetMipmappedArrayLevel

## CUresult cuMipmappedArrayGetMemoryRequirements (CUDA_ARRAY_MEMORY_REQUIREMENTS *memoryRequirements, CUmipmappedArray mipmap, CUdevice device)

Returns the memory requirements of a CUDA mipmapped array.

### Parameters

**memoryRequirements**
- Pointer to CUDA_ARRAY_MEMORY_REQUIREMENTS

**mipmap**
- CUDA mipmapped array to get the memory requirements of

**device**
- Device to get the memory requirements for

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

### Description

Returns the memory requirements of a CUDA mipmapped array in `memoryRequirements` If the CUDA mipmapped array is not allocated with flag CUDA_ARRAY3D_DEFERRED_MAPPING CUDA_ERROR_INVALID_VALUE will be returned.

The returned value in CUDA_ARRAY_MEMORY_REQUIREMENTS::size represents the total size of the CUDA mipmapped array. The returned value in CUDA_ARRAY_MEMORY_REQUIREMENTS::alignment represents the alignment necessary for mapping the CUDA mipmapped array.

See also:

cuArrayGetMemoryRequirements, cuMemMapArrayAsync

## CUresult cuMipmappedArrayGetSparseProperties (CUDA_ARRAY_SPARSE_PROPERTIES *sparseProperties, CUmipmappedArray mipmap)

Returns the layout properties of a sparse CUDA mipmapped array.

### Parameters

**sparseProperties**
- Pointer to CUDA_ARRAY_SPARSE_PROPERTIES

**mipmap**
- CUDA mipmapped array to get the sparse properties of

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

### Description

Returns the sparse array layout properties in `sparseProperties` If the CUDA mipmapped array is not allocated with flag CUDA_ARRAY3D_SPARSE CUDA_ERROR_INVALID_VALUE will be returned.

For non-layered CUDA mipmapped arrays, CUDA_ARRAY_SPARSE_PROPERTIES::miptailSize returns the size of the mip tail region. The mip tail region includes all mip levels whose width, height or depth is less than that of the tile. For layered CUDA mipmapped arrays, if CUDA_ARRAY_SPARSE_PROPERTIES::flags contains CU_ARRAY_SPARSE_PROPERTIES_SINGLE_MIPTAIL, then CUDA_ARRAY_SPARSE_PROPERTIES::miptailSize specifies the size of the mip tail of all layers combined. Otherwise, CUDA_ARRAY_SPARSE_PROPERTIES::miptailSize specifies mip tail size

per layer. The returned value of CUDA_ARRAY_SPARSE_PROPERTIES::miptailFirstLevel is valid only if CUDA_ARRAY_SPARSE_PROPERTIES::miptailSize is non-zero.

See also:

cuArrayGetSparseProperties, cuMemMapArrayAsync

# 6.14. Virtual Memory Management

This section describes the virtual memory management functions of the low-level CUDA driver application programming interface.

## CUresult cuMemAddressFree (CUdeviceptr ptr, size_t size)

Free an address range reservation.

### Parameters

**ptr**
- Starting address of the virtual address range to free

**size**
- Size of the virtual address region to free

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

Frees a virtual address range reserved by cuMemAddressReserve. The size must match what was given to memAddressReserve and the ptr given must match what was returned from memAddressReserve.

See also:

cuMemAddressReserve

# CUresult cuMemAddressReserve (CUdeviceptr *ptr, size_t size, size_t alignment, CUdeviceptr addr, unsigned long long flags)

Allocate an address range reservation.

## Parameters

**ptr**
- Resulting pointer to start of virtual address range allocated

**size**
- Size of the reserved virtual address range requested

**alignment**
- Alignment of the reserved virtual address range requested

**addr**
- Hint address for the start of the address range

**flags**
- Currently unused, must be zero

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

## Description

Reserves a virtual address range based on the given parameters, giving the starting address of the range in `ptr`. This API requires a system that supports UVA. The size and address parameters must be a multiple of the host page size and the alignment must be a power of two or zero for default alignment. If `addr` is 0, then the driver chooses the address at which to place the start of the reservation whereas when it is non-zero then the driver treats it as a hint about where to place the reservation.

See also:

cuMemAddressFree

# CUresult cuMemCreate (CUmemGenericAllocationHandle *handle, size_t size, const CUmemAllocationProp *prop, unsigned long long flags)

Create a CUDA memory handle representing a memory allocation of a given size described by the given properties.

## Parameters

**handle**
- Value of handle returned. All operations on this allocation are to be performed using this handle.

**size**
- Size of the allocation requested

**prop**
- Properties of the allocation to create.

**flags**
- flags for future use, must be zero now.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

## Description

This creates a memory allocation on the target device specified through the `prop` structure. The created allocation will not have any device or host mappings. The generic memory `handle` for the allocation can be mapped to the address space of calling process via cuMemMap. This handle cannot be transmitted directly to other processes (see cuMemExportToShareableHandle). On Windows, the caller must also pass an LPSECURITYATTRIBUTE in `prop` to be associated with this handle which limits or allows access to this handle for a recipient process (see CUmemAllocationProp::win32HandleMetaData for more). The `size` of this allocation must be a multiple of the the value given via cuMemGetAllocationGranularity with the CU_MEM_ALLOC_GRANULARITY_MINIMUM flag. To create a CPU allocation that doesn't target any specific NUMA nodes, applications must set CUmemAllocationProp::CUmemLocation::type to CU_MEM_LOCATION_TYPE_HOST. CUmemAllocationProp::CUmemLocation::id is ignored for HOST allocations. HOST allocations are not IPC capable and CUmemAllocationProp::requestedHandleTypes must be 0, any other value will result in CUDA_ERROR_INVALID_VALUE. To create a CPU allocation targeting a specific host NUMA node, applications must set CUmemAllocationProp::CUmemLocation::type to CU_MEM_LOCATION_TYPE_HOST_NUMA and CUmemAllocationProp::CUmemLocation::id must specify the NUMA ID of the CPU. On

systems where NUMA is not available CUmemAllocationProp::CUmemLocation::id must be set to 0. Specifying CU_MEM_LOCATION_TYPE_HOST_NUMA_CURRENT as the CUmemLocation::type will result in CUDA_ERROR_INVALID_VALUE.

Applications that intend to use CU_MEM_HANDLE_TYPE_FABRIC based memory sharing must ensure: (1) `nvidia-caps-imex-channels` character device is created by the driver and is listed under /proc/devices (2) have at least one IMEX channel file accessible by the user launching the application.

When exporter and importer CUDA processes have been granted access to the same IMEX channel, they can securely share memory.

The IMEX channel security model works on a per user basis. Which means all processes under a user can share memory if the user has access to a valid IMEX channel. When multi-user isolation is desired, a separate IMEX channel is required for each user.

These channel files exist in /dev/nvidia-caps-imex-channels/channel* and can be created using standard OS native calls like mknod on Linux. For example: To create channel0 with the major number from /proc/devices users can execute the following command: `mknod /dev/nvidia-caps-imex-channels/channel0 c <major number>=""> 0`

If CUmemAllocationProp::allocFlags::usage contains CU_MEM_CREATE_USAGE_TILE_POOL flag then the memory allocation is intended only to be used as backing tile pool for sparse CUDA arrays and sparse CUDA mipmapped arrays. (see cuMemMapArrayAsync).

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemRelease, cuMemExportToShareableHandle, cuMemImportFromShareableHandle

# CUresult cuMemExportToShareableHandle (void *shareableHandle, CUmemGenericAllocationHandle handle, CUmemAllocationHandleType handleType, unsigned long long flags)

Exports an allocation to a requested shareable handle type.

## Parameters

**shareableHandle**

- Pointer to the location in which to store the requested handle type

**handle**

- CUDA handle for the memory allocation

**handleType**
- Type of shareable handle requested (defines type and size of the `shareableHandle` output parameter)

**flags**
- Reserved, must be zero

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

Given a CUDA memory handle, create a shareable memory allocation handle that can be used to share the memory with other processes. The recipient process can convert the shareable handle back into a CUDA memory handle using cuMemImportFromShareableHandle and map it with cuMemMap. The implementation of what this handle is and how it can be transferred is defined by the requested handle type in `handleType`

Once all shareable handles are closed and the allocation is released, the allocated memory referenced will be released back to the OS and uses of the CUDA handle afterward will lead to undefined behavior.

This API can also be used in conjunction with other APIs (e.g. Vulkan, OpenGL) that support importing memory from the shareable type

See also:

cuMemImportFromShareableHandle

## CUresult cuMemGetAccess (unsigned long long *flags, const CUmemLocation *location, CUdeviceptr ptr)

Get the access `flags` set for the given `location` and `ptr`.

### Parameters

**flags**
- Flags set for this location

**location**
- Location in which to check the flags for

**ptr**
- Address in which to check the access flags for

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

See also:

cuMemSetAccess

## CUresult cuMemGetAllocationGranularity (size_t *granularity, const CUmemAllocationProp *prop, CUmemAllocationGranularity_flags option)

Calculates either the minimal or recommended granularity.

### Parameters

**granularity**
Returned granularity.

**prop**
Property for which to determine the granularity for

**option**
Determines which granularity to return

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

Calculates either the minimal or recommended granularity for a given allocation specification and returns it in granularity. This granularity can be used as a multiple for alignment, size, or address mapping.

See also:

cuMemCreate, cuMemMap

# CUresult cuMemGetAllocationPropertiesFromHandle (CUmemAllocationProp *prop, CUmemGenericAllocationHandle handle)

Retrieve the contents of the property structure defining properties for this handle.

## Parameters

**prop**
- Pointer to a properties structure which will hold the information about this handle

**handle**
- Handle which to perform the query on

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

## Description

See also:

cuMemCreate, cuMemImportFromShareableHandle

# CUresult cuMemImportFromShareableHandle (CUmemGenericAllocationHandle *handle, void *osHandle, CUmemAllocationHandleType shHandleType)

Imports an allocation from a requested shareable handle type.

## Parameters

**handle**
- CUDA Memory handle for the memory allocation.

**osHandle**
- Shareable Handle representing the memory allocation that is to be imported.

**shHandleType**
- handle type of the exported handle CUmemAllocationHandleType.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

If the current process cannot support the memory described by this shareable handle, this API will error as CUDA_ERROR_NOT_SUPPORTED.

If `shHandleType` is CU_MEM_HANDLE_TYPE_FABRIC and the importer process has not been granted access to the same IMEX channel as the exporter process, this API will error as CUDA_ERROR_NOT_PERMITTED.

Note:

Importing shareable handles exported from some graphics APIs(VUlkan, OpenGL, etc) created on devices under an SLI group may not be supported, and thus this API will return CUDA_ERROR_NOT_SUPPORTED. There is no guarantee that the contents of `handle` will be the same CUDA memory handle for the same given OS shareable handle, or the same underlying allocation.

See also:

cuMemExportToShareableHandle, cuMemMap, cuMemRelease

## CUresult cuMemMap (CUdeviceptr ptr, size_t size, size_t offset, CUmemGenericAllocationHandle handle, unsigned long long flags)

Maps an allocation handle to a reserved virtual address range.

### Parameters

**ptr**
- Address where memory will be mapped.

**size**
- Size of the memory mapping.

**offset**
handle from which to start mapping Note: currently must be zero.
- Offset into the memory represented by

**handle**
- Handle to a shareable memory

**flags**
- flags for future use, must be zero now.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_NOT_INITIALIZED,

CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_ILLEGAL_STATE

- `handle` from which to start mapping
- Note: currently must be zero.

## Description

Maps bytes of memory represented by `handle` starting from byte `offset` to `size` to address range [`addr`, `addr` + `size`]. This range must be an address reservation previously reserved with cuMemAddressReserve, and `offset` + `size` must be less than the size of the memory allocation. Both `ptr`, `size`, and `offset` must be a multiple of the value given via cuMemGetAllocationGranularity with the CU_MEM_ALLOC_GRANULARITY_MINIMUM flag. If `handle` represents a multicast object, `ptr`, `size` and `offset` must be aligned to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_MINIMUM_GRANULARITY. For best performance however, it is recommended that `ptr`, `size` and `offset` be aligned to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_RECOMMENDED_GRANULARITY.

When `handle` represents a multicast object, this call may return CUDA_ERROR_ILLEGAL_STATE if the system configuration is in an illegal state. In such cases, to continue using multicast, verify that the system configuration is in a valid state and all required driver daemons are running properly.

Please note calling cuMemMap does not make the address accessible, the caller needs to update accessibility of a contiguous mapped VA range by calling cuMemSetAccess.

Once a recipient process obtains a shareable memory handle from cuMemImportFromShareableHandle, the process must use cuMemMap to map the memory into its address ranges before setting accessibility with cuMemSetAccess.

cuMemMap can only create mappings on VA range reservations that are not currently mapped.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemUnmap, cuMemSetAccess, cuMemCreate, cuMemAddressReserve, cuMemImportFromShareableHandle

# CUresult cuMemMapArrayAsync (CUarrayMapInfo *mapInfoList, unsigned int count, CUstream hStream)

Maps or unmaps subregions of sparse CUDA arrays and sparse CUDA mipmapped arrays.

## Parameters

**mapInfoList**
- List of CUarrayMapInfo

**count**
- Count of CUarrayMapInfo in `mapInfoList`

**hStream**
- Stream identifier for the stream to use for map or unmap operations

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Performs map or unmap operations on subregions of sparse CUDA arrays and sparse CUDA mipmapped arrays. Each operation is specified by a CUarrayMapInfo entry in the `mapInfoList` array of size `count`. The structure CUarrayMapInfo is defined as follow:

```
typedef struct CUarrayMapInfo_st {
        CUresourcetype resourceType;
        union {
            CUmipmappedArray mipmap;
            CUarray array;
        } resource;

        CUarraySparseSubresourceType subresourceType;
        union {
            struct {
                unsigned int level;
                unsigned int layer;
                unsigned int offsetX;
                unsigned int offsetY;
                unsigned int offsetZ;
                unsigned int extentWidth;
                unsigned int extentHeight;
                unsigned int extentDepth;
            } sparseLevel;
            struct {
                unsigned int layer;
                unsigned long long offset;
                unsigned long long size;
            } miptail;
        } subresource;

        CUmemOperationType memOperationType;

        CUmemHandleType memHandleType;
        union {
            CUmemGenericAllocationHandle memHandle;
        } memHandle;

        unsigned long long offset;
```

```
            unsigned int deviceBitMask;
            unsigned int flags;
            unsigned int reserved[2];
        } CUarrayMapInfo;
```

where CUarrayMapInfo::resourceType specifies the type of resource to be operated on. If CUarrayMapInfo::resourceType is set to CUresourcetype::CU_RESOURCE_TYPE_ARRAY then CUarrayMapInfo::resource::array must be set to a valid sparse CUDA array handle. The CUDA array must be either a 2D, 2D layered or 3D CUDA array and must have been allocated using cuArrayCreate or cuArray3DCreate with the flag CUDA_ARRAY3D_SPARSE or CUDA_ARRAY3D_DEFERRED_MAPPING. For CUDA arrays obtained using cuMipmappedArrayGetLevel, CUDA_ERROR_INVALID_VALUE will be returned. If CUarrayMapInfo::resourceType is set to CUresourcetype::CU_RESOURCE_TYPE_MIPMAPPED_ARRAY then CUarrayMapInfo::resource::mipmap must be set to a valid sparse CUDA mipmapped array handle. The CUDA mipmapped array must be either a 2D, 2D layered or 3D CUDA mipmapped array and must have been allocated using cuMipmappedArrayCreate with the flag CUDA_ARRAY3D_SPARSE or CUDA_ARRAY3D_DEFERRED_MAPPING.

CUarrayMapInfo::subresourceType specifies the type of subresource within the resource. CUarraySparseSubresourceType_enum is defined as:

```
    typedef enum CUarraySparseSubresourceType_enum {
            CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_SPARSE_LEVEL = 0,
            CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_MIPTAIL = 1
        } CUarraySparseSubresourceType;
```

where CUarraySparseSubresourceType::CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_SPARSE_LEVEL indicates a sparse-miplevel which spans at least one tile in every dimension. The remaining miplevels which are too small to span at least one tile in any dimension constitute the mip tail region as indicated by CUarraySparseSubresourceType::CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_MIPTAIL subresource type.

If CUarrayMapInfo::subresourceType is set to CUarraySparseSubresourceType::CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_SPARSE_LEVEL then CUarrayMapInfo::subresource::sparseLevel struct must contain valid array subregion offsets and extents. The CUarrayMapInfo::subresource::sparseLevel::offsetX, CUarrayMapInfo::subresource::sparseLevel::offsetY and CUarrayMapInfo::subresource::sparseLevel::offsetZ must specify valid X, Y and Z offsets respectively. The CUarrayMapInfo::subresource::sparseLevel::extentWidth, CUarrayMapInfo::subresource::sparseLevel::extentHeight and CUarrayMapInfo::subresource::sparseLevel::extentDepth must specify valid width, height and depth extents respectively. These offsets and extents must be aligned to the corresponding tile dimension. For CUDA mipmapped arrays CUarrayMapInfo::subresource::sparseLevel::level must specify a valid mip level index. Otherwise, must be zero. For layered CUDA arrays and layered CUDA mipmapped arrays CUarrayMapInfo::subresource::sparseLevel::layer must specify a valid layer index. Otherwise, must be zero. CUarrayMapInfo::subresource::sparseLevel::offsetZ must be zero and CUarrayMapInfo::subresource::sparseLevel::extentDepth must be set to 1 for 2D and

2D layered CUDA arrays and CUDA mipmapped arrays. Tile extents can be obtained by calling cuArrayGetSparseProperties and cuMipmappedArrayGetSparseProperties

If CUarrayMapInfo::subresourceType is set to CUarraySparseSubresourceType::CU_ARRAY_SPARSE_SUBRESOURCE_TYPE_MIPTAIL then CUarrayMapInfo::subresource::miptail struct must contain valid mip tail offset in CUarrayMapInfo::subresource::miptail::offset and size in CUarrayMapInfo::subresource::miptail::size. Both, mip tail offset and mip tail size must be aligned to the tile size. For layered CUDA mipmapped arrays which don't have the flag CU_ARRAY_SPARSE_PROPERTIES_SINGLE_MIPTAIL set in CUDA_ARRAY_SPARSE_PROPERTIES::flags as returned by cuMipmappedArrayGetSparseProperties, CUarrayMapInfo::subresource::miptail::layer must specify a valid layer index. Otherwise, must be zero.

If CUarrayMapInfo::resource::array or CUarrayMapInfo::resource::mipmap was created with CUDA_ARRAY3D_DEFERRED_MAPPING flag set the CUarrayMapInfo::subresourceType and the contents of CUarrayMapInfo::subresource will be ignored.

CUarrayMapInfo::memOperationType specifies the type of operation. CUmemOperationType is defined as:

```
typedef enum CUmemOperationType_enum {
    CU_MEM_OPERATION_TYPE_MAP = 1,
    CU_MEM_OPERATION_TYPE_UNMAP = 2
} CUmemOperationType;
```

If CUarrayMapInfo::memOperationType is set to CUmemOperationType::CU_MEM_OPERATION_TYPE_MAP then the subresource will be mapped onto the tile pool memory specified by CUarrayMapInfo::memHandle at offset CUarrayMapInfo::offset. The tile pool allocation has to be created by specifying the CU_MEM_CREATE_USAGE_TILE_POOL flag when calling cuMemCreate. Also, CUarrayMapInfo::memHandleType must be set to CUmemHandleType::CU_MEM_HANDLE_TYPE_GENERIC.

If CUarrayMapInfo::memOperationType is set to CUmemOperationType::CU_MEM_OPERATION_TYPE_UNMAP then an unmapping operation is performed. CUarrayMapInfo::memHandle must be NULL.

CUarrayMapInfo::deviceBitMask specifies the list of devices that must map or unmap physical memory. Currently, this mask must have exactly one bit set, and the corresponding device must match the device associated with the stream. If CUarrayMapInfo::memOperationType is set to CUmemOperationType::CU_MEM_OPERATION_TYPE_MAP, the device must also match the device associated with the tile pool memory allocation as specified by CUarrayMapInfo::memHandle.

CUarrayMapInfo::flags and CUarrayMapInfo::reserved[] are unused and must be set to zero.

See also:

cuMipmappedArrayCreate, cuArrayCreate, cuArray3DCreate, cuMemCreate, cuArrayGetSparseProperties, cuMipmappedArrayGetSparseProperties

# CUresult cuMemRelease (CUmemGenericAllocationHandle handle)

Release a memory handle representing a memory allocation which was previously allocated through cuMemCreate.

## Parameters

**handle**
Value of handle which was returned previously by cuMemCreate.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

## Description

Frees the memory that was allocated on a device through cuMemCreate.

The memory allocation will be freed when all outstanding mappings to the memory are unmapped and when all outstanding references to the handle (including it's shareable counterparts) are also released. The generic memory handle can be freed when there are still outstanding mappings made with this handle. Each time a recipient process imports a shareable handle, it needs to pair it with cuMemRelease for the handle to be freed. If `handle` is not a valid handle the behavior is undefined.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemCreate

# CUresult cuMemRetainAllocationHandle (CUmemGenericAllocationHandle *handle, void *addr)

Given an address `addr`, returns the allocation handle of the backing memory allocation.

## Parameters

**handle**
CUDA Memory handle for the backing memory allocation.

**addr**
Memory address to query, that has been mapped previously.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

The handle is guaranteed to be the same handle value used to map the memory. If the address requested is not mapped, the function will fail. The returned handle must be released with corresponding number of calls to cuMemRelease.

Note:

The address `addr`, can be any address in a range previously mapped by cuMemMap, and not necessarily the start address.

See also:

cuMemCreate, cuMemRelease, cuMemMap

## CUresult cuMemSetAccess (CUdeviceptr ptr, size_t size, const CUmemAccessDesc *desc, size_t count)

Set the access flags for each location specified in `desc` for the given virtual address range.

### Parameters

**ptr**
- Starting address for the virtual address range

**size**
- Length of the virtual address range

**desc**
mapping for each location specified
- Array of CUmemAccessDesc that describe how to change the

**count**
- Number of CUmemAccessDesc in `desc`

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_SUPPORTED

- mapping for each location specified

### Description

Given the virtual address range via `ptr` and `size`, and the locations in the array given by `desc` and `count`, set the access flags for the target locations. The range must be a fully mapped address range containing all allocations created by cuMemMap / cuMemCreate. Users cannot specify CU_MEM_LOCATION_TYPE_HOST_NUMA accessibility for allocations created on with other location types. Note: When CUmemAccessDesc::CUmemLocation::type is CU_MEM_LOCATION_TYPE_HOST_NUMA, CUmemAccessDesc::CUmemLocation::id is ignored. When setting the access flags for a virtual address range mapping a multicast object, `ptr` and `size` must be aligned to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_MINIMUM_GRANULARITY. For best performance however, it is recommended that `ptr` and `size` be aligned to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_RECOMMENDED_GRANULARITY.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuMemSetAccess, cuMemCreate, :cuMemMap

## CUresult cuMemUnmap (CUdeviceptr ptr, size_t size)

Unmap the backing memory of a given address range.

### Parameters

**ptr**

- Starting address for the virtual address range to unmap

**size**

- Size of the virtual address range to unmap

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

The range must be the entire contiguous address range that was mapped to. In other words, cuMemUnmap cannot unmap a sub-range of an address range mapped by cuMemCreate / cuMemMap.

Any backing memory allocations will be freed if there are no existing mappings and there are no unreleased memory handles.

When cuMemUnmap returns successfully the address range is converted to an address reservation and can be used for a future calls to cuMemMap. Any new mapping to this virtual address will need to have access granted through cuMemSetAccess, as all mappings start with no accessibility setup.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits synchronous behavior for most use cases.

See also:

cuMemCreate, cuMemAddressReserve

# 6.16. Multicast Object Management

This section describes the CUDA multicast object operations exposed by the low-level CUDA driver application programming interface.

overview

A multicast object created via cuMulticastCreate enables certain memory operations to be broadcast to a team of devices. Devices can be added to a multicast object via cuMulticastAddDevice. Memory can be bound on each participating device via cuMulticastBindMem, cuMulticastBindMem_v2, cuMulticastBindAddr, or cuMulticastBindAddr_v2. Multicast objects can be mapped into a device's virtual address space using the virtual memmory management APIs (see cuMemMap and cuMemSetAccess).

Supported Platforms

Support for multicast on a specific device can be queried using the device attribute CU_DEVICE_ATTRIBUTE_MULTICAST_SUPPORTED

## CUresult cuMulticastAddDevice (CUmemGenericAllocationHandle mcHandle, CUdevice dev)

Associate a device to a multicast object.

### Parameters

**mcHandle**

Handle representing a multicast object.

**dev**
Device that will be associated to the multicast object.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

Associates a device to a multicast object. The added device will be a part of the multicast team of size specified by CUmulticastObjectProp::numDevices during cuMulticastCreate. The association of the device to the multicast object is permanent during the life time of the multicast object. All devices must be added to the multicast team before any memory can be bound to any device in the team. Any calls to cuMulticastBindMem, cuMulticastBindMem_v2, cuMulticastBindAddr, or cuMulticastBindAddr_v2 will block until all devices have been added. Similarly all devices must be added to the multicast team before a virtual address range can be mapped to the multicast object. A call to cuMemMap will block until all devices have been added.

See also:

cuMulticastCreate, cuMulticastBindMem, cuMulticastBindAddr

## CUresult cuMulticastBindAddr (CUmemGenericAllocationHandle mcHandle, size_t mcOffset, CUdeviceptr memptr, size_t size, unsigned long long flags)

Bind a memory allocation represented by a virtual address to a multicast object.

### Parameters

**mcHandle**
Handle representing a multicast object.
**mcOffset**
Offset into multicast va range for attachment.
**memptr**
Virtual address of the memory allocation.
**size**
Size of memory that will be bound to the multicast object.
**flags**
Flags for future use, must be zero now.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE,

## Description

Binds a memory allocation specified by its mapped address `memptr` to a multicast object represented by `mcHandle`. The memory must have been allocated via cuMemCreate or cudaMallocAsync. The intended `size` of the bind, the offset in the multicast range `mcOffset` and `memptr` must be a multiple of the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_MINIMUM. For best performance however, `size`, `mcOffset` and `memptr` should be aligned to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_RECOMMENDED.

The `size` cannot be larger than the size of the allocated memory. Similarly the `size` + `mcOffset` cannot be larger than the total size of the multicast object.

The memory allocation must have beeen created on one of the devices that was added to the multicast team via cuMulticastAddDevice. Externally shareable as well as imported multicast objects can be bound only to externally shareable memory. Note that this call will return CUDA_ERROR_OUT_OF_MEMORY if there are insufficient resources required to perform the bind. This call may also return CUDA_ERROR_SYSTEM_NOT_READY if the necessary system software is not initialized or running.

This call may return CUDA_ERROR_ILLEGAL_STATE if the system configuration is in an illegal state. In such cases, to continue using multicast, verify that the system configuration is in a valid state and all required driver daemons are running properly.

See also:

cuMulticastCreate, cuMulticastAddDevice, cuMemCreate

cuMulticastBindAddr_v2

# CUresult cuMulticastBindAddr_v2 (CUmemGenericAllocationHandle mcHandle, CUdevice dev, size_t mcOffset, CUdeviceptr memptr, size_t size, unsigned long long flags)

Bind a memory allocation represented by a virtual address to a multicast object.

## Parameters

**mcHandle**
Handle representing a multicast object.

**dev**
The device that for which the multicast memory binding will be applicable.

**mcOffset**
Offset into multicast va range for attachment.

**memptr**
Virtual address of the memory allocation.

**size**
Size of memory that will be bound to the multicast object.

**flags**
Flags for future use, must be zero now.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE,

## Description

Binds a memory allocation specified by its mapped address `memptr` to a multicast object represented by `mcHandle`. The binding will be applicable for the device `dev`. The memory must have been allocated via cuMemCreate or cudaMallocAsync. The intended `size` of the bind, the offset in the multicast range `mcOffset` and `memptr` must be a multiple of the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_MINIMUM. For best performance however, `size`, `mcOffset` and `memptr` should be aligned to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_RECOMMENDED.

The `size` cannot be larger than the size of the allocated memory. Similarly the `size` + `mcOffset` cannot be larger than the total size of the multicast object.

For device memory, i.e., type CU_MEM_LOCATION_TYPE_DEVICE, the memory allocation must have been created on the device specified by `dev`. For host NUMA memory, i.e., type

CU_MEM_LOCATION_TYPE_HOST_NUMA, the memory allocation must have been created on the CPU NUMA node closest to `dev`. That is, the value returned when querying CU_DEVICE_ATTRIBUTE_HOST_NUMA_ID for `dev`, must be the CPU NUMA node where the memory was allocated. In both cases, the device named by `dev` must have been added to the multicast team via cuMulticastAddDevice. Externally shareable as well as imported multicast objects can be bound only to externally shareable memory. Note that this call will return CUDA_ERROR_OUT_OF_MEMORY if there are insufficient resources required to perform the bind. This call may also return CUDA_ERROR_SYSTEM_NOT_READY if the necessary system software is not initialized or running.

This call may return CUDA_ERROR_ILLEGAL_STATE if the system configuration is in an illegal state. In such cases, to continue using multicast, verify that the system configuration is in a valid state and all required driver daemons are running properly.

See also:

cuMulticastCreate, cuMulticastAddDevice, cuMemCreate

## CUresult cuMulticastBindMem (CUmemGenericAllocationHandle mcHandle, size_t mcOffset, CUmemGenericAllocationHandle memHandle, size_t memOffset, size_t size, unsigned long long flags)

Bind a memory allocation represented by a handle to a multicast object.

### Parameters

**mcHandle**
Handle representing a multicast object.

**mcOffset**
Offset into the multicast object for attachment.

**memHandle**
Handle representing a memory allocation.

**memOffset**
Offset into the memory for attachment.

**size**
Size of the memory that will be bound to the multicast object.

**flags**
Flags for future use, must be zero for now.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED,

CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE,

### Description

Binds a memory allocation specified by `memHandle` and created via cuMemCreate to a multicast object represented by `mcHandle` and created via cuMulticastCreate. The intended `size` of the bind, the offset in the multicast range `mcOffset` as well as the offset in the memory `memOffset` must be a multiple of the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_MINIMUM. For best performance however, `size`, `mcOffset` and `memOffset` should be aligned to the granularity of the memory allocation(see ::cuMemGetAllocationGranularity) or to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_RECOMMENDED.

The `size` + `memOffset` cannot be larger than the size of the allocated memory. Similarly the `size` + `mcOffset` cannot be larger than the size of the multicast object.

The memory allocation must have beeen created on one of the devices that was added to the multicast team via cuMulticastAddDevice. Externally shareable as well as imported multicast objects can be bound only to externally shareable memory. Note that this call will return CUDA_ERROR_OUT_OF_MEMORY if there are insufficient resources required to perform the bind. This call may also return CUDA_ERROR_SYSTEM_NOT_READY if the necessary system software is not initialized or running.

This call may return CUDA_ERROR_ILLEGAL_STATE if the system configuration is in an illegal state. In such cases, to continue using multicast, verify that the system configuration is in a valid state and all required driver daemons are running properly.

See also:

cuMulticastCreate, cuMulticastAddDevice, cuMemCreate

cuMulticastBindMem_v2

## CUresult cuMulticastBindMem_v2 (CUmemGenericAllocationHandle mcHandle, CUdevice dev, size_t mcOffset, CUmemGenericAllocationHandle memHandle, size_t memOffset, size_t size, unsigned long long flags)

Bind a memory allocation represented by a handle to a multicast object.

### Parameters

**mcHandle**

Handle representing a multicast object.

**dev**
The device that for which the multicast memory binding will be applicable.
**mcOffset**
Offset into the multicast object for attachment.
**memHandle**
Handle representing a memory allocation.
**memOffset**
Offset into the memory for attachment.
**size**
Size of the memory that will be bound to the multicast object.
**flags**
Flags for future use, must be zero for now.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE,

## Description

Binds a memory allocation specified by `memHandle` and created via cuMemCreate to a multicast object represented by `mcHandle` and created via cuMulticastCreate. The binding will be applicable for the device `dev`. The intended `size` of the bind, the offset in the multicast range `mcOffset` as well as the offset in the memory `memOffset` must be a multiple of the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_MINIMUM. For best performance however, `size`, `mcOffset` and `memOffset` should be aligned to the granularity of the memory allocation(see ::cuMemGetAllocationGranularity) or to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_RECOMMENDED.

The `size` + `memOffset` cannot be larger than the size of the allocated memory. Similarly the `size` + `mcOffset` cannot be larger than the size of the multicast object.

The memory allocation must have beeen created on one of the devices that was added to the multicast team via cuMulticastAddDevice. For device memory, i.e., type CU_MEM_LOCATION_TYPE_DEVICE, the memory allocation must have been created on the device specified by `dev`. For host NUMA memory, i.e., type CU_MEM_LOCATION_TYPE_HOST_NUMA, the memory allocation must have been created on the CPU NUMA node closest to `dev`. That is, the value returned when querying CU_DEVICE_ATTRIBUTE_HOST_NUMA_ID for `dev`, must be the CPU NUMA node where the memory was allocated. In both cases, the device named by `dev` must have been added to the multicast team via cuMulticastAddDevice. Externally shareable as well as imported multicast objects can be bound only to externally shareable memory. Note that this call will return CUDA_ERROR_OUT_OF_MEMORY if there are insufficient resources required to perform the bind.

This call may also return CUDA_ERROR_SYSTEM_NOT_READY if the necessary system software is not initialized or running.

This call may return CUDA_ERROR_ILLEGAL_STATE if the system configuration is in an illegal state. In such cases, to continue using multicast, verify that the system configuration is in a valid state and all required driver daemons are running properly.

See also:

cuMulticastCreate, cuMulticastAddDevice, cuMemCreate

# CUresult cuMulticastCreate (CUmemGenericAllocationHandle *mcHandle, const CUmulticastObjectProp *prop)

Create a generic allocation handle representing a multicast object described by the given properties.

## Parameters

**mcHandle**
Value of handle returned.

**prop**
Properties of the multicast object to create.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

## Description

This creates a multicast object as described by `prop`. The number of participating devices is specified by CUmulticastObjectProp::numDevices. Devices can be added to the multicast object via cuMulticastAddDevice. All participating devices must be added to the multicast object before memory can be bound to it. Memory is bound to the multicast object via cuMulticastBindMem, cuMulticastBindMem_v2, cuMulticastBindAddr, or cuMulticastBindAddr_v2. and can be unbound via cuMulticastUnbind. The total amount of memory that can be bound per device is specified by :CUmulticastObjectProp::size. This size must be a multiple of the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_MINIMUM. For best performance however, the size should be aligned to the value returned by cuMulticastGetGranularity with the flag CU_MULTICAST_GRANULARITY_RECOMMENDED.

After all participating devices have been added, multicast objects can also be mapped to a device's virtual address space using the virtual memory management APIs (see cuMemMap and

cuMemSetAccess). Multicast objects can also be shared with other processes by requesting a shareable handle via cuMemExportToShareableHandle. Note that the desired types of shareable handles must be specified in the bitmask CUmulticastObjectProp::handleTypes. Multicast objects can be released using the virtual memory management API cuMemRelease.

See also:

cuMulticastAddDevice, cuMulticastBindMem, cuMulticastBindAddr, cuMulticastUnbind

cuMemCreate, cuMemRelease, cuMemExportToShareableHandle, cuMemImportFromShareableHandle

cuMulticastBindAddr_v2, cuMulticastBindMem_v2

## CUresult cuMulticastGetGranularity (size_t *granularity, const CUmulticastObjectProp *prop, CUmulticastGranularity_flags option)

Calculates either the minimal or recommended granularity for multicast object.

### Parameters

**granularity**
Returned granularity.

**prop**
Properties of the multicast object.

**option**
Determines which granularity to return.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

### Description

Calculates either the minimal or recommended granularity for a given set of multicast object properties and returns it in granularity. This granularity can be used as a multiple for size, bind offsets and address mappings of the multicast object.

See also:

cuMulticastCreate, cuMulticastBindMem, cuMulticastBindAddr, cuMulticastUnbind

cuMulticastBindMem_v2, cuMulticastBindAddr_v2

# CUresult cuMulticastUnbind (CUmemGenericAllocationHandle mcHandle, CUdevice dev, size_t mcOffset, size_t size)

Unbind any memory allocations bound to a multicast object at a given offset and upto a given size.

## Parameters

**mcHandle**
Handle representing a multicast object.

**dev**
Device that hosts the memory allocation.

**mcOffset**
Offset into the multicast object.

**size**
Desired size to unbind.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED

## Description

Unbinds any memory allocations hosted on `dev` and bound to a multicast object at `mcOffset` and upto a given `size`. The intended `size` of the unbind and the offset in the multicast range ( `mcOffset` ) must be a multiple of the value returned by cuMulticastGetGranularity flag CU_MULTICAST_GRANULARITY_MINIMUM. The `size` + `mcOffset` cannot be larger than the total size of the multicast object.

Note:

Warning: The `mcOffset` and the `size` must match the corresponding values specified during the bind call. Any other values may result in undefined behavior.

See also:

cuMulticastBindMem, cuMulticastBindAddr

cuMulticastBindMem_v2, cuMulticastBindAddr_v2

# 6.17. Logical Endpoint

This section describes the logical endpoint functions of the low-level CUDA driver application programming interface.

## struct CUlogicalEndpointFabricHandle

## struct CUlogicalEndpointProp

## enum CUlogicalEndpointFlag

Flags for CUlogicalEndpointProp

### Values

**CU_LOGICAL_ENDPOINT_FLAG_NONE = 0x0**
Default flag for logical endpoint construction

**CU_LOGICAL_ENDPOINT_FLAG_COUNTED_OPS = 0x1**
Indicate the programmer's intention to use counted operations with the logical endpoint

## enum CUlogicalEndpointIpcHandleType

IPC handle types that can be requested/queried for a given logical endpoint

### Values

**CU_LOGICAL_ENDPOINT_IPC_HANDLE_TYPE_NONE**
**CU_LOGICAL_ENDPOINT_IPC_HANDLE_TYPE_FABRIC**

## enum CUlogicalEndpointType

Logical endpoint type

### Values

**CU_LOGICAL_ENDPOINT_TYPE_INVALID**
**CU_LOGICAL_ENDPOINT_TYPE_UNICAST**
**CU_LOGICAL_ENDPOINT_TYPE_MULTICAST**

## typedef cuuint32_t CUlogicalEndpointId

An ID that represents a logical endpoint

# CUresult cuLogicalEndpointAddDevice (CUlogicalEndpointId leId, CUdevice dev)

Associates a device to a multicast logical endpoint.

## Parameters

**leId**
Logical endpoint id representing a multicast logical endpoint.

**dev**
Device that will be associated with the multicast logical endpoint.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED,

## Description

Associates a device to a logical endpoint. The type of the logical endpoint must be CU_LOGICAL_ENDPOINT_TYPE_MULTICAST. The added device will be a part of the multicast team of size specified by CUlogicalEndpointProp::multicast::numDevices during cuLogicalEndpointCreate. The association of the device to the multicast logical endpoint is permanent during the life time of the multicast logical endpoint. All devices must be added to the multicast logical endpoint before any memory can be bound to any device in the team. A multicast logical endpoint will not be ready for use until all devices have been added. User can query whether the logical endpoint is ready for use via cuLogicalEndpointQuery.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointBindAddr (CUlogicalEndpointId leId, CUdevice dev, cuuint64_t offset, void *ptr, cuuint64_t size, unsigned long long flags)

Bind a memory allocation represented by a virtual address to a logical endpoint.

## Parameters

**leId**
Logical endpoint to which memory will be associated.

**dev**
Device on which the memory will be bound to the logical endpoint

**offset**
Offset into the logical endpoint space.

**ptr**
Virtual address of the memory allocation.

**size**
Size of memory that will be bound to the logical endpoint.

**flags**
Flags for future use, must be zero for now.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE

## Description

Binds the memory allocation specified by its mapped address `ptr` to a logical endpoint represented by `leId` at the offset `offset`. The memory must have been allocated via cuMemCreate or cudaMallocAsync. The intended `size` of the bind, the `offset` in the logical endpoint range and `ptr` must be multiples of the value for `bindAlignment` as returned by cuLogicalEndpointGetLimits.

The `size` cannot be larger than the size of the allocated memory. Similarly the `size` + `offset` cannot be larger than the total size of the logical endpoint.

For device memory, i.e., type CU_MEM_LOCATION_TYPE_DEVICE, the memory allocation must have been created on the device specified by `dev`. For host NUMA memory, i.e., type CU_MEM_LOCATION_TYPE_HOST_NUMA, the memory allocation must have been created on the CPU NUMA node closest to `dev`. That is, the value returned when querying CU_DEVICE_ATTRIBUTE_HOST_NUMA_ID for `dev`, must be the CPU NUMA node where the memory was allocated.

For multicast endpoints, the device named by `dev` must have been added to the multicast team via cuLogicalEndpointAddDevice.

For unicast endpoints the device named by `dev` must be the owner device specified during cuLogicalEndpointCreate via CUlogicalEndpointProp::unicast::device.

Externally shareable as well as imported multicast endpoints can be bound only to externally shareable memory. Imported unicast endpoints cannot be bound to any memory.

This call will return CUDA_ERROR_INVALID_VALUE if cuLogicalEndpointQuery has not been called for the logical endpoint to ensure that the endpoint is ready for memory binding.

Note that this call will return CUDA_ERROR_OUT_OF_MEMORY if there are insufficient resources required to perform the bind. This call may also return CUDA_ERROR_SYSTEM_NOT_READY if the necessary system software is not initialized or running. This call may return CUDA_ERROR_ILLEGAL_STATE if the system configuration is in an illegal state. In such cases, to continue using logical endpoints, verify that the system configuration is in a valid state and all required driver daemons are running properly.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointBindMem (CUlogicalEndpointId leId, CUdevice dev, cuuint64_t offset, CUmemGenericAllocationHandle memHandle, cuuint64_t memOffset, cuuint64_t size, unsigned long long flags)

Binds memory object represented by a handle to the logical endpoint.

## Parameters

**leId**
Logical endpoint to which memory will be associated.

**dev**
Device on which the memory will be bound to the logical endpoint

**offset**
Offset into the logical endpoint space.

**memHandle**
Handle representing a memory allocation.

**memOffset**
Offset into the memory for the attachment
**size**
Size of memory that will be bound to the logical endpoint.
**flags**
Flags for future use, must be zero for now.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE

## Description

Binds the memory allocation specified by `memHandle` to a logical endpoint represented by `leId` at the offset `offset`. The memory must have been allocated via cuMemCreate. The intended `size` of the bind, the offset in the logical endpoint range `offset` and the offset in the memory handle `memOffset` must be multiples of the value for `bindAlignment` as returned by cuLogicalEndpointGetLimits.

The `size` + `memOffset` cannot be larger than the size of the allocated memory. Similarly the `size` + `offset` cannot be larger than the total size of the logical endpoint.

For device memory, i.e., type CU_MEM_LOCATION_TYPE_DEVICE, the memory allocation must have been created on the device specified by `dev`. For host NUMA memory, i.e., type CU_MEM_LOCATION_TYPE_HOST_NUMA, the memory allocation must have been created on the CPU NUMA node closest to `dev`. That is, the value returned when querying CU_DEVICE_ATTRIBUTE_HOST_NUMA_ID for `dev`, must be the CPU NUMA node where the memory was allocated.

For multicast endpoints, the device named by `dev` must have been added to the multicast team via cuLogicalEndpointAddDevice.

For unicast endpoints the device named by `dev` must be the owner device specified during cuLogicalEndpointCreate via CUlogicalEndpointProp::unicast::device.

Externally shareable as well as imported multicast endpoints can be bound only to externally shareable memory. Imported unicast endpoints cannot be bound to any memory.

This call will return CUDA_ERROR_INVALID_VALUE if cuLogicalEndpointQuery has not been called for the logical endpoint to ensure that the endpoint is ready for memory binding.

Note that this call will return CUDA_ERROR_OUT_OF_MEMORY if there are insufficient resources required to perform the bind. This call may also return CUDA_ERROR_SYSTEM_NOT_READY if the necessary system software is not initialized or running. This call may return CUDA_ERROR_ILLEGAL_STATE if the system configuration is in an illegal state. In such cases, to

continue using logical endpoints, verify that the system configuration is in a valid state and all required driver daemons are running properly.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointCreate (CUlogicalEndpointId leId, const CUlogicalEndpointProp *prop)

Creates a logical endpoint with the requested properties and associates it with the logical endpoint id.

## Parameters

**leId**
Logical endpoint id that will be associated with the newly created logical endpoint.

**prop**
Properties of the logical endpoint to create.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY,

## Description

This creates a logical endpoint as described by `prop`. The number of participating devices is determined by the CUlogicalEndpointProp::type. If the type is CU_LOGICAL_ENDPOINT_TYPE_UNICAST then CUlogicalEndpointProp::unicast::device specifies the owner device of the unicast logical endpoint. If the type is CU_LOGICAL_ENDPOINT_TYPE_MULTICAST then CUlogicalEndpointProp::multicast::numDevices specifies the number of devices in the multicast logical endpoint team.

Devices can be added to a multicast logical endpoint via cuLogicalEndpointAddDevice. After all the participating devices have been added, a call to cuLogicalEndpointQuery must be made to ensure that the logical endpoint is ready for memory binding and access.

A unicast logical endpoint does not have a notion of adding devices via cuLogicalEndpointAddDevice. However, a call to cuLogicalEndpointQuery must still be made to ensure that the logical endpoint is ready for memory binding and access.

Memory is bound to the logical endpoint via either cuLogicalEndpointBindAddr or cuLogicalEndpointBindMem, and can be unbound via cuLogicalEndpointUnbind. The total amount of memory that can be bound per device is specified by CUlogicalEndpointProp::size. This size must be a multiple of the value for `bindAlignment` as returned by cuLogicalEndpointGetLimits. The maximum size for the logical endpoint cannot exceed the value for `maxSize` as returned by cuLogicalEndpointGetLimits. The bind alignment and maximum size depend on the properties of the logical endpoint.

See also:

cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointDestroy (CUlogicalEndpointId leId)

Removes the association of the logical endpoint from the logical endpoint id.

## Parameters

**leId**

Logical endpoint id of the logical endpoint to be destroyed.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED,

## Description

Removes the association between the logical endpoint id and the logical endpoint resources. Any memory bound by this process to any device associated with the logical endpoint will be unbound. If this was the last reference to the logical endpoint, all associated resources will be destroyed.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointExport (void *handle, CUlogicalEndpointId leId, CUlogicalEndpointIpcHandleType handleType)

Exports a logical endpoint associated with leId to an IPC handle.

## Parameters

**handle**
Pointer to the location in which to store the requested handle type.

**leId**
Logical endpoint id of logical endpoint.

**handleType**
Type of shareable handle requested. Defines type and size of the handle output parameter.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY,

## Description

Given a logical endpoint id `leId`, create a shareable handle `handle` that can be used to share the logical endpoint with other processes. The recipient process can convert the shareable handle back into a logical endpoint id using cuLogicalEndpointImport. The implementation of what this `handle` is and how it can be transfered is defined by the requested handle type in `handletype`.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointGetLimits (cuuint64_t *bindAlignment, cuuint64_t *maxSize, const CUlogicalEndpointProp *prop)

Calculates the minimum alignment and the maximum size for the given logical endpoint properties.

## Parameters

**bindAlignment**
Minimum alignment granularity of the proposed logical endpoint.

**maxSize**
Maximum size of the logical endpoint.

**prop**
Properties of the logical endpoint.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE

## Description

The `bindAlignment` can be used as a multiple for size and bind offset values. The `maxSize` is the maximum size of the logical endpoint. If `maxSize` is less than CUlogicalEndpointProp:size the user must adjust the request to the smaller value.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointIdRelease (CUlogicalEndpointId baseLeId, cuuint32_t count)

Releases a range of logical endpoint ids.

## Parameters

**baseLeId**
First logical endpoint id to be released back to the system.

**count**
Number of logical endpoint ids to release back to the system.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY,

### Description

Releases up to `count` logical endpoint ids starting at `baseLeId`. The range of ids represented by [`baseLeId`, `baseLeId` + `count`) must all be previously reserved. All logical endpoints in the range must be destroyed before they can be released.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

## CUresult cuLogicalEndpointIdReserve (CUlogicalEndpointId *baseLeId, cuuint32_t count)

Reserves a range of logical endpoint ids.

### Parameters

**baseLeId**
If cuLogicalEndpointIdReserve returns CUDA_SUCCESS, *baseLeId contains the base logical endpoint id of the reserved logical endpoint id range.

**count**
The number of logical endpoint ids to reserve.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY,

### Description

Reserves a range of logical endpoint ids starting at `*baseLeId` and extending for `count`. The reserved ids can be used to create or import logical endpoints via cuLogicalEndpointCreate or cuLogicalEndpointImport respectively.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointImport (CUlogicalEndpointId leId, const void *handle, CUlogicalEndpointIpcHandleType handleType)

Imports a logical endpoint from the given IPC handle and associates it with a logical endpoint id.

## Parameters

**leId**
Logical endpoint id that will be used to access the exported logical endpoint.

**handle**
Shareable handle representing the logical endpoint that is to be imported.

**handleType**
Handle type of the exported handle

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY,

## Description

Imports a logical endpoint from the given IPC `handle` and associates it with the logical endpoint id specified by `leId`.

If the current process cannot support the logical endpoint described by the shareable handle, this API will error as CUDA_ERROR_NOT_SUPPORTED. If `handle` is of type CU_LOGICAL_ENDPOINT_IPC_HANDLE_TYPE_FABRIC and the importer process does not have access permissions, then CUDA_ERROR_NOT_PERMITTED will be returned

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# CUresult cuLogicalEndpointQuery (CUlogicalEndpointId leId, cuuint32_t count, int *queryStatus)

Determines if all logical endpoints in the range have been successfully constructed.

## Parameters

**leId**
First logical endpoint ID to be queried.

**count**
Number of logical endpoints IDs to be queried.

**queryStatus**
Status of the logical endpoints. Returns 0 if any logical endpoint in the given range is not fully constructed, and non-zero if all logical endpoints in the given range are fully constructed.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE

## Description

Queries the driver to determine if all logical endpoints in the given range starting at `leId` and extending for `count` have been successfully constructed.

Provides a mechanism to ensure that it is safe to begin using a logical endpoint ID. Using a logical endpoint ID before verifying that it is fully constructed can result in undefined behavior.

This is not a blocking API, it returns immediately with a `queryStatus` of 0 if any logical endpoint ID in the given range is not fully constructed, and a non-zero value otherwise.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointUnbind, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits

# CUresult cuLogicalEndpointUnbind (CUlogicalEndpointId leId, CUdevice dev, cuuint64_t offset, cuuint64_t size)

Unbinds any binding at offset from the logical endpoint.

## Parameters

**leId**
Logical endpoint id representing a logical endpoint.

**dev**
Device on which the memory is bound to the logical endpoint

**offset**
Offset into the logical endpoint.

**size**
Desired size to unbind.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_SYSTEM_NOT_READY, CUDA_ERROR_ILLEGAL_STATE

## Description

Unbinds any memory allocations bound to the logical endpoint on `dev` at `offset` and up to the given `size`. The intended `size` of the unbind and the offset in the logical endpoint range `offset` must be multiples of the value for `bindAlignment` as returned by cuLogicalEndpointGetLimits.

Note:

The `offset` must correspond to a value specified during a bind call. The `size` must either match the bind call of the offset or be the combined `size` of multiple bind calls. The `size` + `offset` must fully enclose all bindings that are covered.

See also:

cuLogicalEndpointCreate, cuLogicalEndpointIdReserve, cuLogicalEndpointIdRelease, cuLogicalEndpointAddDevice, cuLogicalEndpointDestroy, cuLogicalEndpointBindAddr, cuLogicalEndpointBindMem, cuLogicalEndpointExport, cuLogicalEndpointImport, cuLogicalEndpointGetLimits, cuLogicalEndpointQuery

# 6.18. Unified Addressing

This section describes the unified addressing functions of the low-level CUDA driver application programming interface.

Overview

CUDA devices can share a unified address space with the host. For these devices there is no distinction between a device pointer and a host pointer -- the same pointer value may be used to access memory from the host program and from a kernel running on the device (with exceptions enumerated below).

Supported Platforms

Whether or not a device supports unified addressing may be queried by calling cuDeviceGetAttribute() with the device attribute CU_DEVICE_ATTRIBUTE_UNIFIED_ADDRESSING.

Unified addressing is automatically enabled in 64-bit processes

Looking Up Information from Pointer Values

It is possible to look up information about the memory which backs a pointer value. For instance, one may want to know if a pointer points to host or device memory. As another example, in the case of device memory, one may want to know on which CUDA device the memory resides. These properties may be queried using the function cuPointerGetAttribute()

Since pointers are unique, it is not necessary to specify information about the pointers specified to the various copy functions in the CUDA API. The function cuMemcpy() may be used to perform a copy between two pointers, ignoring whether they point to host or device memory (making cuMemcpyHtoD(), cuMemcpyDtoD(), and cuMemcpyDtoH() unnecessary for devices supporting unified addressing). For multidimensional copies, the memory type CU_MEMORYTYPE_UNIFIED may be used to specify that the CUDA driver should infer the location of the pointer from its value.

Automatic Mapping of Host Allocated Host Memory

All host memory allocated in all contexts using cuMemAllocHost() and cuMemHostAlloc() is always directly accessible from all contexts on all devices that support unified addressing. This is the case regardless of whether or not the flags CU_MEMHOSTALLOC_PORTABLE and CU_MEMHOSTALLOC_DEVICEMAP are specified.

The pointer value through which allocated host memory may be accessed in kernels on all devices that support unified addressing is the same as the pointer value through which that memory is accessed on the host, so it is not necessary to call cuMemHostGetDevicePointer() to get the device pointer for these allocations.

Note that this is not the case for memory allocated using the flag CU_MEMHOSTALLOC_WRITECOMBINED, as discussed below.

Automatic Registration of Peer Memory

Upon enabling direct access from a context that supports unified addressing to another peer context that supports unified addressing using cuCtxEnablePeerAccess() all memory allocated in the peer context using cuMemAlloc() and cuMemAllocPitch() will immediately be accessible by the current context. The device pointer value through which any peer memory may be accessed in the current context is the same pointer value through which that memory may be accessed in the peer context.

Exceptions, Disjoint Addressing

Not all memory may be accessed on devices through the same pointer value through which they are accessed on the host. These exceptions are host memory registered using cuMemHostRegister() and host memory allocated using the flag CU_MEMHOSTALLOC_WRITECOMBINED. For these exceptions, there exists a distinct host and device address for the memory. The device address is guaranteed to not overlap any valid host pointer range and is guaranteed to have the same value across all contexts that support unified addressing.

This device address may be queried using cuMemHostGetDevicePointer() when a context using unified addressing is current. Either the host or the unified device pointer value may be used to refer to this memory through cuMemcpy() and similar functions using the CU_MEMORYTYPE_UNIFIED memory type.

# CUresult cuMemAdvise (CUdeviceptr devPtr, size_t count, CUmem_advise advice, CUmemLocation location)

Advise about the usage of a given memory range.

## Parameters

**devPtr**
- Pointer to memory to set the advice for

**count**
- Size in bytes of the memory range

**advice**
- Advice to be applied for the specified memory range

**location**
- location to apply the advice for

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Advise the Unified Memory subsystem about the usage pattern for the memory range starting at `devPtr` with a size of `count` bytes. The start address and end address of the memory range will be rounded down and rounded up respectively to be aligned to CPU page size before the advice is applied. The memory range must refer to managed memory allocated via cuMemAllocManaged or declared via __managed__ variables. The memory range could also refer to system-allocated pageable memory

provided it represents a valid, host-accessible region of memory and all additional constraints imposed by `advice` as outlined below are also satisfied. Specifying an invalid system-allocated pageable memory range results in an error being returned.

The `advice` parameter can take the following values:

- CU_MEM_ADVISE_SET_READ_MOSTLY: This implies that the data is mostly going to be read from and only occasionally written to. Any read accesses from any processor to this region will create a read-only copy of at least the accessed pages in that processor's memory. Additionally, if cuMemPrefetchAsync is called on this region, it will create a read-only copy of the data on the destination processor. If the target location for cuMemPrefetchAsync is a host NUMA node and a read-only copy already exists on another host NUMA node, that copy will be migrated to the targeted host NUMA node. If any processor writes to this region, all copies of the corresponding page will be invalidated except for the one where the write occurred. If the writing processor is the CPU and the preferred location of the page is a host NUMA node, then the page will also be migrated to that host NUMA node. The `location` argument is ignored for this advice. Note that for a page to be read-duplicated, the accessing processor must either be the CPU or a GPU that has a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. Also, if a context is created on a device that does not have the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS set, then read-duplication will not occur until all such contexts are destroyed. If the memory region refers to valid system-allocated pageable memory, then the accessing device must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS for a read-only copy to be created on that device. Note however that if the accessing device also has a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES, then setting this advice will not create a read-only copy when that device accesses this memory region.
- CU_MEM_ADVISE_UNSET_READ_MOSTLY: Undoes the effect of CU_MEM_ADVISE_SET_READ_MOSTLY and also prevents the Unified Memory driver from attempting heuristic read-duplication on the memory range. Any read-duplicated copies of the data will be collapsed into a single copy. The location for the collapsed copy will be the preferred location if the page has a preferred location and one of the read-duplicated copies was resident at that location. Otherwise, the location chosen is arbitrary. Note: The `location` argument is ignored for this advice.
- CU_MEM_ADVISE_SET_PREFERRED_LOCATION: This advice sets the preferred location for the data to be the memory belonging to `location`. When CUmemLocation::type is CU_MEM_LOCATION_TYPE_HOST, CUmemLocation::id is ignored and the preferred location is set to be host memory. To set the preferred location to a specific host NUMA node, applications must set CUmemLocation::type to CU_MEM_LOCATION_TYPE_HOST_NUMA and CUmemLocation::id must specify the NUMA ID of the host NUMA node. If CUmemLocation::type is set to CU_MEM_LOCATION_TYPE_HOST_NUMA_CURRENT, CUmemLocation::id will be ignored and the the host NUMA node closest to the

calling thread's CPU will be used as the preferred location. If CUmemLocation::type is a CU_MEM_LOCATION_TYPE_DEVICE, then CUmemLocation::id must be a valid device ordinal and the device must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. Setting the preferred location does not cause data to migrate to that location immediately. Instead, it guides the migration policy when a fault occurs on that memory region. If the data is already in its preferred location and the faulting processor can establish a mapping without requiring the data to be migrated, then data migration will be avoided. On the other hand, if the data is not in its preferred location or if a direct mapping cannot be established, then it will be migrated to the processor accessing it. It is important to note that setting the preferred location does not prevent data prefetching done using cuMemPrefetchAsync. Having a preferred location can override the page thrash detection and resolution logic in the Unified Memory driver. Normally, if a page is detected to be constantly thrashing between for example host and device memory, the page may eventually be pinned to host memory by the Unified Memory driver. But if the preferred location is set as device memory, then the page will continue to thrash indefinitely. If CU_MEM_ADVISE_SET_READ_MOSTLY is also set on this memory region or any subset of it, then the policies associated with that advice will override the policies of this advice, unless read accesses from `location` will not result in a read-only copy being created on that procesor as outlined in description for the advice CU_MEM_ADVISE_SET_READ_MOSTLY. If the memory region refers to valid system-allocated pageable memory, and CUmemLocation::type is CU_MEM_LOCATION_TYPE_DEVICE then CUmemLocation::id must be a valid device that has a non-zero alue for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS.

- CU_MEM_ADVISE_UNSET_PREFERRED_LOCATION: Undoes the effect of CU_MEM_ADVISE_SET_PREFERRED_LOCATION and changes the preferred location to none. The `location` argument is ignored for this advice.
- CU_MEM_ADVISE_SET_ACCESSED_BY: This advice implies that the data will be accessed by processor `location`. The CUmemLocation::type must be either CU_MEM_LOCATION_TYPE_DEVICE with CUmemLocation::id representing a valid device ordinal or CU_MEM_LOCATION_TYPE_HOST and CUmemLocation::id will be ignored. All other location types are invalid. If CUmemLocation::id is a GPU, then the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS must be non-zero. This advice does not cause data migration and has no impact on the location of the data per se. Instead, it causes the data to always be mapped in the specified processor's page tables, as long as the location of the data permits a mapping to be established. If the data gets migrated for any reason, the mappings are updated accordingly. This advice is recommended in scenarios where data locality is not important, but avoiding faults is. Consider for example a system containing multiple GPUs with peer-to-peer access enabled, where the data located on one GPU is occasionally accessed by peer GPUs. In such scenarios, migrating data over to the other GPUs is not as important because the accesses are infrequent and the overhead of migration may be too high. But preventing faults can still help improve performance, and so having a mapping set up in advance is useful. Note that on CPU access of this data,

the data may be migrated to host memory because the CPU typically cannot access device memory directly. Any GPU that had the CU_MEM_ADVISE_SET_ACCESSED_BY flag set for this data will now have its mapping updated to point to the page in host memory. If CU_MEM_ADVISE_SET_READ_MOSTLY is also set on this memory region or any subset of it, then the policies associated with that advice will override the policies of this advice. Additionally, if the preferred location of this memory region or any subset of it is also `location`, then the policies associated with CU_MEM_ADVISE_SET_PREFERRED_LOCATION will override the policies of this advice. If the memory region refers to valid system-allocated pageable memory, and CUmemLocation::type is CU_MEM_LOCATION_TYPE_DEVICE then device in CUmemLocation::id must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS. Additionally, if CUmemLocation::id has a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES, then this call has no effect.

- CU_MEM_ADVISE_UNSET_ACCESSED_BY: Undoes the effect of CU_MEM_ADVISE_SET_ACCESSED_BY. Any mappings to the data from `location` may be removed at any time causing accesses to result in non-fatal page faults. If the memory region refers to valid system-allocated pageable memory, and CUmemLocation::type is CU_MEM_LOCATION_TYPE_DEVICE then device in CUmemLocation::id must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS. Additionally, if CUmemLocation::id has a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS_USES_HOST_PAGE_TABLES, then this call has no effect.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuMemcpy, cuMemcpyPeer, cuMemcpyAsync, cuMemcpy3DPeerAsync, cuMemPrefetchAsync, cudaMemAdvise

# CUresult cuMemDiscardAndPrefetchBatchAsync (CUdeviceptr *dptrs, size_t *sizes, size_t count, CUmemLocation *prefetchLocs, size_t *prefetchLocIdxs, size_t numPrefetchLocs, unsigned long long flags, CUstream hStream)

Performs a batch of memory discards and prefetches asynchronously.

## Parameters

**dptrs**
- Array of pointers to be discarded

**sizes**
- Array of sizes for memory discard operations.

**count**
- Size of `dptrs` and `sizes` arrays.

**prefetchLocs**
- Array of locations to prefetch to.

**prefetchLocIdxs**
- Array of indices to specify which operands each entry in the `prefetchLocs` array applies to. The locations specified in prefetchLocs[k] will be applied to operations starting from prefetchLocIdxs[k] through prefetchLocIdxs[k+1] - 1. Also prefetchLocs[numPrefetchLocs - 1] will apply to copies starting from prefetchLocIdxs[numPrefetchLocs - 1] through count - 1.

**numPrefetchLocs**
- Size of `prefetchLocs` and `prefetchLocIdxs` arrays.

**flags**
- Flags reserved for future use. Must be zero.

**hStream**
- The stream to enqueue the operations in. Must not be legacy NULL stream.

## Description

Performs a batch of memory discards followed by prefetches. The batch as a whole executes in stream order but operations within a batch are not guaranteed to execute in any specific order. All devices in the system must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS otherwise the API will return an error.

Calling cuMemDiscardAndPrefetchBatchAsync is semantically equivalent to calling cuMemDiscardBatchAsync followed by cuMemPrefetchBatchAsync, but is more optimal. For more details on what discarding and prefetching imply, please refer to cuMemDiscardBatchAsync and cuMemPrefetchBatchAsync respectively. Note that any reads, writes or prefetches to any part of the

memory range that occur simultaneously with this combined discard+prefetch operation result in undefined behavior.

Performs memory discard and prefetch on address ranges specified in `dptrs` and `sizes`. Both arrays must be of the same length as specified by `count`. Each memory range specified must refer to managed memory allocated via cuMemAllocManaged or declared via __managed__ variables or it may also refer to system-allocated memory when all devices have a non-zero value for CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS. Every operation in the batch has to be associated with a valid location to prefetch the address range to and specified in the `prefetchLocs` array. Each entry in this array can apply to more than one operation. This can be done by specifying in the `prefetchLocIdxs` array, the index of the first operation that the corresponding entry in the `prefetchLocs` array applies to. Both `prefetchLocs` and `prefetchLocIdxs` must be of the same length as specified by `numPrefetchLocs`. For example, if a batch has 10 operations listed in dptrs/sizes, the first 6 of which are to be prefetched to one location and the remaining 4 are to be prefetched to another, then `numPrefetchLocs` will be 2, `prefetchLocIdxs` will be {0, 6} and `prefetchLocs` will contain the two set of locations. Note the first entry in `prefetchLocIdxs` must always be 0. Also, each entry must be greater than the previous entry and the last entry should be less than `count`. Furthermore, `numPrefetchLocs` must be lesser than or equal to `count`.

## CUresult cuMemDiscardBatchAsync (CUdeviceptr *dptrs, size_t *sizes, size_t count, unsigned long long flags, CUstream hStream)

Performs a batch of memory discards asynchronously.

### Parameters

**dptrs**
- Array of pointers to be discarded

**sizes**
- Array of sizes for memory discard operations.

**count**
- Size of `dptrs` and `sizes` arrays.

**flags**
- Flags reserved for future use. Must be zero.

**hStream**
- The stream to enqueue the operations in. Must not be legacy NULL stream.

### Description

Performs a batch of memory discards. The batch as a whole executes in stream order but operations within a batch are not guaranteed to execute in any specific order. All devices in the system must have a non-zero value for the device attribute

CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS otherwise the API will return an error.

Discarding a memory range informs the driver that the contents of that range are no longer useful. Discarding memory ranges allows the driver to optimize certain data migrations and can also help reduce memory pressure. This operation can be undone on any part of the range by either writing to it or prefetching it via cuMemPrefetchAsync or cuMemPrefetchBatchAsync. Reading from a discarded range, without a subsequent write or prefetch to that part of the range, will return an indeterminate value. Note that any reads, writes or prefetches to any part of the memory range that occur simultaneously with the discard operation result in undefined behavior.

Performs memory discard on address ranges specified in `dptrs` and `sizes`. Both arrays must be of the same length as specified by `count`. Each memory range specified must refer to managed memory allocated via cuMemAllocManaged or declared via __managed__ variables or it may also refer to system-allocated memory when all devices have a non-zero value for CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS.

# CUresult cuMemPrefetchAsync (CUdeviceptr devPtr, size_t count, CUmemLocation location, unsigned int flags, CUstream hStream)

Prefetches memory to the specified destination location.

## Parameters

**devPtr**
- Pointer to be prefetched

**count**
- Size in bytes

**location**
- Location to prefetch to

**flags**
- flags for future use, must be zero now.

**hStream**
- Stream to enqueue prefetch operation

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Prefetches memory to the specified destination location. `devPtr` is the base device pointer of the memory to be prefetched and `location` specifies the destination location. `count` specifies the number of bytes to copy. `hStream` is the stream in which the operation is enqueued. The memory

range must refer to managed memory allocated via cuMemAllocManaged, via cuMemAllocFromPool from a managed memory pool or declared via __managed__ variables.

Specifying CU_MEM_LOCATION_TYPE_DEVICE for CUmemLocation::type will prefetch memory to GPU specified by device ordinal CUmemLocation::id which must have non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. Additionally, `hStream` must be associated with a device that has a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. Specifying CU_MEM_LOCATION_TYPE_HOST as CUmemLocation::type will prefetch data to host memory. Applications can request prefetching memory to a specific host NUMA node by specifying CU_MEM_LOCATION_TYPE_HOST_NUMA for CUmemLocation::type and a valid host NUMA node id in CUmemLocation::id Users can also request prefetching memory to the host NUMA node closest to the current thread's CPU by specifying CU_MEM_LOCATION_TYPE_HOST_NUMA_CURRENT for CUmemLocation::type. Note when CUmemLocation::type is etiher CU_MEM_LOCATION_TYPE_HOST OR CU_MEM_LOCATION_TYPE_HOST_NUMA_CURRENT, CUmemLocation::id will be ignored.

The start address and end address of the memory range will be rounded down and rounded up respectively to be aligned to CPU page size before the prefetch operation is enqueued in the stream.

If no physical memory has been allocated for this region, then this memory region will be populated and mapped on the destination device. If there's insufficient memory to prefetch the desired region, the Unified Memory driver may evict pages from other cuMemAllocManaged allocations to host memory in order to make room. Device memory allocated using cuMemAlloc or cuArrayCreate will not be evicted.

By default, any mappings to the previous location of the migrated pages are removed and mappings for the new location are only setup on the destination location. The exact behavior however also depends on the settings applied to this memory range via cuMemAdvise as described below:

If CU_MEM_ADVISE_SET_READ_MOSTLY was set on any subset of this memory range, then that subset will create a read-only copy of the pages on destination location. If however the destination location is a host NUMA node, then any pages of that subset that are already in another host NUMA node will be transferred to the destination.

If CU_MEM_ADVISE_SET_PREFERRED_LOCATION was called on any subset of this memory range, then the pages will be migrated to `location` even if `location` is not the preferred location of any pages in the memory range.

If CU_MEM_ADVISE_SET_ACCESSED_BY was called on any subset of this memory range, then mappings to those pages from all the appropriate processors are updated to refer to the new location if establishing such a mapping is possible. Otherwise, those mappings are cleared.

Note that this API is not required for functionality and only serves to improve performance by allowing the application to migrate data to a suitable location before it is accessed. Memory accesses to this range are always coherent and are allowed even when the data is actively being migrated.

Note that this function is asynchronous with respect to the host and all work on other devices.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.
- This function uses standard default stream semantics.

See also:

cuMemcpy, cuMemcpyPeer, cuMemcpyAsync, cuMemcpy3DPeerAsync, cuMemAdvise, cudaMemPrefetchAsync

## CUresult cuMemPrefetchBatchAsync (CUdeviceptr *dptrs, size_t *sizes, size_t count, CUmemLocation *prefetchLocs, size_t *prefetchLocIdxs, size_t numPrefetchLocs, unsigned long long flags, CUstream hStream)

Performs a batch of memory prefetches asynchronously.

### Parameters

**dptrs**
- Array of pointers to be prefetched

**sizes**
- Array of sizes for memory prefetch operations.

**count**
- Size of `dptrs` and `sizes` arrays.

**prefetchLocs**
- Array of locations to prefetch to.

**prefetchLocIdxs**
- Array of indices to specify which operands each entry in the `prefetchLocs` array applies to. The locations specified in prefetchLocs[k] will be applied to copies starting from prefetchLocIdxs[k] through prefetchLocIdxs[k+1] - 1. Also prefetchLocs[numPrefetchLocs - 1] will apply to prefetches starting from prefetchLocIdxs[numPrefetchLocs - 1] through count - 1.

**numPrefetchLocs**
- Size of `prefetchLocs` and `prefetchLocIdxs` arrays.

**flags**
- Flags reserved for future use. Must be zero.

**hStream**
- The stream to enqueue the operations in. Must not be legacy NULL stream.

## Description

Performs a batch of memory prefetches. The batch as a whole executes in stream order but operations within a batch are not guaranteed to execute in any specific order. All devices in the system must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS otherwise the API will return an error.

The semantics of the individual prefetch operations are as described in cuMemPrefetchAsync.

Performs memory prefetch on address ranges specified in `dptrs` and `sizes`. Both arrays must be of the same length as specified by `count`. Each memory range specified must refer to managed memory allocated via cuMemAllocManaged or declared via __managed__ variables or it may also refer to system-allocated memory when all devices have a non-zero value for CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS. The prefetch location for every operation in the batch is specified in the `prefetchLocs` array. Each entry in this array can apply to more than one operation. This can be done by specifying in the `prefetchLocIdxs` array, the index of the first prefetch operation that the corresponding entry in the `prefetchLocs` array applies to. Both `prefetchLocs` and `prefetchLocIdxs` must be of the same length as specified by `numPrefetchLocs`. For example, if a batch has 10 prefetches listed in dptrs/sizes, the first 4 of which are to be prefetched to one location and the remaining 6 are to be prefetched to another, then `numPrefetchLocs` will be 2, `prefetchLocIdxs` will be {0, 4} and `prefetchLocs` will contain the two locations. Note the first entry in `prefetchLocIdxs` must always be 0. Also, each entry must be greater than the previous entry and the last entry should be less than `count`. Furthermore, `numPrefetchLocs` must be lesser than or equal to `count`.

# CUresult cuMemRangeGetAttribute (void *data, size_t dataSize, CUmem_range_attribute attribute, CUdeviceptr devPtr, size_t count)

Query an attribute of a given memory range.

## Parameters

**data**
- A pointers to a memory location where the result of each attribute query will be written to.

**dataSize**
- Array containing the size of data

**attribute**
- The attribute to query

**devPtr**
- Start of the range to query

**count**
- Size of the range to query

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Query an attribute about the memory range starting at `devPtr` with a size of `count` bytes. The memory range must refer to managed memory allocated via cuMemAllocManaged or declared via __managed__ variables.

The `attribute` parameter can take the following values:

- CU_MEM_RANGE_ATTRIBUTE_READ_MOSTLY: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. The result returned will be 1 if all pages in the given memory range have read-duplication enabled, or 0 otherwise.
- CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. The result returned will be a GPU device id if all pages in the memory range have that GPU as their preferred location, or it will be CU_DEVICE_CPU if all pages in the memory range have the CPU as their preferred location, or it will be CU_DEVICE_INVALID if either all the pages don't have the same preferred location or some of the pages don't have a preferred location at all. Note that the actual location of the pages in the memory range at the time of the query may be different from the preferred location.
- CU_MEM_RANGE_ATTRIBUTE_ACCESSED_BY: If this attribute is specified, `data` will be interpreted as an array of 32-bit integers, and `dataSize` must be a non-zero multiple of 4. The result returned will be a list of device ids that had CU_MEM_ADVISE_SET_ACCESSED_BY set for that entire memory range. If any device does not have that advice set for the entire memory range, that device will not be included. If `data` is larger than the number of devices that have that advice set for that memory range, CU_DEVICE_INVALID will be returned in all the extra space provided. For ex., if `dataSize` is 12 (i.e. `data` has 3 elements) and only device 0 has the advice set, then the result returned will be { 0, CU_DEVICE_INVALID, CU_DEVICE_INVALID }. If `data` is smaller than the number of devices that have that advice set, then only as many devices will be returned as can fit in the array. There is no guarantee on which specific devices will be returned, however.
- CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. The result returned will be the last location to which all pages in the memory range were prefetched explicitly via cuMemPrefetchAsync. This will either be a GPU id or CU_DEVICE_CPU depending on whether the last location for prefetch was a GPU or the CPU respectively. If any page in the memory range was never explicitly prefetched or if all pages were not prefetched to the same location, CU_DEVICE_INVALID will be returned. Note that this simply returns the last location that the application requested to prefetch the memory range to. It gives no indication as to whether the prefetch operation to that location has completed or even begun.

- CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION_TYPE: If this attribute is specified, `data` will be interpreted as a CUmemLocationType, and `dataSize` must be sizeof(CUmemLocationType). The CUmemLocationType returned will be CU_MEM_LOCATION_TYPE_DEVICE if all pages in the memory range have the same GPU as their preferred location, or CUmemLocationType will be CU_MEM_LOCATION_TYPE_HOST if all pages in the memory range have the CPU as their preferred location, or it will be CU_MEM_LOCATION_TYPE_HOST_NUMA if all the pages in the memory range have the same host NUMA node ID as their preferred location or it will be CU_MEM_LOCATION_TYPE_INVALID if either all the pages don't have the same preferred location or some of the pages don't have a preferred location at all. Note that the actual location type of the pages in the memory range at the time of the query may be different from the preferred location type.
  - CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION_ID: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. If the CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION_TYPE query for the same address range returns CU_MEM_LOCATION_TYPE_DEVICE, it will be a valid device ordinal or if it returns CU_MEM_LOCATION_TYPE_HOST_NUMA, it will be a valid host NUMA node ID or if it returns any other location type, the id should be ignored.
- CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION_TYPE: If this attribute is specified, `data` will be interpreted as a CUmemLocationType, and `dataSize` must be sizeof(CUmemLocationType). The result returned will be the last location to which all pages in the memory range were prefetched explicitly via cuMemPrefetchAsync. The CUmemLocationType returned will be CU_MEM_LOCATION_TYPE_DEVICE if the last prefetch location was a GPU or CU_MEM_LOCATION_TYPE_HOST if it was the CPU or CU_MEM_LOCATION_TYPE_HOST_NUMA if the last prefetch location was a specific host NUMA node. If any page in the memory range was never explicitly prefetched or if all pages were not prefetched to the same location, CUmemLocationType will be CU_MEM_LOCATION_TYPE_INVALID. Note that this simply returns the last location type that the application requested to prefetch the memory range to. It gives no indication as to whether the prefetch operation to that location has completed or even begun.
  - CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION_ID: If this attribute is specified, `data` will be interpreted as a 32-bit integer, and `dataSize` must be 4. If the CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION_TYPE query for the same address range returns CU_MEM_LOCATION_TYPE_DEVICE, it will be a valid device ordinal or if it returns CU_MEM_LOCATION_TYPE_HOST_NUMA, it will be a valid host NUMA node ID or if it returns any other location type, the id should be ignored.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- This function exhibits asynchronous behavior for most use cases.

- This function uses standard default stream semantics.

See also:

cuMemRangeGetAttributes, cuMemPrefetchAsync, cuMemAdvise, cudaMemRangeGetAttribute

# CUresult cuMemRangeGetAttributes (void **data, size_t *dataSizes, CUmem_range_attribute *attributes, size_t numAttributes, CUdeviceptr devPtr, size_t count)

Query attributes of a given memory range.

## Parameters

**data**
- A two-dimensional array containing pointers to memory locations where the result of each attribute query will be written to.

**dataSizes**
- Array containing the sizes of each result

**attributes**
- An array of attributes to query (numAttributes and the number of attributes in this array should match)

**numAttributes**
- Number of attributes to query

**devPtr**
- Start of the range to query

**count**
- Size of the range to query

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Query attributes of the memory range starting at `devPtr` with a size of `count` bytes. The memory range must refer to managed memory allocated via cuMemAllocManaged or declared via __managed__ variables. The `attributes` array will be interpreted to have `numAttributes` entries. The `dataSizes` array will also be interpreted to have `numAttributes` entries. The results of the query will be stored in `data`.

The list of supported attributes are given below. Please refer to cuMemRangeGetAttribute for attribute descriptions and restrictions.

- CU_MEM_RANGE_ATTRIBUTE_READ_MOSTLY

- CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION
- CU_MEM_RANGE_ATTRIBUTE_ACCESSED_BY
- CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION
- CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION_TYPE
- CU_MEM_RANGE_ATTRIBUTE_PREFERRED_LOCATION_ID
- CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION_TYPE
- CU_MEM_RANGE_ATTRIBUTE_LAST_PREFETCH_LOCATION_ID

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuMemRangeGetAttribute, cuMemAdvise, cuMemPrefetchAsync, cudaMemRangeGetAttributes

# CUresult cuPointerGetAttribute (void *data, CUpointer_attribute attribute, CUdeviceptr ptr)

Returns information about a pointer.

## Parameters

**data**
- Returned pointer attribute value

**attribute**
- Pointer attribute to query

**ptr**
- Pointer

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

The supported attributes are:

- CU_POINTER_ATTRIBUTE_CONTEXT:

Returns in `*data` the CUcontext in which `ptr` was allocated or registered. The type of `data` must be CUcontext *.

If ptr was not allocated by, mapped by, or registered with a CUcontext which uses unified virtual addressing then CUDA_ERROR_INVALID_VALUE is returned.

- CU_POINTER_ATTRIBUTE_MEMORY_TYPE:

Returns in *data the physical memory type of the memory that ptr addresses as a CUmemorytype enumerated value. The type of data must be unsigned int.

If ptr addresses device memory then *data is set to CU_MEMORYTYPE_DEVICE. The particular CUdevice on which the memory resides is the CUdevice of the CUcontext returned by the CU_POINTER_ATTRIBUTE_CONTEXT attribute of ptr.

If ptr addresses host memory then *data is set to CU_MEMORYTYPE_HOST.

If ptr was not allocated by, mapped by, or registered with a CUcontext which uses unified virtual addressing then CUDA_ERROR_INVALID_VALUE is returned.

If the current CUcontext does not support unified virtual addressing then CUDA_ERROR_INVALID_CONTEXT is returned.

- CU_POINTER_ATTRIBUTE_DEVICE_POINTER:

Returns in *data the device pointer value through which ptr may be accessed by kernels running in the current CUcontext. The type of data must be CUdeviceptr *.

If there exists no device pointer value through which kernels running in the current CUcontext may access ptr then CUDA_ERROR_INVALID_VALUE is returned.

If there is no current CUcontext then CUDA_ERROR_INVALID_CONTEXT is returned.

Except in the exceptional disjoint addressing cases discussed below, the value returned in *data will equal the input value ptr.

- CU_POINTER_ATTRIBUTE_HOST_POINTER:

Returns in *data the host pointer value through which ptr may be accessed by by the host program. The type of data must be void **. If there exists no host pointer value through which the host program may directly access ptr then CUDA_ERROR_INVALID_VALUE is returned.

Except in the exceptional disjoint addressing cases discussed below, the value returned in *data will equal the input value ptr.

- CU_POINTER_ATTRIBUTE_P2P_TOKENS:

Returns in *data two tokens for use with the nv-p2p.h Linux kernel interface. data must be a struct of type CUDA_POINTER_ATTRIBUTE_P2P_TOKENS.

ptr must be a pointer to memory obtained from :cuMemAlloc(). Note that p2pToken and vaSpaceToken are only valid for the lifetime of the source allocation. A subsequent allocation at the same address may return completely different tokens. Querying this attribute has a side effect of setting the attribute CU_POINTER_ATTRIBUTE_SYNC_MEMOPS for the region of memory that ptr points to.

- CU_POINTER_ATTRIBUTE_SYNC_MEMOPS:

A boolean attribute which when set, ensures that synchronous memory operations initiated on the region of memory that `ptr` points to will always synchronize. See further documentation in the section titled "API synchronization behavior" to learn more about cases when synchronous memory operations can exhibit asynchronous behavior.

- CU_POINTER_ATTRIBUTE_BUFFER_ID:

Returns in `*data` a buffer ID which is guaranteed to be unique within the process. `data` must point to an unsigned long long.

`ptr` must be a pointer to memory obtained from a CUDA memory allocation API. Every memory allocation from any of the CUDA memory allocation APIs will have a unique ID over a process lifetime. Subsequent allocations do not reuse IDs from previous freed allocations. IDs are only unique within a single process.

- CU_POINTER_ATTRIBUTE_IS_MANAGED:

Returns in `*data` a boolean that indicates whether the pointer points to managed memory or not.

If `ptr` is not a valid CUDA pointer then CUDA_ERROR_INVALID_VALUE is returned.

- CU_POINTER_ATTRIBUTE_DEVICE_ORDINAL:

Returns in `*data` an integer representing a device ordinal of a device against which the memory was allocated or registered.

- CU_POINTER_ATTRIBUTE_IS_LEGACY_CUDA_IPC_CAPABLE:

Returns in `*data` a boolean that indicates if this pointer maps to an allocation that is suitable for cudaIpcGetMemHandle.

- CU_POINTER_ATTRIBUTE_RANGE_START_ADDR:

Returns in `*data` the starting address for the allocation referenced by the device pointer `ptr`. Note that this is not necessarily the address of the mapped region, but the address of the mappable address range `ptr` references (e.g. from cuMemAddressReserve).

- CU_POINTER_ATTRIBUTE_RANGE_SIZE:

Returns in `*data` the size for the allocation referenced by the device pointer `ptr`. Note that this is not necessarily the size of the mapped region, but the size of the mappable address range `ptr` references (e.g. from cuMemAddressReserve). To retrieve the size of the mapped region, see cuMemGetAddressRange

- CU_POINTER_ATTRIBUTE_MAPPED:

Returns in `*data` a boolean that indicates if this pointer is in a valid address range that is mapped to a backing allocation.

- CU_POINTER_ATTRIBUTE_ALLOWED_HANDLE_TYPES:

Returns a bitmask of the allowed handle types for an allocation that may be passed to cuMemExportToShareableHandle.

- CU_POINTER_ATTRIBUTE_MEMPOOL_HANDLE:

Returns in `*data` the handle to the mempool that the allocation was obtained from.

- CU_POINTER_ATTRIBUTE_IS_HW_DECOMPRESS_CAPABLE:

Returns in `*data` a boolean that indicates whether the pointer points to memory that is capable to be used for hardware accelerated decompression.

Note that for most allocations in the unified virtual address space the host and device pointer for accessing the allocation will be the same. The exceptions to this are

- user memory registered using cuMemHostRegister
- host memory allocated using cuMemHostAlloc with the CU_MEMHOSTALLOC_WRITECOMBINED flag For these types of allocation there will exist separate, disjoint host and device addresses for accessing the allocation. In particular
- The host address will correspond to an invalid unmapped device address (which will result in an exception if accessed from the device)
- The device address will correspond to an invalid unmapped host address (which will result in an exception if accessed from the host). For these types of allocations, querying CU_POINTER_ATTRIBUTE_HOST_POINTER and CU_POINTER_ATTRIBUTE_DEVICE_POINTER may be used to retrieve the host and device addresses from either address.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuPointerSetAttribute, cuMemAlloc, cuMemFree, cuMemAllocHost, cuMemFreeHost, cuMemHostAlloc, cuMemHostRegister, cuMemHostUnregister, cudaPointerGetAttributes

# CUresult cuPointerGetAttributes (unsigned int numAttributes, CUpointer_attribute *attributes, void **data, CUdeviceptr ptr)

Returns information about a pointer.

## Parameters

**numAttributes**

- Number of attributes to query

**attributes**
- An array of attributes to query (numAttributes and the number of attributes in this array should match)

**data**
- A two-dimensional array containing pointers to memory locations where the result of each attribute query will be written to.

**ptr**
- Pointer to query

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

The supported attributes are (refer to cuPointerGetAttribute for attribute descriptions and restrictions):

- CU_POINTER_ATTRIBUTE_CONTEXT
- CU_POINTER_ATTRIBUTE_MEMORY_TYPE
- CU_POINTER_ATTRIBUTE_DEVICE_POINTER
- CU_POINTER_ATTRIBUTE_HOST_POINTER
- CU_POINTER_ATTRIBUTE_SYNC_MEMOPS
- CU_POINTER_ATTRIBUTE_BUFFER_ID
- CU_POINTER_ATTRIBUTE_IS_MANAGED
- CU_POINTER_ATTRIBUTE_DEVICE_ORDINAL
- CU_POINTER_ATTRIBUTE_RANGE_START_ADDR
- CU_POINTER_ATTRIBUTE_RANGE_SIZE
- CU_POINTER_ATTRIBUTE_MAPPED
- CU_POINTER_ATTRIBUTE_IS_LEGACY_CUDA_IPC_CAPABLE
- CU_POINTER_ATTRIBUTE_ALLOWED_HANDLE_TYPES
- CU_POINTER_ATTRIBUTE_MEMPOOL_HANDLE
- CU_POINTER_ATTRIBUTE_IS_HW_DECOMPRESS_CAPABLE

Unlike cuPointerGetAttribute, this function will not return an error when the `ptr` encountered is not a valid CUDA pointer. Instead, the attributes are assigned default NULL values and CUDA_SUCCESS is returned.

If `ptr` was not allocated by, mapped by, or registered with a CUcontext which uses UVA (Unified Virtual Addressing), CUDA_ERROR_INVALID_CONTEXT is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuPointerGetAttribute, cuPointerSetAttribute, cudaPointerGetAttributes

# CUresult cuPointerSetAttribute (const void *value, CUpointer_attribute attribute, CUdeviceptr ptr)

Set attributes on a previously allocated memory region.

## Parameters

**value**
- Pointer to memory containing the value to be set

**attribute**
- Pointer attribute to set

**ptr**
- Pointer to a memory region allocated using CUDA memory allocation APIs

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

The supported attributes are:

- CU_POINTER_ATTRIBUTE_SYNC_MEMOPS:

A boolean attribute that can either be set (1) or unset (0). When set, the region of memory that `ptr` points to is guaranteed to always synchronize memory operations that are synchronous. If there are some previously initiated synchronous memory operations that are pending when this attribute is set, the function does not return until those memory operations are complete. See further documentation in the section titled "API synchronization behavior" to learn more about cases when synchronous memory operations can exhibit asynchronous behavior. `value` will be considered as a pointer to an unsigned integer to which this attribute is to be set.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuPointerGetAttribute, cuPointerGetAttributes, cuMemAlloc, cuMemFree, cuMemAllocHost, cuMemFreeHost, cuMemHostAlloc, cuMemHostRegister, cuMemHostUnregister

# 6.19. Stream Management

This section describes the stream management functions of the low-level CUDA driver application programming interface.

## typedef CUresult * (*CUgraphRecaptureCallback) (void* data, CUgraphNode node, const CUgraphNodeParams* originalParams, const CUgraphNodeParams* recaptureParams, CUgraphRecaptureStatus status)

Callback function invoked when node parameter mismatches are detected while recapturing to an existing graph. Parameter struct pointers are only valid within the callback.

## CUresult cuStreamAddCallback (CUstream hStream, CUstreamCallback callback, void *userData, unsigned int flags)

Add a callback to a compute stream.

### Parameters

**hStream**
- Stream to add callback to

**callback**
- The function to call once preceding stream operations are complete

**userData**
- User specified data to be passed to the callback function

**flags**
- Reserved for future use, must be 0

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_SUPPORTED

## Description

Note:

This function is slated for eventual deprecation and removal. If you do not require the callback to execute in case of a device error, consider using cuLaunchHostFunc. Additionally, this function is not supported with cuStreamBeginCapture and cuStreamEndCapture, unlike cuLaunchHostFunc.

Adds a callback to be called on the host after all currently enqueued items in the stream have completed. For each cuStreamAddCallback call, the callback will be executed exactly once. The callback will block later work in the stream until it is finished.

The callback may be passed CUDA_SUCCESS or an error code. In the event of a device error, all subsequently executed callbacks will receive an appropriate CUresult.

Callbacks must not make any CUDA API calls. Attempting to use a CUDA API will result in CUDA_ERROR_NOT_PERMITTED. Callbacks must not perform any synchronization that may depend on outstanding device work or other callbacks that are not mandated to run earlier. Callbacks without a mandated order (in independent streams) execute in undefined order and may be serialized.

For the purposes of Unified Memory, callback execution makes a number of guarantees:

- The callback stream is considered idle for the duration of the callback. Thus, for example, a callback may always use memory attached to the callback stream.
- The start of execution of a callback has the same effect as synchronizing an event recorded in the same stream immediately prior to the callback. It thus synchronizes streams which have been "joined" prior to the callback.
- Adding device work to any stream does not have the effect of making the stream active until all preceding host functions and stream callbacks have executed. Thus, for example, a callback might use global attached memory even if work has been added to another stream, if the work has been ordered behind the callback with an event.
- Completion of a callback does not cause a stream to become active except as described above. The callback stream will remain idle if no device work follows the callback, and will remain idle across consecutive callbacks without device work in between. Thus, for example, stream synchronization can be done by signaling from a callback at the end of the stream.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamQuery, cuStreamSynchronize, cuStreamWaitEvent, cuStreamDestroy, cuMemAllocManaged, cuStreamAttachMemAsync, cuLaunchHostFunc, cudaStreamAddCallback

# CUresult cuStreamAttachMemAsync (CUstream hStream, CUdeviceptr dptr, size_t length, unsigned int flags)

Attach memory to a stream asynchronously.

## Parameters

**hStream**
- Stream in which to enqueue the attach operation

**dptr**
- Pointer to memory (must be a pointer to managed memory or to a valid host-accessible region of system-allocated pageable memory)

**length**
- Length of memory

**flags**
- Must be one of CUmemAttach_flags

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_SUPPORTED

## Description

Enqueues an operation in `hStream` to specify stream association of `length` bytes of memory starting from `dptr`. This function is a stream-ordered operation, meaning that it is dependent on, and will only take effect when, previous work in stream has completed. Any previous association is automatically replaced.

`dptr` must point to one of the following types of memories:

- managed memory declared using the __managed__ keyword or allocated with cuMemAllocManaged.
- a valid host-accessible region of system-allocated pageable memory. This type of memory may only be specified if the device associated with the stream reports a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_PAGEABLE_MEMORY_ACCESS.

For managed allocations, `length` must be either zero or the entire allocation's size. Both indicate that the entire allocation's stream association is being changed. Currently, it is not possible to change stream association for a portion of a managed allocation.

For pageable host allocations, `length` must be non-zero.

The stream association is specified using `flags` which must be one of CUmemAttach_flags. If the CU_MEM_ATTACH_GLOBAL flag is specified, the memory can be accessed by any stream on any device. If the CU_MEM_ATTACH_HOST flag is specified, the program makes a guarantee that it won't access the memory on the device from any stream on a device that has a zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. If the CU_MEM_ATTACH_SINGLE flag is specified and `hStream` is associated with a device that has a zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS, the program makes a guarantee that it will only access the memory on the device from `hStream`. It is illegal to attach singly to the NULL stream, because the NULL stream is a virtual global stream and not a specific stream. An error will be returned in this case.

When memory is associated with a single stream, the Unified Memory system will allow CPU access to this memory region so long as all operations in `hStream` have completed, regardless of whether other streams are active. In effect, this constrains exclusive ownership of the managed memory region by an active GPU to per-stream activity instead of whole-GPU activity.

Accessing memory on the device from streams that are not associated with it will produce undefined results. No error checking is performed by the Unified Memory system to ensure that kernels launched into other streams do not access this region.

It is a program's responsibility to order calls to cuStreamAttachMemAsync via events, synchronization or other means to ensure legal access to memory at all times. Data visibility and coherency will be changed appropriately for all kernels which follow a stream-association change.

If `hStream` is destroyed while data is associated with it, the association is removed and the association reverts to the default visibility of the allocation as specified at cuMemAllocManaged. For __managed__ variables, the default association is always CU_MEM_ATTACH_GLOBAL. Note that destroying a stream is an asynchronous operation, and as a result, the change to default association won't happen until all work in the stream has completed.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamQuery, cuStreamSynchronize, cuStreamWaitEvent, cuStreamDestroy, cuMemAllocManaged, cudaStreamAttachMemAsync

# CUresult cuStreamBeginCapture (CUstream hStream, CUstreamCaptureMode mode)

Begins graph capture on a stream.

## Parameters

**hStream**

- Stream in which to initiate capture

**mode**

- Controls the interaction of this capture sequence with other API calls that are potentially unsafe. For more details see cuThreadExchangeStreamCaptureMode.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Begin graph capture on `hStream`. When a stream is in capture mode, all operations pushed into the stream will not be executed, but will instead be captured into a graph, which will be returned via cuStreamEndCapture. Capture may not be initiated if `stream` is CU_STREAM_LEGACY. Capture must be ended on the same stream in which it was initiated, and it may only be initiated if the stream is not already in capture mode. The capture mode may be queried via cuStreamIsCapturing. A unique id representing the capture sequence may be queried via cuStreamGetCaptureInfo.

If `mode` is not CU_STREAM_CAPTURE_MODE_RELAXED, cuStreamEndCapture must be called on this stream from the same thread.

Note:

Kernels captured using this API must not use texture and surface references. Reading or writing through any texture or surface reference is undefined behavior. This restriction does not apply to texture and surface objects.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamIsCapturing, cuStreamEndCapture, cuThreadExchangeStreamCaptureMode

# CUresult cuStreamBeginCaptureToCig (CUstream hStream, CUstreamCigCaptureParams *streamCigCaptureParams)

Begins capture to CIG on a stream.

## Parameters

**hStream**
- Stream in which to initiate capture to CIG

**streamCigCaptureParams**
- CIG capture parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE,

## Description

Support for CIG streams with D3D12 can be determined using cuDeviceGetAttribute() with CU_DEVICE_ATTRIBUTE_D3D12_CIG_STREAMS_SUPPORTED.

Begin CIG (CUDA in Graphics) capture on `hStream` for the graphics API as provided in `streamCigCaptureParams`. When a stream is in CIG capture mode, all operations pushed into the stream will not be executed, but will instead be captured into a graphics API command list/ command buffer. All kernel launches and memory copy/memory set operations on the CIG stream will be recorded. When the command list is executed by the graphics API, all the stream's operations will execute in order along with other graphics API commands in the command list.

CIG stream capture may not be initiated if `stream` is CU_STREAM_LEGACY. Capture must be ended on the same stream in which it was initiated, and it may only be initiated if the stream is not already in CIG capture mode.

The context must be also created in CIG mode previously, otherwise this operation will fail and CUDA_ERROR_INVALID_CONTEXT will be returned.

Data from the graphics client can be shared with CUDA via the `streamSharedData` in `streamCigCaptureParams`. The format of `streamSharedData` is dependent on the type of the graphics client. For D3D12, `streamSharedData` is an ID3D12CommandList object pointer. The command list must be in ready state for recording commands whenever kernels are launched on the stream. The command list provided must belong to the graphics API device that the CIG context was created with, otherwise the behavior will be undefined.

The stream object may not be destroyed until its associated command list has finished executing on the GPU. The command list/command buffer used for capture may not be submitted for execution before a call to cuStreamEndCaptureToCig is made on the associated stream.

Graphics resources to be accessed by work recorded on the CIG stream must use UAV barriers on the command list prior to recording work that accesses them on the stream.

Resubmission of the same recorded command list is not allowed. Further more, care must be taken for the order of execution of the recorded CUDA work with regards to other CUDA work submitted under the same CIG context. Out-of-order execution can lead to device hangs or exceptions.

CIG capture mode operates similarly to `cuStreamBeginCapture` with the `CU_STREAM_CAPTURE_MODE_RELAXED` option. There are additional limitations to streams in CIG capture mode. The following functions are not allowed for CIG streams whether directly or indirectly via a recorded graph launch: cuLaunchHostFunc cuStreamAddCallback cuStreamSynchronize cuStreamWaitValue32 cuStreamWaitValue64 cuStreamBatchMemOp cuStreamBeginCapture cuStreamBeginCaptureToGraph cuMemAllocAsync cuMemFreeAsync

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamEndCaptureToCig, cuStreamBeginCapture, cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback

## CUresult cuStreamBeginCaptureToGraph (CUstream hStream, CUgraph hGraph, const CUgraphNode *dependencies, const CUgraphEdgeData *dependencyData, size_t numDependencies, CUstreamCaptureMode mode)

Begins graph capture on a stream to an existing graph.

### Parameters

**hStream**
- Stream in which to initiate capture.

**hGraph**
- Graph to capture into.

**dependencies**
- Dependencies of the first node captured in the stream. Can be NULL if numDependencies is 0.

**dependencyData**
- Optional array of data associated with each dependency.

**numDependencies**
- Number of dependencies.

**mode**
- Controls the interaction of this capture sequence with other API calls that are potentially unsafe. For more details see cuThreadExchangeStreamCaptureMode.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Begin graph capture on `hStream`, placing new nodes into an existing graph. When a stream is in capture mode, all operations pushed into the stream will not be executed, but will instead be captured into `hGraph`. The graph will not be instantiable until the user calls cuStreamEndCapture.

Capture may not be initiated if `stream` is CU_STREAM_LEGACY. Capture must be ended on the same stream in which it was initiated, and it may only be initiated if the stream is not already in capture mode. The capture mode may be queried via cuStreamIsCapturing. A unique id representing the capture sequence may be queried via cuStreamGetCaptureInfo.

If `mode` is not CU_STREAM_CAPTURE_MODE_RELAXED, cuStreamEndCapture must be called on this stream from the same thread.

Note:

Kernels captured using this API must not use texture and surface references. Reading or writing through any texture or surface reference is undefined behavior. This restriction does not apply to texture and surface objects.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamBeginCapture, cuStreamCreate, cuStreamIsCapturing, cuStreamEndCapture, cuThreadExchangeStreamCaptureMode, cuGraphAddNode

# CUresult cuStreamBeginRecaptureToGraph (CUstream hStream, CUstreamCaptureMode mode, CUgraph hGraph, CUgraphRecaptureCallback callbackFunc, void *userData)

Begin graph capture on a stream to an existing graph.

## Parameters

**hStream**
- Stream in which to initiate capture

**mode**
- Controls the interaction of this capture sequence with other API calls that are potentially unsafe. For more details see cuThreadExchangeStreamCaptureMode.

**hGraph**
- Existing CUDA graph to be captured into

**callbackFunc**
- Function that will be called for all parameter mismatches from the original graph

**userData**
- A generic pointer to user data that is passed into the callback function

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE,

## Description

Begin graph capture on `hStream` to the existing `hGraph`. The node creation order while recapturing the graph must be identical to the original graph. The recapture will fail immediately for: * Topology mismatches between the existing graph and the recaptured graph * Parameter mismatches for memory allocation or free nodes

Any other node parameter mismatches during recapture can be configured to call the function provided in `callbackFunc`. The recapture will fail immediately if the callback returns anything other than CUDA_SUCCESS.

If the recapture fails for any reason, the `graph` will be in an undefined state and should be destroyed.

See cuStreamBeginCapture for additional detail on beginning the capture.

Note:

Any user objects associated with `graph` will be released prior to the recapture.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamBeginCapture, cuStreamIsCapturing, cuStreamEndCapture, cuThreadExchangeStreamCaptureMode

# CUresult cuStreamCopyAttributes (CUstream dst, CUstream src)

Copies attributes from source stream to destination stream.

## Parameters

**dst**
Destination stream

**src**
Source stream For list of attributes see CUstreamAttrID

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Copies attributes from source stream `src` to destination stream `dst`. Both streams must have the same context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

CUaccessPolicyWindow

# CUresult cuStreamCreate (CUstream *phStream, unsigned int Flags)

Create a stream.

## Parameters

**phStream**
- Returned newly created stream

**Flags**
- Parameters for stream creation

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY CUDA_ERROR_EXTERNAL_DEVICE

### Description

Creates a stream and returns a handle in `phStream`. The `Flags` argument determines behaviors of the stream.

Valid values for `Flags` are:

- CU_STREAM_DEFAULT: Default stream creation flag.
- CU_STREAM_NON_BLOCKING: Specifies that work running in the created stream may run concurrently with work in stream 0 (the NULL stream), and that the created stream should perform no implicit synchronization with stream 0.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamDestroy, cuStreamCreateWithPriority, cuGreenCtxStreamCreate, cuStreamGetPriority, cuStreamGetFlags, cuStreamGetDevice cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cudaStreamCreate, cudaStreamCreateWithFlags

## CUresult cuStreamCreateWithPriority (CUstream *phStream, unsigned int flags, int priority)

Create a stream with the given priority.

### Parameters

**phStream**
- Returned newly created stream

**flags**
- Flags for stream creation. See cuStreamCreate for a list of valid flags

**priority**
- Stream priority. Lower numbers represent higher priorities. See cuCtxGetStreamPriorityRange for more information about meaningful stream priorities that can be passed.

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY CUDA_ERROR_EXTERNAL_DEVICE

### Description

Creates a stream with the specified priority and returns a handle in `phStream`. This affects the scheduling priority of work in the stream. Priorities provide a hint to preferentially run work with higher priority when possible, but do not preempt already-running work or provide any other functional guarantee on execution order.

`priority` follows a convention where lower numbers represent higher priorities. '0' represents default priority. The range of meaningful numerical priorities can be queried using cuCtxGetStreamPriorityRange. If the specified priority is outside the numerical range returned by cuCtxGetStreamPriorityRange, it will automatically be clamped to the lowest or the highest number in the range.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- Stream priorities are supported only on GPUs with compute capability 3.5 or higher.
- In the current implementation, only compute kernels launched in priority streams are affected by the stream's priority. Stream priorities have no effect on host-to-device and device-to-host memory operations.

See also:

cuStreamDestroy, cuStreamCreate, cuGreenCtxStreamCreate, cuStreamGetPriority, cuCtxGetStreamPriorityRange, cuStreamGetFlags, cuStreamGetDevice, cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cudaStreamCreateWithPriority

## CUresult cuStreamDestroy (CUstream hStream)

Destroys a stream.

### Parameters

**hStream**

- Stream to destroy

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE CUDA_ERROR_EXTERNAL_DEVICE

### Description

Destroys the stream specified by `hStream`.

In case the device is still doing work in the stream `hStream` when cuStreamDestroy() is called, the function will return immediately and the resources associated with `hStream` will be released automatically once the device has completed all work in `hStream`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cudaStreamDestroy

## CUresult cuStreamEndCapture (CUstream hStream, CUgraph *phGraph)

Ends capture on a stream, returning the captured graph.

### Parameters

**hStream**
- Stream to query

**phGraph**
- The captured graph

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_STREAM_CAPTURE_WRONG_THREAD

### Description

End capture on `hStream`, returning the captured graph via `phGraph`. Capture must have been initiated on `hStream` via a call to cuStreamBeginCapture. If capture was invalidated, due to a violation of the rules of stream capture, then a NULL graph will be returned.

If the `mode` argument to cuStreamBeginCapture was not CU_STREAM_CAPTURE_MODE_RELAXED, this call must be from the same thread as cuStreamBeginCapture.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamBeginCapture, cuStreamIsCapturing, cuGraphDestroy

# CUresult cuStreamEndCaptureToCig (CUstream hStream)

Ends CIG capture on a stream.

## Parameters

**hStream**

- Stream to end CIG capture

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_STREAM_CAPTURE_WRONG_THREAD

## Description

End CIG capture on `hStream`. Capture must have been initiated on `hStream` via a call to cuStreamBeginCaptureToCig. Once this function is called, `hStream` will exit CIG capture mode and return to its original state, thus removing all CIG stream restrictions. Also, the command list/command buffer that was associated with `hStream` in the previous call to cuStreamBeginCaptureToCig is now allowed to be submitted for execution on the graphics API. However, the stream may not be destroyed until execution of the command list is fully done on the GPU. This requirements extends also to all streams dependant on the CIG stream (e.g. via event waits).

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamBeginCaptureToCig

# CUresult cuStreamGetAttribute (CUstream hStream, CUstreamAttrID attr, CUstreamAttrValue *value_out)

Queries stream attribute.

## Parameters

**hStream**
**attr**
**value_out**

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Queries attribute `attr` from `hStream` and stores it in corresponding member of `value_out`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

CUaccessPolicyWindow

# CUresult cuStreamGetCaptureInfo (CUstream hStream, CUstreamCaptureStatus *captureStatus_out, cuuint64_t *id_out, CUgraph *graph_out, const CUgraphNode **dependencies_out, const CUgraphEdgeData **edgeData_out, size_t *numDependencies_out)

Query a stream's capture state.

## Parameters

**hStream**
- The stream to query

**captureStatus_out**
- Location to return the capture status of the stream; required

**id_out**
- Optional location to return an id for the capture sequence, which is unique over the lifetime of the process

**graph_out**
- Optional location to return the graph being captured into. All operations other than destroy and node removal are permitted on the graph while the capture sequence is in progress. This API does not transfer ownership of the graph, which is transferred or destroyed at cuStreamEndCapture. Note that the graph handle may be invalidated before end of capture for certain errors. Nodes that are or become unreachable from the original stream at cuStreamEndCapture due to direct actions on the graph do not trigger CUDA_ERROR_STREAM_CAPTURE_UNJOINED.

**dependencies_out**
- Optional location to store a pointer to an array of nodes. The next node to be captured in the stream will depend on this set of nodes, absent operations such as event wait which modify this set. The array pointer is valid until the next API call which operates on the stream or until the capture is terminated. The node handles may be copied out and are valid until they or the graph is destroyed. The driver-owned array may also be passed directly to APIs that operate on the graph (not the stream) without copying.

**edgeData_out**
- Optional location to store a pointer to an array of graph edge data. This array parallels `dependencies_out`; the next node to be added has an edge to `dependencies_out`[i] with annotation `edgeData_out`[i] for each `i`. The array pointer is valid until the next API call which operates on the stream or until the capture is terminated.

**numDependencies_out**
- Optional location to store the size of the array returned in dependencies_out.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_STREAM_CAPTURE_IMPLICIT, CUDA_ERROR_LOSSY_QUERY

## Description

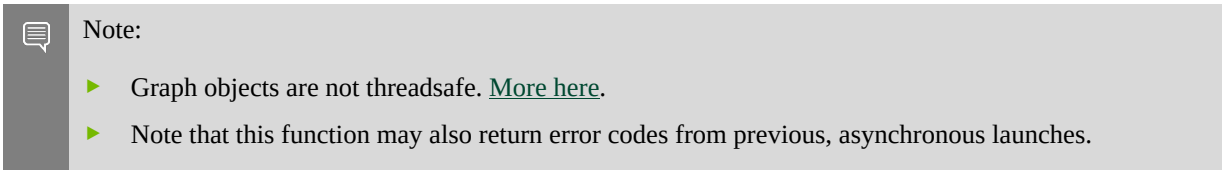
Query stream state related to stream capture.

If called on CU_STREAM_LEGACY (the "null stream") while a stream not created with CU_STREAM_NON_BLOCKING is capturing, returns CUDA_ERROR_STREAM_CAPTURE_IMPLICIT.

Valid data (other than capture status) is returned only if both of the following are true:

- the call returns CUDA_SUCCESS
- the returned capture status is CU_STREAM_CAPTURE_STATUS_ACTIVE

If `edgeData_out` is non-NULL then `dependencies_out` must be as well. If `dependencies_out` is non-NULL and `edgeData_out` is NULL, but there is non-zero edge data for one or more of the current stream dependencies, the call will return CUDA_ERROR_LOSSY_QUERY.



Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamBeginCapture, cuStreamIsCapturing, cuStreamUpdateCaptureDependencies

# CUresult cuStreamGetCtx (CUstream hStream, CUcontext *pctx)

Query the context associated with a stream.

## Parameters

**hStream**

- Handle to the stream to be queried

**pctx**

- Returned context associated with the stream

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_SUPPORTED

## Description

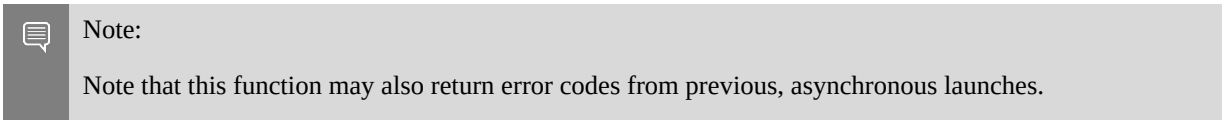
Returns the CUDA context that the stream is associated with.

If the stream was created via the API cuGreenCtxStreamCreate, the returned context is equivalent to the one returned by cuCtxFromGreenCtx() on the green context associated with the stream at creation time.

The stream handle `hStream` can refer to any of the following:

- a stream created via any of the CUDA driver APIs such as cuStreamCreate and cuStreamCreateWithPriority, or their runtime API equivalents such as cudaStreamCreate, cudaStreamCreateWithFlags and cudaStreamCreateWithPriority. The returned context is the context that was active in the calling thread when the stream was created. Passing an invalid handle will result in undefined behavior.
- any of the special streams such as the NULL stream, CU_STREAM_LEGACY and CU_STREAM_PER_THREAD. The runtime API equivalents of these are also accepted, which are NULL, cudaStreamLegacy and cudaStreamPerThread respectively. Specifying any of the special

handles will return the context current to the calling thread. If no context is current to the calling thread, CUDA_ERROR_INVALID_CONTEXT is returned.




See also:

cuStreamDestroy, cuStreamCreateWithPriority, cuStreamGetPriority, cuStreamGetFlags, cuStreamGetDevice cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cudaStreamCreate, cudaStreamCreateWithFlags

# CUresult cuStreamGetCtx_v2 (CUstream hStream, CUcontext *pCtx, CUgreenCtx *pGreenCtx)

Query the contexts associated with a stream.

## Parameters

**hStream**
- Handle to the stream to be queried

**pCtx**
- Returned regular context associated with the stream

**pGreenCtx**
- Returned green context if the stream is associated with a green context or NULL if not

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE

## Description

Returns the contexts that the stream is associated with.

If the stream is associated with a green context, the API returns the green context in `pGreenCtx` and the primary context of the associated device in `pCtx`.

If the stream is associated with a regular context, the API returns the regular context in `pCtx` and NULL in `pGreenCtx`.

The stream handle `hStream` can refer to any of the following:

- a stream created via any of the CUDA driver APIs such as cuStreamCreate, cuStreamCreateWithPriority and cuGreenCtxStreamCreate, or their runtime API equivalents such

as cudaStreamCreate, cudaStreamCreateWithFlags and cudaStreamCreateWithPriority. Passing an invalid handle will result in undefined behavior.

- any of the special streams such as the NULL stream, CU_STREAM_LEGACY and CU_STREAM_PER_THREAD. The runtime API equivalents of these are also accepted, which are NULL, cudaStreamLegacy and cudaStreamPerThread respectively. If any of the special handles are specified, the API will operate on the context current to the calling thread. If a green context (that was converted via cuCtxFromGreenCtx() before setting it current) is current to the calling thread, the API will return the green context in `pGreenCtx` and the primary context of the associated device in `pCtx`. If a regular context is current, the API returns the regular context in `pCtx` and NULL in `pGreenCtx`. Note that specifying CU_STREAM_PER_THREAD or cudaStreamPerThread will return CUDA_ERROR_INVALID_HANDLE if a green context is current to the calling thread. If no context is current to the calling thread, CUDA_ERROR_INVALID_CONTEXT is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamDestroy, cuStreamCreate cuStreamCreateWithPriority, cuGreenCtxStreamCreate, cuStreamGetPriority, cuStreamGetFlags, cuStreamGetDevice, cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cudaStreamCreate, cudaStreamCreateWithFlags,

# CUresult cuStreamGetDevice (CUstream hStream, CUdevice *device)

Returns the device handle of the stream.

## Parameters

**hStream**

- Handle to the stream to be queried

**device**

- Returns the device to which a stream belongs

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Returns in `*device` the device handle of the stream

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamDestroy, cuStreamCreate, cuGreenCtxStreamCreate, cuStreamGetFlags

# CUresult cuStreamGetFlags (CUstream hStream, unsigned int *flags)

Query the flags of a given stream.

## Parameters

**hStream**

- Handle to the stream to be queried

**flags**

- Pointer to an unsigned integer in which the stream's flags are returned The value returned in `flags` is a logical 'OR' of all flags that were used while creating this stream. See cuStreamCreate for the list of valid flags

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Query the flags of a stream created using cuStreamCreate, cuStreamCreateWithPriority or cuGreenCtxStreamCreate and return the flags in `flags`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamDestroy, cuStreamCreate, cuGreenCtxStreamCreate, cuStreamGetPriority, cudaStreamGetFlags, cuStreamGetDevice

# CUresult cuStreamGetId (CUstream hStream, unsigned long long *streamId)

Returns the unique Id associated with the stream handle supplied.

## Parameters

**hStream**
- Handle to the stream to be queried

**streamId**
- Pointer to store the Id of the stream

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Returns in `streamId` the unique Id which is associated with the given stream handle. The Id is unique for the life of the program.

The stream handle `hStream` can refer to any of the following:

- a stream created via any of the CUDA driver APIs such as cuStreamCreate and cuStreamCreateWithPriority, or their runtime API equivalents such as cudaStreamCreate, cudaStreamCreateWithFlags and cudaStreamCreateWithPriority. Passing an invalid handle will result in undefined behavior.
- any of the special streams such as the NULL stream, CU_STREAM_LEGACY and CU_STREAM_PER_THREAD. The runtime API equivalents of these are also accepted, which are NULL, cudaStreamLegacy and cudaStreamPerThread respectively.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamDestroy, cuStreamCreate, cuStreamGetPriority, cudaStreamGetId

# CUresult cuStreamGetPriority (CUstream hStream, int *priority)

Query the priority of a given stream.

## Parameters

**hStream**
- Handle to the stream to be queried

**priority**
- Pointer to a signed integer in which the stream's priority is returned

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Query the priority of a stream created using cuStreamCreate, cuStreamCreateWithPriority or cuGreenCtxStreamCreate and return the priority in `priority`. Note that if the stream was created with a priority outside the numerical range returned by cuCtxGetStreamPriorityRange, this function returns the clamped priority. See cuStreamCreateWithPriority for details about priority clamping.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamDestroy, cuStreamCreate, cuStreamCreateWithPriority, cuGreenCtxStreamCreate, cuCtxGetStreamPriorityRange, cuStreamGetFlags, cuStreamGetDevice, cudaStreamGetPriority

# CUresult cuStreamIsCapturing (CUstream hStream, CUstreamCaptureStatus *captureStatus)

Returns a stream's capture status.

## Parameters

**hStream**
- Stream to query

**captureStatus**
- Returns the stream's capture status

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_STREAM_CAPTURE_IMPLICIT

### Description

Return the capture status of `hStream` via `captureStatus`. After a successful call, `*captureStatus` will contain one of the following:

- CU_STREAM_CAPTURE_STATUS_NONE: The stream is not capturing.
- CU_STREAM_CAPTURE_STATUS_ACTIVE: The stream is capturing.
- CU_STREAM_CAPTURE_STATUS_INVALIDATED: The stream was capturing but an error has invalidated the capture sequence. The capture sequence must be terminated with cuStreamEndCapture on the stream where it was initiated in order to continue using `hStream`.

Note that, if this is called on CU_STREAM_LEGACY (the "null stream") while a blocking stream in the same context is capturing, it will return CUDA_ERROR_STREAM_CAPTURE_IMPLICIT and `*captureStatus` is unspecified after the call. The blocking stream capture is not invalidated.

When a blocking stream is capturing, the legacy stream is in an unusable state until the blocking stream capture is terminated. The legacy stream is not supported for stream capture, but attempted use would have an implicit dependency on the capturing stream(s).

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamBeginCapture, cuStreamEndCapture

## CUresult cuStreamQuery (CUstream hStream)

Determine status of a compute stream.

### Parameters

**hStream**

- Stream to query status of

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_READY

### Description

Returns CUDA_SUCCESS if all operations in the stream specified by `hStream` have completed, or CUDA_ERROR_NOT_READY if not.

For the purposes of Unified Memory, a return value of CUDA_SUCCESS is equivalent to having called cuStreamSynchronize().

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamWaitEvent, cuStreamDestroy, cuStreamSynchronize, cuStreamAddCallback, cudaStreamQuery

## CUresult cuStreamSetAttribute (CUstream hStream, CUstreamAttrID attr, const CUstreamAttrValue *value)

Sets stream attribute.

### Parameters

**hStream**
**attr**
**value**

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Sets attribute `attr` on `hStream` from corresponding attribute of `value`. The updated attribute will be applied to subsequent work submitted to the stream. It will not affect previously submitted work.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

CUaccessPolicyWindow

# CUresult cuStreamSynchronize (CUstream hStream)

Wait until a stream's tasks are completed.

## Parameters

**hStream**
- Stream to wait for

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE

## Description

Waits until the device has completed all operations in the stream specified by `hStream`. If the context was created with the CU_CTX_SCHED_BLOCKING_SYNC flag, the CPU thread will block until the stream is finished with all of its tasks.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamDestroy, cuStreamWaitEvent, cuStreamQuery, cuStreamAddCallback, cudaStreamSynchronize

# CUresult cuStreamUpdateCaptureDependencies (CUstream hStream, CUgraphNode *dependencies, const CUgraphEdgeData *dependencyData, size_t numDependencies, unsigned int flags)

Update the set of dependencies in a capturing stream.

## Parameters

**hStream**
- The stream to update

**dependencies**
- The set of dependencies to add

**dependencyData**
- Optional array of data associated with each dependency.

**numDependencies**
- The size of the dependencies array

**flags**
- See above

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_ILLEGAL_STATE

### Description

Modifies the dependency set of a capturing stream. The dependency set is the set of nodes that the next captured node in the stream will depend on along with the edge data for those dependencies.

Valid flags are CU_STREAM_ADD_CAPTURE_DEPENDENCIES and CU_STREAM_SET_CAPTURE_DEPENDENCIES. These control whether the set passed to the API is added to the existing set or replaces it. A flags value of 0 defaults to CU_STREAM_ADD_CAPTURE_DEPENDENCIES.

Nodes that are removed from the dependency set via this API do not result in CUDA_ERROR_STREAM_CAPTURE_UNJOINED if they are unreachable from the stream at cuStreamEndCapture.

Returns CUDA_ERROR_ILLEGAL_STATE if the stream is not capturing.

See also:

cuStreamBeginCapture, cuStreamGetCaptureInfo

## CUresult cuStreamWaitEvent (CUstream hStream, CUevent hEvent, unsigned int Flags)

Make a compute stream wait on an event.

### Parameters

**hStream**
- Stream to wait

**hEvent**
- Event to wait on (may not be NULL)

**Flags**
- See CUevent_capture_flags

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE,

### Description

Makes all future work submitted to `hStream` wait for all work captured in `hEvent`. See cuEventRecord() for details on what is captured by an event. The synchronization will be performed efficiently on the device when applicable. `hEvent` may be from a different context or device than `hStream`.

flags include:

- CU_EVENT_WAIT_DEFAULT: Default event creation flag.
- CU_EVENT_WAIT_EXTERNAL: Event is captured in the graph as an external event node when performing stream capture. This flag is invalid outside of stream capture.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuEventRecord, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cuStreamDestroy, cudaStreamWaitEvent

## CUresult cuThreadExchangeStreamCaptureMode (CUstreamCaptureMode *mode)

Swaps the stream capture interaction mode for a thread.

### Parameters

**mode**

- Pointer to mode value to swap with the current mode

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Sets the calling thread's stream capture interaction mode to the value contained in `*mode`, and overwrites `*mode` with the previous mode for the thread. To facilitate deterministic behavior across function or module boundaries, callers are encouraged to use this API in a push-pop fashion:

```
CUstreamCaptureMode mode = desiredMode;
     cuThreadExchangeStreamCaptureMode(&mode);
     ...
     cuThreadExchangeStreamCaptureMode(&mode); // restore previous mode
```

During stream capture (see cuStreamBeginCapture), some actions, such as a call to cudaMalloc, may be unsafe. In the case of cudaMalloc, the operation is not enqueued asynchronously to a stream, and is not observed by stream capture. Therefore, if the sequence of operations captured via cuStreamBeginCapture depended on the allocation being replayed whenever the graph is launched, the captured graph would be invalid.

Therefore, stream capture places restrictions on API calls that can be made within or concurrently to a cuStreamBeginCapture-cuStreamEndCapture sequence. This behavior can be controlled via this API and flags to cuStreamBeginCapture.

A thread's mode is one of the following:

- `CU_STREAM_CAPTURE_MODE_GLOBAL`: This is the default mode. If the local thread has an ongoing capture sequence that was not initiated with `CU_STREAM_CAPTURE_MODE_RELAXED` at `cuStreamBeginCapture`, or if any other thread has a concurrent capture sequence initiated with `CU_STREAM_CAPTURE_MODE_GLOBAL`, this thread is prohibited from potentially unsafe API calls.
- `CU_STREAM_CAPTURE_MODE_THREAD_LOCAL`: If the local thread has an ongoing capture sequence not initiated with `CU_STREAM_CAPTURE_MODE_RELAXED`, it is prohibited from potentially unsafe API calls. Concurrent capture sequences in other threads are ignored.
- `CU_STREAM_CAPTURE_MODE_RELAXED`: The local thread is not prohibited from potentially unsafe API calls. Note that the thread is still prohibited from API calls which necessarily conflict with stream capture, for example, attempting cuEventQuery on an event that was last recorded inside a capture sequence.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamBeginCapture

# 6.20. Event Management

This section describes the event management functions of the low-level CUDA driver application programming interface.

## CUresult cuEventCreate (CUevent *phEvent, unsigned int Flags)

Creates an event.

### Parameters

**phEvent**
- Returns newly created event

**Flags**
- Event creation flags

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

### Description

Creates an event *phEvent for the current context with the flags specified via `Flags`. Valid flags include:

- CU_EVENT_DEFAULT: Default event creation flag.
- CU_EVENT_BLOCKING_SYNC: Specifies that the created event should use blocking synchronization. A CPU thread that uses cuEventSynchronize() to wait on an event created with this flag will block until the event has actually been recorded.
- CU_EVENT_DISABLE_TIMING: Specifies that the created event does not need to record timing data. Events created with this flag specified and the CU_EVENT_BLOCKING_SYNC flag not specified will provide the best performance when used with cuStreamWaitEvent() and cuEventQuery().
- CU_EVENT_INTERPROCESS: Specifies that the created event may be used as an interprocess event by cuIpcGetEventHandle(). CU_EVENT_INTERPROCESS must be specified along with CU_EVENT_DISABLE_TIMING.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuEventRecord, cuEventQuery, cuEventSynchronize, cuEventDestroy, cuEventElapsedTime, cudaEventCreate, cudaEventCreateWithFlags

# CUresult cuEventDestroy (CUevent hEvent)

Destroys an event.

## Parameters

**hEvent**
- Event to destroy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE

## Description

Destroys the event specified by `hEvent`.

An event may be destroyed before it is complete (i.e., while cuEventQuery() would return CUDA_ERROR_NOT_READY). In this case, the call does not block on completion of the event, and any associated resources will automatically be released asynchronously at completion.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuEventCreate, cuEventRecord, cuEventQuery, cuEventSynchronize, cuEventElapsedTime, cudaEventDestroy

# CUresult cuEventElapsedTime (float *pMilliseconds, CUevent hStart, CUevent hEnd)

Computes the elapsed time between two events.

## Parameters

**pMilliseconds**
- Time between `hStart` and `hEnd` in ms

**hStart**
- Starting event

**hEnd**
- Ending event

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_READY, CUDA_ERROR_UNKNOWN

### Description

Computes the elapsed time between two events (in milliseconds with a resolution of around 0.5 microseconds). Note this API is not guaranteed to return the latest errors for pending work. As such this API is intended to serve as an elapsed time calculation only and any polling for completion on the events to be compared should be done with cuEventQuery instead.

If either event was last recorded in a non-NULL stream, the resulting time may be greater than expected (even if both used the same stream handle). This happens because the cuEventRecord() operation takes place asynchronously and there is no guarantee that the measured latency is actually just between the two events. Any number of other different stream operations could execute in between the two measured events, thus altering the timing in a significant way.

If cuEventRecord() has not been called on either event then CUDA_ERROR_INVALID_HANDLE is returned. If cuEventRecord() has been called on both events but one or both of them has not yet been completed (that is, cuEventQuery() would return CUDA_ERROR_NOT_READY on at least one of the events), CUDA_ERROR_NOT_READY is returned. If either event was created with the CU_EVENT_DISABLE_TIMING flag, then this function will return CUDA_ERROR_INVALID_HANDLE.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuEventCreate, cuEventRecord, cuEventQuery, cuEventSynchronize, cuEventDestroy, cudaEventElapsedTime

## CUresult cuEventQuery (CUevent hEvent)

Queries an event's status.

### Parameters

**hEvent**
- Event to query

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_READY

### Description

Queries the status of all work currently captured by `hEvent`. See cuEventRecord() for details on what is captured by an event.

Returns CUDA_SUCCESS if all captured work has been completed, or CUDA_ERROR_NOT_READY if any captured work is incomplete.

For the purposes of Unified Memory, a return value of CUDA_SUCCESS is equivalent to having called cuEventSynchronize().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuEventCreate, cuEventRecord, cuEventSynchronize, cuEventDestroy, cuEventElapsedTime, cudaEventQuery

## CUresult cuEventRecord (CUevent hEvent, CUstream hStream)

Records an event.

### Parameters

**hEvent**

- Event to record

**hStream**

- Stream to record event for

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

### Description

Captures in `hEvent` the contents of `hStream` at the time of this call. `hEvent` and `hStream` must be from the same context otherwise CUDA_ERROR_INVALID_HANDLE is returned. Calls such as cuEventQuery() or cuStreamWaitEvent() will then examine or wait for completion of the work that was captured. Uses of `hStream` after this call do not modify `hEvent`. See note on default stream behavior for what is captured in the default case.

cuEventRecord() can be called multiple times on the same event and will overwrite the previously captured state. Other APIs such as cuStreamWaitEvent() use the most recently captured state at the time of the API call, and are not affected by later calls to cuEventRecord(). Before the first call to cuEventRecord(), an event represents an empty set of work, so for example cuEventQuery() would return CUDA_SUCCESS.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuEventCreate, cuEventQuery, cuEventSynchronize, cuStreamWaitEvent, cuEventDestroy, cuEventElapsedTime, cudaEventRecord, cuEventRecordWithFlags

## CUresult cuEventRecordWithFlags (CUevent hEvent, CUstream hStream, unsigned int flags)

Records an event.

### Parameters

**hEvent**
- Event to record

**hStream**
- Stream to record event for

**flags**
- See CUevent_capture_flags

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

### Description

Captures in `hEvent` the contents of `hStream` at the time of this call. `hEvent` and `hStream` must be from the same context otherwise CUDA_ERROR_INVALID_HANDLE is returned. Calls such as cuEventQuery() or cuStreamWaitEvent() will then examine or wait for completion of the work that was captured. Uses of `hStream` after this call do not modify `hEvent`. See note on default stream behavior for what is captured in the default case.

cuEventRecordWithFlags() can be called multiple times on the same event and will overwrite the previously captured state. Other APIs such as cuStreamWaitEvent() use the most recently captured state at the time of the API call, and are not affected by later calls to cuEventRecordWithFlags(). Before the first call to cuEventRecordWithFlags(), an event represents an empty set of work, so for example cuEventQuery() would return CUDA_SUCCESS.

flags include:

- CU_EVENT_RECORD_DEFAULT: Default event creation flag.
- CU_EVENT_RECORD_EXTERNAL: Event is captured in the graph as an external event node when performing stream capture. This flag is invalid outside of stream capture.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuEventCreate, cuEventQuery, cuEventSynchronize, cuStreamWaitEvent, cuEventDestroy, cuEventElapsedTime, cuEventRecord, cudaEventRecord

## CUresult cuEventSynchronize (CUevent hEvent)

Waits for an event to complete.

### Parameters

**hEvent**

- Event to wait for

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE

### Description

Waits until the completion of all work currently captured in `hEvent`. See cuEventRecord() for details on what is captured by an event.

Waiting for an event that was created with the CU_EVENT_BLOCKING_SYNC flag will cause the calling CPU thread to block until the event has been completed by the device. If the CU_EVENT_BLOCKING_SYNC flag has not been set, then the CPU thread will busy-wait until the event has been completed by the device.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuEventCreate, cuEventRecord, cuEventQuery, cuEventDestroy, cuEventElapsedTime, cudaEventSynchronize

## 6.21. External Resource Interoperability

This section describes the external resource interoperability functions of the low-level CUDA driver application programming interface.

## CUresult cuDestroyExternalMemory (CUexternalMemory extMem)

Destroys an external memory object.

### Parameters

**extMem**

- External memory object to be destroyed

### Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE

### Description

Destroys the specified external memory object. Any existing buffers and CUDA mipmapped arrays mapped onto this object must no longer be used and must be explicitly freed using cuMemFree and cuMipmappedArrayDestroy respectively.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuImportExternalMemory, cuExternalMemoryGetMappedBuffer, cuExternalMemoryGetMappedMipmappedArray

# CUresult cuDestroyExternalSemaphore (CUexternalSemaphore extSem)

Destroys an external semaphore.

## Parameters

**extSem**

- External semaphore to be destroyed

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE

## Description

Destroys an external semaphore object and releases any references to the underlying resource. Any outstanding signals or waits must have completed before the semaphore is destroyed.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuImportExternalSemaphore, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync

# CUresult cuExternalMemoryGetMappedBuffer (CUdeviceptr *devPtr, CUexternalMemory extMem, const CUDA_EXTERNAL_MEMORY_BUFFER_DESC *bufferDesc)

Maps a buffer onto an imported memory object.

## Parameters

**devPtr**
- Returned device pointer to buffer

**extMem**
- Handle to external memory object

**bufferDesc**
- Buffer descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Maps a buffer onto an imported memory object and returns a device pointer in `devPtr`.

The properties of the buffer being mapped must be described in `bufferDesc`. The CUDA_EXTERNAL_MEMORY_BUFFER_DESC structure is defined as follows:

```
typedef struct CUDA_EXTERNAL_MEMORY_BUFFER_DESC_st {
         unsigned long long offset;
         unsigned long long size;
         unsigned int flags;
     } CUDA_EXTERNAL_MEMORY_BUFFER_DESC;
```

where CUDA_EXTERNAL_MEMORY_BUFFER_DESC::offset is the offset in the memory object where the buffer's base address is. CUDA_EXTERNAL_MEMORY_BUFFER_DESC::size is the size of the buffer. CUDA_EXTERNAL_MEMORY_BUFFER_DESC::flags must be zero.

The offset and size have to be suitably aligned to match the requirements of the external API. Mapping two buffers whose ranges overlap may or may not result in the same virtual address being returned for the overlapped portion. In such cases, the application must ensure that all accesses to that region from the GPU are volatile. Otherwise writes made via one address are not guaranteed to be visible via the other address, even if they're issued by the same thread. It is recommended that applications map the combined range instead of mapping separate buffers and then apply the appropriate offsets to the returned pointer to derive the individual buffers.

The returned pointer `devPtr` must be freed using cuMemFree.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuImportExternalMemory, cuDestroyExternalMemory, cuExternalMemoryGetMappedMipmappedArray

# CUresult cuExternalMemoryGetMappedMipmappedArray (CUmipmappedArray *mipmap, CUexternalMemory extMem, const CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC *mipmapDesc)

Maps a CUDA mipmapped array onto an external memory object.

## Parameters

**mipmap**
- Returned CUDA mipmapped array

**extMem**
- Handle to external memory object

**mipmapDesc**
- CUDA array descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Maps a CUDA mipmapped array onto an external object and returns a handle to it in `mipmap`.

The properties of the CUDA mipmapped array being mapped must be described in `mipmapDesc`. The structure CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC is defined as follows:

```
typedef struct CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_st {
         unsigned long long offset;
         CUDA_ARRAY3D_DESCRIPTOR arrayDesc;
         unsigned int numLevels;
     } CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC;
```

where CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::offset is the offset in the memory object where the base level of the mipmap chain is. CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::arrayDesc describes

the format, dimensions and type of the base level of the mipmap chain. For further details on these parameters, please refer to the documentation for cuMipmappedArrayCreate. Note that if the mipmapped array is bound as a color target in the graphics API, then the flag CUDA_ARRAY3D_COLOR_ATTACHMENT must be specified in CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::arrayDesc::Flags. CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::numLevels specifies the total number of levels in the mipmap chain.

If `extMem` was imported from a handle of type CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF, then CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC::numLevels must be equal to 1.

Mapping `extMem` imported from a handle of type CU_EXTERNAL_MEMORY_HANDLE_TYPE_DMABUF_FD, is not supported.

The returned CUDA mipmapped array must be freed using cuMipmappedArrayDestroy.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuImportExternalMemory, cuDestroyExternalMemory, cuExternalMemoryGetMappedBuffer

# CUresult cuImportExternalMemory (CUexternalMemory *extMem_out, const CUDA_EXTERNAL_MEMORY_HANDLE_DESC *memHandleDesc)

Imports an external memory object.

## Parameters

**extMem_out**
- Returned handle to an external memory object

**memHandleDesc**
- Memory import handle descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OPERATING_SYSTEM

## Description

Imports an externally allocated memory object and returns a handle to that in `extMem_out`.

The properties of the handle being imported must be described in `memHandleDesc`. The CUDA_EXTERNAL_MEMORY_HANDLE_DESC structure is defined as follows:

```
typedef struct CUDA_EXTERNAL_MEMORY_HANDLE_DESC_st {
    CUexternalMemoryHandleType type;
    union {
        int fd;
        struct {
            void *handle;
            const void *name;
        } win32;
        const void *nvSciBufObject;
    } handle;
    unsigned long long size;
    unsigned int flags;
} CUDA_EXTERNAL_MEMORY_HANDLE_DESC;
```

where CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type specifies the type of handle being imported. CUexternalMemoryHandleType is defined as:

```
typedef enum CUexternalMemoryHandleType_enum {
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_FD          = 1,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32       = 2,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32_KMT   = 3,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_HEAP         = 4,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE     = 5,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE     = 6,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT = 7,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF           = 8,
    CU_EXTERNAL_MEMORY_HANDLE_TYPE_DMABUF_FD          = 9
} CUexternalMemoryHandleType;
```

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_FD, then CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::fd must be a valid file descriptor referencing a memory object. Ownership of the file descriptor is transferred to the CUDA driver when the handle is imported successfully. Performing any operations on the file descriptor after it is imported results in undefined behavior.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32, then exactly one of CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle and CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name must not be NULL. If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle is not NULL, then it must represent a valid shared NT handle that references a memory object. Ownership of this handle is not transferred to CUDA after the import operation, so the application must release the handle using the appropriate system call. If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a memory object.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32_KMT, then

CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle must be non-NULL and CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name must be NULL. The handle specified must be a globally shared KMT handle. This handle does not hold a reference to the underlying object, and thus will be invalid when all references to the memory object are destroyed.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_HEAP, then exactly one of CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle and CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name must not be NULL. If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle is not NULL, then it must represent a valid shared NT handle that is returned by ID3D12Device::CreateSharedHandle when referring to a ID3D12Heap object. This handle holds a reference to the underlying object. If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a ID3D12Heap object.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE, then exactly one of CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle and CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name must not be NULL. If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle is not NULL, then it must represent a valid shared NT handle that is returned by ID3D12Device::CreateSharedHandle when referring to a ID3D12Resource object. This handle holds a reference to the underlying object. If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a ID3D12Resource object.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE, then CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle must represent a valid shared NT handle that is returned by IDXGIResource1::CreateSharedHandle when referring to a ID3D11Resource object. If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name is not NULL, then it must point to a NULL-terminated array of UTF-16 characters that refers to a ID3D11Resource object.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT, then CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::handle must represent a valid shared KMT handle that is returned by IDXGIResource::GetSharedHandle when referring to a ID3D11Resource object and CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::win32::name must be NULL.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF, then CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::nvSciBufObject must be non-NULL and reference a valid NvSciBuf object. If the NvSciBuf object imported into CUDA is also mapped by other drivers, then the application must use cuWaitExternalSemaphoresAsync or cuSignalExternalSemaphoresAsync as

appropriate barriers to maintain coherence between CUDA and the other drivers. See CUDA_EXTERNAL_SEMAPHORE_SIGNAL_SKIP_NVSCIBUF_MEMSYNC and CUDA_EXTERNAL_SEMAPHORE_WAIT_SKIP_NVSCIBUF_MEMSYNC for memory synchronization.

If CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_DMABUF_FD, then CUDA_EXTERNAL_MEMORY_HANDLE_DESC::handle::fd must be a valid file descriptor referencing a dma_buf object and CUDA_EXTERNAL_MEMORY_HANDLE_DESC::flags must be zero. Importing a dma_buf object is supported only on Tegra Jetson platform starting with Thor series. Mapping an imported dma_buf object as CUDA mipmapped array using cuExternalMemoryGetMappedMipmappedArray is not supported.

The size of the memory object must be specified in CUDA_EXTERNAL_MEMORY_HANDLE_DESC::size.

Specifying the flag CUDA_EXTERNAL_MEMORY_DEDICATED in CUDA_EXTERNAL_MEMORY_HANDLE_DESC::flags indicates that the resource is a dedicated resource. The definition of what a dedicated resource is outside the scope of this extension. This flag must be set if CUDA_EXTERNAL_MEMORY_HANDLE_DESC::type is one of the following: CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- If the Vulkan memory imported into CUDA is mapped on the CPU then the application must use vkInvalidateMappedMemoryRanges/vkFlushMappedMemoryRanges as well as appropriate Vulkan pipeline barriers to maintain coherence between CPU and GPU. For more information on these APIs, please refer to "Synchronization and Cache Control" chapter from Vulkan specification.

See also:

cuDestroyExternalMemory, cuExternalMemoryGetMappedBuffer, cuExternalMemoryGetMappedMipmappedArray

# CUresult cuImportExternalSemaphore (CUexternalSemaphore *extSem_out, const CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC *semHandleDesc)

Imports an external semaphore.

## Parameters

**extSem_out**

- Returned handle to an external semaphore

**semHandleDesc**

- Semaphore import handle descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OPERATING_SYSTEM

## Description

Imports an externally allocated synchronization object and returns a handle to that in `extSem_out`.

The properties of the handle being imported must be described in `semHandleDesc`. The CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC is defined as follows:

```
typedef struct CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_st {
        CUexternalSemaphoreHandleType type;
        union {
            int fd;
            struct {
                void *handle;
                const void *name;
            } win32;
            const void* NvSciSyncObj;
        } handle;
        unsigned int flags;
    } CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC;
```

where CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type specifies the type of handle being imported. CUexternalSemaphoreHandleType is defined as:

```
typedef enum CUexternalSemaphoreHandleType_enum {
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD                 = 1,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32              = 2,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT          = 3,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE               = 4,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE               = 5,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC                 = 6,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX         = 7,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT     = 8,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_FD     = 9,
        CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_WIN32 = 10
    } CUexternalSemaphoreHandleType;
```

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD, then CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::fd must be a valid file descriptor referencing a synchronization object. Ownership of the file descriptor is transferred to the CUDA driver when the handle is imported successfully. Performing any operations on the file descriptor after it is imported results in undefined behavior.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32, then exactly one of CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle and CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name must not be NULL. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle is not NULL, then it must represent a valid shared NT handle that references a synchronization object. Ownership of this handle is not transferred to CUDA after the import operation, so the application must release the handle using the appropriate system call. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name is not NULL, then it must name a valid synchronization object.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT, then CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle must be non-NULL and CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name must be NULL. The handle specified must be a globally shared KMT handle. This handle does not hold a reference to the underlying object, and thus will be invalid when all references to the synchronization object are destroyed.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE, then exactly one of CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle and CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name must not be NULL. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle is not NULL, then it must represent a valid shared NT handle that is returned by ID3D12Device::CreateSharedHandle when referring to a ID3D12Fence object. This handle holds a reference to the underlying object. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name is not NULL, then it must name a valid synchronization object that refers to a valid ID3D12Fence object.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE, then CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle represents a valid shared NT handle that is returned by ID3D11Fence::CreateSharedHandle. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name is not NULL, then it must name a valid synchronization object that refers to a valid ID3D11Fence object.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC, then

CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::nvSciSyncObj represents a valid NvSciSyncObj.

CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX, then CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle represents a valid shared NT handle that is returned by IDXGIResource1::CreateSharedHandle when referring to a IDXGIKeyedMutex object. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name is not NULL, then it must name a valid synchronization object that refers to a valid IDXGIKeyedMutex object.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT, then CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle represents a valid shared KMT handle that is returned by IDXGIResource::GetSharedHandle when referring to a IDXGIKeyedMutex object and CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name must be NULL.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_FD, then CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::fd must be a valid file descriptor referencing a synchronization object. Ownership of the file descriptor is transferred to the CUDA driver when the handle is imported successfully. Performing any operations on the file descriptor after it is imported results in undefined behavior.

If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::type is CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_WIN32, then exactly one of CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle and CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name must not be NULL. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::handle is not NULL, then it must represent a valid shared NT handle that references a synchronization object. Ownership of this handle is not transferred to CUDA after the import operation, so the application must release the handle using the appropriate system call. If CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC::handle::win32::name is not NULL, then it must name a valid synchronization object.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDestroyExternalSemaphore, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync

# CUresult cuSignalExternalSemaphoresAsync (const CUexternalSemaphore *extSemArray, const CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS *paramsArray, unsigned int numExtSems, CUstream stream)

Signals a set of external semaphore objects.

## Parameters

**extSemArray**
- Set of external semaphores to be signaled

**paramsArray**
- Array of semaphore parameters

**numExtSems**
- Number of semaphores to signal

**stream**
- Stream to enqueue the signal operations in

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_SUPPORTED

## Description

Enqueues a signal operation on a set of externally allocated semaphore object in the specified stream. The operations will be executed when all prior operations in the stream complete.

The exact semantics of signaling a semaphore depends on the type of the object.

If the semaphore object is any one of the following types: CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT then signaling the semaphore will set it to the signaled state.

If the semaphore object is any one of the following types: CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_FD, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_WIN32 then the semaphore will be set to the value specified in CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS::params::fence::value.

If the semaphore object is of the type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC this API sets CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS::params::nvSciSync::fence to a value that can be used by subsequent waiters of the same NvSciSync object to order operations with those currently submitted in `stream`. Such an update will overwrite previous contents of CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS::params::nvSciSync::fence. By default, signaling such an external semaphore object causes appropriate memory synchronization operations to be performed over all external memory objects that are imported as CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF. This ensures that any subsequent accesses made by other importers of the same set of NvSciBuf memory object(s) are coherent. These operations can be skipped by specifying the flag CUDA_EXTERNAL_SEMAPHORE_SIGNAL_SKIP_NVSCIBUF_MEMSYNC, which can be used as a performance optimization when data coherency is not required. But specifying this flag in scenarios where data coherency is required results in undefined behavior. Also, for semaphore object of the type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC, if the NvSciSyncAttrList used to create the NvSciSyncObj had not set the flags in cuDeviceGetNvSciSyncAttributes to CUDA_NVSCISYNC_ATTR_SIGNAL, this API will return CUDA_ERROR_NOT_SUPPORTED. NvSciSyncFence associated with semaphore object of the type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC can be deterministic. For this the NvSciSyncAttrList used to create the semaphore object must have value of NvSciSyncAttrKey_RequireDeterministicFences key set to true. Deterministic fences allow users to enqueue a wait over the semaphore object even before corresponding signal is enqueued. For such a semaphore object, CUDA guarantees that each signal operation will increment the fence value by '1'. Users are expected to track count of signals enqueued on the semaphore object and insert waits accordingly. When such a semaphore object is signaled from multiple streams, due to concurrent stream execution, it is possible that the order in which the semaphore gets signaled is indeterministic. This could lead to waiters of the semaphore getting unblocked incorrectly. Users are expected to handle such situations, either by not using the same semaphore object with deterministic fence support enabled in different streams or by adding explicit dependency amongst such streams so that the semaphore is signaled in order. NvSciSyncFence associated with semaphore object of the type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC can be timestamp enabled. For this the NvSciSyncAttrList used to create the object must have the value of NvSciSyncAttrKey_WaiterRequireTimestamps key set to true. Timestamps are emitted asynchronously by the GPU and CUDA saves the GPU timestamp in the corresponding NvSciSyncFence at the time of signal on GPU. Users are expected to convert GPU clocks to CPU clocks using appropriate scaling functions. Users are expected to wait for the completion of the fence before extracting timestamp using appropriate NvSciSync APIs. Users are expected to ensure that there is only one outstanding timestamp enabled fence per Cuda-NvSciSync object at any point of time, failing which leads to undefined behavior. Extracting the timestamp before the corresponding fence is signalled could lead to undefined behaviour. Timestamp extracted via appropriate NvSciSync API would be in microseconds.

If the semaphore object is any one of the following types: CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX,

CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT
then the keyed mutex will be released with the key specified in
CUDA_EXTERNAL_SEMAPHORE_PARAMS::params::keyedmutex::key.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuImportExternalSemaphore, cuDestroyExternalSemaphore, cuWaitExternalSemaphoresAsync

# CUresult cuWaitExternalSemaphoresAsync (const CUexternalSemaphore *extSemArray, const CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS *paramsArray, unsigned int numExtSems, CUstream stream)

Waits on a set of external semaphore objects.

## Parameters

**extSemArray**
- External semaphores to be waited on

**paramsArray**
- Array of semaphore parameters

**numExtSems**
- Number of semaphores to wait on

**stream**
- Stream to enqueue the wait operations in

## Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_TIMEOUT

## Description

Enqueues a wait operation on a set of externally allocated semaphore object in the specified stream. The operations will be executed when all prior operations in the stream complete.

The exact semantics of waiting on a semaphore depends on the type of the object.

If the semaphore object is any one of the following types:
CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD,

CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT then waiting on the semaphore will wait until the semaphore reaches the signaled state. The semaphore will then be reset to the unsignaled state. Therefore for every signal operation, there can only be one wait operation.

If the semaphore object is any one of the following types: CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_FD, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_WIN32 then waiting on the semaphore will wait until the value of the semaphore is greater than or equal to CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS::params::fence::value.

If the semaphore object is of the type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC then, waiting on the semaphore will wait until the CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS::params::nvSciSync::fence is signaled by the signaler of the NvSciSyncObj that was associated with this semaphore object. By default, waiting on such an external semaphore object causes appropriate memory synchronization operations to be performed over all external memory objects that are imported as CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF. This ensures that any subsequent accesses made by other importers of the same set of NvSciBuf memory object(s) are coherent. These operations can be skipped by specifying the flag CUDA_EXTERNAL_SEMAPHORE_WAIT_SKIP_NVSCIBUF_MEMSYNC, which can be used as a performance optimization when data coherency is not required. But specifying this flag in scenarios where data coherency is required results in undefined behavior. Also, for semaphore object of the type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC, if the NvSciSyncAttrList used to create the NvSciSyncObj had not set the flags in cuDeviceGetNvSciSyncAttributes to CUDA_NVSCISYNC_ATTR_WAIT, this API will return CUDA_ERROR_NOT_SUPPORTED.

If the semaphore object is any one of the following types: CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX, CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT then the keyed mutex will be acquired when it is released with the key specified in CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS::params::keyedmutex::key or until the timeout specified by CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS::params::keyedmutex::timeoutMs has lapsed. The timeout interval can either be a finite value specified in milliseconds or an infinite value. In case an infinite value is specified the timeout never elapses. The windows INFINITE macro must be used to specify infinite timeout.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuImportExternalSemaphore, cuDestroyExternalSemaphore, cuSignalExternalSemaphoresAsync

# 6.22. Stream Memory Operations

This section describes the stream memory operations of the low-level CUDA driver application programming interface.

Support for the CU_STREAM_WAIT_VALUE_NOR flag can be queried with CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR_V2.

Support for the cuStreamWriteValue64() and cuStreamWaitValue64() functions, as well as for the CU_STREAM_MEM_OP_WAIT_VALUE_64 and CU_STREAM_MEM_OP_WRITE_VALUE_64 flags, can be queried with CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS.

Support for both CU_STREAM_WAIT_VALUE_FLUSH and CU_STREAM_MEM_OP_FLUSH_REMOTE_WRITES requires dedicated platform hardware features and can be queried with cuDeviceGetAttribute() and CU_DEVICE_ATTRIBUTE_CAN_FLUSH_REMOTE_WRITES.

Note that all memory pointers passed as parameters to these operations are device pointers. Where necessary a device pointer should be obtained, for example with cuMemHostGetDevicePointer().

None of the operations accepts pointers to managed memory buffers (cuMemAllocManaged).

Note:

Warning: Improper use of these APIs may deadlock the application. Synchronization ordering established through these APIs is not visible to CUDA. CUDA tasks that are (even indirectly) ordered by these APIs should also have that order expressed with CUDA-visible dependencies such as events. This ensures that the scheduler does not serialize them in an improper order.

## CUresult cuStreamBatchMemOp (CUstream stream, unsigned int count, CUstreamBatchMemOpParams *paramArray, unsigned int flags)

Batch operations to synchronize the stream via memory operations.

### Parameters

**stream**

The stream to enqueue the operations in.

**count**

The number of operations in the array. Must be less than 256.

**paramArray**
The types and parameters of the individual operations.
**flags**
Reserved for future expansion; must be 0.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

This is a batch version of cuStreamWaitValue32() and cuStreamWriteValue32(). Batching operations may avoid some performance overhead in both the API call and the device execution versus adding them to the stream in separate API calls. The operations are enqueued in the order they appear in the array.

See CUstreamBatchMemOpType for the full set of supported operations, and cuStreamWaitValue32(), cuStreamWaitValue64(), cuStreamWriteValue32(), and cuStreamWriteValue64() for details of specific operations.

See related APIs for details on querying support for specific operations.

Note:

Warning: Improper use of this API may deadlock the application. Synchronization ordering established through this API is not visible to CUDA. CUDA tasks that are (even indirectly) ordered by this API should also have that order expressed with CUDA-visible dependencies such as events. This ensures that the scheduler does not serialize them in an improper order.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamWaitValue32, cuStreamWaitValue64, cuStreamWriteValue32, cuStreamWriteValue64, cuMemHostRegister

# CUresult cuStreamWaitValue32 (CUstream stream, CUdeviceptr addr, cuuint32_t value, unsigned int flags)

Wait on a memory location.

## Parameters

**stream**
The stream to synchronize on the memory location.

**addr**
The memory location to wait on.

**value**
The value to compare with the memory location.

**flags**
See CUstreamWaitValue_flags.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

Enqueues a synchronization of the stream on the given memory location. Work ordered after the operation will block until the given condition on the memory is satisfied. By default, the condition is to wait for (int32_t)(*addr - value) >= 0, a cyclic greater-or-equal. Other condition types can be specified via `flags`.

If the memory was registered via cuMemHostRegister(), the device pointer should be obtained with cuMemHostGetDevicePointer(). This function cannot be used with managed memory (cuMemAllocManaged).

Support for CU_STREAM_WAIT_VALUE_NOR can be queried with cuDeviceGetAttribute() and CU_DEVICE_ATTRIBUTE_CAN_USE_STREAM_WAIT_VALUE_NOR_V2.

Note:

Warning: Improper use of this API may deadlock the application. Synchronization ordering established through this API is not visible to CUDA. CUDA tasks that are (even indirectly) ordered by this API should also have that order expressed with CUDA-visible dependencies such as events. This ensures that the scheduler does not serialize them in an improper order.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamWaitValue64, cuStreamWriteValue32, cuStreamWriteValue64, cuStreamBatchMemOp, cuMemHostRegister, cuStreamWaitEvent

# CUresult cuStreamWaitValue64 (CUstream stream, CUdeviceptr addr, cuuint64_t value, unsigned int flags)

Wait on a memory location.

## Parameters

**stream**
The stream to synchronize on the memory location.

**addr**
The memory location to wait on.

**value**
The value to compare with the memory location.

**flags**
See CUstreamWaitValue_flags.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

Enqueues a synchronization of the stream on the given memory location. Work ordered after the operation will block until the given condition on the memory is satisfied. By default, the condition is to wait for (int64_t)(*addr - value) >= 0, a cyclic greater-or-equal. Other condition types can be specified via `flags`.

If the memory was registered via cuMemHostRegister(), the device pointer should be obtained with cuMemHostGetDevicePointer().

Support for this can be queried with cuDeviceGetAttribute() and CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS.

Note:

Warning: Improper use of this API may deadlock the application. Synchronization ordering established through this API is not visible to CUDA. CUDA tasks that are (even indirectly) ordered by this API should also have that order expressed with CUDA-visible dependencies such as events. This ensures that the scheduler does not serialize them in an improper order.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamWaitValue32, cuStreamWriteValue32, cuStreamWriteValue64, cuStreamBatchMemOp, cuMemHostRegister, cuStreamWaitEvent

# CUresult cuStreamWriteValue32 (CUstream stream, CUdeviceptr addr, cuuint32_t value, unsigned int flags)

Write a value to memory.

## Parameters

**stream**
The stream to do the write in.

**addr**
The device address to write to.

**value**
The value to write.

**flags**
See CUstreamWriteValue_flags.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

Write a value to memory.

If the memory was registered via cuMemHostRegister(), the device pointer should be obtained with cuMemHostGetDevicePointer(). This function cannot be used with managed memory (cuMemAllocManaged).

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamWriteValue64, cuStreamWaitValue32, cuStreamWaitValue64, cuStreamBatchMemOp, cuMemHostRegister, cuEventRecord

## CUresult cuStreamWriteValue64 (CUstream stream, CUdeviceptr addr, cuuint64_t value, unsigned int flags)

Write a value to memory.

### Parameters

**stream**
The stream to do the write in.

**addr**
The device address to write to.

**value**
The value to write.

**flags**
See CUstreamWriteValue_flags.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

### Description

Write a value to memory.

If the memory was registered via cuMemHostRegister(), the device pointer should be obtained with cuMemHostGetDevicePointer().

Support for this can be queried with cuDeviceGetAttribute() and CU_DEVICE_ATTRIBUTE_CAN_USE_64_BIT_STREAM_MEM_OPS.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamWriteValue32, cuStreamWaitValue32, cuStreamWaitValue64, cuStreamBatchMemOp, cuMemHostRegister, cuEventRecord

# 6.23. Execution Control

This section describes the execution control functions of the low-level CUDA driver application programming interface.

# CUresult cuFuncGetAttribute (int *pi, CUfunction_attribute attrib, CUfunction hfunc)

Returns information about a function.

## Parameters

**pi**
- Returned attribute value

**attrib**
- Attribute requested

**hfunc**
- Function to query attribute of

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_FUNCTION_NOT_LOADED

## Description

Returns in `*pi` the integer value of the attribute `attrib` on the kernel given by `hfunc`. The supported attributes are:

- CU_FUNC_ATTRIBUTE_MAX_THREADS_PER_BLOCK: The maximum number of threads per block, beyond which a launch of the function would fail. This number depends on both the function and the device on which the function is currently loaded.
- CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES: The size in bytes of statically-allocated shared memory per block required by this function. This does not include dynamically-allocated shared memory requested by the user at runtime.
- CU_FUNC_ATTRIBUTE_CONST_SIZE_BYTES: The size in bytes of user-allocated constant memory required by this function.
- CU_FUNC_ATTRIBUTE_LOCAL_SIZE_BYTES: The size in bytes of local memory used by each thread of this function.
- CU_FUNC_ATTRIBUTE_NUM_REGS: The number of registers used by each thread of this function.
- CU_FUNC_ATTRIBUTE_PTX_VERSION: The PTX virtual architecture version for which the function was compiled. This value is the major PTX version * 10 + the minor PTX version, so a PTX version 1.3 function would return the value 13. Note that this may return the undefined value of 0 for cubins compiled prior to CUDA 3.0.
- CU_FUNC_ATTRIBUTE_BINARY_VERSION: The binary architecture version for which the function was compiled. This value is the major binary version * 10 + the minor binary version, so

a binary version 1.3 function would return the value 13. Note that this will return a value of 10 for legacy cubins that do not have a properly-encoded binary architecture version.

- CU_FUNC_CACHE_MODE_CA: The attribute to indicate whether the function has been compiled with user specified option "-Xptxas --dlcm=ca" set .
- CU_FUNC_ATTRIBUTE_MAX_DYNAMIC_SHARED_SIZE_BYTES: The maximum size in bytes of dynamically-allocated shared memory.
- CU_FUNC_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT: Preferred shared memory-L1 cache split ratio in percent of total shared memory.
- CU_FUNC_ATTRIBUTE_CLUSTER_SIZE_MUST_BE_SET: If this attribute is set, the kernel must launch with a valid cluster size specified.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_WIDTH: The required cluster width in blocks.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_HEIGHT: The required cluster height in blocks.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_DEPTH: The required cluster depth in blocks.
- CU_FUNC_ATTRIBUTE_NON_PORTABLE_CLUSTER_SIZE_ALLOWED: Indicates whether the function can be launched with non-portable cluster size. 1 is allowed, 0 is disallowed. A non-portable cluster size may only function on the specific SKUs the program is tested on. The launch might fail if the program is run on a different hardware platform. CUDA API provides cudaOccupancyMaxActiveClusters to assist with checking whether the desired size can be launched on the current device. A portable cluster size is guaranteed to be functional on all compute capabilities higher than the target compute capability. The portable cluster size for sm_90 is 8 blocks per cluster. This value may increase for future compute capabilities. The specific hardware unit may support higher cluster sizes that’s not guaranteed to be portable.
- CU_FUNC_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE: The block scheduling policy of a function. The value type is CUclusterSchedulingPolicy.

With a few exceptions, function attributes may also be queried on unloaded function handles returned from cuModuleEnumerateFunctions. CUDA_ERROR_FUNCTION_NOT_LOADED is returned if the attribute requires a fully loaded function but the function is not loaded. The loading state of a function may be queried using cuFuncIsloaded. cuFuncLoad may be called to explicitly load a function before querying the following attributes that require the function to be loaded:

- CU_FUNC_ATTRIBUTE_MAX_THREADS_PER_BLOCK
- CU_FUNC_ATTRIBUTE_CONST_SIZE_BYTES
- CU_FUNC_ATTRIBUTE_MAX_DYNAMIC_SHARED_SIZE_BYTES

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuFuncSetCacheConfig, cuLaunchKernel, cudaFuncGetAttributes, cudaFuncSetAttribute, cuFuncIsLoaded, cuFuncLoad, cuKernelGetAttribute

# CUresult cuFuncGetModule (CUmodule *hmod, CUfunction hfunc)

Returns a module handle.

## Parameters

**hmod**
- Returned module handle

**hfunc**
- Function to retrieve module for

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND

## Description

Returns in `*hmod` the handle of the module that function `hfunc` is located in. The lifetime of the module corresponds to the lifetime of the context it was loaded in or until the module is explicitly unloaded.

The CUDA runtime manages its own modules loaded into the primary context. If the handle returned by this API refers to a module loaded by the CUDA runtime, calling cuModuleUnload() on that module will result in undefined behavior.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

# CUresult cuFuncGetName (const char **name, CUfunction hfunc)

Returns the function name for a CUfunction handle.

## Parameters

**name**
- The returned name of the function

**hfunc**
- The function handle to retrieve the name for

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

### Description

Returns in `**name` the function name associated with the function handle `hfunc` . The function name is returned as a null-terminated string. The returned name is only valid when the function handle is valid. If the module is unloaded or reloaded, one must call the API again to get the updated name. This API may return a mangled name if the function is not declared as having C linkage. If either `**name` or `hfunc` is NULL, CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

## CUresult cuFuncGetParamCount (CUfunction func, size_t *paramCount)

Returns the number of parameters used by the function.

### Parameters

**func**
- The function to query

**paramCount**
- Returns the number of parameters used by the function

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

Queries the number of kernel parameters used by `func` and returns it in `paramCount`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncGetParamInfo

# CUresult cuFuncGetParamInfo (CUfunction func, size_t paramIndex, size_t *paramOffset, size_t *paramSize)

Returns the offset and size of a kernel parameter in the device-side parameter layout.

## Parameters

**func**
- The function to query

**paramIndex**
- The parameter index to query

**paramOffset**
- Returns the offset into the device-side parameter layout at which the parameter resides

**paramSize**
- Optionally returns the size of the parameter in the device-side parameter layout

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Queries the kernel parameter at `paramIndex` into `func's` list of parameters, and returns in `paramOffset` and `paramSize` the offset and size, respectively, where the parameter will reside in the device-side parameter layout. This information can be used to update kernel node parameters from the device via cudaGraphKernelNodeSetParam() and cudaGraphKernelNodeUpdatesApply(). `paramIndex` must be less than the number of parameters that `func` takes. `paramSize` can be set to NULL if only the parameter offset is desired.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuKernelGetParamInfo

# CUresult cuFuncIsLoaded (CUfunctionLoadingState *state, CUfunction function)

Returns if the function is loaded.

## Parameters

**state**
- returned loading state

**function**
- the function to check

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `state` the loading state of `function`.

See also:

cuFuncLoad, cuModuleEnumerateFunctions

# CUresult cuFuncLoad (CUfunction function)

Loads a function.

## Parameters

**function**
- the function to load

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

## Description

Finalizes function loading for `function`. Calling this API with a fully loaded function has no effect.

See also:

cuModuleEnumerateFunctions, cuFuncIsLoaded

# CUresult cuFuncSetAttribute (CUfunction hfunc, CUfunction_attribute attrib, int value)

Sets information about a function.

## Parameters

**hfunc**
- Function to query attribute of

**attrib**
- Attribute requested

**value**
- The value to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

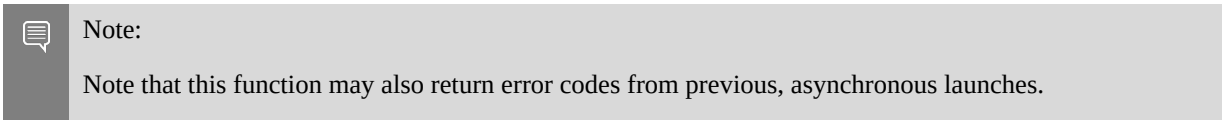
## Description

This call sets the value of a specified attribute `attrib` on the kernel given by `hfunc` to an integer value specified by `val` This function returns CUDA_SUCCESS if the new value of the attribute could be successfully set. If the set fails, this call will return an error. Not all attributes can have values set. Attempting to set a value on a read-only attribute will result in an error (CUDA_ERROR_INVALID_VALUE)

Supported attributes for the cuFuncSetAttribute call are:

- CU_FUNC_ATTRIBUTE_MAX_DYNAMIC_SHARED_SIZE_BYTES: This maximum size in bytes of dynamically-allocated shared memory. The value should contain the requested maximum size of dynamically-allocated shared memory. The sum of this value and the function attribute CU_FUNC_ATTRIBUTE_SHARED_SIZE_BYTES cannot exceed the device attribute CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_BLOCK_OPTIN. The maximal size of requestable dynamic shared memory may differ by GPU architecture.
- CU_FUNC_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT: On devices where the L1 cache and shared memory use the same hardware resources, this sets the shared memory carveout preference, in percent of the total shared memory. See CU_DEVICE_ATTRIBUTE_MAX_SHARED_MEMORY_PER_MULTIPROCESSOR This is only a hint, and the driver can choose a different ratio if required to execute the function.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_WIDTH: The required cluster width in blocks. The width, height, and depth values must either all be 0 or all be positive. The validity of the cluster dimensions is checked at launch time. If the value is set during compile time, it cannot be set at runtime. Setting it at runtime will return CUDA_ERROR_NOT_PERMITTED.

- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_HEIGHT: The required cluster height in blocks. The width, height, and depth values must either all be 0 or all be positive. The validity of the cluster dimensions is checked at launch time. If the value is set during compile time, it cannot be set at runtime. Setting it at runtime will return CUDA_ERROR_NOT_PERMITTED.
- CU_FUNC_ATTRIBUTE_REQUIRED_CLUSTER_DEPTH: The required cluster depth in blocks. The width, height, and depth values must either all be 0 or all be positive. The validity of the cluster dimensions is checked at launch time. If the value is set during compile time, it cannot be set at runtime. Setting it at runtime will return CUDA_ERROR_NOT_PERMITTED.
- CU_FUNC_ATTRIBUTE_NON_PORTABLE_CLUSTER_SIZE_ALLOWED: Indicates whether the function can be launched with non-portable cluster size. 1 is allowed, 0 is disallowed.
- CU_FUNC_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE: The block scheduling policy of a function. The value type is CUclusterSchedulingPolicy.




See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuFuncSetCacheConfig, cuLaunchKernel, cudaFuncGetAttributes, cudaFuncSetAttribute, cuKernelSetAttribute

# CUresult cuFuncSetCacheConfig (CUfunction hfunc, CUfunc_cache config)

Sets the preferred cache configuration for a device function.

## Parameters

**hfunc**
- Kernel to configure cache for

**config**
- Requested cache configuration

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT

## Description

On devices where the L1 cache and shared memory use the same hardware resources, this sets through `config` the preferred cache configuration for the device function `hfunc`. This is only a preference. The driver will use the requested configuration if possible, but it is free to choose a different configuration if required to execute `hfunc`. Any context-wide preference set via

cuCtxSetCacheConfig() will be overridden by this per-function setting unless the per-function setting is CU_FUNC_CACHE_PREFER_NONE. In that case, the current context-wide setting will be used.

This setting does nothing on devices where the size of the L1 cache and shared memory are fixed.

Launching a kernel with a different preference than the most recent preference setting may insert a device-side synchronization point.

The supported cache configurations are:

- CU_FUNC_CACHE_PREFER_NONE: no preference for shared memory or L1 (default)
- CU_FUNC_CACHE_PREFER_SHARED: prefer larger shared memory and smaller L1 cache
- CU_FUNC_CACHE_PREFER_L1: prefer larger L1 cache and smaller shared memory
- CU_FUNC_CACHE_PREFER_EQUAL: prefer equal sized L1 cache and shared memory

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuFuncGetAttribute, cuLaunchKernel, cudaFuncSetCacheConfig, cuKernelSetCacheConfig

# CUresult cuLaunchCooperativeKernel (CUfunction f, unsigned int gridDimX, unsigned int gridDimY, unsigned int gridDimZ, unsigned int blockDimX, unsigned int blockDimY, unsigned int blockDimZ, unsigned int sharedMemBytes, CUstream hStream, void **kernelParams)

Launches a CUDA function CUfunction or a CUDA kernel CUkernel where thread blocks can cooperate and synchronize as they execute.

## Parameters

**f**

- Function CUfunction or Kernel CUkernel to launch

**gridDimX**

- Width of grid in blocks

**gridDimY**

- Height of grid in blocks

**gridDimZ**
- Depth of grid in blocks

**blockDimX**
- X dimension of each thread block

**blockDimY**
- Y dimension of each thread block

**blockDimZ**
- Z dimension of each thread block

**sharedMemBytes**
- Dynamic shared-memory size per thread block in bytes

**hStream**
- Stream identifier

**kernelParams**
- Array of pointers to kernel parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_IMAGE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_LAUNCH_FAILED, CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES, CUDA_ERROR_LAUNCH_TIMEOUT, CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING, CUDA_ERROR_COOPERATIVE_LAUNCH_TOO_LARGE, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_NOT_FOUND

## Description

Invokes the function CUfunction or the kernel CUkernel `f` on a `gridDimX` x `gridDimY` x `gridDimZ` grid of blocks. Each block contains `blockDimX` x `blockDimY` x `blockDimZ` threads.

`sharedMemBytes` sets the amount of dynamic shared memory that will be available to each thread block.

The device on which this kernel is invoked must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_COOPERATIVE_LAUNCH.

The total number of blocks launched cannot exceed the maximum number of blocks per multiprocessor as returned by cuOccupancyMaxActiveBlocksPerMultiprocessor (or cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags) times the number of multiprocessors as specified by the device attribute CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT.

The kernel cannot make use of CUDA dynamic parallelism.

Kernel parameters must be specified via `kernelParams`. If `f` has N parameters, then `kernelParams` needs to be an array of N pointers. Each of `kernelParams`[0] through `kernelParams`[N-1] must point to a region of memory from which the actual kernel parameter will

be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.

Calling cuLaunchCooperativeKernel() sets persistent function state that is the same as function state set through cuLaunchKernel API

When the kernel `f` is launched via cuLaunchCooperativeKernel(), the previous block shape, shared size and parameter info associated with `f` is overwritten.

Note that to use cuLaunchCooperativeKernel(), the kernel `f` must either have been compiled with toolchain version 3.2 or later so that it will contain kernel parameter information, or have no kernel parameters. If either of these conditions is not met, then cuLaunchCooperativeKernel() will return CUDA_ERROR_INVALID_IMAGE.

Note that the API can also be used to launch context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to launch the kernel on will either be taken from the specified stream `hStream` or the current context in case of NULL stream.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuFuncSetCacheConfig, cuFuncGetAttribute, cuLaunchCooperativeKernelMultiDevice, cudaLaunchCooperativeKernel, cuLibraryGetKernel, cuKernelSetCacheConfig, cuKernelGetAttribute, cuKernelSetAttribute

# CUresult cuLaunchHostFunc (CUstream hStream, CUhostFn fn, void *userData)

Enqueues a host function call in a stream.

## Parameters

**hStream**
- Stream to enqueue function call in

**fn**
- The function to call once preceding stream operations are complete

**userData**
- User-specified data to be passed to the function

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_SUPPORTED

## Description

Enqueues a host function to run in a stream. The function will be called after currently enqueued work and will block work added after it.

The host function must not make any CUDA API calls. Attempting to use a CUDA API may result in CUDA_ERROR_NOT_PERMITTED, but this is not required. The host function must not perform any synchronization that may depend on outstanding CUDA work not mandated to run earlier. Host functions without a mandated order (such as in independent streams) execute in undefined order and may be serialized.

For the purposes of Unified Memory, execution makes a number of guarantees:

- The stream is considered idle for the duration of the function's execution. Thus, for example, the function may always use memory attached to the stream it was enqueued in.
- The start of execution of the function has the same effect as synchronizing an event recorded in the same stream immediately prior to the function. It thus synchronizes streams which have been "joined" prior to the function.
- Adding device work to any stream does not have the effect of making the stream active until all preceding host functions and stream callbacks have executed. Thus, for example, a function might use global attached memory even if work has been added to another stream, if the work has been ordered behind the function call with an event.
- Completion of the function does not cause a stream to become active except as described above. The stream will remain idle if no device work follows the function, and will remain idle across consecutive host functions or stream callbacks without device work in between. Thus, for example, stream synchronization can be done by signaling from a host function at the end of the stream.

Note that, in contrast to cuStreamAddCallback, the function will not be called in the event of an error in the CUDA context.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamQuery, cuStreamSynchronize, cuStreamWaitEvent, cuStreamDestroy, cuMemAllocManaged, cuStreamAttachMemAsync, cuStreamAddCallback

# CUresult cuLaunchHostFunc_v2 (CUstream hStream, CUhostFn fn, void *userData, unsigned int syncMode)

Enqueues a host function call in a stream.

## Parameters

**hStream**
- Stream to enqueue function call in

**fn**
- The function to call once preceding stream operations are complete

**userData**
- User-specified data to be passed to the function

**syncMode**
- Synchronization mode for the host function

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_SUPPORTED

## Description

Enqueues a host function to run in a stream. The function will be called after currently enqueued work and will block work added after it.

The host function must not make any CUDA API calls. Attempting to use a CUDA API may result in CUDA_ERROR_NOT_PERMITTED, but this is not required. The host function must not perform any synchronization that may depend on outstanding CUDA work not mandated to run earlier. Host functions without a mandated order (such as in independent streams) execute in undefined order and may be serialized.

For the purposes of Unified Memory, execution makes a number of guarantees:

- The stream is considered idle for the duration of the function's execution. Thus, for example, the function may always use memory attached to the stream it was enqueued in.
- The start of execution of the function has the same effect as synchronizing an event recorded in the same stream immediately prior to the function. It thus synchronizes streams which have been "joined" prior to the function.
- Adding device work to any stream does not have the effect of making the stream active until all preceding host functions and stream callbacks have executed. Thus, for example, a function might use global attached memory even if work has been added to another stream, if the work has been ordered behind the function call with an event.
- Completion of the function does not cause a stream to become active except as described above. The stream will remain idle if no device work follows the function, and will remain idle across

consecutive host functions or stream callbacks without device work in between. Thus, for example, stream synchronization can be done by signaling from a host function at the end of the stream.

Note that, in contrast to cuStreamAddCallback, the function will not be called in the event of an error in the CUDA context.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamCreate, cuStreamQuery, cuStreamSynchronize, cuStreamWaitEvent, cuStreamDestroy, cuMemAllocManaged, cuStreamAttachMemAsync, cuStreamAddCallback

## CUresult cuLaunchKernel (CUfunction f, unsigned int gridDimX, unsigned int gridDimY, unsigned int gridDimZ, unsigned int blockDimX, unsigned int blockDimY, unsigned int blockDimZ, unsigned int sharedMemBytes, CUstream hStream, void **kernelParams, void **extra)

Launches a CUDA function CUfunction or a CUDA kernel CUkernel.

### Parameters

**f**
- Function CUfunction or Kernel CUkernel to launch

**gridDimX**
- Width of grid in blocks

**gridDimY**
- Height of grid in blocks

**gridDimZ**
- Depth of grid in blocks

**blockDimX**
- X dimension of each thread block

**blockDimY**
- Y dimension of each thread block

**blockDimZ**
- Z dimension of each thread block

**sharedMemBytes**
- Dynamic shared-memory size per thread block in bytes

**hStream**
- Stream identifier

**kernelParams**
- Array of pointers to kernel parameters

**extra**
- Extra options

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_IMAGE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_LAUNCH_FAILED, CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES, CUDA_ERROR_LAUNCH_TIMEOUT, CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_NOT_FOUND

## Description

Invokes the function CUfunction or the kernel CUkernel `f` on a `gridDimX` x `gridDimY` x `gridDimZ` grid of blocks. Each block contains `blockDimX` x `blockDimY` x `blockDimZ` threads.

`sharedMemBytes` sets the amount of dynamic shared memory that will be available to each thread block.

Kernel parameters to `f` can be specified in one of two ways:

1) Kernel parameters can be specified via `kernelParams`. If `f` has N parameters, then `kernelParams` needs to be an array of N pointers. Each of `kernelParams`[0] through `kernelParams`[N-1] must point to a region of memory from which the actual kernel parameter will be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.

2) Kernel parameters can also be packaged by the application into a single buffer that is passed in via the `extra` parameter. This places the burden on the application of knowing each kernel parameter's size and alignment/padding within the buffer. Here is an example of using the `extra` parameter in this manner:

```
    size_t argBufferSize;
    char argBuffer[256];

    // populate argBuffer and argBufferSize

    void *config[] = {
        CU_LAUNCH_PARAM_BUFFER_POINTER, argBuffer,
        CU_LAUNCH_PARAM_BUFFER_SIZE,    &argBufferSize,
        CU_LAUNCH_PARAM_END
    };
    status = cuLaunchKernel(f, gx, gy, gz, bx, by, bz, sh, s, NULL, config);
```

The `extra` parameter exists to allow cuLaunchKernel to take additional less commonly used arguments. `extra` specifies a list of names of extra settings and their corresponding values. Each extra

setting name is immediately followed by the corresponding value. The list must be terminated with either NULL or CU_LAUNCH_PARAM_END.

- CU_LAUNCH_PARAM_END, which indicates the end of the `extra` array;
- CU_LAUNCH_PARAM_BUFFER_POINTER, which specifies that the next value in `extra` will be a pointer to a buffer containing all the kernel parameters for launching kernel `f`;
- CU_LAUNCH_PARAM_BUFFER_SIZE, which specifies that the next value in `extra` will be a pointer to a size_t containing the size of the buffer specified with CU_LAUNCH_PARAM_BUFFER_POINTER;

The error CUDA_ERROR_INVALID_VALUE will be returned if kernel parameters are specified with both `kernelParams` and `extra` (i.e. both `kernelParams` and `extra` are non-NULL).

Calling cuLaunchKernel() invalidates the persistent function state set through the following deprecated APIs: cuFuncSetBlockShape(), cuFuncSetSharedSize(), cuParamSetSize(), cuParamSeti(), cuParamSetf(), cuParamSetv().

Note that to use cuLaunchKernel(), the kernel `f` must either have been compiled with toolchain version 3.2 or later so that it will contain kernel parameter information, or have no kernel parameters. If either of these conditions is not met, then cuLaunchKernel() will return CUDA_ERROR_INVALID_IMAGE.

Note that the API can also be used to launch context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to launch the kernel on will either be taken from the specified stream `hStream` or the current context in case of NULL stream.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuFuncSetCacheConfig, cuFuncGetAttribute, cudaLaunchKernel, cuLibraryGetKernel, cuKernelSetCacheConfig, cuKernelGetAttribute, cuKernelSetAttribute

# CUresult cuLaunchKernelEx (const CUlaunchConfig *config, CUfunction f, void **kernelParams, void **extra)

Launches a CUDA function CUfunction or a CUDA kernel CUkernel with launch-time configuration.

## Parameters

**config**
- Config to launch

**f**
- Function CUfunction or Kernel CUkernel to launch

**kernelParams**
- Array of pointers to kernel parameters

**extra**
- Extra options

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_IMAGE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_LAUNCH_FAILED, CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES, CUDA_ERROR_LAUNCH_TIMEOUT, CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING, CUDA_ERROR_COOPERATIVE_LAUNCH_TOO_LARGE, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED, CUDA_ERROR_NOT_FOUND

## Description

Invokes the function CUfunction or the kernel CUkernel `f` with the specified launch-time configuration `config`.

The CUlaunchConfig structure is defined as:

```
typedef struct CUlaunchConfig_st {
   unsigned int gridDimX;
   unsigned int gridDimY;
   unsigned int gridDimZ;
   unsigned int blockDimX;
   unsigned int blockDimY;
   unsigned int blockDimZ;
   unsigned int sharedMemBytes;
   CUstream hStream;
   CUlaunchAttribute *attrs;
   unsigned int numAttrs;
} CUlaunchConfig;
```

where:

- CUlaunchConfig::gridDimX is the width of the grid in blocks.
- CUlaunchConfig::gridDimY is the height of the grid in blocks.

- CUlaunchConfig::gridDimZ is the depth of the grid in blocks.
- CUlaunchConfig::blockDimX is the X dimension of each thread block.
- CUlaunchConfig::blockDimX is the Y dimension of each thread block.
- CUlaunchConfig::blockDimZ is the Z dimension of each thread block.
- CUlaunchConfig::sharedMemBytes is the dynamic shared-memory size per thread block in bytes.
- CUlaunchConfig::hStream is the handle to the stream to perform the launch in. The CUDA context associated with this stream must match that associated with function f.
- CUlaunchConfig::attrs is an array of CUlaunchConfig::numAttrs continguous CUlaunchAttribute elements. The value of this pointer is not considered if CUlaunchConfig::numAttrs is zero. However, in that case, it is recommended to set the pointer to NULL.
- CUlaunchConfig::numAttrs is the number of attributes populating the first CUlaunchConfig::numAttrs positions of the CUlaunchConfig::attrs array.

Launch-time configuration is specified by adding entries to CUlaunchConfig::attrs. Each entry is an attribute ID and a corresponding attribute value.

The CUlaunchAttribute structure is defined as:

```
typedef struct CUlaunchAttribute_st {
    CUlaunchAttributeID id;
    CUlaunchAttributeValue value;
} CUlaunchAttribute;
```

where:

- CUlaunchAttribute::id is a unique enum identifying the attribute.
- CUlaunchAttribute::value is a union that hold the attribute value.

An example of using the `config` parameter:

```
CUlaunchAttribute coopAttr = {.id = CU_LAUNCH_ATTRIBUTE_COOPERATIVE,
                              .value = 1};
CUlaunchConfig config = {... // set block and grid dimensions
                         .attrs = &coopAttr,
                         .numAttrs = 1};

cuLaunchKernelEx(&config, kernel, NULL, NULL);
```

The CUlaunchAttributeID enum is defined as:

```
typedef enum CUlaunchAttributeID_enum {
    CU_LAUNCH_ATTRIBUTE_IGNORE = 0,
    CU_LAUNCH_ATTRIBUTE_ACCESS_POLICY_WINDOW   = 1,
    CU_LAUNCH_ATTRIBUTE_COOPERATIVE            = 2,
    CU_LAUNCH_ATTRIBUTE_SYNCHRONIZATION_POLICY = 3,
    CU_LAUNCH_ATTRIBUTE_CLUSTER_DIMENSION                        = 4,
    CU_LAUNCH_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE = 5,
    CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_STREAM_SERIALIZATION    = 6,
    CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_EVENT                   = 7,
    CU_LAUNCH_ATTRIBUTE_PRIORITY               = 8,
    CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN_MAP    = 9,
    CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN        = 10,
    CU_LAUNCH_ATTRIBUTE_PREFERRED_CLUSTER_DIMENSION = 11,
    CU_LAUNCH_ATTRIBUTE_LAUNCH_COMPLETION_EVENT = 12,
    CU_LAUNCH_ATTRIBUTE_DEVICE_UPDATABLE_KERNEL_NODE = 13,
} CUlaunchAttributeID;
```

and the corresponding CUlaunchAttributeValue union as :

```
typedef union CUlaunchAttributeValue_union {
```

```
            CUaccessPolicyWindow accessPolicyWindow;
            int cooperative;
            CUsynchronizationPolicy syncPolicy;
            struct {
                unsigned int x;
                unsigned int y;
                unsigned int z;
            } clusterDim;
            CUclusterSchedulingPolicy clusterSchedulingPolicyPreference;
            int programmaticStreamSerializationAllowed;
            struct {
                CUevent event;
                int flags;
                int triggerAtBlockStart;
            } programmaticEvent;
            int priority;
            CUlaunchMemSyncDomainMap memSyncDomainMap;
            CUlaunchMemSyncDomain memSyncDomain;
            struct {
                unsigned int x;
                unsigned int y;
                unsigned int z;
            } preferredClusterDim;
            struct {
                CUevent event;
                int flags;
            } launchCompletionEvent;
            struct {
                int deviceUpdatable;
                CUgraphDeviceNode devNode;
            } deviceUpdatableKernelNode;
        } CUlaunchAttributeValue;
```

Setting CU_LAUNCH_ATTRIBUTE_COOPERATIVE to a non-zero value causes the kernel launch to be a cooperative launch, with exactly the same usage and semantics of cuLaunchCooperativeKernel.

Setting CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_STREAM_SERIALIZATION to a non-zero values causes the kernel to use programmatic means to resolve its stream dependency -- enabling the CUDA runtime to opportunistically allow the grid's execution to overlap with the previous kernel in the stream, if that kernel requests the overlap.

CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_EVENT records an event along with the kernel launch. Event recorded through this launch attribute is guaranteed to only trigger after all block in the associated kernel trigger the event. A block can trigger the event through PTX launchdep.release or CUDA builtin function cudaTriggerProgrammaticLaunchCompletion(). A trigger can also be inserted at the beginning of each block's execution if triggerAtBlockStart is set to non-0. Note that dependents (including the CPU thread calling cuEventSynchronize()) are not guaranteed to observe the release precisely when it is released. For example, cuEventSynchronize() may only observe the event trigger long after the associated kernel has completed. This recording type is primarily meant for establishing programmatic dependency between device tasks. The event supplied must not be an interprocess or interop event. The event must disable timing (i.e. created with CU_EVENT_DISABLE_TIMING flag set).

CU_LAUNCH_ATTRIBUTE_LAUNCH_COMPLETION_EVENT records an event along with the kernel launch. Nominally, the event is triggered once all blocks of the kernel have begun execution. Currently this is a best effort. If a kernel B has a launch completion dependency on a kernel A, B may

wait until A is complete. Alternatively, blocks of B may begin before all blocks of A have begun, for example:

- If B can claim execution resources unavailable to A, for example if they run on different GPUs.
- If B is a higher priority than A.

Exercise caution if such an ordering inversion could lead to deadlock. The event supplied must not be an interprocess or interop event. The event must disable timing (i.e. must be created with the CU_EVENT_DISABLE_TIMING flag set).

Setting CU_LAUNCH_ATTRIBUTE_DEVICE_UPDATABLE_KERNEL_NODE to 1 on a captured launch causes the resulting kernel node to be device-updatable. This attribute is specific to graphs, and passing it to a launch in a non-capturing stream results in an error. Passing a value other than 0 or 1 is not allowed.

On success, a handle will be returned via CUlaunchAttributeValue::deviceUpdatableKernelNode::devNode which can be passed to the various device-side update functions to update the node's kernel parameters from within another kernel. For more information on the types of device updates that can be made, as well as the relevant limitations thereof, see cudaGraphKernelNodeUpdatesApply.

Kernel nodes which are device-updatable have additional restrictions compared to regular kernel nodes. Firstly, device-updatable nodes cannot be removed from their graph via cuGraphDestroyNode. Additionally, once opted-in to this functionality, a node cannot opt out, and any attempt to set the attribute to 0 will result in an error. Graphs containing one or more device-updatable node also do not allow multiple instantiation.

CU_LAUNCH_ATTRIBUTE_PREFERRED_CLUSTER_DIMENSION allows the kernel launch to specify a preferred substitute cluster dimension. Blocks may be grouped according to either the dimensions specified with this attribute (grouped into a "preferred substitute cluster"), or the one specified with CU_LAUNCH_ATTRIBUTE_CLUSTER_DIMENSION attribute (grouped into a "regular cluster"). The cluster dimensions of a "preferred substitute cluster" shall be an integer multiple greater than zero of the regular cluster dimensions. The device will attempt - on a best-effort basis - to group thread blocks into preferred clusters over grouping them into regular clusters. When it deems necessary (primarily when the device temporarily runs out of physical resources to launch the larger preferred clusters), the device may switch to launch the regular clusters instead to attempt to utilize as much of the physical device resources as possible.

Each type of cluster will have its enumeration / coordinate setup as if the grid consists solely of its type of cluster. For example, if the preferred substitute cluster dimensions double the regular cluster dimensions, there might be simultaneously a regular cluster indexed at (1,0,0), and a preferred cluster indexed at (1,0,0). In this example, the preferred substitute cluster (1,0,0) replaces regular clusters (2,0,0) and (3,0,0) and groups their blocks.

This attribute will only take effect when a regular cluster dimension has been specified. The preferred substitute The preferred substitute cluster dimension must be an integer multiple greater than zero of the regular cluster dimension and must divide the grid. It must also be no more than `maxBlocksPerCluster`, if it is set in the kernel's `__launch_bounds__`. Otherwise it must be less than

the maximum value the driver can support. Otherwise, setting this attribute to a value physically unable to fit on any particular device is permitted.

The effect of other attributes is consistent with their effect when set via persistent APIs.

See cuStreamSetAttribute for

- CU_LAUNCH_ATTRIBUTE_ACCESS_POLICY_WINDOW
- CU_LAUNCH_ATTRIBUTE_SYNCHRONIZATION_POLICY

See cuFuncSetAttribute for

- CU_LAUNCH_ATTRIBUTE_CLUSTER_DIMENSION
- CU_LAUNCH_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE

Kernel parameters to `f` can be specified in the same ways that they can be using cuLaunchKernel.

Note that the API can also be used to launch context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to launch the kernel on will either be taken from the specified stream CUlaunchConfig::hStream or the current context in case of NULL stream.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuFuncSetCacheConfig, cuFuncGetAttribute, cudaLaunchKernel, cudaLaunchKernelEx, cuLibraryGetKernel, cuKernelSetCacheConfig, cuKernelGetAttribute, cuKernelSetAttribute

# 6.24. Execution Control [DEPRECATED]

This section describes the deprecated execution control functions of the low-level CUDA driver application programming interface.

# CUresult cuFuncSetBlockShape (CUfunction hfunc, int x, int y, int z)

Sets the block-dimensions for the function.

## Parameters

**hfunc**
- Kernel to specify dimensions of

**x**
- X dimension

**y**
- Y dimension

**z**
- Z dimension

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Specifies the `x`, `y`, and `z` dimensions of the thread blocks that are created when the kernel given by `hfunc` is launched.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetSharedSize, cuFuncSetCacheConfig, cuFuncGetAttribute, cuParamSetSize, cuParamSeti, cuParamSetf, cuParamSetv, cuLaunch, cuLaunchGrid, cuLaunchGridAsync, cuLaunchKernel

# CUresult cuFuncSetSharedMemConfig (CUfunction hfunc, CUsharedconfig config)

Sets the shared memory configuration for a device function.

## Parameters

**hfunc**
- kernel to be given a shared memory config

**config**
- requested shared memory configuration

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT

## Description

Deprecated

On devices with configurable shared memory banks, this function will force all subsequent launches of the specified device function to have the given shared memory bank size configuration. On any given launch of the function, the shared memory configuration of the device will be temporarily changed if needed to suit the function's preferred configuration. Changes in shared memory configuration between subsequent launches of functions, may introduce a device side synchronization point.

Any per-function setting of shared memory bank size set via cuFuncSetSharedMemConfig will override the context wide setting set with cuCtxSetSharedMemConfig.

Changing the shared memory bank size will not increase shared memory usage or affect occupancy of kernels, but may have major effects on performance. Larger bank sizes will allow for greater potential bandwidth to shared memory, but will change what kinds of accesses to shared memory will result in bank conflicts.

This function will do nothing on devices with fixed shared memory bank size.

The supported bank configurations are:

- CU_SHARED_MEM_CONFIG_DEFAULT_BANK_SIZE: use the context's shared memory configuration when launching this function.
- CU_SHARED_MEM_CONFIG_FOUR_BYTE_BANK_SIZE: set shared memory bank width to be natively four bytes when launching this function.
- CU_SHARED_MEM_CONFIG_EIGHT_BYTE_BANK_SIZE: set shared memory bank width to be natively eight bytes when launching this function.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuCtxGetSharedMemConfig, cuCtxSetSharedMemConfig, cuFuncGetAttribute, cuLaunchKernel, cudaFuncSetSharedMemConfig

# CUresult cuFuncSetSharedSize (CUfunction hfunc, unsigned int bytes)

Sets the dynamic shared-memory size for the function.

## Parameters

**hfunc**

- Kernel to specify dynamic shared-memory size for

**bytes**

- Dynamic shared-memory size per thread in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Sets through `bytes` the amount of dynamic shared memory that will be available to each thread block when the kernel given by `hfunc` is launched.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetCacheConfig, cuFuncGetAttribute, cuParamSetSize, cuParamSeti, cuParamSetf, cuParamSetv, cuLaunch, cuLaunchGrid, cuLaunchGridAsync, cuLaunchKernel

# CUresult cuLaunch (CUfunction f)

Launches a CUDA function.

## Parameters

**f**

- Kernel to launch

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_LAUNCH_FAILED, CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES, CUDA_ERROR_LAUNCH_TIMEOUT, CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED

## Description

Deprecated

Invokes the kernel `f` on a 1 x 1 x 1 grid of blocks. The block contains the number of threads specified by a previous call to cuFuncSetBlockShape().

The block shape, dynamic shared memory size, and parameter information must be set using cuFuncSetBlockShape(), cuFuncSetSharedSize(), cuParamSetSize(), cuParamSeti(), cuParamSetf(), and cuParamSetv() prior to calling this function.

Launching a function via cuLaunchKernel() invalidates the function's block shape, dynamic shared memory size, and parameter information. After launching via cuLaunchKernel, this state must be re-initialized prior to calling this function. Failure to do so results in undefined behavior.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetSharedSize, cuFuncGetAttribute, cuParamSetSize, cuParamSetf, cuParamSeti, cuParamSetv, cuLaunchGrid, cuLaunchGridAsync, cuLaunchKernel

# CUresult cuLaunchCooperativeKernelMultiDevice (CUDA_LAUNCH_PARAMS *launchParamsList, unsigned int numDevices, unsigned int flags)

Launches CUDA functions on multiple devices where thread blocks can cooperate and synchronize as they execute.

## Parameters

**launchParamsList**
- List of launch parameters, one per device

**numDevices**
- Size of the `launchParamsList` array

**flags**
- Flags to control launch behavior

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_IMAGE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_LAUNCH_FAILED, CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES, CUDA_ERROR_LAUNCH_TIMEOUT, CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING, CUDA_ERROR_COOPERATIVE_LAUNCH_TOO_LARGE, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED

## Description

Deprecated This function is deprecated as of CUDA 11.3.

Invokes kernels as specified in the `launchParamsList` array where each element of the array specifies all the parameters required to perform a single kernel launch. These kernels can cooperate and synchronize as they execute. The size of the array is specified by `numDevices`.

No two kernels can be launched on the same device. All the devices targeted by this multi-device launch must be identical. All devices must have a non-zero value for the device attribute CU_DEVICE_ATTRIBUTE_COOPERATIVE_MULTI_DEVICE_LAUNCH.

All kernels launched must be identical with respect to the compiled code. Note that any __device__, __constant__ or __managed__ variables present in the module that owns the kernel launched on each device, are independently instantiated on every device. It is the application's responsibility to ensure these variables are initialized and used appropriately.

The size of the grids as specified in blocks, the size of the blocks themselves and the amount of shared memory used by each thread block must also match across all launched kernels.

The streams used to launch these kernels must have been created via either cuStreamCreate or cuStreamCreateWithPriority. The NULL stream or CU_STREAM_LEGACY or CU_STREAM_PER_THREAD cannot be used.

The total number of blocks launched per kernel cannot exceed the maximum number of blocks per multiprocessor as returned by cuOccupancyMaxActiveBlocksPerMultiprocessor (or cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags) times the number of multiprocessors as specified by the device attribute CU_DEVICE_ATTRIBUTE_MULTIPROCESSOR_COUNT. Since the total number of blocks launched per device has to match across all devices, the maximum number of blocks that can be launched per device will be limited by the device with the least number of multiprocessors.

The kernels cannot make use of CUDA dynamic parallelism.

The CUDA_LAUNCH_PARAMS structure is defined as:

```
typedef struct CUDA_LAUNCH_PARAMS_st
     {
         CUfunction function;
         unsigned int gridDimX;
         unsigned int gridDimY;
         unsigned int gridDimZ;
         unsigned int blockDimX;
         unsigned int blockDimY;
         unsigned int blockDimZ;
         unsigned int sharedMemBytes;
         CUstream hStream;
         void **kernelParams;
     } CUDA_LAUNCH_PARAMS;
```

where:

- CUDA_LAUNCH_PARAMS::function specifies the kernel to be launched. All functions must be identical with respect to the compiled code. Note that you can also specify context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then casting to CUfunction. In this case, the context to launch the kernel on be taken from the specified stream CUDA_LAUNCH_PARAMS::hStream.
- CUDA_LAUNCH_PARAMS::gridDimX is the width of the grid in blocks. This must match across all kernels launched.
- CUDA_LAUNCH_PARAMS::gridDimY is the height of the grid in blocks. This must match across all kernels launched.
- CUDA_LAUNCH_PARAMS::gridDimZ is the depth of the grid in blocks. This must match across all kernels launched.
- CUDA_LAUNCH_PARAMS::blockDimX is the X dimension of each thread block. This must match across all kernels launched.
- CUDA_LAUNCH_PARAMS::blockDimX is the Y dimension of each thread block. This must match across all kernels launched.
- CUDA_LAUNCH_PARAMS::blockDimZ is the Z dimension of each thread block. This must match across all kernels launched.
- CUDA_LAUNCH_PARAMS::sharedMemBytes is the dynamic shared-memory size per thread block in bytes. This must match across all kernels launched.

- CUDA_LAUNCH_PARAMS::hStream is the handle to the stream to perform the launch in. This cannot be the NULL stream or CU_STREAM_LEGACY or CU_STREAM_PER_THREAD. The CUDA context associated with this stream must match that associated with CUDA_LAUNCH_PARAMS::function.
- CUDA_LAUNCH_PARAMS::kernelParams is an array of pointers to kernel parameters. If CUDA_LAUNCH_PARAMS::function has N parameters, then CUDA_LAUNCH_PARAMS::kernelParams needs to be an array of N pointers. Each of CUDA_LAUNCH_PARAMS::kernelParams[0] through CUDA_LAUNCH_PARAMS::kernelParams[N-1] must point to a region of memory from which the actual kernel parameter will be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.

By default, the kernel won't begin execution on any GPU until all prior work in all the specified streams has completed. This behavior can be overridden by specifying the flag CUDA_COOPERATIVE_LAUNCH_MULTI_DEVICE_NO_PRE_LAUNCH_SYNC. When this flag is specified, each kernel will only wait for prior work in the stream corresponding to that GPU to complete before it begins execution.

Similarly, by default, any subsequent work pushed in any of the specified streams will not begin execution until the kernels on all GPUs have completed. This behavior can be overridden by specifying the flag CUDA_COOPERATIVE_LAUNCH_MULTI_DEVICE_NO_POST_LAUNCH_SYNC. When this flag is specified, any subsequent work pushed in any of the specified streams will only wait for the kernel launched on the GPU corresponding to that stream to complete before it begins execution.

Calling cuLaunchCooperativeKernelMultiDevice() sets persistent function state that is the same as function state set through cuLaunchKernel API when called individually for each element in `launchParamsList`.

When kernels are launched via cuLaunchCooperativeKernelMultiDevice(), the previous block shape, shared size and parameter info associated with each CUDA_LAUNCH_PARAMS::function in `launchParamsList` is overwritten.

Note that to use cuLaunchCooperativeKernelMultiDevice(), the kernels must either have been compiled with toolchain version 3.2 or later so that it will contain kernel parameter information, or have no kernel parameters. If either of these conditions is not met, then cuLaunchCooperativeKernelMultiDevice() will return CUDA_ERROR_INVALID_IMAGE.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxGetCacheConfig, cuCtxSetCacheConfig, cuFuncSetCacheConfig, cuFuncGetAttribute, cuLaunchCooperativeKernel, cudaLaunchCooperativeKernelMultiDevice

# CUresult cuLaunchGrid (CUfunction f, int grid_width, int grid_height)

Launches a CUDA function.

## Parameters

**f**
- Kernel to launch

**grid_width**
- Width of grid in blocks

**grid_height**
- Height of grid in blocks

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_LAUNCH_FAILED, CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES, CUDA_ERROR_LAUNCH_TIMEOUT, CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED

## Description

Deprecated

Invokes the kernel `f` on a `grid_width` x `grid_height` grid of blocks. Each block contains the number of threads specified by a previous call to cuFuncSetBlockShape().

The block shape, dynamic shared memory size, and parameter information must be set using cuFuncSetBlockShape(), cuFuncSetSharedSize(), cuParamSetSize(), cuParamSeti(), cuParamSetf(), and cuParamSetv() prior to calling this function.

Launching a function via cuLaunchKernel() invalidates the function's block shape, dynamic shared memory size, and parameter information. After launching via cuLaunchKernel, this state must be re-initialized prior to calling this function. Failure to do so results in undefined behavior.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetSharedSize, cuFuncGetAttribute, cuParamSetSize, cuParamSetf, cuParamSeti, cuParamSetv, cuLaunch, cuLaunchGridAsync, cuLaunchKernel

# CUresult cuLaunchGridAsync (CUfunction f, int grid_width, int grid_height, CUstream hStream)

Launches a CUDA function.

## Parameters

**f**
- Kernel to launch

**grid_width**
- Width of grid in blocks

**grid_height**
- Height of grid in blocks

**hStream**
- Stream identifier

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_LAUNCH_FAILED, CUDA_ERROR_LAUNCH_OUT_OF_RESOURCES, CUDA_ERROR_LAUNCH_TIMEOUT, CUDA_ERROR_LAUNCH_INCOMPATIBLE_TEXTURING, CUDA_ERROR_SHARED_OBJECT_INIT_FAILED

## Description

Deprecated

Invokes the kernel `f` on a `grid_width` x `grid_height` grid of blocks. Each block contains the number of threads specified by a previous call to cuFuncSetBlockShape().

The block shape, dynamic shared memory size, and parameter information must be set using cuFuncSetBlockShape(), cuFuncSetSharedSize(), cuParamSetSize(), cuParamSeti(), cuParamSetf(), and cuParamSetv() prior to calling this function.

Launching a function via cuLaunchKernel() invalidates the function's block shape, dynamic shared memory size, and parameter information. After launching via cuLaunchKernel, this state must be re-initialized prior to calling this function. Failure to do so results in undefined behavior.

Note:

- In certain cases where cubins are created with no ABI (i.e., using `ptxas --abi-compile no`), this function may serialize kernel launches. The CUDA driver retains asynchronous behavior by growing the per-thread stack as needed per launch and not shrinking it afterwards.
- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetSharedSize, cuFuncGetAttribute, cuParamSetSize, cuParamSetf, cuParamSeti, cuParamSetv, cuLaunch, cuLaunchGrid, cuLaunchKernel

# CUresult cuParamSetf (CUfunction hfunc, int offset, float value)

Adds a floating-point parameter to the function's argument list.

## Parameters

**hfunc**
- Kernel to add parameter to

**offset**
- Offset to add parameter to argument list

**value**
- Value of parameter

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Sets a floating-point parameter that will be specified the next time the kernel corresponding to `hfunc` will be invoked. `offset` is a byte offset.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetSharedSize, cuFuncGetAttribute, cuParamSetSize, cuParamSeti, cuParamSetv, cuLaunch, cuLaunchGrid, cuLaunchGridAsync, cuLaunchKernel

# CUresult cuParamSeti (CUfunction hfunc, int offset, unsigned int value)

Adds an integer parameter to the function's argument list.

## Parameters

**hfunc**
- Kernel to add parameter to

**offset**
- Offset to add parameter to argument list

**value**
- Value of parameter

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Sets an integer parameter that will be specified the next time the kernel corresponding to `hfunc` will be invoked. `offset` is a byte offset.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetSharedSize, cuFuncGetAttribute, cuParamSetSize, cuParamSetf, cuParamSetv, cuLaunch, cuLaunchGrid, cuLaunchGridAsync, cuLaunchKernel

# CUresult cuParamSetSize (CUfunction hfunc, unsigned int numbytes)

Sets the parameter size for the function.

## Parameters

**hfunc**
- Kernel to set parameter size for

**numbytes**
- Size of parameter list in bytes

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Sets through `numbytes` the total size in bytes needed by the function parameters of the kernel corresponding to `hfunc`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetSharedSize, cuFuncGetAttribute, cuParamSetf, cuParamSeti, cuParamSetv, cuLaunch, cuLaunchGrid, cuLaunchGridAsync, cuLaunchKernel

## CUresult cuParamSetTexRef (CUfunction hfunc, int texunit, CUtexref hTexRef)

Adds a texture-reference to the function's argument list.

### Parameters

**hfunc**
- Kernel to add texture-reference to

**texunit**
- Texture unit (must be CU_PARAM_TR_DEFAULT)

**hTexRef**
- Texture-reference to add to argument list

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Makes the CUDA array or linear memory bound to the texture reference `hTexRef` available to a device program as a texture. In this version of CUDA, the texture-reference must be obtained via cuModuleGetTexRef() and the `texunit` parameter must be set to CU_PARAM_TR_DEFAULT.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

# CUresult cuParamSetv (CUfunction hfunc, int offset, void *ptr, unsigned int numbytes)

Adds arbitrary data to the function's argument list.

## Parameters

**hfunc**
- Kernel to add data to

**offset**
- Offset to add data to argument list

**ptr**
- Pointer to arbitrary data

**numbytes**
- Size of data to copy in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Copies an arbitrary amount of data (specified in `numbytes`) from `ptr` into the parameter space of the kernel corresponding to `hfunc`. `offset` is a byte offset.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuFuncSetBlockShape, cuFuncSetSharedSize, cuFuncGetAttribute, cuParamSetSize, cuParamSetf, cuParamSeti, cuLaunch, cuLaunchGrid, cuLaunchGridAsync, cuLaunchKernel

# 6.25. Graph Management

This section describes the graph management functions of the low-level CUDA driver application programming interface.

## CUresult cuDeviceGetGraphMemAttribute (CUdevice device, CUgraphMem_attribute attr, void *value)

Query asynchronous allocation attributes related to graphs.

### Parameters

**device**
- Specifies the scope of the query

**attr**
- attribute to get

**value**
- retrieved value

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_DEVICE

### Description

Valid attributes are:

- CU_GRAPH_MEM_ATTR_USED_MEM_CURRENT: Amount of memory, in bytes, currently associated with graphs
- CU_GRAPH_MEM_ATTR_USED_MEM_HIGH: High watermark of memory, in bytes, associated with graphs since the last time it was reset. High watermark can only be reset to zero.
- CU_GRAPH_MEM_ATTR_RESERVED_MEM_CURRENT: Amount of memory, in bytes, currently allocated for use by the CUDA graphs asynchronous allocator.
- CU_GRAPH_MEM_ATTR_RESERVED_MEM_HIGH: High watermark of memory, in bytes, currently allocated for use by the CUDA graphs asynchronous allocator.

See also:

cuDeviceSetGraphMemAttribute, cuGraphAddMemAllocNode, cuGraphAddMemFreeNode

# CUresult cuDeviceGraphMemTrim (CUdevice device)

Free unused memory that was cached on the specified device for use with graphs back to the OS.

## Parameters

**device**
- The device for which cached memory should be freed.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_DEVICE

## Description

Blocks which are not in use by a graph that is either currently executing or scheduled to execute are freed back to the operating system.

See also:

cuGraphAddMemAllocNode, cuGraphAddMemFreeNode, cuDeviceSetGraphMemAttribute, cuDeviceGetGraphMemAttribute

# CUresult cuDeviceSetGraphMemAttribute (CUdevice device, CUgraphMem_attribute attr, void *value)

Set asynchronous allocation attributes related to graphs.

## Parameters

**device**
- Specifies the scope of the query

**attr**
- attribute to get

**value**
- pointer to value to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_DEVICE

## Description

Valid attributes are:

- CU_GRAPH_MEM_ATTR_USED_MEM_HIGH: High watermark of memory, in bytes, associated with graphs since the last time it was reset. High watermark can only be reset to zero.

- CU_GRAPH_MEM_ATTR_RESERVED_MEM_HIGH: High watermark of memory, in bytes, currently allocated for use by the CUDA graphs asynchronous allocator.

See also:

cuDeviceGetGraphMemAttribute, cuGraphAddMemAllocNode, cuGraphAddMemFreeNode

# CUresult cuGraphAddBatchMemOpNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, const CUDA_BATCH_MEM_OP_NODE_PARAMS *nodeParams)

Creates a batch memory operation node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**nodeParams**
- Parameters for the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new batch memory operation node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

When the node is added, the paramArray inside `nodeParams` is copied and therefore it can be freed after the call returns.

Note:

Warning: Improper use of this API may deadlock the application. Synchronization ordering established through this API is not visible to CUDA. CUDA tasks that are (even indirectly) ordered by this API should also have that order expressed with CUDA-visible dependencies such as events. This ensures that the scheduler does not serialize them in an improper order.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuStreamBatchMemOp, cuStreamWaitValue32, cuStreamWriteValue32, cuStreamWaitValue64, cuStreamWriteValue64, cuGraphBatchMemOpNodeGetParams, cuGraphBatchMemOpNodeSetParams, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

# CUresult cuGraphAddChildGraphNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, CUgraph childGraph)

Creates a child graph node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**childGraph**
- The graph to clone into this node

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE,

### Description

Creates a new node which executes an embedded graph, and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

If `childGraph` contains allocation nodes, free nodes, or conditional nodes, this call will return an error.

The node executes an embedded child graph. The child graph is cloned in this call.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphChildGraphNodeGetGraph, cuGraphCreate, cuGraphDestroyNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddHostNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode, cuGraphClone

## CUresult cuGraphAddDependencies (CUgraph hGraph, const CUgraphNode *from, const CUgraphNode *to, const CUgraphEdgeData *edgeData, size_t numDependencies)

Adds dependency edges to a graph.

### Parameters

**hGraph**
- Graph to which dependencies are added

**from**
- Array of nodes that provide the dependencies

**to**
- Array of dependent nodes

**edgeData**
- Optional array of edge data. If NULL, default (zeroed) edge data is assumed.

**numDependencies**
- Number of dependencies to be added

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

The number of dependencies to be added is defined by `numDependencies` Elements in `from` and `to` at corresponding indices define a dependency. Each node in `from` and `to` must belong to `hGraph`.

If `numDependencies` is 0, elements in `from` and `to` will be ignored. Specifying an existing dependency will return an error.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphRemoveDependencies, cuGraphGetEdges, cuGraphNodeGetDependencies, cuGraphNodeGetDependentNodes

## CUresult cuGraphAddEmptyNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies)

Creates an empty node and adds it to a graph.

### Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE,

### Description

Creates a new node which performs no operation, and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

An empty node performs no operation during execution, but can be used for transitive ordering. For example, a phased execution graph with 2 groups of n nodes with a barrier between them can be represented using an empty node and 2*n dependency edges, rather than no empty node and n^2 dependency edges.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddKernelNode, cuGraphAddHostNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

## CUresult cuGraphAddEventRecordNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, CUevent event)

Creates an event record node and adds it to a graph.

### Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**event**
- Event for the node

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

### Description

Creates a new event record node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and event specified in `event`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

Each launch of the graph will record `event` to capture execution of the node's dependencies.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphAddEventWaitNode, cuEventRecordWithFlags, cuStreamWaitEvent, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

## CUresult cuGraphAddEventWaitNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, CUevent event)

Creates an event wait node and adds it to a graph.

### Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**event**
- Event for the node

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

### Description

Creates a new event wait node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and event specified in `event`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

The graph node will wait for all work captured in `event`. See cuEventRecord() for details on what is captured by an event. `event` may be from a different context or device than the launch stream.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphAddEventRecordNode, cuEventRecordWithFlags, cuStreamWaitEvent, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

## CUresult cuGraphAddExternalSemaphoresSignalNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, const CUDA_EXT_SEM_SIGNAL_NODE_PARAMS *nodeParams)

Creates an external semaphore signal node and adds it to a graph.

### Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**nodeParams**
- Parameters for the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new external semaphore signal node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

Performs a signal operation on a set of externally allocated semaphore objects when the node is launched. The operation(s) will occur after all of the node's dependencies have completed.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphExternalSemaphoresSignalNodeGetParams, cuGraphExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphAddExternalSemaphoresWaitNode, cuImportExternalSemaphore, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync, cuGraphCreate, cuGraphDestroyNode, cuGraphAddEventRecordNode, cuGraphAddEventWaitNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

# CUresult cuGraphAddExternalSemaphoresWaitNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, const CUDA_EXT_SEM_WAIT_NODE_PARAMS *nodeParams)

Creates an external semaphore wait node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**nodeParams**
- Parameters for the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new external semaphore wait node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

Performs a wait operation on a set of externally allocated semaphore objects when the node is launched. The node's dependencies will not be launched until the wait operation has completed.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphExternalSemaphoresWaitNodeGetParams, cuGraphExternalSemaphoresWaitNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphAddExternalSemaphoresSignalNode, cuImportExternalSemaphore, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync, cuGraphCreate, cuGraphDestroyNode, cuGraphAddEventRecordNode, cuGraphAddEventWaitNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

# CUresult cuGraphAddHostNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, const CUDA_HOST_NODE_PARAMS *nodeParams)

Creates a host execution node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**nodeParams**
- Parameters for the host node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new CPU execution node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

When the graph is launched, the node will invoke the specified CPU function. Host nodes are not supported under MPS with pre-Volta GPUs.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuLaunchHostFunc, cuGraphHostNodeGetParams, cuGraphHostNodeSetParams, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

# CUresult cuGraphAddKernelNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, const CUDA_KERNEL_NODE_PARAMS *nodeParams)

Creates a kernel execution node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**nodeParams**
- Parameters for the GPU execution node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new kernel execution node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

The CUDA_KERNEL_NODE_PARAMS structure is defined as:

```
typedef struct CUDA_KERNEL_NODE_PARAMS_st {
          CUfunction func;
          unsigned int gridDimX;
          unsigned int gridDimY;
          unsigned int gridDimZ;
          unsigned int blockDimX;
          unsigned int blockDimY;
          unsigned int blockDimZ;
          unsigned int sharedMemBytes;
          void **kernelParams;
          void **extra;
          CUkernel kern;
          CUcontext ctx;
        } CUDA_KERNEL_NODE_PARAMS;
```

When the graph is launched, the node will invoke kernel `func` on a (`gridDimX` x `gridDimY` x `gridDimZ`) grid of blocks. Each block contains (`blockDimX` x `blockDimY` x `blockDimZ`) threads.

`sharedMemBytes` sets the amount of dynamic shared memory that will be available to each thread block.

Kernel parameters to `func` can be specified in one of two ways:

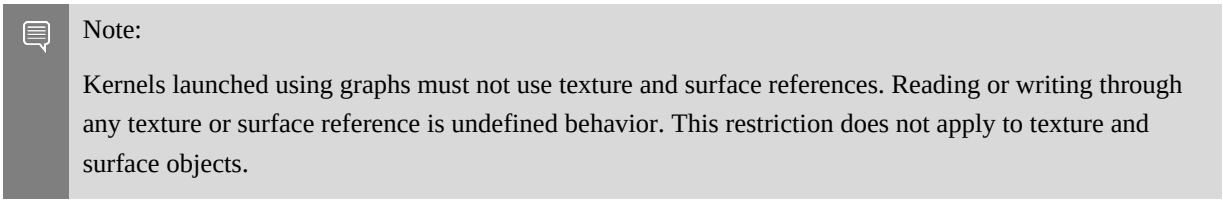
1) Kernel parameters can be specified via `kernelParams`. If the kernel has N parameters, then `kernelParams` needs to be an array of N pointers. Each pointer, from `kernelParams`[0] to `kernelParams`[N-1], points to the region of memory from which the actual parameter will be copied. The number of kernel parameters and their offsets and sizes do not need to be specified as that information is retrieved directly from the kernel's image.

2) Kernel parameters for non-cooperative kernels can also be packaged by the application into a single buffer that is passed in via `extra`. This places the burden on the application of knowing each kernel parameter's size and alignment/padding within the buffer. The `extra` parameter exists to allow this function to take additional less commonly used arguments. `extra` specifies a list of names of extra settings and their corresponding values. Each extra setting name is immediately followed by the corresponding value. The list must be terminated with either NULL or CU_LAUNCH_PARAM_END.

- CU_LAUNCH_PARAM_END, which indicates the end of the `extra` array;
- CU_LAUNCH_PARAM_BUFFER_POINTER, which specifies that the next value in `extra` will be a pointer to a buffer containing all the kernel parameters for launching kernel `func`;
- CU_LAUNCH_PARAM_BUFFER_SIZE, which specifies that the next value in `extra` will be a pointer to a size_t containing the size of the buffer specified with CU_LAUNCH_PARAM_BUFFER_POINTER;

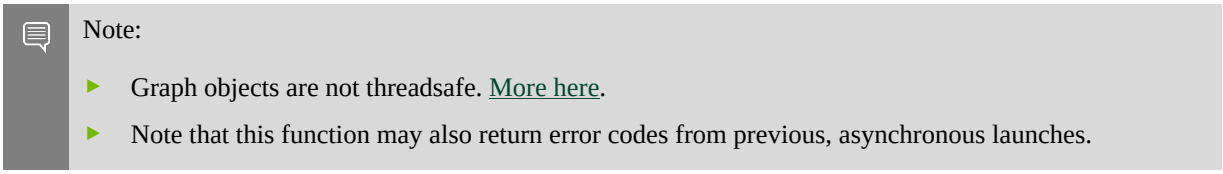
The error CUDA_ERROR_INVALID_VALUE will be returned if kernel parameters are specified with both `kernelParams` and `extra` (i.e. both `kernelParams` and `extra` are non-NULL). CUDA_ERROR_INVALID_VALUE will be returned if `extra` is used for a cooperative kernel.

The `kernelParams` or `extra` array, as well as the argument values it points to, are copied during this call.



Note:

Kernels launched using graphs must not use texture and surface references. Reading or writing through any texture or surface reference is undefined behavior. This restriction does not apply to texture and surface objects.



Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuLaunchKernel, cuLaunchCooperativeKernel, cuGraphKernelNodeGetParams, cuGraphKernelNodeSetParams, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddHostNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

## CUresult cuGraphAddMemAllocNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, CUDA_MEM_ALLOC_NODE_PARAMS *nodeParams)

Creates an allocation node and adds it to a graph.

### Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**nodeParams**
- Parameters for the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new allocation node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

When cuGraphAddMemAllocNode creates an allocation node, it returns the address of the allocation in `nodeParams.dptr`. The allocation's address remains fixed across instantiations and launches.

If the allocation is freed in the same graph, by creating a free node using cuGraphAddMemFreeNode, the allocation can be accessed by nodes ordered after the allocation node but before the free node. These allocations cannot be freed outside the owning graph, and they can only be freed once in the owning graph.

If the allocation is not freed in the same graph, then it can be accessed not only by nodes in the graph which are ordered after the allocation node, but also by stream operations ordered after the graph's execution but before the allocation is freed.

Allocations which are not freed in the same graph can be freed by:

- passing the allocation to cuMemFreeAsync or cuMemFree;
- launching a graph with a free node for that allocation; or
- specifying CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH during instantiation, which makes each launch behave as though it called cuMemFreeAsync for every unfreed allocation.

It is not possible to free an allocation in both the owning graph and another graph. If the allocation is freed in the same graph, a free node cannot be added to another graph. If the allocation is freed in another graph, a free node can no longer be added to the owning graph.

The following restrictions apply to graphs which contain allocation and/or memory free nodes:

- Nodes and edges of the graph cannot be deleted.
- The graph can only be used in a child node if the ownership is moved to the parent.
- Only one instantiation of the graph may exist at any point in time.
- The graph cannot be cloned.

Note:

- Graph objects are not threadsafe. More here.

- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphAddMemFreeNode, cuGraphMemAllocNodeGetParams, cuDeviceGraphMemTrim, cuDeviceGetGraphMemAttribute, cuDeviceSetGraphMemAttribute, cuMemAllocAsync, cuMemFreeAsync, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddEventRecordNode, cuGraphAddEventWaitNode, cuGraphAddExternalSemaphoresSignalNode, cuGraphAddExternalSemaphoresWaitNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

# CUresult cuGraphAddMemcpyNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, const CUDA_MEMCPY3D *copyParams, CUcontext ctx)

Creates a memcpy node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**copyParams**
- Parameters for the memory copy

**ctx**
- Context on which to run the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new memcpy node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

When the graph is launched, the node will perform the memcpy described by `copyParams`. See cuMemcpy3D() for a description of the structure and its restrictions.

Memcpy nodes have some additional restrictions with regards to managed memory, if the system contains at least one device which has a zero value for the device attribute CU_DEVICE_ATTRIBUTE_CONCURRENT_MANAGED_ACCESS. If one or more of the operands refer to managed memory, then using the memory type CU_MEMORYTYPE_UNIFIED is disallowed for those operand(s). The managed memory will be treated as residing on either the host or the device, depending on which memory type is specified.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuMemcpy3D, cuGraphMemcpyNodeGetParams, cuGraphMemcpyNodeSetParams, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddHostNode, cuGraphAddMemsetNode

# CUresult cuGraphAddMemFreeNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, CUdeviceptr dptr)

Creates a memory free node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**dptr**
- Address of memory to free

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_INVALID_VALUE

## Description

Creates a new memory free node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies` and arguments specified in `nodeParams`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

cuGraphAddMemFreeNode will return CUDA_ERROR_INVALID_VALUE if the user attempts to free:

- an allocation twice in the same graph.
- an address that was not returned by an allocation node.
- an invalid address.

The following restrictions apply to graphs which contain allocation and/or memory free nodes:

- Nodes and edges of the graph cannot be deleted.
- The graph can only be used in a child node if the ownership is moved to the parent.
- Only one instantiation of the graph may exist at any point in time.
- The graph cannot be cloned.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphAddMemAllocNode, cuGraphMemFreeNodeGetParams, cuDeviceGraphMemTrim, cuDeviceGetGraphMemAttribute, cuDeviceSetGraphMemAttribute, cuMemAllocAsync, cuMemFreeAsync, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddEventRecordNode, cuGraphAddEventWaitNode, cuGraphAddExternalSemaphoresSignalNode, cuGraphAddExternalSemaphoresWaitNode, cuGraphAddKernelNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

# CUresult cuGraphAddMemsetNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, size_t numDependencies, const CUDA_MEMSET_NODE_PARAMS *memsetParams, CUcontext ctx)

Creates a memset node and adds it to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**numDependencies**
- Number of dependencies

**memsetParams**
- Parameters for the memory set

**ctx**
- Context on which to run the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_CONTEXT

## Description

Creates a new memset node and adds it to `hGraph` with `numDependencies` dependencies specified via `dependencies`. It is possible for `numDependencies` to be 0, in which case the node will be placed at the root of the graph. `dependencies` may not have any duplicate entries. A handle to the new node will be returned in `phGraphNode`.

The element size must be 1, 2, or 4 bytes. When the graph is launched, the node will perform the memset described by `memsetParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuMemsetD2D32, cuGraphMemsetNodeGetParams, cuGraphMemsetNodeSetParams, cuGraphCreate, cuGraphDestroyNode, cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddHostNode, cuGraphAddMemcpyNode

# CUresult cuGraphAddNode (CUgraphNode *phGraphNode, CUgraph hGraph, const CUgraphNode *dependencies, const CUgraphEdgeData *dependencyData, size_t numDependencies, CUgraphNodeParams *nodeParams)

Adds a node of arbitrary type to a graph.

## Parameters

**phGraphNode**
- Returns newly created node

**hGraph**
- Graph to which to add the node

**dependencies**
- Dependencies of the node

**dependencyData**
- Optional edge data for the dependencies. If NULL, the data is assumed to be default (zeroed) for all dependencies.

**numDependencies**
- Number of dependencies

**nodeParams**
- Specification of the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_NOT_SUPPORTED

## Description

Creates a new node in `hGraph` described by `nodeParams` with `numDependencies` dependencies specified via `dependencies`. `numDependencies` may be 0. `dependencies` may be null if `numDependencies` is 0. `dependencies` may not have any duplicate entries.

`nodeParams` is a tagged union. The node type should be specified in the `type` field, and type-specific parameters in the corresponding union member. All unused bytes - that is, `reserved0`

and all bytes past the utilized union member - must be set to zero. It is recommended to use brace initialization or memset to ensure all bytes are initialized.

Note that for some node types, `nodeParams` may contain "out parameters" which are modified during the call, such as `nodeParams->alloc.dptr`.

A handle to the new node will be returned in `phGraphNode`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphCreate, cuGraphNodeSetParams, cuGraphExecNodeSetParams

# CUresult cuGraphBatchMemOpNodeGetParams (CUgraphNode hNode, CUDA_BATCH_MEM_OP_NODE_PARAMS *nodeParams_out)

Returns a batch mem op node's parameters.

## Parameters

**hNode**
- Node to get the parameters for

**nodeParams_out**
- Pointer to return the parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns the parameters of batch mem op node `hNode` in `nodeParams_out`. The `paramArray` returned in `nodeParams_out` is owned by the node. This memory remains valid until the node is destroyed or its parameters are modified, and should not be modified directly. Use cuGraphBatchMemOpNodeSetParams to update the parameters of this node.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuStreamBatchMemOp, cuGraphAddBatchMemOpNode, cuGraphBatchMemOpNodeSetParams

# CUresult cuGraphBatchMemOpNodeSetParams (CUgraphNode hNode, const CUDA_BATCH_MEM_OP_NODE_PARAMS *nodeParams)

Sets a batch mem op node's parameters.

## Parameters

**hNode**

- Node to set the parameters for

**nodeParams**

- Parameters to copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Sets the parameters of batch mem op node `hNode` to `nodeParams`.

The paramArray inside `nodeParams` is copied and therefore it can be freed after the call returns.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuStreamBatchMemOp, cuGraphAddBatchMemOpNode, cuGraphBatchMemOpNodeGetParams

# CUresult cuGraphChildGraphNodeGetGraph (CUgraphNode hNode, CUgraph *phGraph)

Gets a handle to the embedded graph of a child graph node.

## Parameters

**hNode**
- Node to get the embedded graph for

**phGraph**
- Location to store a handle to the graph

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE,

## Description

Gets a handle to the embedded graph in a child graph node. This call does not clone the graph. Changes to the graph will be reflected in the node, and the node retains ownership of the graph.

Allocation and free nodes cannot be added to the returned graph. Attempting to do so will return an error.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddChildGraphNode, cuGraphNodeFindInClone

# CUresult cuGraphClone (CUgraph *phGraphClone, CUgraph originalGraph)

Clones a graph.

## Parameters

**phGraphClone**
- Returns newly created cloned graph

**originalGraph**
- Graph to clone

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

### Description

This function creates a copy of `originalGraph` and returns it in `phGraphClone`. All parameters are copied into the cloned graph. The original graph may be modified after this call without affecting the clone.

Child graph nodes in the original graph are recursively copied into the clone.

Note:

: Cloning is not supported for graphs which contain memory allocation nodes, memory free nodes, or conditional nodes.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphCreate, cuGraphNodeFindInClone

## CUresult cuGraphConditionalHandleCreate (CUgraphConditionalHandle *pHandle_out, CUgraph hGraph, CUcontext ctx, unsigned int defaultLaunchValue, unsigned int flags)

Create a conditional handle.

### Parameters

**pHandle_out**
- Pointer used to return the handle to the caller.

**hGraph**
- Graph which will contain the conditional node using this handle.

**ctx**
- Context for the handle and associated conditional node.

**defaultLaunchValue**
- Optional initial value for the conditional variable. Applied at the beginning of each graph execution if CU_GRAPH_COND_ASSIGN_DEFAULT is set in `flags`.

**flags**
- Currently must be CU_GRAPH_COND_ASSIGN_DEFAULT or 0.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

### Description

Creates a conditional handle associated with `hGraph`.

The conditional handle must be associated with a conditional node in this graph or one of its children.

Handles not associated with a conditional node may cause graph instantiation to fail.

Handles can only be set from the context with which they are associated.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode

## CUresult cuGraphCreate (CUgraph *phGraph, unsigned int flags)

Creates a graph.

### Parameters

**phGraph**
- Returns newly created graph

**flags**
- Graph creation flags, must be 0

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

### Description

Creates an empty graph, which is returned via `phGraph`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddHostNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode, cuGraphInstantiate, cuGraphDestroy, cuGraphGetNodes, cuGraphGetRootNodes, cuGraphGetEdges, cuGraphClone

## CUresult cuGraphDebugDotPrint (CUgraph hGraph, const char *path, unsigned int flags)

Write a DOT file describing graph structure.

### Parameters

**hGraph**
- The graph to create a DOT file from

**path**
- The path to write the DOT file to

**flags**
- Flags from CUgraphDebugDot_flags for specifying which additional node information to write

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OPERATING_SYSTEM

### Description

Using the provided `hGraph`, write to `path` a DOT formatted description of the graph. By default this includes the graph topology, node types, node id, kernel names and memcpy direction. `flags` can be specified to write more detailed information about each node type such as parameter values, kernel attributes, node and function handles.

# CUresult cuGraphDestroy (CUgraph hGraph)

Destroys a graph.

## Parameters

**hGraph**
- Graph to destroy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Destroys the graph specified by `hGraph`, as well as all of its nodes.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphCreate

# CUresult cuGraphDestroyNode (CUgraphNode hNode)

Remove a node from the graph.

## Parameters

**hNode**
- Node to remove

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Removes `hNode` from its graph. This operation also severs any dependencies of other nodes on `hNode` and vice versa.

Nodes which belong to a graph which contains allocation or free nodes cannot be destroyed. Any attempt to do so will return an error.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddChildGraphNode, cuGraphAddEmptyNode, cuGraphAddKernelNode, cuGraphAddHostNode, cuGraphAddMemcpyNode, cuGraphAddMemsetNode

# CUresult cuGraphEventRecordNodeGetEvent (CUgraphNode hNode, CUevent *event_out)

Returns the event associated with an event record node.

## Parameters

**hNode**
- Node to get the event for

**event_out**
- Pointer to return the event

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns the event of event record node `hNode` in `event_out`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddEventRecordNode, cuGraphEventRecordNodeSetEvent, cuGraphEventWaitNodeGetEvent, cuEventRecordWithFlags, cuStreamWaitEvent

# CUresult cuGraphEventRecordNodeSetEvent (CUgraphNode hNode, CUevent event)

Sets an event record node's event.

## Parameters

**hNode**
- Node to set the event for

**event**
- Event to use

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Sets the event of event record node `hNode` to `event`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuGraphAddEventRecordNode, cuGraphEventRecordNodeGetEvent, cuGraphEventWaitNodeSetEvent, cuEventRecordWithFlags, cuStreamWaitEvent

# CUresult cuGraphEventWaitNodeGetEvent (CUgraphNode hNode, CUevent *event_out)

Returns the event associated with an event wait node.

## Parameters

**hNode**
- Node to get the event for

**event_out**
- Pointer to return the event

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns the event of event wait node `hNode` in `event_out`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddEventWaitNode, cuGraphEventWaitNodeSetEvent, cuGraphEventRecordNodeGetEvent, cuEventRecordWithFlags, cuStreamWaitEvent

## CUresult cuGraphEventWaitNodeSetEvent (CUgraphNode hNode, CUevent event)

Sets an event wait node's event.

### Parameters

**hNode**
- Node to set the event for

**event**
- Event to use

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

### Description

Sets the event of event wait node `hNode` to `event`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuGraphAddEventWaitNode, cuGraphEventWaitNodeGetEvent, cuGraphEventRecordNodeSetEvent, cuEventRecordWithFlags, cuStreamWaitEvent

# CUresult cuGraphExecBatchMemOpNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA_BATCH_MEM_OP_NODE_PARAMS *nodeParams)

Sets the parameters for a batch mem op node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- Batch mem op node from the graph from which graphExec was instantiated

**nodeParams**
- Updated Parameters to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets the parameters of a batch mem op node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

The following fields on operations may be modified on an executable graph:

op.waitValue.address op.waitValue.value[64] op.waitValue.flags bits corresponding to wait type (i.e. CU_STREAM_WAIT_VALUE_FLUSH bit cannot be modified) op.writeValue.address op.writeValue.value[64]

Other fields, such as the context, count or type of operations, and other types of operations such as membars, may not be modified.

`hNode` must not have been removed from the original graph.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

The paramArray inside `nodeParams` is copied and therefore it can be freed after the call returns.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuStreamBatchMemOp, cuGraphAddBatchMemOpNode, cuGraphBatchMemOpNodeGetParams, cuGraphBatchMemOpNodeSetParams, cuGraphInstantiate

# CUresult cuGraphExecChildGraphNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, CUgraph childGraph)

Updates node parameters in the child graph node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- Host node from the graph which was used to instantiate graphExec

**childGraph**
- The graph supplying the updated parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Updates the work represented by `hNode` in `hGraphExec` as though the nodes contained in `hNode`'s graph had the parameters contained in `childGraph`'s nodes at instantiation. `hNode` must remain in the graph which was used to instantiate `hGraphExec`. Changed edges to and from `hNode` are ignored.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

The topology of `childGraph`, as well as the node insertion order, must match that of the graph contained in `hNode`. See cuGraphExecUpdate() for a list of restrictions on what can be updated in an instantiated graph. The update is recursive, so child graph nodes contained within the top level child graph will also be updated.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddChildGraphNode, cuGraphChildGraphNodeGetGraph, cuGraphExecKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams, cuGraphExecMemsetNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecDestroy (CUgraphExec hGraphExec)

Destroys an executable graph.

## Parameters

**hGraphExec**
- Executable graph to destroy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Destroys the executable graph specified by `hGraphExec`, as well as all of its executable nodes. If the executable graph is in-flight, it will not be terminated, but rather freed asynchronously on completion.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphInstantiate, cuGraphUpload, cuGraphLaunch

# CUresult cuGraphExecEventRecordNodeSetEvent (CUgraphExec hGraphExec, CUgraphNode hNode, CUevent event)

Sets the event for an event record node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- event record node from the graph from which graphExec was instantiated

**event**
- Updated event to use

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets the event of an event record node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddEventRecordNode, cuGraphEventRecordNodeGetEvent, cuGraphEventWaitNodeSetEvent, cuEventRecordWithFlags, cuStreamWaitEvent, cuGraphExecKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams, cuGraphExecMemsetNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecEventWaitNodeSetEvent (CUgraphExec hGraphExec, CUgraphNode hNode, CUevent event)

Sets the event for an event wait node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- event wait node from the graph from which graphExec was instantiated

**event**
- Updated event to use

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets the event of an event wait node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddEventWaitNode, cuGraphEventWaitNodeGetEvent, cuGraphEventRecordNodeSetEvent, cuEventRecordWithFlags, cuStreamWaitEvent, cuGraphExecKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams, cuGraphExecMemsetNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecExternalSemaphoresSignalNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA_EXT_SEM_SIGNAL_NODE_PARAMS *nodeParams)

Sets the parameters for an external semaphore signal node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- semaphore signal node from the graph from which graphExec was instantiated

**nodeParams**
- Updated Parameters to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets the parameters of an external semaphore signal node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

`hNode` must not have been removed from the original graph.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

Changing `nodeParams->numExtSems` is not supported.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddExternalSemaphoresSignalNode, cuImportExternalSemaphore, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync, cuGraphExecKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams,

cuGraphExecMemsetNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecExternalSemaphoresWaitNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA_EXT_SEM_WAIT_NODE_PARAMS *nodeParams)

Sets the parameters for an external semaphore wait node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- semaphore wait node from the graph from which graphExec was instantiated

**nodeParams**
- Updated Parameters to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets the parameters of an external semaphore wait node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

`hNode` must not have been removed from the original graph.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

Changing `nodeParams->numExtSems` is not supported.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddExternalSemaphoresWaitNode, cuImportExternalSemaphore, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync, cuGraphExecKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams, cuGraphExecMemsetNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecGetFlags (CUgraphExec hGraphExec, cuuint64_t *flags)

Query the instantiation flags of an executable graph.

## Parameters

**hGraphExec**
- The executable graph to query

**flags**
- Returns the instantiation flags

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Returns the flags that were passed to instantiation for the given executable graph. CUDA_GRAPH_INSTANTIATE_FLAG_UPLOAD will not be returned by this API as it does not affect the resulting executable graph.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphInstantiate, cuGraphInstantiateWithParams

# CUresult cuGraphExecGetId (CUgraphExec hGraphExec, unsigned int *graphId)

Returns the id of a given graph exec.

## Parameters

**hGraphExec**
- Graph to query

**graphId**

## Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## Description

Returns the id of `hGraphExec` in `*graphId`. The value in `*graphId` will match that referenced by cuGraphDebugDotPrint.

See also:

cuGraphGetNodes, cuGraphDebugDotPrint cuGraphNodeGetContainingGraph cuGraphNodeGetLocalId cuGraphNodeGetToolsId cuGraphGetId

# CUresult cuGraphExecHostNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA_HOST_NODE_PARAMS *nodeParams)

Sets the parameters for a host node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- Host node from the graph which was used to instantiate graphExec

**nodeParams**
- The updated parameters to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Updates the work represented by `hNode` in `hGraphExec` as though `hNode` had contained `nodeParams` at instantiation. hNode must remain in the graph which was used to instantiate `hGraphExec`. Changed edges to and from hNode are ignored.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. hNode is also not modified by this call.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddHostNode, cuGraphHostNodeSetParams, cuGraphExecKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams, cuGraphExecMemsetNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecKernelNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA_KERNEL_NODE_PARAMS *nodeParams)

Sets the parameters for a kernel node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- kernel node from the graph from which graphExec was instantiated

**nodeParams**
- Updated Parameters to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets the parameters of a kernel node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

`hNode` must not have been removed from the original graph. All `nodeParams` fields may change, but the following restrictions apply to `func` updates:

- The owning context of the function cannot change.
- A node whose function originally did not use CUDA dynamic parallelism cannot be updated to a function which uses CDP
- A node whose function originally did not make device-side update calls cannot be updated to a function which makes device-side update calls.
- If `hGraphExec` was not instantiated for device launch, a node whose function originally did not use device-side cudaGraphLaunch() cannot be updated to a function which uses device-side cudaGraphLaunch() unless the node resides on the same context as nodes which contained such calls at instantiate-time. If no such calls were present at instantiation, these updates cannot be performed at all.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

If `hNode` is a device-updatable kernel node, the next upload/launch of `hGraphExec` will overwrite any previous device-side updates. Additionally, applying host updates to a device-updatable kernel node while it is being updated from the device will result in undefined behavior.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddKernelNode, cuGraphKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams, cuGraphExecMemsetNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecMemcpyNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA_MEMCPY3D *copyParams, CUcontext ctx)

Sets the parameters for a memcpy node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- Memcpy node from the graph which was used to instantiate graphExec

**copyParams**
- The updated parameters to set

**ctx**
- Context on which to run the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Updates the work represented by `hNode` in `hGraphExec` as though `hNode` had contained `copyParams` at instantiation. hNode must remain in the graph which was used to instantiate `hGraphExec`. Changed edges to and from hNode are ignored.

The source and destination memory in `copyParams` must be allocated from the same contexts as the original source and destination memory. Both the instantiation-time memory operands and the memory operands in `copyParams` must be 1-dimensional. Zero-length operations are not supported.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. hNode is also not modified by this call.

Returns CUDA_ERROR_INVALID_VALUE if the memory operands' mappings changed or either the original or new memory operands are multidimensional.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddMemcpyNode, cuGraphMemcpyNodeSetParams, cuGraphExecKernelNodeSetParams,

cuGraphExecMemsetNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecMemsetNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, const CUDA_MEMSET_NODE_PARAMS *memsetParams, CUcontext ctx)

Sets the parameters for a memset node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- Memset node from the graph which was used to instantiate graphExec

**memsetParams**
- The updated parameters to set

**ctx**
- Context on which to run the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Updates the work represented by `hNode` in `hGraphExec` as though `hNode` had contained `memsetParams` at instantiation. hNode must remain in the graph which was used to instantiate `hGraphExec`. Changed edges to and from hNode are ignored.

Zero sized operations are not supported.

The new destination pointer in memsetParams must be to the same kind of allocation as the original destination pointer and have the same context association and device mapping as the original destination pointer.

Both the value and pointer address may be updated. Changing other aspects of the memset (width, height, element size or pitch) may cause the update to be rejected. Specifically, for 2d memsets, all dimension changes are rejected. For 1d memsets, changes in height are explicitly rejected and other changes are opportunistically allowed if the resulting work maps onto the work resources already allocated for the node.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. hNode is also not modified by this call.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphExecNodeSetParams, cuGraphAddMemsetNode, cuGraphMemsetNodeSetParams, cuGraphExecKernelNodeSetParams, cuGraphExecMemcpyNodeSetParams, cuGraphExecHostNodeSetParams, cuGraphExecChildGraphNodeSetParams, cuGraphExecEventRecordNodeSetEvent, cuGraphExecEventWaitNodeSetEvent, cuGraphExecExternalSemaphoresSignalNodeSetParams, cuGraphExecExternalSemaphoresWaitNodeSetParams, cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecNodeSetParams (CUgraphExec hGraphExec, CUgraphNode hNode, CUgraphNodeParams *nodeParams)

Update a graph node's parameters in an instantiated graph.

## Parameters

**hGraphExec**
- The executable graph in which to update the specified node

**hNode**
- Corresponding node from the graph from which graphExec was instantiated

**nodeParams**
- Updated Parameters to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

Sets the parameters of a node in an executable graph `hGraphExec`. The node is identified by the corresponding node `hNode` in the non-executable graph from which the executable graph was instantiated. `hNode` must not have been removed from the original graph.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

Allowed changes to parameters on executable graphs are as follows:

| Node type | Allowed changes |
|---|---|
| kernel | See cuGraphExecKernelNodeSetParams |
| memcpy | Addresses for 1-dimensional copies if allocated in same context; see cuGraphExecMemcpyNodeSetParams |
| memset | Addresses for 1-dimensional memsets if allocated in same context; see cuGraphExecMemsetNodeSetParams |
| host | Unrestricted |
| child graph | Topology must match and restrictions apply recursively; see cuGraphExecUpdate |
| event wait | Unrestricted |
| event record | Unrestricted |
| external semaphore signal | Number of semaphore operations cannot change |
| external semaphore wait | Number of semaphore operations cannot change |
| memory allocation | API unsupported |
| memory free | API unsupported |
| batch memops | Addresses, values, and operation type for wait operations; see cuGraphExecBatchMemOpNodeSetParams |

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphNodeSetParams cuGraphExecUpdate, cuGraphInstantiate

# CUresult cuGraphExecUpdate (CUgraphExec hGraphExec, CUgraph hGraph, CUgraphExecUpdateResultInfo *resultInfo)

Check whether an executable graph can be updated with a graph and perform the update if possible.

## Parameters

**hGraphExec**
The instantiated graph to be updated

**hGraph**
The graph containing the updated parameters

**resultInfo**
the error info structure

## Returns

CUDA_SUCCESS, CUDA_ERROR_GRAPH_EXEC_UPDATE_FAILURE,

## Description

Updates the node parameters in the instantiated graph specified by `hGraphExec` with the node parameters in a topologically identical graph specified by `hGraph`.

Limitations:

- Kernel nodes:
  - The owning context of the function cannot change.
  - A node whose function originally did not use CUDA dynamic parallelism cannot be updated to a function which uses CDP.
  - A node whose function originally did not make device-side update calls cannot be updated to a function which makes device-side update calls.
  - A cooperative node cannot be updated to a non-cooperative node, and vice-versa.
  - If the graph was instantiated with CUDA_GRAPH_INSTANTIATE_FLAG_USE_NODE_PRIORITY, the priority attribute cannot change. Equality is checked on the originally requested priority values, before they are clamped to the device's supported range.
  - If `hGraphExec` was not instantiated for device launch, a node whose function originally did not use device-side cudaGraphLaunch() cannot be updated to a function which uses device-side cudaGraphLaunch() unless the node resides on the same context as nodes which contained such calls at instantiate-time. If no such calls were present at instantiation, these updates cannot be performed at all.
  - Neither `hGraph` nor `hGraphExec` may contain device-updatable kernel nodes.

- Memset and memcpy nodes:
  - The CUDA device(s) to which the operand(s) was allocated/mapped cannot change.
  - The source/destination memory must be allocated from the same contexts as the original source/destination memory.
  - For 2d memsets, only address and assigned value may be updated.
  - For 1d memsets, updating dimensions is also allowed, but may fail if the resulting operation doesn't map onto the work resources already allocated for the node.
- Additional memcpy node restrictions:
  - Changing either the source or destination memory type(i.e. CU_MEMORYTYPE_DEVICE, CU_MEMORYTYPE_ARRAY, etc.) is not supported.
- External semaphore wait nodes and record nodes:
  - Changing the number of semaphores is not supported.
- Conditional nodes:
  - Changing node parameters is not supported.
  - Changing parameters of nodes within the conditional body graph is subject to the rules above.
  - Conditional handle flags and default values are updated as part of the graph update.

Note: The API may add further restrictions in future releases. The return code should always be checked.

cuGraphExecUpdate sets the result member of `resultInfo` to CU_GRAPH_EXEC_UPDATE_ERROR_TOPOLOGY_CHANGED under the following conditions:

- The count of nodes directly in `hGraphExec` and `hGraph` differ, in which case resultInfo->errorNode is set to NULL.
- `hGraph` has more exit nodes than `hGraph`, in which case resultInfo->errorNode is set to one of the exit nodes in hGraph.
- A node in `hGraph` has a different number of dependencies than the node from `hGraphExec` it is paired with, in which case resultInfo->errorNode is set to the node from `hGraph`.
- A node in `hGraph` has a dependency that does not match with the corresponding dependency of the paired node from `hGraphExec`. resultInfo->errorNode will be set to the node from `hGraph`. resultInfo->errorFromNode will be set to the mismatched dependency. The dependencies are paired based on edge order and a dependency does not match when the nodes are already paired based on other edges examined in the graph.

cuGraphExecUpdate sets the result member of `resultInfo` to:

- CU_GRAPH_EXEC_UPDATE_ERROR if passed an invalid value.
- CU_GRAPH_EXEC_UPDATE_ERROR_TOPOLOGY_CHANGED if the graph topology changed
- CU_GRAPH_EXEC_UPDATE_ERROR_NODE_TYPE_CHANGED if the type of a node changed, in which case `hErrorNode_out` is set to the node from `hGraph`.

- CU_GRAPH_EXEC_UPDATE_ERROR_UNSUPPORTED_FUNCTION_CHANGE if the function changed in an unsupported way(see note above), in which case `hErrorNode_out` is set to the node from `hGraph`
- CU_GRAPH_EXEC_UPDATE_ERROR_PARAMETERS_CHANGED if any parameters to a node changed in a way that is not supported, in which case `hErrorNode_out` is set to the node from `hGraph`.
- CU_GRAPH_EXEC_UPDATE_ERROR_ATTRIBUTES_CHANGED if any attributes of a node changed in a way that is not supported, in which case `hErrorNode_out` is set to the node from `hGraph`.
- CU_GRAPH_EXEC_UPDATE_ERROR_NOT_SUPPORTED if something about a node is unsupported, like the node's type or configuration, in which case `hErrorNode_out` is set to the node from `hGraph`

If the update fails for a reason not listed above, the result member of `resultInfo` will be set to CU_GRAPH_EXEC_UPDATE_ERROR. If the update succeeds, the result member will be set to CU_GRAPH_EXEC_UPDATE_SUCCESS.

cuGraphExecUpdate returns CUDA_SUCCESS when the updated was performed successfully. It returns CUDA_ERROR_GRAPH_EXEC_UPDATE_FAILURE if the graph update was not performed because it included changes which violated constraints specific to instantiated graph update.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphInstantiate

# CUresult cuGraphExternalSemaphoresSignalNodeGetParams (CUgraphNode hNode, CUDA_EXT_SEM_SIGNAL_NODE_PARAMS *params_out)

Returns an external semaphore signal node's parameters.

## Parameters

**hNode**

- Node to get the parameters for

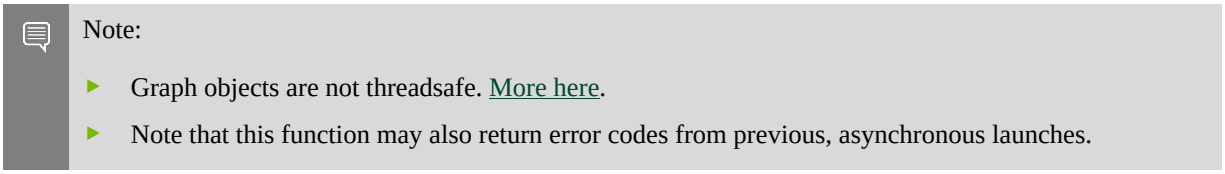
**params_out**
- Pointer to return the parameters

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns the parameters of an external semaphore signal node `hNode` in `params_out`. The `extSemArray` and `paramsArray` returned in `params_out`, are owned by the node. This memory remains valid until the node is destroyed or its parameters are modified, and should not be modified directly. Use cuGraphExternalSemaphoresSignalNodeSetParams to update the parameters of this node.




See also:

cuGraphNodeGetParams, cuLaunchKernel, cuGraphAddExternalSemaphoresSignalNode, cuGraphExternalSemaphoresSignalNodeSetParams, cuGraphAddExternalSemaphoresWaitNode, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync

## CUresult cuGraphExternalSemaphoresSignalNodeSetParams (CUgraphNode hNode, const CUDA_EXT_SEM_SIGNAL_NODE_PARAMS *nodeParams)

Sets an external semaphore signal node's parameters.

### Parameters

**hNode**
- Node to set the parameters for

**nodeParams**
- Parameters to copy

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

### Description

Sets the parameters of an external semaphore signal node `hNode` to `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuGraphAddExternalSemaphoresSignalNode, cuGraphExternalSemaphoresSignalNodeSetParams, cuGraphAddExternalSemaphoresWaitNode, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync

## CUresult cuGraphExternalSemaphoresWaitNodeGetParams (CUgraphNode hNode, CUDA_EXT_SEM_WAIT_NODE_PARAMS *params_out)

Returns an external semaphore wait node's parameters.

### Parameters

**hNode**
- Node to get the parameters for

**params_out**
- Pointer to return the parameters

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns the parameters of an external semaphore wait node `hNode` in `params_out`. The `extSemArray` and `paramsArray` returned in `params_out`, are owned by the node. This memory

remains valid until the node is destroyed or its parameters are modified, and should not be modified directly. Use cuGraphExternalSemaphoresSignalNodeSetParams to update the parameters of this node.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuLaunchKernel, cuGraphAddExternalSemaphoresWaitNode, cuGraphExternalSemaphoresWaitNodeSetParams, cuGraphAddExternalSemaphoresWaitNode, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync

# CUresult cuGraphExternalSemaphoresWaitNodeSetParams (CUgraphNode hNode, const CUDA_EXT_SEM_WAIT_NODE_PARAMS *nodeParams)

Sets an external semaphore wait node's parameters.

## Parameters

**hNode**
- Node to set the parameters for

**nodeParams**
- Parameters to copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Sets the parameters of an external semaphore wait node `hNode` to `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuGraphAddExternalSemaphoresWaitNode, cuGraphExternalSemaphoresWaitNodeSetParams, cuGraphAddExternalSemaphoresWaitNode, cuSignalExternalSemaphoresAsync, cuWaitExternalSemaphoresAsync

# CUresult cuGraphGetEdges (CUgraph hGraph, CUgraphNode *from, CUgraphNode *to, CUgraphEdgeData *edgeData, size_t *numEdges)

Returns a graph's dependency edges.

## Parameters

**hGraph**
- Graph to get the edges from

**from**
- Location to return edge endpoints

**to**
- Location to return edge endpoints

**edgeData**
- Optional location to return edge data

**numEdges**
- See description

## Returns

CUDA_SUCCESS, CUDA_ERROR_LOSSY_QUERY, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns a list of `hGraph's` dependency edges. Edges are returned via corresponding indices in `from`, `to` and `edgeData`; that is, the node in `to`[i] has a dependency on the node in `from`[i] with data `edgeData`[i]. `from` and `to` may both be NULL, in which case this function only returns the number of edges in `numEdges`. Otherwise, `numEdges` entries will be filled in. If `numEdges` is higher than the actual number of edges, the remaining entries in `from` and `to` will be set to NULL, and the number of edges actually returned will be written to `numEdges`. `edgeData` may alone be NULL, in which case the edges must all have default (zeroed) edge data. Attempting a lossy query via NULL `edgeData` will result in CUDA_ERROR_LOSSY_QUERY. If `edgeData` is non-NULL then `from` and `to` must be as well.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphGetNodes, cuGraphGetRootNodes, cuGraphAddDependencies, cuGraphRemoveDependencies, cuGraphNodeGetDependencies, cuGraphNodeGetDependentNodes

# CUresult cuGraphGetId (CUgraph hGraph, unsigned int *graphId)

Returns the id of a given graph.

## Parameters

**hGraph**
- Graph to query

**graphId**

## Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## Description

Returns the id of `hGraph` in `*graphId`. The value in `*graphId` will match that referenced by cuGraphDebugDotPrint.

See also:

cuGraphGetNodes, cuGraphDebugDotPrint cuGraphNodeGetContainingGraph cuGraphNodeGetLocalId cuGraphNodeGetToolsId cuGraphExecGetId

# CUresult cuGraphGetNodes (CUgraph hGraph, CUgraphNode *nodes, size_t *numNodes)

Returns a graph's nodes.

## Parameters

**hGraph**
- Graph to query

**nodes**
- Pointer to return the nodes

**numNodes**
- See description

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns a list of `hGraph's` nodes. `nodes` may be NULL, in which case this function will return the number of nodes in `numNodes`. Otherwise, `numNodes` entries will be filled in. If `numNodes` is higher than the actual number of nodes, the remaining entries in `nodes` will be set to NULL, and the number of nodes actually obtained will be returned in `numNodes`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphCreate, cuGraphGetRootNodes, cuGraphGetEdges, cuGraphNodeGetType, cuGraphNodeGetDependencies, cuGraphNodeGetDependentNodes

## CUresult cuGraphGetRootNodes (CUgraph hGraph, CUgraphNode *rootNodes, size_t *numRootNodes)

Returns a graph's root nodes.

### Parameters

**hGraph**
- Graph to query

**rootNodes**
- Pointer to return the root nodes

**numRootNodes**
- See description

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns a list of `hGraph's` root nodes. `rootNodes` may be NULL, in which case this function will return the number of root nodes in `numRootNodes`. Otherwise, `numRootNodes` entries will be

filled in. If `numRootNodes` is higher than the actual number of root nodes, the remaining entries in `rootNodes` will be set to NULL, and the number of nodes actually obtained will be returned in `numRootNodes`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphCreate, cuGraphGetNodes, cuGraphGetEdges, cuGraphNodeGetType, cuGraphNodeGetDependencies, cuGraphNodeGetDependentNodes

# CUresult cuGraphHostNodeGetParams (CUgraphNode hNode, CUDA_HOST_NODE_PARAMS *nodeParams)

Returns a host node's parameters.

## Parameters

**hNode**
- Node to get the parameters for

**nodeParams**
- Pointer to return the parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns the parameters of host node `hNode` in `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuLaunchHostFunc, cuGraphAddHostNode, cuGraphHostNodeSetParams

# CUresult cuGraphHostNodeSetParams (CUgraphNode hNode, const CUDA_HOST_NODE_PARAMS *nodeParams)

Sets a host node's parameters.

## Parameters

**hNode**
- Node to set the parameters for

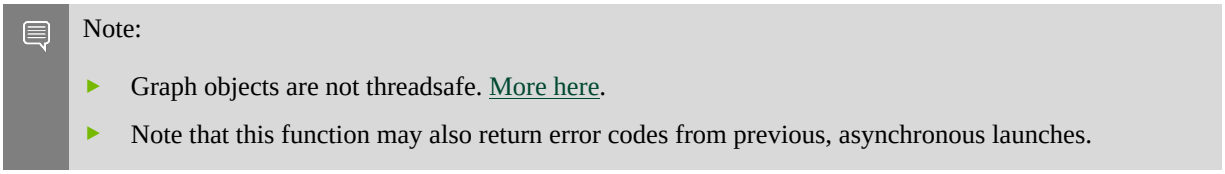
**nodeParams**
- Parameters to copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Sets the parameters of host node `hNode` to `nodeParams`.




See also:

cuGraphNodeSetParams, cuLaunchHostFunc, cuGraphAddHostNode, cuGraphHostNodeGetParams

# CUresult cuGraphInstantiate (CUgraphExec *phGraphExec, CUgraph hGraph, unsigned long long flags)

Creates an executable graph from a graph.

## Parameters

**phGraphExec**
- Returns instantiated graph

**hGraph**
- Graph to instantiate

**flags**
- Flags to control instantiation. See CUgraphInstantiate_flags.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Instantiates `hGraph` as an executable graph. The graph is validated for any structural constraints or intra-node constraints which were not previously validated. If instantiation is successful, a handle to the instantiated graph is returned in `phGraphExec`.

The `flags` parameter controls the behavior of instantiation and subsequent graph launches. Valid flags are:

- CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH, which configures a graph containing memory allocation nodes to automatically free any unfreed memory allocations before the graph is relaunched.
- CUDA_GRAPH_INSTANTIATE_FLAG_DEVICE_LAUNCH, which configures the graph for launch from the device. If this flag is passed, the executable graph handle returned can be used to launch the graph from both the host and device. This flag can only be used on platforms which support unified addressing. This flag cannot be used in conjunction with CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH.
- CUDA_GRAPH_INSTANTIATE_FLAG_USE_NODE_PRIORITY, which causes the graph to use the priorities from the per-node attributes rather than the priority of the launch stream during execution. Note that priorities are only available on kernel nodes, and are copied from stream priority during stream capture.

If `hGraph` contains any allocation or free nodes, there can be at most one executable graph in existence for that graph at a time. An attempt to instantiate a second executable graph before destroying the first with cuGraphExecDestroy will result in an error. The same also applies if `hGraph` contains any device-updatable kernel nodes.

If `hGraph` contains kernels which call device-side cudaGraphLaunch() from multiple contexts, this will result in an error.

Graphs instantiated for launch on the device have additional restrictions which do not apply to host graphs:

- The graph's nodes must reside on a single context.
- The graph can only contain kernel nodes, memcpy nodes, memset nodes, and child graph nodes.
- The graph cannot be empty and must contain at least one kernel, memcpy, or memset node. Operation-specific restrictions are outlined below.
- Kernel nodes:

- Use of CUDA Dynamic Parallelism is not permitted.
- Cooperative launches are permitted as long as MPS is not in use.

- Memcpy nodes:
  - Only copies involving device memory and/or pinned device-mapped host memory are permitted.
  - Copies involving CUDA arrays are not permitted.
  - Both operands must be accessible from the current context, and the current context must match the context of other nodes in the graph.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphInstantiate, cuGraphCreate, cuGraphUpload, cuGraphLaunch, cuGraphExecDestroy

# CUresult cuGraphInstantiateWithParams (CUgraphExec *phGraphExec, CUgraph hGraph, CUDA_GRAPH_INSTANTIATE_PARAMS *instantiateParams)

Creates an executable graph from a graph.

## Parameters

**phGraphExec**
- Returns instantiated graph

**hGraph**
- Graph to instantiate

**instantiateParams**
- Instantiation parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Instantiates `hGraph` as an executable graph according to the `instantiateParams` structure. The graph is validated for any structural constraints or intra-node constraints which were not

previously validated. If instantiation is successful, a handle to the instantiated graph is returned in `phGraphExec`.

`instantiateParams` controls the behavior of instantiation and subsequent graph launches, as well as returning more detailed information in the event of an error. CUDA_GRAPH_INSTANTIATE_PARAMS is defined as:

```
typedef struct {
          cuuint64_t flags;
          CUstream hUploadStream;
          CUgraphNode hErrNode_out;
          CUgraphInstantiateResult result_out;
      } CUDA_GRAPH_INSTANTIATE_PARAMS;
```

The `flags` field controls the behavior of instantiation and subsequent graph launches. Valid flags are:

- CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH, which configures a graph containing memory allocation nodes to automatically free any unfreed memory allocations before the graph is relaunched.
- CUDA_GRAPH_INSTANTIATE_FLAG_UPLOAD, which will perform an upload of the graph into `hUploadStream` once the graph has been instantiated.
- CUDA_GRAPH_INSTANTIATE_FLAG_DEVICE_LAUNCH, which configures the graph for launch from the device. If this flag is passed, the executable graph handle returned can be used to launch the graph from both the host and device. This flag can only be used on platforms which support unified addressing. This flag cannot be used in conjunction with CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH.
- CUDA_GRAPH_INSTANTIATE_FLAG_USE_NODE_PRIORITY, which causes the graph to use the priorities from the per-node attributes rather than the priority of the launch stream during execution. Note that priorities are only available on kernel nodes, and are copied from stream priority during stream capture.

If `hGraph` contains any allocation or free nodes, there can be at most one executable graph in existence for that graph at a time. An attempt to instantiate a second executable graph before destroying the first with cuGraphExecDestroy will result in an error. The same also applies if `hGraph` contains any device-updatable kernel nodes.

If `hGraph` contains kernels which call device-side cudaGraphLaunch() from multiple contexts, this will result in an error.

Graphs instantiated for launch on the device have additional restrictions which do not apply to host graphs:

- The graph's nodes must reside on a single context.
- The graph can only contain kernel nodes, memcpy nodes, memset nodes, and child graph nodes.
- The graph cannot be empty and must contain at least one kernel, memcpy, or memset node. Operation-specific restrictions are outlined below.
- Kernel nodes:
  - Use of CUDA Dynamic Parallelism is not permitted.

- Cooperative launches are permitted as long as MPS is not in use.

- Memcpy nodes:
  - Only copies involving device memory and/or pinned device-mapped host memory are permitted.
  - Copies involving CUDA arrays are not permitted.
  - Both operands must be accessible from the current context, and the current context must match the context of other nodes in the graph.

In the event of an error, the `result_out` and `hErrNode_out` fields will contain more information about the nature of the error. Possible error reporting includes:

- CUDA_GRAPH_INSTANTIATE_ERROR, if passed an invalid value or if an unexpected error occurred which is described by the return value of the function. `hErrNode_out` will be set to NULL.
- CUDA_GRAPH_INSTANTIATE_INVALID_STRUCTURE, if the graph structure is invalid. `hErrNode_out` will be set to one of the offending nodes.
- CUDA_GRAPH_INSTANTIATE_NODE_OPERATION_NOT_SUPPORTED, if the graph is instantiated for device launch but contains a node of an unsupported node type, or a node which performs unsupported operations, such as use of CUDA dynamic parallelism within a kernel node. `hErrNode_out` will be set to this node.
- CUDA_GRAPH_INSTANTIATE_MULTIPLE_CTXS_NOT_SUPPORTED, if the graph is instantiated for device launch but a node's context differs from that of another node. This error can also be returned if a graph is not instantiated for device launch and it contains kernels which call device-side cudaGraphLaunch() from multiple contexts. `hErrNode_out` will be set to this node.

If instantiation is successful, `result_out` will be set to CUDA_GRAPH_INSTANTIATE_SUCCESS, and `hErrNode_out` will be set to NULL.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphCreate, cuGraphInstantiate, cuGraphExecDestroy

# CUresult cuGraphKernelNodeCopyAttributes (CUgraphNode dst, CUgraphNode src)

Copies attributes from source node to destination node.

## Parameters

**dst**
Destination node
**src**
Source node For list of attributes see CUkernelNodeAttrID

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Copies attributes from source node `src` to destination node `dst`. Both node must have the same context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

CUaccessPolicyWindow

# CUresult cuGraphKernelNodeGetAttribute (CUgraphNode hNode, CUkernelNodeAttrID attr, CUkernelNodeAttrValue *value_out)

Queries node attribute.

## Parameters

**hNode**
**attr**
**value_out**

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Queries attribute `attr` from node `hNode` and stores it in corresponding member of `value_out`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

CUaccessPolicyWindow

## CUresult cuGraphKernelNodeGetParams (CUgraphNode hNode, CUDA_KERNEL_NODE_PARAMS *nodeParams)

Returns a kernel node's parameters.

### Parameters

**hNode**
- Node to get the parameters for

**nodeParams**
- Pointer to return the parameters

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns the parameters of kernel node `hNode` in `nodeParams`. The `kernelParams` or `extra` array returned in `nodeParams`, as well as the argument values it points to, are owned by the node. This memory remains valid until the node is destroyed or its parameters are modified, and should not be modified directly. Use cuGraphKernelNodeSetParams to update the parameters of this node.

The params will contain either `kernelParams` or `extra`, according to which of these was most recently set on the node.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuLaunchKernel, cuGraphAddKernelNode, cuGraphKernelNodeSetParams

## CUresult cuGraphKernelNodeSetAttribute (CUgraphNode hNode, CUkernelNodeAttrID attr, const CUkernelNodeAttrValue *value)

Sets node attribute.

### Parameters

**hNode**
**attr**
**value**

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Sets attribute `attr` on node `hNode` from corresponding attribute of `value`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

CUaccessPolicyWindow

## CUresult cuGraphKernelNodeSetParams (CUgraphNode hNode, const CUDA_KERNEL_NODE_PARAMS *nodeParams)

Sets a kernel node's parameters.

### Parameters

**hNode**
- Node to set the parameters for

**nodeParams**
- Parameters to copy

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY

### Description

Sets the parameters of kernel node `hNode` to `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuLaunchKernel, cuGraphAddKernelNode, cuGraphKernelNodeGetParams

## CUresult cuGraphLaunch (CUgraphExec hGraphExec, CUstream hStream)

Launches an executable graph in a stream.

### Parameters

**hGraphExec**
- Executable graph to launch

**hStream**
- Stream in which to launch the graph

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Executes `hGraphExec` in `hStream`. Only one instance of `hGraphExec` may be executing at a time. Each launch is ordered behind both any previous work in `hStream` and any previous launches of `hGraphExec`. To execute a graph concurrently, it must be instantiated multiple times into multiple executable graphs.

If any allocations created by `hGraphExec` remain unfreed (from a previous launch) and `hGraphExec` was not instantiated with CUDA_GRAPH_INSTANTIATE_FLAG_AUTO_FREE_ON_LAUNCH, the launch will fail with CUDA_ERROR_INVALID_VALUE.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphInstantiate, cuGraphUpload, cuGraphExecDestroy

## CUresult cuGraphMemAllocNodeGetParams (CUgraphNode hNode, CUDA_MEM_ALLOC_NODE_PARAMS *params_out)

Returns a memory alloc node's parameters.

### Parameters

**hNode**
- Node to get the parameters for

**params_out**
- Pointer to return the parameters

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns the parameters of a memory alloc node `hNode` in `params_out`. The `poolProps` and `accessDescs` returned in `params_out`, are owned by the node. This memory remains valid until the node is destroyed. The returned parameters must not be modified.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuGraphAddMemAllocNode, cuGraphMemFreeNodeGetParams

# CUresult cuGraphMemcpyNodeGetParams (CUgraphNode hNode, CUDA_MEMCPY3D *nodeParams)

Returns a memcpy node's parameters.

## Parameters

**hNode**
- Node to get the parameters for

**nodeParams**
- Pointer to return the parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns the parameters of memcpy node `hNode` in `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuMemcpy3D, cuGraphAddMemcpyNode, cuGraphMemcpyNodeSetParams

# CUresult cuGraphMemcpyNodeSetParams (CUgraphNode hNode, const CUDA_MEMCPY3D *nodeParams)

Sets a memcpy node's parameters.

## Parameters

**hNode**
- Node to set the parameters for

**nodeParams**
- Parameters to copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE,

### Description

Sets the parameters of memcpy node `hNode` to `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuMemcpy3D, cuGraphAddMemcpyNode, cuGraphMemcpyNodeGetParams

## CUresult cuGraphMemFreeNodeGetParams (CUgraphNode hNode, CUdeviceptr *dptr_out)

Returns a memory free node's parameters.

### Parameters

**hNode**
- Node to get the parameters for

**dptr_out**
- Pointer to return the device address

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Returns the address of a memory free node `hNode` in `dptr_out`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuGraphAddMemFreeNode, cuGraphMemAllocNodeGetParams

# CUresult cuGraphMemsetNodeGetParams (CUgraphNode hNode, CUDA_MEMSET_NODE_PARAMS *nodeParams)

Returns a memset node's parameters.

## Parameters

**hNode**
- Node to get the parameters for

**nodeParams**
- Pointer to return the parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns the parameters of memset node `hNode` in `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetParams, cuMemsetD2D32, cuGraphAddMemsetNode, cuGraphMemsetNodeSetParams

# CUresult cuGraphMemsetNodeSetParams (CUgraphNode hNode, const CUDA_MEMSET_NODE_PARAMS *nodeParams)

Sets a memset node's parameters.

## Parameters

**hNode**
- Node to set the parameters for

**nodeParams**
- Parameters to copy

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

### Description

Sets the parameters of memset node `hNode` to `nodeParams`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuMemsetD2D32, cuGraphAddMemsetNode, cuGraphMemsetNodeGetParams

## CUresult cuGraphNodeFindInClone (CUgraphNode *phNode, CUgraphNode hOriginalNode, CUgraph hClonedGraph)

Finds a cloned version of a node.

### Parameters

**phNode**
- Returns handle to the cloned node

**hOriginalNode**
- Handle to the original node

**hClonedGraph**
- Cloned graph to query

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

### Description

This function returns the node in `hClonedGraph` corresponding to `hOriginalNode` in the original graph.

`hClonedGraph` must have been cloned from `hOriginalGraph` via cuGraphClone. `hOriginalNode` must have been in `hOriginalGraph` at the time of the call to cuGraphClone,

and the corresponding cloned node in `hClonedGraph` must not have been removed. The cloned node is then returned via `phClonedNode`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphClone

# CUresult cuGraphNodeGetContainingGraph (CUgraphNode hNode, CUgraph *phGraph)

Returns the graph that contains a given graph node.

## Parameters

**hNode**
- Node to query

**phGraph**

## Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## Description

Returns the graph that contains `hNode` in `*phGraph`. If `hNode` is in a child graph, the child graph it is in is returned.

See also:

cuGraphGetNodes, cuGraphDebugDotPrint cuGraphNodeGetLocalId cuGraphNodeGetToolsId cuGraphGetId cuGraphExecGetId

# CUresult cuGraphNodeGetDependencies (CUgraphNode hNode, CUgraphNode *dependencies, CUgraphEdgeData *edgeData, size_t *numDependencies)

Returns a node's dependencies.

## Parameters

**hNode**
- Node to query

**dependencies**
- Pointer to return the dependencies

**edgeData**
- Optional array to return edge data for each dependency

**numDependencies**
- See description

## Returns

CUDA_SUCCESS, CUDA_ERROR_LOSSY_QUERY, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns a list of `node's` dependencies. `dependencies` may be NULL, in which case this function will return the number of dependencies in `numDependencies`. Otherwise, `numDependencies` entries will be filled in. If `numDependencies` is higher than the actual number of dependencies, the remaining entries in `dependencies` will be set to NULL, and the number of nodes actually obtained will be returned in `numDependencies`.

Note that if an edge has non-zero (non-default) edge data and `edgeData` is NULL, this API will return CUDA_ERROR_LOSSY_QUERY. If `edgeData` is non-NULL, then `dependencies` must be as well.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetDependentNodes, cuGraphGetNodes, cuGraphGetRootNodes, cuGraphGetEdges, cuGraphAddDependencies, cuGraphRemoveDependencies

# CUresult cuGraphNodeGetDependentNodes (CUgraphNode hNode, CUgraphNode *dependentNodes, CUgraphEdgeData *edgeData, size_t *numDependentNodes)

Returns a node's dependent nodes.

## Parameters

**hNode**
- Node to query

**dependentNodes**
- Pointer to return the dependent nodes

**edgeData**
- Optional pointer to return edge data for dependent nodes

**numDependentNodes**
- See description

## Returns

CUDA_SUCCESS, CUDA_ERROR_LOSSY_QUERY, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns a list of `node's` dependent nodes. `dependentNodes` may be NULL, in which case this function will return the number of dependent nodes in `numDependentNodes`. Otherwise, `numDependentNodes` entries will be filled in. If `numDependentNodes` is higher than the actual number of dependent nodes, the remaining entries in `dependentNodes` will be set to NULL, and the number of nodes actually obtained will be returned in `numDependentNodes`.

Note that if an edge has non-zero (non-default) edge data and `edgeData` is NULL, this API will return CUDA_ERROR_LOSSY_QUERY. If `edgeData` is non-NULL, then `dependentNodes` must be as well.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetDependencies, cuGraphGetNodes, cuGraphGetRootNodes, cuGraphGetEdges, cuGraphAddDependencies, cuGraphRemoveDependencies

# CUresult cuGraphNodeGetEnabled (CUgraphExec hGraphExec, CUgraphNode hNode, unsigned int *isEnabled)

Query whether a node in the given graphExec is enabled.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- Node from the graph from which graphExec was instantiated

**isEnabled**
- Location to return the enabled status of the node

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets isEnabled to 1 if `hNode` is enabled, or 0 if `hNode` is disabled.

The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

`hNode` must not have been removed from the original graph.

Note:

- Currently only kernel, memset and memcpy nodes are supported.
- This function will not reflect device-side updates for device-updatable kernel nodes.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetEnabled, cuGraphExecUpdate, cuGraphInstantiate cuGraphLaunch

# CUresult cuGraphNodeGetLocalId (CUgraphNode hNode, unsigned int *nodeId)

Returns the local node id of a given graph node.

## Parameters

**hNode**
- Node to query

**nodeId**
- Pointer to return the nodeId

## Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## Description

Returns the node id of `hNode` in `*nodeId`. The nodeId matches that referenced by cuGraphDebugDotPrint. The local nodeId and graphId together can uniquely identify the node.

See also:

cuGraphGetNodes, cuGraphDebugDotPrint cuGraphNodeGetContainingGraph cuGraphNodeGetToolsId cuGraphGetId cuGraphExecGetId

# CUresult cuGraphNodeGetParams (CUgraphNode hNode, CUgraphNodeParams *nodeParams)

Return a graph node's parameters.

## Parameters

**hNode**
- Node to get the parameters for

**nodeParams**
- Pointer to return the parameters

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns the parameters of graph node `hNode` in `*nodeParams`.

Any pointers returned in `*nodeParams` point to driver-owned memory associated with the node. This memory remains valid until the node is destroyed. Any memory pointed to from `*nodeParams` must not be modified.

The returned parameters are a description of the node, but may not be identical to the struct provided at creation and may not be suitable for direct creation of identical nodes. This is because parameters may be partially unspecified and filled in by the driver at creation, may reference non-copyable handles, or may describe ownership semantics or other parameters that govern behavior of node creation but are not part of the final functional descriptor.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeSetParams, cuGraphAddNode, cuGraphExecNodeSetParams

# CUresult cuGraphNodeGetToolsId (CUgraphNode hNode, unsigned long long *toolsNodeId)

Returns an id used by tools to identify a given node.

## Parameters

**hNode**
- Node to query

**toolsNodeId**

## Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## Description

See also:

cuGraphGetNodes, cuGraphDebugDotPrint cuGraphNodeGetContainingGraph cuGraphNodeGetLocalId cuGraphGetId cuGraphExecGetId

# CUresult cuGraphNodeGetType (CUgraphNode hNode, CUgraphNodeType *type)

Returns a node's type.

## Parameters

**hNode**
- Node to query

**type**
- Pointer to return the node type

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Returns the node type of `hNode` in `type`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphGetNodes, cuGraphGetRootNodes, cuGraphChildGraphNodeGetGraph, cuGraphKernelNodeGetParams, cuGraphKernelNodeSetParams, cuGraphHostNodeGetParams, cuGraphHostNodeSetParams, cuGraphMemcpyNodeGetParams, cuGraphMemcpyNodeSetParams, cuGraphMemsetNodeGetParams, cuGraphMemsetNodeSetParams

# CUresult cuGraphNodeSetEnabled (CUgraphExec hGraphExec, CUgraphNode hNode, unsigned int isEnabled)

Enables or disables the specified node in the given graphExec.

## Parameters

**hGraphExec**
- The executable graph in which to set the specified node

**hNode**
- Node from the graph from which graphExec was instantiated

**isEnabled**
- Node is enabled if != 0, otherwise the node is disabled

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE,

## Description

Sets `hNode` to be either enabled or disabled. Disabled nodes are functionally equivalent to empty nodes until they are reenabled. Existing node parameters are not affected by disabling/enabling the node.

The node is identified by the corresponding node `hNode` in the non-executable graph, from which the executable graph was instantiated.

`hNode` must not have been removed from the original graph.

The modifications only affect future launches of `hGraphExec`. Already enqueued or running launches of `hGraphExec` are not affected by this call. `hNode` is also not modified by this call.

If `hNode` is a device-updatable kernel node, the next upload/launch of `hGraphExec` will overwrite any previous device-side updates. Additionally, applying host updates to a device-updatable kernel node while it is being updated from the device will result in undefined behavior.

Note:

Currently only kernel, memset and memcpy nodes are supported.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphNodeGetEnabled, cuGraphExecUpdate, cuGraphInstantiate cuGraphLaunch

# CUresult cuGraphNodeSetParams (CUgraphNode hNode, CUgraphNodeParams *nodeParams)

Update a graph node's parameters.

## Parameters

**hNode**
- Node to set the parameters for

**nodeParams**
- Parameters to copy

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

Sets the parameters of graph node `hNode` to `nodeParams`. The node type specified by `nodeParams->type` must match the type of `hNode`. `nodeParams` must be fully initialized and all unused bytes (reserved, padding) zeroed.

Modifying parameters is not supported for node types CU_GRAPH_NODE_TYPE_MEM_ALLOC and CU_GRAPH_NODE_TYPE_MEM_FREE.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddNode, cuGraphNodeGetParams, cuGraphExecNodeSetParams

# CUresult cuGraphReleaseUserObject (CUgraph graph, CUuserObject object, unsigned int count)

Release a user object reference from a graph.

## Parameters

**graph**
- The graph that will release the reference

**object**
- The user object to release a reference for

**count**
- The number of references to release, typically 1. Must be nonzero and not larger than INT_MAX.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

Releases user object references owned by a graph.

See CUDA User Objects in the CUDA C++ Programming Guide for more information on user objects.

See also:

cuUserObjectCreate, cuUserObjectRetain, cuUserObjectRelease, cuGraphRetainUserObject, cuGraphCreate

## CUresult cuGraphRemoveDependencies (CUgraph hGraph, const CUgraphNode *from, const CUgraphNode *to, const CUgraphEdgeData *edgeData, size_t numDependencies)

Removes dependency edges from a graph.

### Parameters

**hGraph**
- Graph from which to remove dependencies

**from**
- Array of nodes that provide the dependencies

**to**
- Array of dependent nodes

**edgeData**
- Optional array of edge data. If NULL, edge data is assumed to be default (zeroed).

**numDependencies**
- Number of dependencies to be removed

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

The number of `dependencies` to be removed is defined by `numDependencies`. Elements in `from` and `to` at corresponding indices define a dependency. Each node in `from` and `to` must belong to `hGraph`.

If `numDependencies` is 0, elements in `from` and `to` will be ignored. Specifying an edge that does not exist in the graph, with data matching `edgeData`, results in an error. `edgeData` is nullable, which is equivalent to passing default (zeroed) data for each edge.

Dependencies cannot be removed from graphs which contain allocation or free nodes. Any attempt to do so will return an error.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphAddDependencies, cuGraphGetEdges, cuGraphNodeGetDependencies, cuGraphNodeGetDependentNodes

# CUresult cuGraphRetainUserObject (CUgraph graph, CUuserObject object, unsigned int count, unsigned int flags)

Retain a reference to a user object from a graph.

## Parameters

**graph**
- The graph to associate the reference with

**object**
- The user object to retain a reference for

**count**
- The number of references to add to the graph, typically 1. Must be nonzero and not larger than INT_MAX.

**flags**
- The optional flag CU_GRAPH_USER_OBJECT_MOVE transfers references from the calling thread, rather than create new references. Pass 0 to create new references.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Creates or moves user object references that will be owned by a CUDA graph.

See CUDA User Objects in the CUDA C++ Programming Guide for more information on user objects.

See also:

cuUserObjectCreate, cuUserObjectRetain, cuUserObjectRelease, cuGraphReleaseUserObject, cuGraphCreate

# CUresult cuGraphUpload (CUgraphExec hGraphExec, CUstream hStream)

Uploads an executable graph in a stream.

## Parameters

**hGraphExec**
- Executable graph to upload

**hStream**
- Stream in which to upload the graph

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE

## Description

Uploads `hGraphExec` to the device in `hStream` without executing it. Uploads of the same `hGraphExec` will be serialized. Each upload is ordered behind both any previous work in `hStream` and any previous launches of `hGraphExec`. Uses memory cached by `stream` to back the allocations owned by `hGraphExec`.

Note:

- Graph objects are not threadsafe. More here.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphInstantiate, cuGraphLaunch, cuGraphExecDestroy

# CUresult cuUserObjectCreate (CUuserObject *object_out, void *ptr, CUhostFn destroy, unsigned int initialRefcount, unsigned int flags)

Create a user object.

## Parameters

**object_out**
- Location to return the user object handle

**ptr**
- The pointer to pass to the destroy function

**destroy**
- Callback to free the user object when it is no longer in use

**initialRefcount**
- The initial refcount to create the object with, typically 1. The initial references are owned by the calling thread.

**flags**
- Currently it is required to pass CU_USER_OBJECT_NO_DESTRUCTOR_SYNC, which is the only defined flag. This indicates that the destroy callback cannot be waited on by any CUDA API. Users requiring synchronization of the callback should signal its completion manually.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Create a user object with the specified destructor callback and initial reference count. The initial references are owned by the caller.

Destructor callbacks cannot make CUDA API calls and should avoid blocking behavior, as they are executed by a shared internal thread. Another thread may be signaled to perform such actions, if it does not block forward progress of tasks scheduled through CUDA.

See CUDA User Objects in the CUDA C++ Programming Guide for more information on user objects.

See also:

cuUserObjectRetain, cuUserObjectRelease, cuGraphRetainUserObject, cuGraphReleaseUserObject, cuGraphCreate

# CUresult cuUserObjectRelease (CUuserObject object, unsigned int count)

Release a reference to a user object.

## Parameters

**object**
- The object to release

**count**
- The number of references to release, typically 1. Must be nonzero and not larger than INT_MAX.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Releases user object references owned by the caller. The object's destructor is invoked if the reference count reaches zero.

It is undefined behavior to release references not owned by the caller, or to use a user object handle after all references are released.

See CUDA User Objects in the CUDA C++ Programming Guide for more information on user objects.

See also:

cuUserObjectCreate, cuUserObjectRetain, cuGraphRetainUserObject, cuGraphReleaseUserObject, cuGraphCreate

# CUresult cuUserObjectRetain (CUuserObject object, unsigned int count)

Retain a reference to a user object.

## Parameters

**object**
- The object to retain

**count**
- The number of references to retain, typically 1. Must be nonzero and not larger than INT_MAX.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

### Description

Retains new references to a user object. The new references are owned by the caller.

See CUDA User Objects in the CUDA C++ Programming Guide for more information on user objects.

See also:

cuUserObjectCreate, cuUserObjectRelease, cuGraphRetainUserObject, cuGraphReleaseUserObject, cuGraphCreate

## 6.26. Occupancy

This section describes the occupancy calculation functions of the low-level CUDA driver application programming interface.

### CUresult cuOccupancyAvailableDynamicSMemPerBlock (size_t *dynamicSmemSize, CUfunction func, int numBlocks, int blockSize)

Returns dynamic shared memory available per block when launching `numBlocks` blocks on SM.

#### Parameters

**dynamicSmemSize**
- Returned maximum dynamic shared memory

**func**
- Kernel function for which occupancy is calculated

**numBlocks**
- Number of blocks to fit on SM

**blockSize**
- Size of the blocks

#### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_UNKNOWN

#### Description

Returns in `*dynamicSmemSize` the maximum size of dynamic shared memory to allow `numBlocks` blocks per SM.

Note that the API can also be used with context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to use for calculations will be the current context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

# CUresult cuOccupancyMaxActiveBlocksPerMultiprocessor (int *numBlocks, CUfunction func, int blockSize, size_t dynamicSMemSize)

Returns occupancy of a function.

## Parameters

**numBlocks**
- Returned occupancy

**func**
- Kernel for which occupancy is calculated

**blockSize**
- Block size the kernel is intended to be launched with

**dynamicSMemSize**
- Per-block dynamic shared memory usage intended, in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_UNKNOWN

## Description

Returns in `*numBlocks` the number of the maximum active blocks per streaming multiprocessor.

Note that the API can also be used with context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to use for calculations will be the current context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cudaOccupancyMaxActiveBlocksPerMultiprocessor

# CUresult cuOccupancyMaxActiveBlocksPerMultiprocessorWithFlags (int *numBlocks, CUfunction func, int blockSize, size_t dynamicSMemSize, unsigned int flags)

Returns occupancy of a function.

## Parameters

**numBlocks**
- Returned occupancy

**func**
- Kernel for which occupancy is calculated

**blockSize**
- Block size the kernel is intended to be launched with

**dynamicSMemSize**
- Per-block dynamic shared memory usage intended, in bytes

**flags**
- Requested behavior for the occupancy calculator

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_UNKNOWN

## Description

Returns in `*numBlocks` the number of the maximum active blocks per streaming multiprocessor.

The `Flags` parameter controls how special cases are handled. The valid flags are:

- CU_OCCUPANCY_DEFAULT, which maintains the default behavior as cuOccupancyMaxActiveBlocksPerMultiprocessor;
- CU_OCCUPANCY_DISABLE_CACHING_OVERRIDE, which suppresses the default behavior on platform where global caching affects occupancy. On such platforms, if caching is enabled, but per-block SM resource usage would result in zero occupancy, the occupancy calculator will calculate the occupancy as if caching is disabled. Setting CU_OCCUPANCY_DISABLE_CACHING_OVERRIDE makes the occupancy calculator to return 0 in such cases. More information can be found about this feature in the "Unified L1/Texture Cache" section of the Maxwell tuning guide.

Note that the API can also be with launch context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to use for calculations will be the current context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cudaOccupancyMaxActiveBlocksPerMultiprocessorWithFlags

# CUresult cuOccupancyMaxActiveClusters (int *numClusters, CUfunction func, const CUlaunchConfig *config)

Given the kernel function (`func`) and launch configuration (`config`), return the maximum number of clusters that could co-exist on the target device in `*numClusters`.

## Parameters

**numClusters**

- Returned maximum number of clusters that could co-exist on the target device

**func**

- Kernel function for which maximum number of clusters are calculated

**config**

- Launch configuration for the given kernel function

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_CLUSTER_SIZE, CUDA_ERROR_UNKNOWN

## Description

If the function has required cluster size already set (see cudaFuncGetAttributes / cuFuncGetAttribute), the cluster size from config must either be unspecified or match the required size. Without required sizes, the cluster size must be specified in config, else the function will return an error.

Note that various attributes of the kernel function may affect occupancy calculation. Runtime environment may affect how the hardware schedules the clusters, so the calculated occupancy is not guaranteed to be achievable.

Note that the API can also be used with context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to

use for calculations will either be taken from the specified stream `config->hStream` or the current context in case of NULL stream.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cudaFuncGetAttributes, cuFuncGetAttribute

## CUresult cuOccupancyMaxPotentialBlockSize (int *minGridSize, int *blockSize, CUfunction func, CUoccupancyB2DSize blockSizeToDynamicSMemSize, size_t dynamicSMemSize, int blockSizeLimit)

Suggest a launch configuration with reasonable occupancy.

### Parameters

**minGridSize**
- Returned minimum grid size needed to achieve the maximum occupancy

**blockSize**
- Returned maximum block size that can achieve the maximum occupancy

**func**
- Kernel for which launch configuration is calculated

**blockSizeToDynamicSMemSize**
- A function that calculates how much per-block dynamic shared memory `func` uses based on the block size

**dynamicSMemSize**
- Dynamic shared memory usage intended, in bytes

**blockSizeLimit**
- The maximum block size `func` is designed to handle

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_UNKNOWN

## Description

Returns in `*blockSize` a reasonable block size that can achieve the maximum occupancy (or, the maximum number of active warps with the fewest blocks per multiprocessor), and in `*minGridSize` the minimum grid size to achieve the maximum occupancy.

If `blockSizeLimit` is 0, the configurator will use the maximum block size permitted by the device / function instead.

If per-block dynamic shared memory allocation is not needed, the user should leave both `blockSizeToDynamicSMemSize` and `dynamicSMemSize` as 0.

If per-block dynamic shared memory allocation is needed, then if the dynamic shared memory size is constant regardless of block size, the size should be passed through `dynamicSMemSize`, and `blockSizeToDynamicSMemSize` should be NULL.

Otherwise, if the per-block dynamic shared memory size varies with different block sizes, the user needs to provide a unary function through `blockSizeToDynamicSMemSize` that computes the dynamic shared memory needed by `func` for any given block size. `dynamicSMemSize` is ignored. An example signature is:

```
    // Take block size, returns dynamic shared memory needed
         size_t blockToSmem(int blockSize);
```

Note that the API can also be used with context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to use for calculations will be the current context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cudaOccupancyMaxPotentialBlockSize

# CUresult cuOccupancyMaxPotentialBlockSizeWithFlags (int *minGridSize, int *blockSize, CUfunction func, CUoccupancyB2DSize blockSizeToDynamicSMemSize, size_t dynamicSMemSize, int blockSizeLimit, unsigned int flags)

Suggest a launch configuration with reasonable occupancy.

## Parameters

**minGridSize**
- Returned minimum grid size needed to achieve the maximum occupancy

**blockSize**
- Returned maximum block size that can achieve the maximum occupancy

**func**
- Kernel for which launch configuration is calculated

**blockSizeToDynamicSMemSize**
- A function that calculates how much per-block dynamic shared memory `func` uses based on the block size

**dynamicSMemSize**
- Dynamic shared memory usage intended, in bytes

**blockSizeLimit**
- The maximum block size `func` is designed to handle

**flags**
- Options

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_UNKNOWN

## Description

An extended version of cuOccupancyMaxPotentialBlockSize. In addition to arguments passed to cuOccupancyMaxPotentialBlockSize, cuOccupancyMaxPotentialBlockSizeWithFlags also takes a `Flags` parameter.

The `Flags` parameter controls how special cases are handled. The valid flags are:

- CU_OCCUPANCY_DEFAULT, which maintains the default behavior as cuOccupancyMaxPotentialBlockSize;
- CU_OCCUPANCY_DISABLE_CACHING_OVERRIDE, which suppresses the default behavior on platform where global caching affects occupancy. On such platforms, the launch

configurations that produces maximal occupancy might not support global caching. Setting CU_OCCUPANCY_DISABLE_CACHING_OVERRIDE guarantees that the the produced launch configuration is global caching compatible at a potential cost of occupancy. More information can be found about this feature in the "Unified L1/Texture Cache" section of the Maxwell tuning guide.

Note that the API can also be used with context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to use for calculations will be the current context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cudaOccupancyMaxPotentialBlockSizeWithFlags

# CUresult cuOccupancyMaxPotentialClusterSize (int *clusterSize, CUfunction func, const CUlaunchConfig *config)

Given the kernel function (`func`) and launch configuration (`config`), return the maximum cluster size in `*clusterSize`.

## Parameters

**clusterSize**

- Returned maximum cluster size that can be launched for the given kernel function and launch configuration

**func**

- Kernel function for which maximum cluster size is calculated

**config**

- Launch configuration for the given kernel function

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_UNKNOWN

## Description

The cluster dimensions in `config` are ignored. If func has a required cluster size set (see cudaFuncGetAttributes / cuFuncGetAttribute),`*clusterSize` will reflect the required cluster size.

By default this function will always return a value that's portable on future hardware. A higher value may be returned if the kernel function allows non-portable cluster sizes.

This function will respect the compile time launch bounds.

Note that the API can also be used with context-less kernel CUkernel by querying the handle using cuLibraryGetKernel() and then passing it to the API by casting to CUfunction. Here, the context to use for calculations will either be taken from the specified stream `config->hStream` or the current context in case of NULL stream.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cudaFuncGetAttributes, cuFuncGetAttribute

# 6.27. Texture Reference Management [DEPRECATED]

This section describes the deprecated texture reference management functions of the low-level CUDA driver application programming interface.

## CUresult cuTexRefCreate (CUtexref *pTexRef)

Creates a texture reference.

### Parameters

**pTexRef**
- Returned texture reference

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Creates a texture reference and returns its handle in `*pTexRef`. Once created, the application must call cuTexRefSetArray() or cuTexRefSetAddress() to associate the reference with allocated memory. Other texture reference functions are used to specify the format and interpretation (addressing, filtering, etc.) to be used when the memory is read through this texture reference.

See also:

cuTexRefDestroy

## CUresult cuTexRefDestroy (CUtexref hTexRef)

Destroys a texture reference.

### Parameters

**hTexRef**
- Texture reference to destroy

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Destroys the texture reference specified by `hTexRef`.

See also:

cuTexRefCreate

## CUresult cuTexRefGetAddress (CUdeviceptr *pdptr, CUtexref hTexRef)

Gets the address associated with a texture reference.

### Parameters

**pdptr**
- Returned device address

**hTexRef**
- Texture reference

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns in `*pdptr` the base address bound to the texture reference `hTexRef`, or returns CUDA_ERROR_INVALID_VALUE if the texture reference is not bound to any device memory range.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefGetAddressMode (CUaddress_mode *pam, CUtexref hTexRef, int dim)

Gets the addressing mode used by a texture reference.

## Parameters

**pam**
- Returned addressing mode

**hTexRef**
- Texture reference

**dim**
- Dimension

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Returns in `*pam` the addressing mode corresponding to the dimension `dim` of the texture reference `hTexRef`. Currently, the only valid value for `dim` are 0 and 1.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefGetArray (CUarray *phArray, CUtexref hTexRef)

Gets the array bound to a texture reference.

## Parameters

**phArray**
- Returned array

**hTexRef**
- Texture reference

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Returns in `*phArray` the CUDA array bound to the texture reference `hTexRef`, or returns CUDA_ERROR_INVALID_VALUE if the texture reference is not bound to any CUDA array.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefGetBorderColor (float *pBorderColor, CUtexref hTexRef)

Gets the border color used by a texture reference.

## Parameters

**pBorderColor**
- Returned Type and Value of RGBA color

**hTexRef**
- Texture reference

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns in `pBorderColor`, values of the RGBA color used by the texture reference `hTexRef`. The color value is of type float and holds color components in the following sequence: pBorderColor[0] holds 'R' component pBorderColor[1] holds 'G' component pBorderColor[2] holds 'B' component pBorderColor[3] holds 'A' component

See also:

cuTexRefSetAddressMode, cuTexRefSetAddressMode, cuTexRefSetBorderColor

## CUresult cuTexRefGetFilterMode (CUfilter_mode *pfm, CUtexref hTexRef)

Gets the filter-mode used by a texture reference.

### Parameters

**pfm**
- Returned filtering mode

**hTexRef**
- Texture reference

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns in `*pfm` the filtering mode of the texture reference `hTexRef`.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefGetFlags (unsigned int *pFlags, CUtexref hTexRef)

Gets the flags used by a texture reference.

## Parameters

**pFlags**
- Returned flags

**hTexRef**
- Texture reference

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Returns in `*pFlags` the flags of the texture reference `hTexRef`.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFormat

# CUresult cuTexRefGetFormat (CUarray_format *pFormat, int *pNumChannels, CUtexref hTexRef)

Gets the format used by a texture reference.

## Parameters

**pFormat**
- Returned format

**pNumChannels**
- Returned number of components

**hTexRef**
- Texture reference

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns in `*pFormat` and `*pNumChannels` the format and number of components of the CUDA array bound to the texture reference `hTexRef`. If `pFormat` or `pNumChannels` is NULL, it will be ignored.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags

## CUresult cuTexRefGetMaxAnisotropy (int *pmaxAniso, CUtexref hTexRef)

Gets the maximum anisotropy for a texture reference.

### Parameters

**pmaxAniso**
- Returned maximum anisotropy

**hTexRef**
- Texture reference

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns the maximum anisotropy in `pmaxAniso` that's used when reading memory through the texture reference `hTexRef`.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefGetMipmapFilterMode (CUfilter_mode *pfm, CUtexref hTexRef)

Gets the mipmap filtering mode for a texture reference.

## Parameters

**pfm**
- Returned mipmap filtering mode

**hTexRef**
- Texture reference

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Returns the mipmap filtering mode in `pfm` that's used when reading memory through the texture reference `hTexRef`.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefGetMipmapLevelBias (float *pbias, CUtexref hTexRef)

Gets the mipmap level bias for a texture reference.

## Parameters

**pbias**
- Returned mipmap level bias

**hTexRef**
- Texture reference

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns the mipmap level bias in `pBias` that's added to the specified mipmap level when reading memory through the texture reference `hTexRef`.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

## CUresult cuTexRefGetMipmapLevelClamp (float *pminMipmapLevelClamp, float *pmaxMipmapLevelClamp, CUtexref hTexRef)

Gets the min/max mipmap level clamps for a texture reference.

### Parameters

**pminMipmapLevelClamp**
- Returned mipmap min level clamp

**pmaxMipmapLevelClamp**
- Returned mipmap max level clamp

**hTexRef**
- Texture reference

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns the min/max mipmap level clamps in `pminMipmapLevelClamp` and `pmaxMipmapLevelClamp` that's used when reading memory through the texture reference `hTexRef`.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefGetMipmappedArray (CUmipmappedArray *phMipmappedArray, CUtexref hTexRef)

Gets the mipmapped array bound to a texture reference.

## Parameters

**phMipmappedArray**
- Returned mipmapped array

**hTexRef**
- Texture reference

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Returns in `*phMipmappedArray` the CUDA mipmapped array bound to the texture reference `hTexRef`, or returns CUDA_ERROR_INVALID_VALUE if the texture reference is not bound to any CUDA mipmapped array.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetAddress (size_t *ByteOffset, CUtexref hTexRef, CUdeviceptr dptr, size_t bytes)

Binds an address as a texture reference.

## Parameters

**ByteOffset**
- Returned byte offset

**hTexRef**
- Texture reference to bind

**dptr**
- Device pointer to bind

**bytes**
- Size of memory to bind in bytes

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Binds a linear address range to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. Any memory previously bound to `hTexRef` is unbound.

Since the hardware enforces an alignment requirement on texture base addresses, cuTexRefSetAddress() passes back a byte offset in `*ByteOffset` that must be applied to texture fetches in order to read from the desired memory. This offset must be divided by the texel size and passed to kernels that read from the texture so they can be applied to the tex1Dfetch() function.

If the device memory pointer was returned from cuMemAlloc(), the offset is guaranteed to be 0 and NULL may be passed as the `ByteOffset` parameter.

The total number of elements (or texels) in the linear address range cannot exceed CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LINEAR_WIDTH. The number of elements is computed as (`bytes` / bytesPerElement), where bytesPerElement is determined from the data format and number of components set using cuTexRefSetFormat().

See also:

cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

## CUresult cuTexRefSetAddress2D (CUtexref hTexRef, const CUDA_ARRAY_DESCRIPTOR *desc, CUdeviceptr dptr, size_t Pitch)

Binds an address as a 2D texture reference.

### Parameters

**hTexRef**
- Texture reference to bind

**desc**
- Descriptor of CUDA array

**dptr**
- Device pointer to bind

**Pitch**
- Line pitch in bytes

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Binds a linear address range to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. Any memory previously bound to `hTexRef` is unbound.

Using a tex2D() function inside a kernel requires a call to either cuTexRefSetArray() to bind the corresponding texture reference to an array, or cuTexRefSetAddress2D() to bind the texture reference to linear memory.

Function calls to cuTexRefSetFormat() cannot follow calls to cuTexRefSetAddress2D() for the same texture reference.

It is required that `dptr` be aligned to the appropriate hardware-specific texture alignment. You can query this value using the device attribute CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT. If an unaligned `dptr` is supplied, CUDA_ERROR_INVALID_VALUE is returned.

`Pitch` has to be aligned to the hardware-specific texture pitch alignment. This value can be queried using the device attribute CU_DEVICE_ATTRIBUTE_TEXTURE_PITCH_ALIGNMENT. If an unaligned `Pitch` is supplied, CUDA_ERROR_INVALID_VALUE is returned.

Width and Height, which are specified in elements (or texels), cannot exceed CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_WIDTH and CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_HEIGHT respectively. `Pitch`, which is specified in bytes, cannot exceed CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_PITCH.

See also:

cuTexRefSetAddress, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetAddressMode (CUtexref hTexRef, int dim, CUaddress_mode am)

Sets the addressing mode for a texture reference.

## Parameters

**hTexRef**
- Texture reference

**dim**
- Dimension

**am**
- Addressing mode to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Specifies the addressing mode `am` for the given dimension `dim` of the texture reference `hTexRef`. If `dim` is zero, the addressing mode is applied to the first parameter of the functions used to fetch from the texture; if `dim` is 1, the second, and so on. CUaddress_mode is defined as:

```
typedef enum CUaddress_mode_enum {
        CU_TR_ADDRESS_MODE_WRAP = 0,
        CU_TR_ADDRESS_MODE_CLAMP = 1,
        CU_TR_ADDRESS_MODE_MIRROR = 2,
        CU_TR_ADDRESS_MODE_BORDER = 3
      } CUaddress_mode;
```

Note that this call has no effect if `hTexRef` is bound to linear memory. Also, if the flag, CU_TRSF_NORMALIZED_COORDINATES, is not set, the only supported address mode is CU_TR_ADDRESS_MODE_CLAMP.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetArray (CUtexref hTexRef, CUarray hArray, unsigned int Flags)

Binds an array as a texture reference.

## Parameters

**hTexRef**
- Texture reference to bind

**hArray**
- Array to bind

**Flags**
- Options (must be CU_TRSA_OVERRIDE_FORMAT)

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Binds the CUDA array `hArray` to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. `Flags` must be set to CU_TRSA_OVERRIDE_FORMAT. Any CUDA array previously bound to `hTexRef` is unbound.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetBorderColor (CUtexref hTexRef, float *pBorderColor)

Sets the border color for a texture reference.

## Parameters

**hTexRef**
- Texture reference

**pBorderColor**
- RGBA color

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Specifies the value of the RGBA color via the `pBorderColor` to the texture reference `hTexRef`. The color value supports only float type and holds color components in the following sequence: pBorderColor[0] holds 'R' component pBorderColor[1] holds 'G' component pBorderColor[2] holds 'B' component pBorderColor[3] holds 'A' component

Note that the color values can be set only when the Address mode is set to CU_TR_ADDRESS_MODE_BORDER using cuTexRefSetAddressMode. Applications using integer border color values have to "reinterpret_cast" their values to float.

See also:

cuTexRefSetAddressMode, cuTexRefGetAddressMode, cuTexRefGetBorderColor

## CUresult cuTexRefSetFilterMode (CUtexref hTexRef, CUfilter_mode fm)

Sets the filtering mode for a texture reference.

### Parameters

**hTexRef**
- Texture reference

**fm**
- Filtering mode to set

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Specifies the filtering mode `fm` to be used when reading memory through the texture reference `hTexRef`. CUfilter_mode_enum is defined as:

```
typedef enum CUfilter_mode_enum {
        CU_TR_FILTER_MODE_POINT = 0,
        CU_TR_FILTER_MODE_LINEAR = 1
      } CUfilter_mode;
```

Note that this call has no effect if `hTexRef` is bound to linear memory.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetFlags (CUtexref hTexRef, unsigned int Flags)

Sets the flags for a texture reference.

## Parameters

**hTexRef**
- Texture reference

**Flags**
- Optional flags to set

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Specifies optional flags via `Flags` to specify the behavior of data returned through the texture reference `hTexRef`. The valid flags are:

- CU_TRSF_READ_AS_INTEGER, which suppresses the default behavior of having the texture promote integer data to floating point data in the range [0, 1]. Note that texture with 32-bit integer format would not be promoted, regardless of whether or not this flag is specified;
- CU_TRSF_NORMALIZED_COORDINATES, which suppresses the default behavior of having the texture coordinates range from [0, Dim) where Dim is the width or height of the CUDA array. Instead, the texture coordinates [0, 1.0) reference the entire breadth of the array dimension;
- CU_TRSF_DISABLE_TRILINEAR_OPTIMIZATION, which disables any trilinear filtering optimizations. Trilinear optimizations improve texture filtering performance by allowing bilinear filtering on textures in scenarios where it can closely approximate the expected results.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetFormat (CUtexref hTexRef, CUarray_format fmt, int NumPackedComponents)

Sets the format for a texture reference.

## Parameters

**hTexRef**
- Texture reference

**fmt**
- Format to set

**NumPackedComponents**
- Number of components per array element

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Specifies the format of the data to be read by the texture reference `hTexRef`. `fmt` and `NumPackedComponents` are exactly analogous to the Format and NumChannels members of the CUDA_ARRAY_DESCRIPTOR structure: They specify the format of each component and the number of components per array element.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat, cudaCreateChannelDesc

# CUresult cuTexRefSetMaxAnisotropy (CUtexref hTexRef, unsigned int maxAniso)

Sets the maximum anisotropy for a texture reference.

## Parameters

**hTexRef**
- Texture reference

**maxAniso**
- Maximum anisotropy

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Specifies the maximum anisotropy `maxAniso` to be used when reading memory through the texture reference `hTexRef`.

Note that this call has no effect if `hTexRef` is bound to linear memory.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

## CUresult cuTexRefSetMipmapFilterMode (CUtexref hTexRef, CUfilter_mode fm)

Sets the mipmap filtering mode for a texture reference.

### Parameters

**hTexRef**
- Texture reference

**fm**
- Filtering mode to set

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Specifies the mipmap filtering mode `fm` to be used when reading memory through the texture reference `hTexRef`. CUfilter_mode_enum is defined as:

```
typedef enum CUfilter_mode_enum {
        CU_TR_FILTER_MODE_POINT = 0,
        CU_TR_FILTER_MODE_LINEAR = 1
      } CUfilter_mode;
```

Note that this call has no effect if `hTexRef` is not bound to a mipmapped array.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetMipmapLevelBias (CUtexref hTexRef, float bias)

Sets the mipmap level bias for a texture reference.

## Parameters

**hTexRef**
- Texture reference

**bias**
- Mipmap level bias

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Deprecated

Specifies the mipmap level bias `bias` to be added to the specified mipmap level when reading memory through the texture reference `hTexRef`.

Note that this call has no effect if `hTexRef` is not bound to a mipmapped array.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

# CUresult cuTexRefSetMipmapLevelClamp (CUtexref hTexRef, float minMipmapLevelClamp, float maxMipmapLevelClamp)

Sets the mipmap min/max mipmap level clamps for a texture reference.

## Parameters

**hTexRef**
- Texture reference

**minMipmapLevelClamp**
- Mipmap min level clamp

**maxMipmapLevelClamp**
- Mipmap max level clamp

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Specifies the min/max mipmap level clamps, `minMipmapLevelClamp` and `maxMipmapLevelClamp` respectively, to be used when reading memory through the texture reference `hTexRef`.

Note that this call has no effect if `hTexRef` is not bound to a mipmapped array.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetArray, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

## CUresult cuTexRefSetMipmappedArray (CUtexref hTexRef, CUmipmappedArray hMipmappedArray, unsigned int Flags)

Binds a mipmapped array to a texture reference.

### Parameters

**hTexRef**
- Texture reference to bind

**hMipmappedArray**
- Mipmapped array to bind

**Flags**
- Options (must be CU_TRSA_OVERRIDE_FORMAT)

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Binds the CUDA mipmapped array `hMipmappedArray` to the texture reference `hTexRef`. Any previous address or CUDA array state associated with the texture reference is superseded by this function. `Flags` must be set to CU_TRSA_OVERRIDE_FORMAT. Any CUDA array previously bound to `hTexRef` is unbound.

See also:

cuTexRefSetAddress, cuTexRefSetAddress2D, cuTexRefSetAddressMode, cuTexRefSetFilterMode, cuTexRefSetFlags, cuTexRefSetFormat, cuTexRefGetAddress, cuTexRefGetAddressMode, cuTexRefGetArray, cuTexRefGetFilterMode, cuTexRefGetFlags, cuTexRefGetFormat

## 6.28. Surface Reference Management [DEPRECATED]

This section describes the surface reference management functions of the low-level CUDA driver application programming interface.

## CUresult cuSurfRefGetArray (CUarray *phArray, CUsurfref hSurfRef)

Passes back the CUDA array bound to a surface reference.

### Parameters

**phArray**
- Surface reference handle

**hSurfRef**
- Surface reference handle

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Returns in `*phArray` the CUDA array bound to the surface reference `hSurfRef`, or returns CUDA_ERROR_INVALID_VALUE if the surface reference is not bound to any CUDA array.

See also:

cuModuleGetSurfRef, cuSurfRefSetArray

## CUresult cuSurfRefSetArray (CUsurfref hSurfRef, CUarray hArray, unsigned int Flags)

Sets the CUDA array for a surface reference.

### Parameters

**hSurfRef**
- Surface reference handle

**hArray**
- CUDA array handle

**Flags**
- set to 0

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated

Sets the CUDA array `hArray` to be read and written by the surface reference `hSurfRef`. Any previous CUDA array state associated with the surface reference is superseded by this function. `Flags` must be set to 0. The CUDA_ARRAY3D_SURFACE_LDST flag must have been set for the CUDA array. Any CUDA array previously bound to `hSurfRef` is unbound.

See also:

cuModuleGetSurfRef, cuSurfRefGetArray

# 6.29. Texture Object Management

This section describes the texture object management functions of the low-level CUDA driver application programming interface. The texture object API is only supported on devices of compute capability 3.0 or higher.

# CUresult cuTexObjectCreate (CUtexObject *pTexObject, const CUDA_RESOURCE_DESC *pResDesc, const CUDA_TEXTURE_DESC *pTexDesc, const CUDA_RESOURCE_VIEW_DESC *pResViewDesc)

Creates a texture object.

## Parameters

**pTexObject**
- Texture object to create

**pResDesc**
- Resource descriptor

**pTexDesc**
- Texture descriptor

**pResViewDesc**
- Resource view descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Creates a texture object and returns it in `pTexObject`. `pResDesc` describes the data to texture from. `pTexDesc` describes how the data should be sampled. `pResViewDesc` is an optional argument that specifies an alternate format for the data described by `pResDesc`, and also describes the subresource region to restrict access to when texturing. `pResViewDesc` can only be specified if the type of resource is a CUDA array or a CUDA mipmapped array not in a block compressed format.

Texture objects are only supported on devices of compute capability 3.0 or higher. Additionally, a texture object is an opaque value, and, as such, should only be accessed through CUDA API calls.

The CUDA_RESOURCE_DESC structure is defined as:

```
typedef struct CUDA_RESOURCE_DESC_st
     {
         CUresourcetype resType;

         union {
             struct {
                 CUarray hArray;
             } array;
             struct {
                 CUmipmappedArray hMipmappedArray;
             } mipmap;
             struct {
                 CUdeviceptr devPtr;
                 CUarray_format format;
                 unsigned int numChannels;
```

```
                        size_t sizeInBytes;
                    } linear;
                    struct {
                        CUdeviceptr devPtr;
                        CUarray_format format;
                        unsigned int numChannels;
                        size_t width;
                        size_t height;
                        size_t pitchInBytes;
                    } pitch2D;
                } res;

                unsigned int flags;
            } CUDA_RESOURCE_DESC;
```

where:

- CUDA_RESOURCE_DESC::resType specifies the type of resource to texture from. CUresourceType is defined as:

```
        typedef enum CUresourcetype_enum {
                CU_RESOURCE_TYPE_ARRAY           = 0x00,
                CU_RESOURCE_TYPE_MIPMAPPED_ARRAY = 0x01,
                CU_RESOURCE_TYPE_LINEAR          = 0x02,
                CU_RESOURCE_TYPE_PITCH2D         = 0x03
            } CUresourcetype;
```

If CUDA_RESOURCE_DESC::resType is set to CU_RESOURCE_TYPE_ARRAY, CUDA_RESOURCE_DESC::res::array::hArray must be set to a valid CUDA array handle.

If CUDA_RESOURCE_DESC::resType is set to CU_RESOURCE_TYPE_MIPMAPPED_ARRAY, CUDA_RESOURCE_DESC::res::mipmap::hMipmappedArray must be set to a valid CUDA mipmapped array handle.

If CUDA_RESOURCE_DESC::resType is set to CU_RESOURCE_TYPE_LINEAR, CUDA_RESOURCE_DESC::res::linear::devPtr must be set to a valid device pointer, that is aligned to CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT. CUDA_RESOURCE_DESC::res::linear::format and CUDA_RESOURCE_DESC::res::linear::numChannels describe the format of each component and the number of components per array element. CUDA_RESOURCE_DESC::res::linear::sizeInBytes specifies the size of the array in bytes. The total number of elements in the linear address range cannot exceed CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE1D_LINEAR_WIDTH. The number of elements is computed as (sizeInBytes / (sizeof(format) * numChannels)).

If CUDA_RESOURCE_DESC::resType is set to CU_RESOURCE_TYPE_PITCH2D, CUDA_RESOURCE_DESC::res::pitch2D::devPtr must be set to a valid device pointer, that is aligned to CU_DEVICE_ATTRIBUTE_TEXTURE_ALIGNMENT. CUDA_RESOURCE_DESC::res::pitch2D::format and CUDA_RESOURCE_DESC::res::pitch2D::numChannels describe the format of each component and the number of components per array element. CUDA_RESOURCE_DESC::res::pitch2D::width and CUDA_RESOURCE_DESC::res::pitch2D::height specify the width and height of the array in elements, and cannot exceed CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_WIDTH and CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_HEIGHT respectively.

CUDA_RESOURCE_DESC::res::pitch2D::pitchInBytes specifies the pitch between two rows in bytes and has to be aligned to CU_DEVICE_ATTRIBUTE_TEXTURE_PITCH_ALIGNMENT. Pitch cannot exceed CU_DEVICE_ATTRIBUTE_MAXIMUM_TEXTURE2D_LINEAR_PITCH.

- flags must be set to zero.

The CUDA_TEXTURE_DESC struct is defined as

```
typedef struct CUDA_TEXTURE_DESC_st {
        CUaddress_mode addressMode[3];
        CUfilter_mode filterMode;
        unsigned int flags;
        unsigned int maxAnisotropy;
        CUfilter_mode mipmapFilterMode;
        float mipmapLevelBias;
        float minMipmapLevelClamp;
        float maxMipmapLevelClamp;
    } CUDA_TEXTURE_DESC;
```

where

- CUDA_TEXTURE_DESC::addressMode specifies the addressing mode for each dimension of the texture data. CUaddress_mode is defined as:

  ```
  typedef enum CUaddress_mode_enum {
          CU_TR_ADDRESS_MODE_WRAP = 0,
          CU_TR_ADDRESS_MODE_CLAMP = 1,
          CU_TR_ADDRESS_MODE_MIRROR = 2,
          CU_TR_ADDRESS_MODE_BORDER = 3
      } CUaddress_mode;
  ```

  This is ignored if CUDA_RESOURCE_DESC::resType is CU_RESOURCE_TYPE_LINEAR. Also, if the flag, CU_TRSF_NORMALIZED_COORDINATES is not set, the only supported address mode is CU_TR_ADDRESS_MODE_CLAMP.

- CUDA_TEXTURE_DESC::filterMode specifies the filtering mode to be used when fetching from the texture. CUfilter_mode is defined as:

  ```
  typedef enum CUfilter_mode_enum {
          CU_TR_FILTER_MODE_POINT = 0,
          CU_TR_FILTER_MODE_LINEAR = 1
      } CUfilter_mode;
  ```

  This is ignored if CUDA_RESOURCE_DESC::resType is CU_RESOURCE_TYPE_LINEAR.

- CUDA_TEXTURE_DESC::flags can be any combination of the following:

  - CU_TRSF_READ_AS_INTEGER, which suppresses the default behavior of having the texture promote integer data to floating point data in the range [0, 1]. Note that texture with 32-bit integer format would not be promoted, regardless of whether or not this flag is specified.
  - CU_TRSF_NORMALIZED_COORDINATES, which suppresses the default behavior of having the texture coordinates range from [0, Dim) where Dim is the width or height of the CUDA array. Instead, the texture coordinates [0, 1.0) reference the entire breadth of the array dimension; Note that for CUDA mipmapped arrays, this flag has to be set.
  - CU_TRSF_DISABLE_TRILINEAR_OPTIMIZATION, which disables any trilinear filtering optimizations. Trilinear optimizations improve texture filtering performance by allowing bilinear filtering on textures in scenarios where it can closely approximate the expected results.
  - CU_TRSF_SEAMLESS_CUBEMAP, which enables seamless cube map filtering.
    This flag can only be specified if the underlying resource is a CUDA array or a CUDA

mipmapped array that was created with the flag CUDA_ARRAY3D_CUBEMAP. When seamless cube map filtering is enabled, texture address modes specified by CUDA_TEXTURE_DESC::addressMode are ignored. Instead, if the CUDA_TEXTURE_DESC::filterMode is set to CU_TR_FILTER_MODE_POINT the address mode CU_TR_ADDRESS_MODE_CLAMP will be applied for all dimensions. If the CUDA_TEXTURE_DESC::filterMode is set to CU_TR_FILTER_MODE_LINEAR seamless cube map filtering will be performed when sampling along the cube face borders.

- CUDA_TEXTURE_DESC::maxAnisotropy specifies the maximum anisotropy ratio to be used when doing anisotropic filtering. This value will be clamped to the range [1,16].
- CUDA_TEXTURE_DESC::mipmapFilterMode specifies the filter mode when the calculated mipmap level lies between two defined mipmap levels.
- CUDA_TEXTURE_DESC::mipmapLevelBias specifies the offset to be applied to the calculated mipmap level.
- CUDA_TEXTURE_DESC::minMipmapLevelClamp specifies the lower end of the mipmap level range to clamp access to.
- CUDA_TEXTURE_DESC::maxMipmapLevelClamp specifies the upper end of the mipmap level range to clamp access to.

The CUDA_RESOURCE_VIEW_DESC struct is defined as

```
typedef struct CUDA_RESOURCE_VIEW_DESC_st
    {
        CUresourceViewFormat format;
        size_t width;
        size_t height;
        size_t depth;
        unsigned int firstMipmapLevel;
        unsigned int lastMipmapLevel;
        unsigned int firstLayer;
        unsigned int lastLayer;
    } CUDA_RESOURCE_VIEW_DESC;
```

where:

- CUDA_RESOURCE_VIEW_DESC::format specifies how the data contained in the CUDA array or CUDA mipmapped array should be interpreted. Note that this can incur a change in size of the texture data. If the resource view format is a block compressed format, then the underlying CUDA array or CUDA mipmapped array has to have a base of format CU_AD_FORMAT_UNSIGNED_INT32. with 2 or 4 channels, depending on the block compressed format. For ex., BC1 and BC4 require the underlying CUDA array to have a format of CU_AD_FORMAT_UNSIGNED_INT32 with 2 channels. The other BC formats require the underlying resource to have the same base format but with 4 channels.
- CUDA_RESOURCE_VIEW_DESC::width specifies the new width of the texture data. If the resource view format is a block compressed format, this value has to be 4 times the original width of the resource. For non block compressed formats, this value has to be equal to that of the original resource.

- CUDA_RESOURCE_VIEW_DESC::height specifies the new height of the texture data. If the resource view format is a block compressed format, this value has to be 4 times the original height of the resource. For non block compressed formats, this value has to be equal to that of the original resource.
- CUDA_RESOURCE_VIEW_DESC::depth specifies the new depth of the texture data. This value has to be equal to that of the original resource.
- CUDA_RESOURCE_VIEW_DESC::firstMipmapLevel specifies the most detailed mipmap level. This will be the new mipmap level zero. For non-mipmapped resources, this value has to be zero.CUDA_TEXTURE_DESC::minMipmapLevelClamp and CUDA_TEXTURE_DESC::maxMipmapLevelClamp will be relative to this value. For ex., if the firstMipmapLevel is set to 2, and a minMipmapLevelClamp of 1.2 is specified, then the actual minimum mipmap level clamp will be 3.2.
- CUDA_RESOURCE_VIEW_DESC::lastMipmapLevel specifies the least detailed mipmap level. For non-mipmapped resources, this value has to be zero.
- CUDA_RESOURCE_VIEW_DESC::firstLayer specifies the first layer index for layered textures. This will be the new layer zero. For non-layered resources, this value has to be zero.
- CUDA_RESOURCE_VIEW_DESC::lastLayer specifies the last layer index for layered textures. For non-layered resources, this value has to be zero.

See also:

cuTexObjectDestroy, cudaCreateTextureObject

# CUresult cuTexObjectDestroy (CUtexObject texObject)

Destroys a texture object.

## Parameters

**texObject**
- Texture object to destroy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Destroys the texture object specified by `texObject`.

See also:

cuTexObjectCreate, cudaDestroyTextureObject

# CUresult cuTexObjectGetResourceDesc (CUDA_RESOURCE_DESC *pResDesc, CUtexObject texObject)

Returns a texture object's resource descriptor.

## Parameters

**pResDesc**
- Resource descriptor

**texObject**
- Texture object

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Returns the resource descriptor for the texture object specified by `texObject`.

See also:

cuTexObjectCreate, cudaGetTextureObjectResourceDesc,

# CUresult cuTexObjectGetResourceViewDesc (CUDA_RESOURCE_VIEW_DESC *pResViewDesc, CUtexObject texObject)

Returns a texture object's resource view descriptor.

## Parameters

**pResViewDesc**
- Resource view descriptor

**texObject**
- Texture object

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Returns the resource view descriptor for the texture object specified by `texObject`. If no resource view was set for `texObject`, the CUDA_ERROR_INVALID_VALUE is returned.

See also:

cuTexObjectCreate, cudaGetTextureObjectResourceViewDesc

## CUresult cuTexObjectGetTextureDesc (CUDA_TEXTURE_DESC *pTexDesc, CUtexObject texObject)

Returns a texture object's texture descriptor.

### Parameters

**pTexDesc**
- Texture descriptor

**texObject**
- Texture object

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Returns the texture descriptor for the texture object specified by `texObject`.

See also:

cuTexObjectCreate, cudaGetTextureObjectTextureDesc

# 6.30. Surface Object Management

This section describes the surface object management functions of the low-level CUDA driver application programming interface. The surface object API is only supported on devices of compute capability 3.0 or higher.

# CUresult cuSurfObjectCreate (CUsurfObject *pSurfObject, const CUDA_RESOURCE_DESC *pResDesc)

Creates a surface object.

## Parameters

**pSurfObject**
- Surface object to create

**pResDesc**
- Resource descriptor

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Creates a surface object and returns it in `pSurfObject`. `pResDesc` describes the data to perform surface load/stores on. CUDA_RESOURCE_DESC::resType must be CU_RESOURCE_TYPE_ARRAY and CUDA_RESOURCE_DESC::res::array::hArray must be set to a valid CUDA array handle. CUDA_RESOURCE_DESC::flags must be set to zero.

Surface objects are only supported on devices of compute capability 3.0 or higher. Additionally, a surface object is an opaque value, and, as such, should only be accessed through CUDA API calls.

See also:

cuSurfObjectDestroy, cudaCreateSurfaceObject

# CUresult cuSurfObjectDestroy (CUsurfObject surfObject)

Destroys a surface object.

## Parameters

**surfObject**
- Surface object to destroy

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Destroys the surface object specified by `surfObject`.

See also:

cuSurfObjectCreate, cudaDestroySurfaceObject

## CUresult cuSurfObjectGetResourceDesc (CUDA_RESOURCE_DESC *pResDesc, CUsurfObject surfObject)

Returns a surface object's resource descriptor.

### Parameters

**pResDesc**
- Resource descriptor

**surfObject**
- Surface object

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Returns the resource descriptor for the surface object specified by `surfObject`.

See also:

cuSurfObjectCreate, cudaGetSurfaceObjectResourceDesc

# 6.31. Tensor Map Object Managment

This section describes the tensor map object management functions of the low-level CUDA driver application programming interface. The tensor core API is only supported on devices of compute capability 9.0 or higher.

# CUresult cuTensorMapEncodeIm2col (CUtensorMap *tensorMap, CUtensorMapDataType tensorDataType, cuuint32_t tensorRank, void *globalAddress, const cuuint64_t *globalDim, const cuuint64_t *globalStrides, const int *pixelBoxLowerCorner, const int *pixelBoxUpperCorner, cuuint32_t channelsPerPixel, cuuint32_t pixelsPerColumn, const cuuint32_t *elementStrides, CUtensorMapInterleave interleave, CUtensorMapSwizzle swizzle, CUtensorMapL2promotion l2Promotion, CUtensorMapFloatOOBfill oobFill)

Create a tensor map descriptor object representing im2col memory region.

## Parameters

**tensorMap**
- Tensor map object to create

**tensorDataType**
- Tensor data type

**tensorRank**
- Dimensionality of tensor; must be at least 3

**globalAddress**
- Starting address of memory region described by tensor

**globalDim**
- Array containing tensor size (number of elements) along each of the `tensorRank` dimensions

**globalStrides**
- Array containing stride size (in bytes) along each of the `tensorRank` - 1 dimensions

**pixelBoxLowerCorner**
- Array containing DHW dimensions of lower box corner

**pixelBoxUpperCorner**
- Array containing DHW dimensions of upper box corner

**channelsPerPixel**
- Number of channels per pixel

**pixelsPerColumn**
- Number of pixels per column

**elementStrides**
- Array containing traversal stride in each of the `tensorRank` dimensions

**interleave**
- Type of interleaved layout the tensor addresses

**swizzle**
- Bank swizzling pattern inside shared memory

**l2Promotion**
- L2 promotion size

**oobFill**
- Indicate whether zero or special NaN constant will be used to fill out-of-bound elements

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Creates a descriptor for Tensor Memory Access (TMA) object specified by the parameters describing a im2col memory layout and returns it in `tensorMap`.

Tensor map objects are only supported on devices of compute capability 9.0 or higher. Additionally, a tensor map object is an opaque value, and, as such, should only be accessed through CUDA APIs and PTX.

The parameters passed are bound to the following requirements:

- `tensorMap` address must be aligned to 64 bytes.
- `tensorDataType` has to be an enum from CUtensorMapDataType which is defined as:

```
typedef enum CUtensorMapDataType_enum {
    CU_TENSOR_MAP_DATA_TYPE_UINT8 = 0,        // 1 byte
    CU_TENSOR_MAP_DATA_TYPE_UINT16,           // 2 bytes
    CU_TENSOR_MAP_DATA_TYPE_UINT32,           // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_INT32,            // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_UINT64,           // 8 bytes
    CU_TENSOR_MAP_DATA_TYPE_INT64,            // 8 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT16,          // 2 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT32,          // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT64,          // 8 bytes
    CU_TENSOR_MAP_DATA_TYPE_BFLOAT16,         // 2 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT32_FTZ,      // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_TFLOAT32,         // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_TFLOAT32_FTZ      // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B,     // 4 bits
    CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B,    // 4 bits
    CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B     // 6 bits
} CUtensorMapDataType;
```

  CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B copies '16 x U4' packed values to memory aligned as 8 bytes. There are no gaps between packed values. CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B copies '16 x U4' packed values to memory aligned as 16 bytes. There are 8 byte gaps between every 8 byte chunk of packed values. CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B copies '16 x U6' packed values to memory aligned as 16 bytes. There are 4 byte gaps between every 12 byte chunk of packed values.
- `tensorRank`, which specifies the number of tensor dimensions, must be 3, 4, or 5.

- `globalAddress`, which specifies the starting address of the memory region described, must be 16 byte aligned. The following requirements need to also be met:
  - When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, `globalAddress` must be 32 byte aligned.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, `globalAddress` must be 32 byte aligned.
- `globalDim` array, which specifies tensor size of each of the `tensorRank` dimensions, must be non-zero and less than or equal to 2^32. Additionally, the following requirements need to be met for the packed data types:
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, globalDim[0] must be a multiple of 128.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B, `globalDim`[0] must be a multiple of 2.
  - Dimension for the packed data types must reflect the number of individual U# values.
- `globalStrides` array, which specifies tensor stride of each of the lower `tensorRank` - 1 dimensions in bytes, must be a multiple of 16 and less than 2^40. Additionally, the following requirements need to be met:
  - When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, the strides must be a multiple of 32.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, the strides must be a multiple of 32. Each following dimension specified includes previous dimension stride:

```
    globalStrides[0] = globalDim[0] * elementSizeInBytes(tensorDataType) +
padding[0];
          for (i = 1; i < tensorRank - 1; i++)
              globalStrides[i] = globalStrides[i - 1] * (globalDim[i] +
padding[i]);
              assert(globalStrides[i] >= globalDim[i]);
```

- `pixelBoxLowerCorner` array specifies the coordinate offsets {D, H, W} of the bounding box from top/left/front corner. The number of offsets and their precision depend on the tensor dimensionality:
  - When `tensorRank` is 3, one signed offset within range [-32768, 32767] is supported.
  - When `tensorRank` is 4, two signed offsets each within range [-128, 127] are supported.
  - When `tensorRank` is 5, three offsets each within range [-16, 15] are supported.
- `pixelBoxUpperCorner` array specifies the coordinate offsets {D, H, W} of the bounding box from bottom/right/back corner. The number of offsets and their precision depend on the tensor dimensionality:
  - When `tensorRank` is 3, one signed offset within range [-32768, 32767] is supported.

- When `tensorRank` is 4, two signed offsets each within range [-128, 127] are supported.
- When `tensorRank` is 5, three offsets each within range [-16, 15] are supported. The bounding box specified by `pixelBoxLowerCorner` and `pixelBoxUpperCorner` must have non-zero area.

- `channelsPerPixel`, which specifies the number of elements which must be accessed along C dimension, must be less than or equal to 256. Additionally, when `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, `channelsPerPixel` must be 128.
- `pixelsPerColumn`, which specifies the number of elements that must be accessed along the {N, D, H, W} dimensions, must be less than or equal to 1024.
- `elementStrides` array, which specifies the iteration step along each of the `tensorRank` dimensions, must be non-zero and less than or equal to 8. Note that when `interleave` is CU_TENSOR_MAP_INTERLEAVE_NONE, the first element of this array is ignored since TMA doesn't support the stride for dimension zero. When all elements of the `elementStrides` array are one, `boxDim` specifies the number of elements to load. However, if `elementStrides`[i] is not equal to one for some `i`, then TMA loads ceil( `boxDim`[i] / `elementStrides`[i]) number of elements along i-th dimension. To load N elements along i-th dimension, `boxDim`[i] must be set to N * `elementStrides`[i].
- `interleave` specifies the interleaved layout of type CUtensorMapInterleave, which is defined as:

```
typedef enum CUtensorMapInterleave_enum {
    CU_TENSOR_MAP_INTERLEAVE_NONE = 0,
    CU_TENSOR_MAP_INTERLEAVE_16B,
    CU_TENSOR_MAP_INTERLEAVE_32B
} CUtensorMapInterleave;
```

  TMA supports interleaved layouts like NC/8HWC8 where C8 utilizes 16 bytes in memory assuming 2 byte per channel or NC/16HWC16 where C16 uses 32 bytes. When `interleave` is CU_TENSOR_MAP_INTERLEAVE_NONE and `swizzle` is not CU_TENSOR_MAP_SWIZZLE_NONE, the bounding box inner dimension (computed as `channelsPerPixel` multiplied by element size in bytes derived from `tensorDataType`) must be less than or equal to the swizzle size.

  - CU_TENSOR_MAP_SWIZZLE_32B requires the bounding box inner dimension to be <= 32.
  - CU_TENSOR_MAP_SWIZZLE_64B requires the bounding box inner dimension to be <= 64.
  - CU_TENSOR_MAP_SWIZZLE_128B* require the bounding box inner dimension to be <= 128. Additionally, `tensorDataType` of CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B requires `interleave` to be CU_TENSOR_MAP_INTERLEAVE_NONE.

- `swizzle`, which specifies the shared memory bank swizzling pattern, has to be of type CUtensorMapSwizzle which is defined as:

```
typedef enum CUtensorMapSwizzle_enum {
    CU_TENSOR_MAP_SWIZZLE_NONE = 0,
    CU_TENSOR_MAP_SWIZZLE_32B,                    // Swizzle 16B chunks
within 32B  span
```

```
            CU_TENSOR_MAP_SWIZZLE_64B,                    // Swizzle 16B chunks
within 64B  span
            CU_TENSOR_MAP_SWIZZLE_128B,                   // Swizzle 16B chunks
within 128B span
            CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B,          // Swizzle 32B chunks
within 128B span
            CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B_FLIP_8B, // Swizzle 32B chunks
within 128B span, additionally swap lower 8B with upper 8B within each 16B for
every alternate row
            CU_TENSOR_MAP_SWIZZLE_128B_ATOM_64B,          // Swizzle 64B chunks
within 128B span
        } CUtensorMapSwizzle;
```

Data are organized in a specific order in global memory; however, this may not match the order in which the application accesses data in shared memory. This difference in data organization may cause bank conflicts when shared memory is accessed. In order to avoid this problem, data can be loaded to shared memory with shuffling across shared memory banks. When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, `swizzle` must be CU_TENSOR_MAP_SWIZZLE_32B. Other interleave modes can have any swizzling pattern. When the `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B, only the following swizzle modes are supported:

- CU_TENSOR_MAP_SWIZZLE_NONE (Load & Store)
- CU_TENSOR_MAP_SWIZZLE_128B (Load & Store)
- CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B (Load & Store)
- CU_TENSOR_MAP_SWIZZLE_128B_ATOM_64B (Store only) When the `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, only the following swizzle modes are supported:
- CU_TENSOR_MAP_SWIZZLE_NONE (Load only)
- CU_TENSOR_MAP_SWIZZLE_128B (Load only)
- CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B (Load only)

- `l2Promotion` specifies L2 fetch size which indicates the byte granularity at which L2 requests are filled from DRAM. It must be of type CUtensorMapL2promotion, which is defined as:

```
    typedef enum CUtensorMapL2promotion_enum {
            CU_TENSOR_MAP_L2_PROMOTION_NONE = 0,
            CU_TENSOR_MAP_L2_PROMOTION_L2_64B,
            CU_TENSOR_MAP_L2_PROMOTION_L2_128B,
            CU_TENSOR_MAP_L2_PROMOTION_L2_256B
        } CUtensorMapL2promotion;
```

- `oobFill`, which indicates whether zero or a special NaN constant should be used to fill out-of-bound elements, must be of type CUtensorMapFloatOOBfill which is defined as:

```
    typedef enum CUtensorMapFloatOOBfill_enum {
            CU_TENSOR_MAP_FLOAT_OOB_FILL_NONE = 0,
            CU_TENSOR_MAP_FLOAT_OOB_FILL_NAN_REQUEST_ZERO_FMA
        } CUtensorMapFloatOOBfill;
```

Note that CU_TENSOR_MAP_FLOAT_OOB_FILL_NAN_REQUEST_ZERO_FMA can only be used when `tensorDataType` represents a floating-point data type, and when `tensorDataType` is not CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B, CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, and CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B.

See also:

cuTensorMapEncodeTiled, cuTensorMapEncodeIm2colWide, cuTensorMapReplaceAddress

## CUresult cuTensorMapEncodeIm2colWide (CUtensorMap *tensorMap, CUtensorMapDataType tensorDataType, cuuint32_t tensorRank, void *globalAddress, const cuuint64_t *globalDim, const cuuint64_t *globalStrides, int pixelBoxLowerCornerWidth, int pixelBoxUpperCornerWidth, cuuint32_t channelsPerPixel, cuuint32_t pixelsPerColumn, const cuuint32_t *elementStrides, CUtensorMapInterleave interleave, CUtensorMapIm2ColWideMode mode, CUtensorMapSwizzle swizzle, CUtensorMapL2promotion l2Promotion, CUtensorMapFloatOOBfill oobFill)

Create a tensor map descriptor object representing im2col memory region, but where the elements are exclusively loaded along the W dimension.

### Parameters

**tensorMap**
- Tensor map object to create

**tensorDataType**
- Tensor data type

**tensorRank**
- Dimensionality of tensor; must be at least 3

**globalAddress**
- Starting address of memory region described by tensor

**globalDim**
- Array containing tensor size (number of elements) along each of the `tensorRank` dimensions

**globalStrides**
- Array containing stride size (in bytes) along each of the `tensorRank` - 1 dimensions

**pixelBoxLowerCornerWidth**
- Width offset of left box corner

**pixelBoxUpperCornerWidth**
- Width offset of right box corner

**channelsPerPixel**
- Number of channels per pixel

**pixelsPerColumn**
- Number of pixels per column

**elementStrides**
- Array containing traversal stride in each of the `tensorRank` dimensions

**interleave**
- Type of interleaved layout the tensor addresses

**mode**
- W or W128 mode

**swizzle**
- Bank swizzling pattern inside shared memory

**l2Promotion**
- L2 promotion size

**oobFill**
- Indicate whether zero or special NaN constant will be used to fill out-of-bound elements

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Creates a descriptor for Tensor Memory Access (TMA) object specified by the parameters describing a im2col memory layout and where the row is always loaded along the W dimensuin and returns it in `tensorMap`. This assumes the tensor layout in memory is either NDHWC, NHWC, or NWC.

This API is only supported on devices of compute capability 10.0 or higher. Additionally, a tensor map object is an opaque value, and, as such, should only be accessed through CUDA APIs and PTX.

The parameters passed are bound to the following requirements:

- `tensorMap` address must be aligned to 64 bytes.
- `tensorDataType` has to be an enum from CUtensorMapDataType which is defined as:

```
typedef enum CUtensorMapDataType_enum {
    CU_TENSOR_MAP_DATA_TYPE_UINT8 = 0,       // 1 byte
    CU_TENSOR_MAP_DATA_TYPE_UINT16,          // 2 bytes
    CU_TENSOR_MAP_DATA_TYPE_UINT32,          // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_INT32,           // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_UINT64,          // 8 bytes
    CU_TENSOR_MAP_DATA_TYPE_INT64,           // 8 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT16,         // 2 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT32,         // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT64,         // 8 bytes
    CU_TENSOR_MAP_DATA_TYPE_BFLOAT16,        // 2 bytes
    CU_TENSOR_MAP_DATA_TYPE_FLOAT32_FTZ,     // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_TFLOAT32,        // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_TFLOAT32_FTZ     // 4 bytes
    CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B,    // 4 bits
    CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B,   // 4 bits
    CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B    // 6 bits
} CUtensorMapDataType;
```

CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B copies '16 x U4' packed values to memory aligned as 8 bytes. There are no gaps between packed values. CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B copies '16 x U4' packed values to memory aligned as 16 bytes. There are 8 byte gaps between every 8 byte chunk of packed values. CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B copies '16 x U6' packed values to memory aligned as 16 bytes. There are 4 byte gaps between every 12 byte chunk of packed values.

- `tensorRank`, which specifies the number of tensor dimensions, must be 3, 4, or 5.
- `globalAddress`, which specifies the starting address of the memory region described, must be 16 byte aligned. The following requirements need to also be met:
  - When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, `globalAddress` must be 32 byte aligned.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, `globalAddress` must be 32 byte aligned.
- `globalDim` array, which specifies tensor size of each of the `tensorRank` dimensions, must be non-zero and less than or equal to 2^32. Additionally, the following requirements need to be met for the packed data types:
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, globalDim[0] must be a multiple of 128.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B, `globalDim`[0] must be a multiple of 2.
  - Dimension for the packed data types must reflect the number of individual U# values.
- `globalStrides` array, which specifies tensor stride of each of the lower `tensorRank` - 1 dimensions in bytes, must be a multiple of 16 and less than 2^40. Additionally, the following requirements need to be met:
  - When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, the strides must be a multiple of 32.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, the strides must be a multiple of 32. Each following dimension specified includes previous dimension stride:

```
    globalStrides[0] = globalDim[0] * elementSizeInBytes(tensorDataType) +
padding[0];
          for (i = 1; i < tensorRank - 1; i++)
              globalStrides[i] = globalStrides[i - 1] * (globalDim[i] +
padding[i]);
              assert(globalStrides[i] >= globalDim[i]);
```

- `pixelBoxLowerCornerWidth` specifies the coordinate offset W of the bounding box from left corner. The offset must be within range [-32768, 32767].

- `pixelBoxUpperCornerWidth` specifies the coordinate offset W of the bounding box from right corner. The offset must be within range [-32768, 32767].

The bounding box specified by `pixelBoxLowerCornerWidth` and `pixelBoxUpperCornerWidth` must have non-zero area. Note that the size of the box along D and H dimensions is always equal to one.

- `channelsPerPixel`, which specifies the number of elements which must be accessed along C dimension, must be less than or equal to 256. Additionally, when `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, `channelsPerPixel` must be 128.
- `pixelsPerColumn`, which specifies the number of elements that must be accessed along the W dimension, must be less than or equal to 1024. This field is ignored when `mode` is CU_TENSOR_MAP_IM2COL_WIDE_MODE_W128.
- `elementStrides` array, which specifies the iteration step along each of the `tensorRank` dimensions, must be non-zero and less than or equal to 8. Note that when `interleave` is CU_TENSOR_MAP_INTERLEAVE_NONE, the first element of this array is ignored since TMA doesn't support the stride for dimension zero. When all elements of the `elementStrides` array are one, `boxDim` specifies the number of elements to load. However, if `elementStrides`[i] is not equal to one for some `i`, then TMA loads ceil( `boxDim`[i] / `elementStrides`[i]) number of elements along i-th dimension. To load N elements along i-th dimension, `boxDim`[i] must be set to N * `elementStrides`[i].
- `interleave` specifies the interleaved layout of type CUtensorMapInterleave, which is defined as:

```
typedef enum CUtensorMapInterleave_enum {
          CU_TENSOR_MAP_INTERLEAVE_NONE = 0,
          CU_TENSOR_MAP_INTERLEAVE_16B,
          CU_TENSOR_MAP_INTERLEAVE_32B
        } CUtensorMapInterleave;
```

  TMA supports interleaved layouts like NC/8HWC8 where C8 utilizes 16 bytes in memory assuming 2 byte per channel or NC/16HWC16 where C16 uses 32 bytes. When `interleave` is CU_TENSOR_MAP_INTERLEAVE_NONE, the bounding box inner dimension (computed as `channelsPerPixel` multiplied by element size in bytes derived from `tensorDataType`) must be less than or equal to the swizzle size.

  - CU_TENSOR_MAP_SWIZZLE_64B requires the bounding box inner dimension to be <= 64.
  - CU_TENSOR_MAP_SWIZZLE_128B* require the bounding box inner dimension to be <= 128. Additionally, `tensorDataType` of CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B requires `interleave` to be CU_TENSOR_MAP_INTERLEAVE_NONE.

- `mode`, which describes loading of elements loaded along the W dimension, has to be one of the following CUtensorMapIm2ColWideMode types:

```
CU_TENSOR_MAP_IM2COL_WIDE_MODE_W,
     CU_TENSOR_MAP_IM2COL_WIDE_MODE_W128
```

CU_TENSOR_MAP_IM2COL_WIDE_MODE_W allows the number of elements loaded along the W dimension to be specified via the `pixelsPerColumn` field.

- `swizzle`, which specifies the shared memory bank swizzling pattern, must be one of the following CUtensorMapSwizzle modes (other swizzle modes are not supported):

```
typedef enum CUtensorMapSwizzle_enum {
    CU_TENSOR_MAP_SWIZZLE_64B,                  // Swizzle 16B chunks within 64B  span
    CU_TENSOR_MAP_SWIZZLE_128B,                 // Swizzle 16B chunks within 128B span
    CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B,        // Swizzle 32B chunks within 128B span
} CUtensorMapSwizzle;
```

  Data are organized in a specific order in global memory; however, this may not match the order in which the application accesses data in shared memory. This difference in data organization may cause bank conflicts when shared memory is accessed. In order to avoid this problem, data can be loaded to shared memory with shuffling across shared memory banks. When the `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B, only the following swizzle modes are supported:

  - CU_TENSOR_MAP_SWIZZLE_64B (Store only)
  - CU_TENSOR_MAP_SWIZZLE_128B (Load & Store)
  - CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B (Load & Store) When the `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, only the following swizzle modes are supported:
  - CU_TENSOR_MAP_SWIZZLE_128B (Load only)
  - CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B (Load only)

Additionally, CU_TENSOR_MAP_SWIZZLE_96B is supported only when `mode` is CU_TENSOR_MAP_IM2COL_WIDE_MODE_W.

- `l2Promotion` specifies L2 fetch size which indicates the byte granularity at which L2 requests are filled from DRAM. It must be of type CUtensorMapL2promotion, which is defined as:

```
typedef enum CUtensorMapL2promotion_enum {
    CU_TENSOR_MAP_L2_PROMOTION_NONE = 0,
    CU_TENSOR_MAP_L2_PROMOTION_L2_64B,
    CU_TENSOR_MAP_L2_PROMOTION_L2_128B,
    CU_TENSOR_MAP_L2_PROMOTION_L2_256B
} CUtensorMapL2promotion;
```

- `oobFill`, which indicates whether zero or a special NaN constant should be used to fill out-of-bound elements, must be of type CUtensorMapFloatOOBfill which is defined as:

```
typedef enum CUtensorMapFloatOOBfill_enum {
    CU_TENSOR_MAP_FLOAT_OOB_FILL_NONE = 0,
    CU_TENSOR_MAP_FLOAT_OOB_FILL_NAN_REQUEST_ZERO_FMA
} CUtensorMapFloatOOBfill;
```

  Note that CU_TENSOR_MAP_FLOAT_OOB_FILL_NAN_REQUEST_ZERO_FMA can only be used when `tensorDataType` represents a floating-point data type, and when `tensorDataType` is not CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B, CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, and CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B.

See also:

cuTensorMapEncodeTiled, cuTensorMapEncodeIm2col, cuTensorMapReplaceAddress

## CUresult cuTensorMapEncodeTiled (CUtensorMap *tensorMap, CUtensorMapDataType tensorDataType, cuuint32_t tensorRank, void *globalAddress, const cuuint64_t *globalDim, const cuuint64_t *globalStrides, const cuuint32_t *boxDim, const cuuint32_t *elementStrides, CUtensorMapInterleave interleave, CUtensorMapSwizzle swizzle, CUtensorMapL2promotion l2Promotion, CUtensorMapFloatOOBfill oobFill)

Create a tensor map descriptor object representing tiled memory region.

### Parameters

**tensorMap**
- Tensor map object to create

**tensorDataType**
- Tensor data type

**tensorRank**
- Dimensionality of tensor

**globalAddress**
- Starting address of memory region described by tensor

**globalDim**
- Array containing tensor size (number of elements) along each of the `tensorRank` dimensions

**globalStrides**
- Array containing stride size (in bytes) along each of the `tensorRank` - 1 dimensions

**boxDim**
- Array containing traversal box size (number of elments) along each of the `tensorRank` dimensions. Specifies how many elements to be traversed along each tensor dimension.

**elementStrides**
- Array containing traversal stride in each of the `tensorRank` dimensions

**interleave**
- Type of interleaved layout the tensor addresses

**swizzle**
- Bank swizzling pattern inside shared memory

**l2Promotion**
- L2 promotion size

**oobFill**

- Indicate whether zero or special NaN constant must be used to fill out-of-bound elements

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Creates a descriptor for Tensor Memory Access (TMA) object specified by the parameters describing a tiled region and returns it in `tensorMap`.

Tensor map objects are only supported on devices of compute capability 9.0 or higher. Additionally, a tensor map object is an opaque value, and, as such, should only be accessed through CUDA APIs and PTX.

The parameters passed are bound to the following requirements:

- `tensorMap` address must be aligned to 64 bytes.
- `tensorDataType` has to be an enum from CUtensorMapDataType which is defined as:

```
typedef enum CUtensorMapDataType_enum {
        CU_TENSOR_MAP_DATA_TYPE_UINT8 = 0,       // 1 byte
        CU_TENSOR_MAP_DATA_TYPE_UINT16,          // 2 bytes
        CU_TENSOR_MAP_DATA_TYPE_UINT32,          // 4 bytes
        CU_TENSOR_MAP_DATA_TYPE_INT32,           // 4 bytes
        CU_TENSOR_MAP_DATA_TYPE_UINT64,          // 8 bytes
        CU_TENSOR_MAP_DATA_TYPE_INT64,           // 8 bytes
        CU_TENSOR_MAP_DATA_TYPE_FLOAT16,         // 2 bytes
        CU_TENSOR_MAP_DATA_TYPE_FLOAT32,         // 4 bytes
        CU_TENSOR_MAP_DATA_TYPE_FLOAT64,         // 8 bytes
        CU_TENSOR_MAP_DATA_TYPE_BFLOAT16,        // 2 bytes
        CU_TENSOR_MAP_DATA_TYPE_FLOAT32_FTZ,     // 4 bytes
        CU_TENSOR_MAP_DATA_TYPE_TFLOAT32,        // 4 bytes
        CU_TENSOR_MAP_DATA_TYPE_TFLOAT32_FTZ,    // 4 bytes
        CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B,    // 4 bits
        CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B,   // 4 bits
        CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B    // 6 bits
    } CUtensorMapDataType;
```

  CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B copies '16 x U4' packed values to memory aligned as 8 bytes. There are no gaps between packed values. CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B copies '16 x U4' packed values to memory aligned as 16 bytes. There are 8 byte gaps between every 8 byte chunk of packed values. CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B copies '16 x U6' packed values to memory aligned as 16 bytes. There are 4 byte gaps between every 12 byte chunk of packed values.

- `tensorRank` must be non-zero and less than or equal to the maximum supported dimensionality of 5. If `interleave` is not CU_TENSOR_MAP_INTERLEAVE_NONE, then `tensorRank` must additionally be greater than or equal to 3.
- `globalAddress`, which specifies the starting address of the memory region described, must be 16 byte aligned. The following requirements need to also be met:

- When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, `globalAddress` must be 32 byte aligned.
- When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, `globalAddress` must be 32 byte aligned.

- `globalDim` array, which specifies tensor size of each of the `tensorRank` dimensions, must be non-zero and less than or equal to 2^32. Additionally, the following requirements need to be met for the packed data types:
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, globalDim[0] must be a multiple of 128.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B, `globalDim`[0] must be a multiple of 2.
  - Dimension for the packed data types must reflect the number of individual U# values.
- `globalStrides` array, which specifies tensor stride of each of the lower `tensorRank` - 1 dimensions in bytes, must be a multiple of 16 and less than 2^40. Additionally, the following requirements need to be met:
  - When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, the strides must be a multiple of 32.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, the strides must be a multiple of 32. Each following dimension specified includes previous dimension stride:

```
    globalStrides[0] = globalDim[0] * elementSizeInBytes(tensorDataType) +
padding[0];
          for (i = 1; i < tensorRank - 1; i++)
              globalStrides[i] = globalStrides[i - 1] * (globalDim[i] +
padding[i]);
              assert(globalStrides[i] >= globalDim[i]);
```

- `boxDim` array, which specifies number of elements to be traversed along each of the `tensorRank` dimensions, must be non-zero and less than or equal to 256. Additionally, the following requirements need to be met:
  - When `interleave` is CU_TENSOR_MAP_INTERLEAVE_NONE, { `boxDim`[0] * elementSizeInBytes( `tensorDataType` ) } must be a multiple of 16 bytes.
  - When `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B or CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, boxDim[0] must be 128.
- `elementStrides` array, which specifies the iteration step along each of the `tensorRank` dimensions, must be non-zero and less than or equal to 8. Note that when `interleave` is CU_TENSOR_MAP_INTERLEAVE_NONE, the first element of this array is ignored since TMA doesn't support the stride for dimension zero. When all elements of `elementStrides` array is one, `boxDim` specifies the number of elements to load. However, if the `elementStrides`[i] is not equal to one, then TMA loads ceil( `boxDim`[i] / `elementStrides`[i]) number of elements

along i-th dimension. To load N elements along i-th dimension, `boxDim`[i] must be set to N * `elementStrides`[i].

- `interleave` specifies the interleaved layout of type CUtensorMapInterleave, which is defined as:

```
typedef enum CUtensorMapInterleave_enum {
    CU_TENSOR_MAP_INTERLEAVE_NONE = 0,
    CU_TENSOR_MAP_INTERLEAVE_16B,
    CU_TENSOR_MAP_INTERLEAVE_32B
} CUtensorMapInterleave;
```

TMA supports interleaved layouts like NC/8HWC8 where C8 utilizes 16 bytes in memory assuming 2 byte per channel or NC/16HWC16 where C16 uses 32 bytes. When `interleave` is CU_TENSOR_MAP_INTERLEAVE_NONE and `swizzle` is not CU_TENSOR_MAP_SWIZZLE_NONE, the bounding box inner dimension (computed as `boxDim`[0] multiplied by element size derived from `tensorDataType`) must be less than or equal to the swizzle size.

  - CU_TENSOR_MAP_SWIZZLE_32B requires the bounding box inner dimension to be <= 32.
  - CU_TENSOR_MAP_SWIZZLE_64B requires the bounding box inner dimension to be <= 64.
  - CU_TENSOR_MAP_SWIZZLE_128B* require the bounding box inner dimension to be <= 128. Additionally, `tensorDataType` of CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B requires `interleave` to be CU_TENSOR_MAP_INTERLEAVE_NONE.

- `swizzle`, which specifies the shared memory bank swizzling pattern, has to be of type CUtensorMapSwizzle which is defined as:

```
typedef enum CUtensorMapSwizzle_enum {
    CU_TENSOR_MAP_SWIZZLE_NONE = 0,
    CU_TENSOR_MAP_SWIZZLE_32B,                    // Swizzle 16B chunks
within 32B  span
    CU_TENSOR_MAP_SWIZZLE_64B,                    // Swizzle 16B chunks
within 64B  span
    CU_TENSOR_MAP_SWIZZLE_128B,                   // Swizzle 16B chunks
within 128B span
    CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B,          // Swizzle 32B chunks
within 128B span
    CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B_FLIP_8B, // Swizzle 32B chunks
within 128B span, additionally swap lower 8B with upper 8B within each 16B for
every alternate row
    CU_TENSOR_MAP_SWIZZLE_128B_ATOM_64B,          // Swizzle 64B chunks
within 128B span
} CUtensorMapSwizzle;
```

Data are organized in a specific order in global memory; however, this may not match the order in which the application accesses data in shared memory. This difference in data organization may cause bank conflicts when shared memory is accessed. In order to avoid this problem, data can be loaded to shared memory with shuffling across shared memory banks. When `interleave` is CU_TENSOR_MAP_INTERLEAVE_32B, `swizzle` must be CU_TENSOR_MAP_SWIZZLE_32B. Other interleave modes can have any swizzling pattern. When the `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B, only the following swizzle modes are supported:

  - CU_TENSOR_MAP_SWIZZLE_NONE (Load & Store)

- CU_TENSOR_MAP_SWIZZLE_128B (Load & Store)
- CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B (Load & Store)
- CU_TENSOR_MAP_SWIZZLE_128B_ATOM_64B (Store only) When the `tensorDataType` is CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, only the following swizzle modes are supported:
- CU_TENSOR_MAP_SWIZZLE_NONE (Load only)
- CU_TENSOR_MAP_SWIZZLE_128B (Load only)
- CU_TENSOR_MAP_SWIZZLE_128B_ATOM_32B (Load only)

- `l2Promotion` specifies L2 fetch size which indicates the byte granurality at which L2 requests is filled from DRAM. It must be of type CUtensorMapL2promotion, which is defined as:

```
typedef enum CUtensorMapL2promotion_enum {
          CU_TENSOR_MAP_L2_PROMOTION_NONE = 0,
          CU_TENSOR_MAP_L2_PROMOTION_L2_64B,
          CU_TENSOR_MAP_L2_PROMOTION_L2_128B,
          CU_TENSOR_MAP_L2_PROMOTION_L2_256B
     } CUtensorMapL2promotion;
```

- `oobFill`, which indicates whether zero or a special NaN constant should be used to fill out-of-bound elements, must be of type CUtensorMapFloatOOBfill which is defined as:

```
typedef enum CUtensorMapFloatOOBfill_enum {
          CU_TENSOR_MAP_FLOAT_OOB_FILL_NONE = 0,
          CU_TENSOR_MAP_FLOAT_OOB_FILL_NAN_REQUEST_ZERO_FMA
     } CUtensorMapFloatOOBfill;
```

  Note that CU_TENSOR_MAP_FLOAT_OOB_FILL_NAN_REQUEST_ZERO_FMA can only be used when `tensorDataType` represents a floating-point data type, and when `tensorDataType` is not CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN8B, CU_TENSOR_MAP_DATA_TYPE_16U4_ALIGN16B, and CU_TENSOR_MAP_DATA_TYPE_16U6_ALIGN16B.

See also:

cuTensorMapEncodeIm2col, cuTensorMapEncodeIm2colWide, cuTensorMapReplaceAddress

# CUresult cuTensorMapReplaceAddress (CUtensorMap *tensorMap, void *globalAddress)

Modify an existing tensor map descriptor with an updated global address.

## Parameters

**tensorMap**

- Tensor map object to modify

**globalAddress**

- Starting address of memory region described by tensor, must follow previous alignment requirements

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Modifies the descriptor for Tensor Memory Access (TMA) object passed in `tensorMap` with an updated `globalAddress`.

Tensor map objects are only supported on devices of compute capability 9.0 or higher. Additionally, a tensor map object is an opaque value, and, as such, should only be accessed through CUDA API calls.

See also:

cuTensorMapEncodeTiled, cuTensorMapEncodeIm2col, cuTensorMapEncodeIm2colWide

## 6.32. Peer Context Memory Access

This section describes the direct peer context memory access functions of the low-level CUDA driver application programming interface.

## CUresult cuCtxDisablePeerAccess (CUcontext peerContext)

Disables direct access to memory allocations in a peer context and unregisters any registered allocations.

### Parameters

**peerContext**
- Peer context to disable direct access to

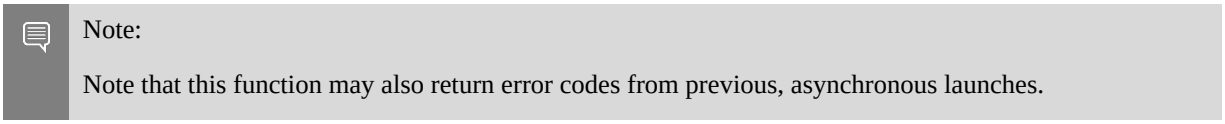
### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_PEER_ACCESS_NOT_ENABLED, CUDA_ERROR_INVALID_CONTEXT,

### Description

Returns CUDA_ERROR_PEER_ACCESS_NOT_ENABLED if direct peer access has not yet been enabled from `peerContext` to the current context.

Returns CUDA_ERROR_INVALID_CONTEXT if there is no current context, or if `peerContext` is not a valid context.


Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceCanAccessPeer, cuCtxEnablePeerAccess, cudaDeviceDisablePeerAccess

# CUresult cuCtxEnablePeerAccess (CUcontext peerContext, unsigned int Flags)

Enables direct access to memory allocations in a peer context.

## Parameters

**peerContext**

- Peer context to enable direct access to from the current context

**Flags**

- Reserved for future use and must be set to 0

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_PEER_ACCESS_ALREADY_ENABLED, CUDA_ERROR_TOO_MANY_PEERS, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_PEER_ACCESS_UNSUPPORTED, CUDA_ERROR_INVALID_VALUE

## Description

If both the current context and `peerContext` are on devices which support unified addressing (as may be queried using CU_DEVICE_ATTRIBUTE_UNIFIED_ADDRESSING) and same major compute capability, then on success all allocations from `peerContext` will immediately be accessible by the current context. See Unified Addressing for additional details.

Note that access granted by this call is unidirectional and that in order to access memory from the current context in `peerContext`, a separate symmetric call to cuCtxEnablePeerAccess() is required.

Note that there are both device-wide and system-wide limitations per system configuration, as noted in the CUDA Programming Guide under the section "Peer-to-Peer Memory Access".

Returns CUDA_ERROR_PEER_ACCESS_UNSUPPORTED if cuDeviceCanAccessPeer() indicates that the CUdevice of the current context cannot directly access memory from the CUdevice of `peerContext`.

Returns CUDA_ERROR_PEER_ACCESS_ALREADY_ENABLED if direct access of `peerContext` from the current context has already been enabled.

Returns CUDA_ERROR_TOO_MANY_PEERS if direct peer access is not possible because hardware resources required for peer access have been exhausted.

Returns CUDA_ERROR_INVALID_CONTEXT if there is no current context, `peerContext` is not a valid context, or if the current context is `peerContext`.

Returns CUDA_ERROR_INVALID_VALUE if `Flags` is not 0.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceCanAccessPeer, cuCtxDisablePeerAccess, cudaDeviceEnablePeerAccess

# CUresult cuDeviceCanAccessPeer (int *canAccessPeer, CUdevice dev, CUdevice peerDev)

Queries if a device may directly access a peer device's memory.

## Parameters

**canAccessPeer**
- Returned access capability

**dev**
- Device from which allocations on `peerDev` are to be directly accessed.

**peerDev**
- Device on which the allocations to be directly accessed by `dev` reside.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE

## Description

Returns in `*canAccessPeer` a value of 1 if contexts on `dev` are capable of directly accessing memory from contexts on `peerDev` and 0 otherwise. If direct access of `peerDev` from `dev` is possible, then access may be enabled on two specific contexts by calling cuCtxEnablePeerAccess().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxEnablePeerAccess, cuCtxDisablePeerAccess, cudaDeviceCanAccessPeer

# CUresult cuDeviceGetP2PAtomicCapabilities (unsigned int *capabilities, const CUatomicOperation *operations, unsigned int count, CUdevice srcDevice, CUdevice dstDevice)

Queries details about atomic operations supported between two devices.

## Parameters

**capabilities**
- Returned capability details of each requested operation

**operations**
- Requested operations

**count**
- Count of requested operations and size of capabilities

**srcDevice**
- The source device of the target link

**dstDevice**
- The destination device of the target link

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `*capabilities` the details about requested atomic `*operations` over the the link between `srcDevice` and `dstDevice`. The allocated size of `*operations` and `*capabilities` must be `count`.

For each CUatomicOperation in `*operations`, the corresponding result in `*capabilities` will be a bitmask indicating which of CUatomicOperationCapability the link supports natively.

Returns CUDA_ERROR_INVALID_DEVICE if `srcDevice` or `dstDevice` are not valid or if they represent the same device.

Returns CUDA_ERROR_INVALID_VALUE if `*capabilities` or `*operations` is NULL, if `count` is 0, or if any of `*operations` is not valid.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuDeviceGetP2PAttribute, cudaDeviceGetP2PAttribute, cudaDeviceGetP2PAtomicCapabilities

# CUresult cuDeviceGetP2PAttribute (int *value, CUdevice_P2PAttribute attrib, CUdevice srcDevice, CUdevice dstDevice)

Queries attributes of the link between two devices.

## Parameters

**value**
- Returned value of the requested attribute

**attrib**
- The requested attribute of the link between `srcDevice` and `dstDevice`.

**srcDevice**
- The source device of the target link.

**dstDevice**
- The destination device of the target link.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `*value` the value of the requested attribute `attrib` of the link between `srcDevice` and `dstDevice`. The supported attributes are:

- CU_DEVICE_P2P_ATTRIBUTE_PERFORMANCE_RANK: A relative value indicating the performance of the link between two devices.
- CU_DEVICE_P2P_ATTRIBUTE_ACCESS_SUPPORTED P2P: 1 if P2P Access is enable.
- CU_DEVICE_P2P_ATTRIBUTE_NATIVE_ATOMIC_SUPPORTED: 1 if all CUDA-valid atomic operations over the link are supported.
- CU_DEVICE_P2P_ATTRIBUTE_CUDA_ARRAY_ACCESS_SUPPORTED: 1 if cudaArray can be accessed over the link.
- CU_DEVICE_P2P_ATTRIBUTE_ONLY_PARTIAL_NATIVE_ATOMIC_SUPPORTED: 1 if some CUDA-valid atomic operations over the link are supported. Information about specific operations can be retrieved with cuDeviceGetP2PAtomicCapabilities.

Returns CUDA_ERROR_INVALID_DEVICE if `srcDevice` or `dstDevice` are not valid or if they represent the same device.

Returns CUDA_ERROR_INVALID_VALUE if `attrib` is not valid or if `value` is a null pointer.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxEnablePeerAccess, cuCtxDisablePeerAccess, cuDeviceCanAccessPeer, cuDeviceGetP2PAtomicCapabilities, cudaDeviceGetP2PAttribute

# 6.33. Graphics Interoperability

This section describes the graphics interoperability functions of the low-level CUDA driver application programming interface.

## CUresult cuGraphicsMapResources (unsigned int count, CUgraphicsResource *resources, CUstream hStream)

Map graphics resources for access by CUDA.

### Parameters

**count**
- Number of resources to map

**resources**
- Resources to map for CUDA usage

**hStream**
- Stream with which to synchronize

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_UNKNOWN

### Description

Maps the `count` graphics resources in `resources` for access by CUDA.

The resources in `resources` may be accessed by CUDA until they are unmapped. The graphics API from which `resources` were registered should not access any resources while they are mapped by CUDA. If an application does so, the results are undefined.

This function provides the synchronization guarantee that any graphics calls issued before cuGraphicsMapResources() will complete before any subsequent CUDA work issued in `stream` begins.

If `resources` includes any duplicate entries then CUDA_ERROR_INVALID_HANDLE is returned. If any of `resources` are presently mapped for access by CUDA then CUDA_ERROR_ALREADY_MAPPED is returned.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceGetMappedPointer, cuGraphicsSubResourceGetMappedArray, cuGraphicsUnmapResources, cudaGraphicsMapResources

# CUresult cuGraphicsResourceGetMappedMipmappedArray (CUmipmappedArray *pMipmappedArray, CUgraphicsResource resource)

Get a mipmapped array through which to access a mapped graphics resource.

## Parameters

**pMipmappedArray**
- Returned mipmapped array through which `resource` may be accessed

**resource**
- Mapped resource to access

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED, CUDA_ERROR_NOT_MAPPED_AS_ARRAY

## Description

Returns in `*pMipmappedArray` a mipmapped array through which the mapped graphics resource `resource`. The value set in `*pMipmappedArray` may change every time that `resource` is mapped.

If `resource` is not a texture then it cannot be accessed via a mipmapped array and CUDA_ERROR_NOT_MAPPED_AS_ARRAY is returned. If `resource` is not mapped then CUDA_ERROR_NOT_MAPPED is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceGetMappedPointer, cudaGraphicsResourceGetMappedMipmappedArray

# CUresult cuGraphicsResourceGetMappedPointer (CUdeviceptr *pDevPtr, size_t *pSize, CUgraphicsResource resource)

Get a device pointer through which to access a mapped graphics resource.

## Parameters

**pDevPtr**

- Returned pointer through which `resource` may be accessed

**pSize**

- Returned size of the buffer accessible starting at `*pPointer`

**resource**

- Mapped resource to access

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED, CUDA_ERROR_NOT_MAPPED_AS_POINTER

## Description

Returns in `*pDevPtr` a pointer through which the mapped graphics resource `resource` may be accessed. Returns in `pSize` the size of the memory in bytes which may be accessed from that pointer. The value set in `pPointer` may change every time that `resource` is mapped.

If `resource` is not a buffer then it cannot be accessed via a pointer and CUDA_ERROR_NOT_MAPPED_AS_POINTER is returned. If `resource` is not mapped then CUDA_ERROR_NOT_MAPPED is returned. *

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsMapResources, cuGraphicsSubResourceGetMappedArray, cudaGraphicsResourceGetMappedPointer

# CUresult cuGraphicsResourceSetMapFlags (CUgraphicsResource resource, unsigned int flags)

Set usage flags for mapping a graphics resource.

## Parameters

**resource**
- Registered resource to set flags for

**flags**
- Parameters for resource mapping

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED

## Description

Set `flags` for mapping the graphics resource `resource`.

Changes to `flags` will take effect the next time `resource` is mapped. The `flags` argument may be any of the following:

- CU_GRAPHICS_MAP_RESOURCE_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA kernels. This is the default value.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_READONLY: Specifies that CUDA kernels which access this resource will not write to this resource.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_WRITEDISCARD: Specifies that CUDA kernels which access this resource will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

If `resource` is presently mapped for access by CUDA then CUDA_ERROR_ALREADY_MAPPED is returned. If `flags` is not one of the above values then CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsMapResources, cudaGraphicsResourceSetMapFlags

# CUresult cuGraphicsSubResourceGetMappedArray (CUarray *pArray, CUgraphicsResource resource, unsigned int arrayIndex, unsigned int mipLevel)

Get an array through which to access a subresource of a mapped graphics resource.

## Parameters

**pArray**
- Returned array through which a subresource of `resource` may be accessed

**resource**
- Mapped resource to access

**arrayIndex**
- Array index for array textures or cubemap face index as defined by CUarray_cubemap_face for cubemap textures for the subresource to access

**mipLevel**
- Mipmap level for the subresource to access

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED, CUDA_ERROR_NOT_MAPPED_AS_ARRAY

## Description

Returns in `*pArray` an array through which the subresource of the mapped graphics resource `resource` which corresponds to array index `arrayIndex` and mipmap level `mipLevel` may be accessed. The value set in `*pArray` may change every time that `resource` is mapped.

If `resource` is not a texture then it cannot be accessed via an array and CUDA_ERROR_NOT_MAPPED_AS_ARRAY is returned. If `arrayIndex` is not a valid array index for `resource` then CUDA_ERROR_INVALID_VALUE is returned. If `mipLevel` is not a valid mipmap level for `resource` then CUDA_ERROR_INVALID_VALUE is returned. If `resource` is not mapped then CUDA_ERROR_NOT_MAPPED is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceGetMappedPointer, cudaGraphicsSubResourceGetMappedArray

# CUresult cuGraphicsUnmapResources (unsigned int count, CUgraphicsResource *resources, CUstream hStream)

Unmap graphics resources.

## Parameters

**count**
- Number of resources to unmap

**resources**
- Resources to unmap

**hStream**
- Stream with which to synchronize

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED, CUDA_ERROR_UNKNOWN

## Description

Unmaps the `count` graphics resources in `resources`.

Once unmapped, the resources in `resources` may not be accessed by CUDA until they are mapped again.

This function provides the synchronization guarantee that any CUDA work issued in `stream` before cuGraphicsUnmapResources() will complete before any subsequently issued graphics work begins.

If `resources` includes any duplicate entries then CUDA_ERROR_INVALID_HANDLE is returned. If any of `resources` are not presently mapped for access by CUDA then CUDA_ERROR_NOT_MAPPED is returned.

Note:

- This function uses standard default stream semantics.
- Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsMapResources, cudaGraphicsUnmapResources

## CUresult cuGraphicsUnregisterResource (CUgraphicsResource resource)

Unregisters a graphics resource for access by CUDA.

### Parameters

**resource**
- Resource to unregister

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_UNKNOWN

### Description

Unregisters the graphics resource `resource` so it is not accessible by CUDA unless registered again.

If `resource` is invalid then CUDA_ERROR_INVALID_HANDLE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsD3D9RegisterResource, cuGraphicsD3D10RegisterResource, cuGraphicsD3D11RegisterResource, cuGraphicsGLRegisterBuffer, cuGraphicsGLRegisterImage, cudaGraphicsUnregisterResource

# 6.34. Driver Entry Point Access

This section describes the driver entry point access functions of the low-level CUDA driver application programming interface.

# CUresult cuGetProcAddress (const char *symbol, void **pfn, int cudaVersion, cuuint64_t flags, CUdriverProcAddressQueryResult *symbolStatus)

Returns the requested driver API function pointer.

## Parameters

**symbol**

- The base name of the driver API function to look for. As an example, for the driver API cuMemAlloc_v2, `symbol` would be cuMemAlloc and `cudaVersion` would be the ABI compatible CUDA version for the _v2 variant.

**pfn**

- Location to return the function pointer to the requested driver function

**cudaVersion**

- The CUDA version to look for the requested driver symbol

**flags**

- Flags to specify search options.

**symbolStatus**

- Optional location to store the status of the search for `symbol` based on `cudaVersion`. See CUdriverProcAddressQueryResult for possible values.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED

## Description

Returns in `**pfn` the address of the CUDA driver function for the requested CUDA version and flags.

The CUDA version is specified as (1000 * major + 10 * minor), so CUDA 11.2 should be specified as 11020. For a requested driver symbol, if the specified CUDA version is greater than or equal to the CUDA version in which the driver symbol was introduced, this API will return the function pointer to the corresponding versioned function. If the specified CUDA version is greater than the driver version, the API will return CUDA_ERROR_INVALID_VALUE.

The pointer returned by the API should be cast to a function pointer matching the requested driver function's definition in the API header file. The function pointer typedef can be picked up from the corresponding typedefs header file. For example, cudaTypedefs.h consists of function pointer typedefs for driver APIs defined in cuda.h.

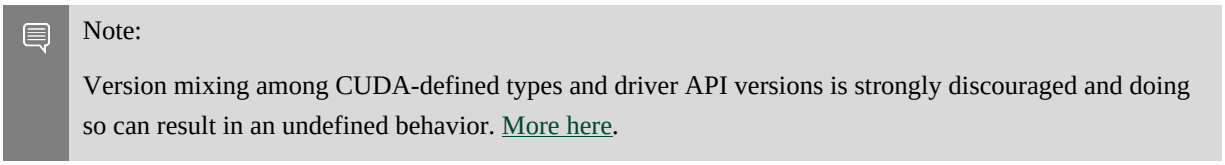
The API will return CUDA_SUCCESS and set the returned `pfn` to NULL if the requested driver function is not supported on the platform, no ABI compatible driver function exists for the specified `cudaVersion` or if the driver symbol is invalid.

It will also set the optional `symbolStatus` to one of the values in CUdriverProcAddressQueryResult with the following meanings:

- CU_GET_PROC_ADDRESS_SUCCESS - The requested symbol was succesfully found based on input arguments and `pfn` is valid
- CU_GET_PROC_ADDRESS_SYMBOL_NOT_FOUND - The requested symbol was not found
- CU_GET_PROC_ADDRESS_VERSION_NOT_SUFFICIENT - The requested symbol was found but is not supported by cudaVersion specified

The requested flags can be:

- CU_GET_PROC_ADDRESS_DEFAULT: This is the default mode. This is equivalent to CU_GET_PROC_ADDRESS_PER_THREAD_DEFAULT_STREAM if the code is compiled with --default-stream per-thread compilation flag or the macro CUDA_API_PER_THREAD_DEFAULT_STREAM is defined; CU_GET_PROC_ADDRESS_LEGACY_STREAM otherwise.
- CU_GET_PROC_ADDRESS_LEGACY_STREAM: This will enable the search for all driver symbols that match the requested driver symbol name except the corresponding per-thread versions.
- CU_GET_PROC_ADDRESS_PER_THREAD_DEFAULT_STREAM: This will enable the search for all driver symbols that match the requested driver symbol name including the per-thread versions. If a per-thread version is not found, the API will return the legacy version of the driver function.




See also:

cudaGetDriverEntryPointByVersion

# 6.35. Coredump Attributes Control API

This section describes the coredump attribute control functions of the low-level CUDA driver application programming interface.

## enum CUCoredumpGenerationFlags

Flags for controlling coredump contents

### Values

**CU_COREDUMP_DEFAULT_FLAGS = 0**
**CU_COREDUMP_SKIP_NONRELOCATED_ELF_IMAGES = (1<<0)**

**CU_COREDUMP_SKIP_GLOBAL_MEMORY = (1<<1)**
**CU_COREDUMP_SKIP_SHARED_MEMORY = (1<<2)**
**CU_COREDUMP_SKIP_LOCAL_MEMORY = (1<<3)**
**CU_COREDUMP_SKIP_ABORT = (1<<4)**
**CU_COREDUMP_SKIP_CONSTBANK_MEMORY = (1<<5)**
**CU_COREDUMP_GZIP_COMPRESS = (1<<6)**
**CU_COREDUMP_FAULTED_CONTEXTS_ONLY = (1<<7)**
**CU_COREDUMP_NO_ERRBAR_AT_EXIT = (1<<30)**
**CU_COREDUMP_LOG_ONLY = (1<<31)**
**CU_COREDUMP_LIGHTWEIGHT_FLAGS =**
**CU_COREDUMP_SKIP_NONRELOCATED_ELF_IMAGES |**
**CU_COREDUMP_SKIP_GLOBAL_MEMORY |**
**CU_COREDUMP_SKIP_SHARED_MEMORY |CU_COREDUMP_SKIP_LOCAL_MEMORY |**
**CU_COREDUMP_SKIP_CONSTBANK_MEMORY**

## enum CUcoredumpSettings

Flags for choosing a coredump attribute to get/set

### Values

**CU_COREDUMP_ENABLE_ON_EXCEPTION = 1**
**CU_COREDUMP_TRIGGER_HOST**
**CU_COREDUMP_LIGHTWEIGHT**
**CU_COREDUMP_ENABLE_USER_TRIGGER**
**CU_COREDUMP_FILE**
**CU_COREDUMP_PIPE**
**CU_COREDUMP_GENERATION_FLAGS**
**CU_COREDUMP_MAX**

## typedef struct CUcoredumpCallbackEntry_st *CUcoredumpCallbackHandle

Opaque handle representing a registered coredump status callback.

This handle is returned when registering a callback and must be provided when deregistering the callback.

## typedef void (CUDA_CB *CUcoredumpStatusCallback)(void* userData, int pid, CUdevice dev)

Callback function prototype for GPU coredump status notifications.

This callback will be invoked when a GPU coredump begins or completes, depending on which registration function was used. The callback executes synchronously during the coredump process.

# CUresult cuCoredumpDeregisterCompleteCallback (CUcoredumpCallbackHandle callback)

Deregister a previously registered coredump complete callback.

## Parameters

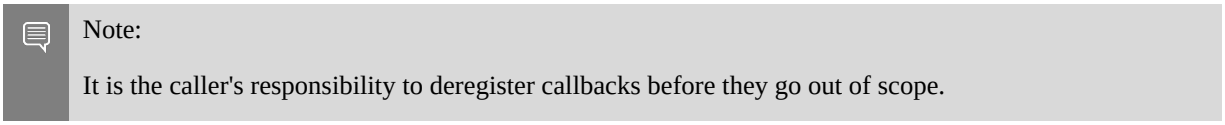
**callback**
- The callback handle to deregister

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

This function removes a callback that was registered with cuCoredumpRegisterCompleteCallback. The callback handle becomes invalid after this call.




See also:

cuCoredumpRegisterCompleteCallback

# CUresult cuCoredumpDeregisterStartCallback (CUcoredumpCallbackHandle callback)

Deregister a previously registered coredump start callback.

## Parameters

**callback**
- The callback handle to deregister

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

This function removes a callback that was registered with cuCoredumpRegisterStartCallback. The callback handle becomes invalid after this call.

Note:

It is the caller's responsibility to deregister callbacks before they go out of scope.

See also:

cuCoredumpRegisterStartCallback

# CUresult cuCoredumpGetAttribute (CUcoredumpSettings attrib, void *value, size_t *size)

Allows caller to fetch a coredump attribute value for the current context.

## Parameters

**attrib**

- The enum defining which value to fetch.

**value**

- void* containing the requested data.

**size**

- The size of the memory region `value` points to.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_CONTEXT_IS_DESTROYED

## Description

Returns in `*value` the requested value specified by `attrib`. It is up to the caller to ensure that the data type and size of `*value` matches the request.

If the caller calls this function with `*value` equal to NULL, the size of the memory region (in bytes) expected for `attrib` will be placed in `size`.

The supported attributes are:

- CU_COREDUMP_ENABLE_ON_EXCEPTION: Bool where true means that GPU exceptions from this context will create a coredump at the location specified by CU_COREDUMP_FILE. The default value is false unless set to true globally or locally, or the CU_CTX_USER_COREDUMP_ENABLE flag was set during context creation.
- CU_COREDUMP_TRIGGER_HOST: Bool where true means that the host CPU will also create a coredump. The default value is true unless set to false globally or or locally. This value is deprecated as of CUDA 12.5 - raise the CU_COREDUMP_SKIP_ABORT flag to disable host device abort() if needed.

- CU_COREDUMP_LIGHTWEIGHT: Bool where true means that any resulting coredumps will not have a dump of GPU memory or non-reloc ELF images. The default value is false unless set to true globally or locally. This attribute is deprecated as of CUDA 12.5, please use CU_COREDUMP_GENERATION_FLAGS instead.
- CU_COREDUMP_ENABLE_USER_TRIGGER: Bool where true means that a coredump can be created by writing to the system pipe specified by CU_COREDUMP_PIPE. The default value is false unless set to true globally or locally.
- CU_COREDUMP_FILE: String of up to 1023 characters that defines the location where any coredumps generated by this context will be written. The default value is core.cuda.HOSTNAME.PID where HOSTNAME is the host name of the machine running the CUDA applications and PID is the process ID of the CUDA application.
- CU_COREDUMP_PIPE: String of up to 1023 characters that defines the name of the pipe that will be monitored if user-triggered coredumps are enabled. The default value is corepipe.cuda.HOSTNAME.PID where HOSTNAME is the host name of the machine running the CUDA application and PID is the process ID of the CUDA application.
- CU_COREDUMP_GENERATION_FLAGS: An integer with values to allow granular control the data contained in a coredump specified as a bitwise OR combination of the following values: + CU_COREDUMP_DEFAULT_FLAGS - if set by itself, coredump generation returns to its default settings of including all memory regions that it is able to access + CU_COREDUMP_SKIP_NONRELOCATED_ELF_IMAGES - Coredump will not include the data from CUDA source modules that are not relocated at runtime. + CU_COREDUMP_SKIP_GLOBAL_MEMORY - Coredump will not include device-side global data that does not belong to any context. + CU_COREDUMP_SKIP_SHARED_MEMORY - Coredump will not include grid-scale shared memory for the warp that the dumped kernel belonged to. + CU_COREDUMP_SKIP_LOCAL_MEMORY - Coredump will not include local memory from the kernel. + CU_COREDUMP_LIGHTWEIGHT_FLAGS - Enables all of the above options. Equiavlent to setting the CU_COREDUMP_LIGHTWEIGHT attribute to true. + CU_COREDUMP_SKIP_ABORT - If set, GPU exceptions will not raise an abort() in the host CPU process. Same functional goal as CU_COREDUMP_TRIGGER_HOST but better reflects the default behavior. + CU_COREDUMP_SKIP_CONSTBANK_MEMORY - Coredump will not include constbank memory. + CU_COREDUMP_GZIP_COMPRESS - The generated coredump will be compressed with gzip, and .gz suffix will be appended to the filename, if it's not a part of it already. + CU_COREDUMP_FAULTED_CONTEXTS_ONLY - The coredump will only include contexts that have encountered an exception or a trap. + CU_COREDUMP_NO_ERRBAR_AT_EXIT - By default, when coredumps are requested, the GPU will ensure memory faults and other errors prevent warps from exiting, if possible. This can potentially affect the performance of the application. Setting this flag will disable this functionality, making it possible for faulted warps to exit, but also avoiding the potential performance hit. + CU_COREDUMP_LOG_ONLY - Setting this flag will disable actual generation of the coredump file, but exception details will still be logged.

See also:

cuCoredumpGetAttributeGlobal, cuCoredumpSetAttribute, cuCoredumpSetAttributeGlobal

# CUresult cuCoredumpGetAttributeGlobal (CUcoredumpSettings attrib, void *value, size_t *size)

Allows caller to fetch a coredump attribute value for the entire application.

## Parameters

**attrib**
- The enum defining which value to fetch.

**value**
- void* containing the requested data.

**size**
- The size of the memory region `value` points to.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `*value` the requested value specified by `attrib`. It is up to the caller to ensure that the data type and size of `*value` matches the request.

If the caller calls this function with `*value` equal to NULL, the size of the memory region (in bytes) expected for `attrib` will be placed in `size`.

The supported attributes are:

- CU_COREDUMP_ENABLE_ON_EXCEPTION: Bool where true means that GPU exceptions from this context will create a coredump at the location specified by CU_COREDUMP_FILE. The default value is false.
- CU_COREDUMP_TRIGGER_HOST: Bool where true means that the host CPU will also create a coredump. The default value is true unless set to false globally or or locally. This value is deprecated as of CUDA 12.5 - raise the CU_COREDUMP_SKIP_ABORT flag to disable host device abort() if needed.
- CU_COREDUMP_LIGHTWEIGHT: Bool where true means that any resulting coredumps will not have a dump of GPU memory or non-reloc ELF images. The default value is false. This attribute is deprecated as of CUDA 12.5, please use CU_COREDUMP_GENERATION_FLAGS instead.
- CU_COREDUMP_ENABLE_USER_TRIGGER: Bool where true means that a coredump can be created by writing to the system pipe specified by CU_COREDUMP_PIPE. The default value is false.
- CU_COREDUMP_FILE: String of up to 1023 characters that defines the location where any coredumps generated by this context will be written. The default value is

core.cuda.HOSTNAME.PID where HOSTNAME is the host name of the machine running the CUDA applications and PID is the process ID of the CUDA application.

- CU_COREDUMP_PIPE: String of up to 1023 characters that defines the name of the pipe that will be monitored if user-triggered coredumps are enabled. The default value is corepipe.cuda.HOSTNAME.PID where HOSTNAME is the host name of the machine running the CUDA application and PID is the process ID of the CUDA application.
- CU_COREDUMP_GENERATION_FLAGS: An integer with values to allow granular control the data contained in a coredump specified as a bitwise OR combination of the following values: + CU_COREDUMP_DEFAULT_FLAGS - if set by itself, coredump generation returns to its default settings of including all memory regions that it is able to access + CU_COREDUMP_SKIP_NONRELOCATED_ELF_IMAGES - Coredump will not include the data from CUDA source modules that are not relocated at runtime. + CU_COREDUMP_SKIP_GLOBAL_MEMORY - Coredump will not include device-side global data that does not belong to any context. + CU_COREDUMP_SKIP_SHARED_MEMORY - Coredump will not include grid-scale shared memory for the warp that the dumped kernel belonged to. + CU_COREDUMP_SKIP_LOCAL_MEMORY - Coredump will not include local memory from the kernel. + CU_COREDUMP_LIGHTWEIGHT_FLAGS - Enables all of the above options. Equiavlent to setting the CU_COREDUMP_LIGHTWEIGHT attribute to true. + CU_COREDUMP_SKIP_ABORT - If set, GPU exceptions will not raise an abort() in the host CPU process. Same functional goal as CU_COREDUMP_TRIGGER_HOST but better reflects the default behavior. + CU_COREDUMP_SKIP_CONSTBANK_MEMORY - Coredump will not include constbank memory. + CU_COREDUMP_GZIP_COMPRESS - The generated coredump will be compressed with gzip, and .gz suffix will be appended to the filename, if it's not a part of it already. + CU_COREDUMP_FAULTED_CONTEXTS_ONLY - The coredump will only include contexts that have encountered an exception or a trap. + CU_COREDUMP_NO_ERRBAR_AT_EXIT - By default, when coredumps are requested, the GPU will ensure memory faults and other errors prevent warps from exiting, if possible. This can potentially affect the performance of the application. Setting this flag will disable this functionality, making it possible for faulted warps to exit, but also avoiding the potential performance hit. + CU_COREDUMP_LOG_ONLY - Setting this flag will disable actual generation of the coredump file, but exception details will still be logged.

See also:

cuCoredumpGetAttribute, cuCoredumpSetAttribute, cuCoredumpSetAttributeGlobal

# CUresult cuCoredumpRegisterCompleteCallback (CUcoredumpStatusCallback callback, void *userData, CUcoredumpCallbackHandle *callbackOut)

Register a callback to be invoked when a GPU coredump completes.

## Parameters

**callback**
- The callback function to register

**userData**
- User data pointer to pass to the callback

**callbackOut**
- Location to store the callback handle (optional, may be NULL)

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

## Description

This function registers a callback that will be called when a GPU coredump has been fully collected and written to disk. Callbacks are executed in the order they were registered. The same callback function can be registered multiple times with different userData, and each registration will receive a unique handle.

Note:

Callbacks execute synchronously during the coredump process and will block coredump progress while running.

See also:

cuCoredumpDeregisterCompleteCallback, cuCoredumpRegisterStartCallback

# CUresult cuCoredumpRegisterStartCallback (CUcoredumpStatusCallback callback, void *userData, CUcoredumpCallbackHandle *callbackOut)

Register a callback to be invoked when a GPU coredump begins.

## Parameters

**callback**
- The callback function to register

**userData**
- User data pointer to pass to the callback

**callbackOut**
- Location to store the callback handle (optional, may be NULL)

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

## Description

This function registers a callback that will be called when a GPU coredump is initiated, before any coredump data is collected. Callbacks are executed in the order they were registered. The same callback function can be registered multiple times with different userData, and each registration will receive a unique handle.

Note:

Callbacks execute synchronously during the coredump process and will block coredump progress while running.

See also:

cuCoredumpDeregisterStartCallback, cuCoredumpRegisterCompleteCallback

# CUresult cuCoredumpSetAttribute (CUcoredumpSettings attrib, void *value, size_t *size)

Allows caller to set a coredump attribute value for the current context.

## Parameters

**attrib**
- The enum defining which value to set.

**value**
- void* containing the requested data.

**size**
- The size of the memory region `value` points to.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_PERMITTED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_CONTEXT_IS_DESTROYED, CUDA_ERROR_NOT_SUPPORTED

## Description

This function should be considered an alternate interface to the CUDA-GDB environment variables defined in this document: https://docs.nvidia.com/cuda/cuda-gdb/index.html#gpu-coredump

An important design decision to note is that any coredump environment variable values set before CUDA initializes will take permanent precedence over any values set with this function. This decision was made to ensure no change in behavior for any users that may be currently using these variables to get coredumps.

`*value` shall contain the requested value specified by `set`. It is up to the caller to ensure that the data type and size of `*value` matches the request.

If the caller calls this function with `*value` equal to NULL, the size of the memory region (in bytes) expected for `set` will be placed in `size`.

/note This function will return CUDA_ERROR_NOT_SUPPORTED if the caller attempts to set CU_COREDUMP_ENABLE_ON_EXCEPTION on a GPU of with Compute Capability < 6.0. cuCoredumpSetAttributeGlobal works on those platforms as an alternative.

/note CU_COREDUMP_ENABLE_USER_TRIGGER and CU_COREDUMP_PIPE cannot be set on a per-context basis.

The supported attributes are:

- CU_COREDUMP_ENABLE_ON_EXCEPTION: Bool where true means that GPU exceptions from this context will create a coredump at the location specified by CU_COREDUMP_FILE. The default value is false.
- CU_COREDUMP_TRIGGER_HOST: Bool where true means that the host CPU will also create a coredump. The default value is true unless set to false globally or or locally. This value is deprecated as of CUDA 12.5 - raise the CU_COREDUMP_SKIP_ABORT flag to disable host device abort() if needed.
- CU_COREDUMP_LIGHTWEIGHT: Bool where true means that any resulting coredumps will not have a dump of GPU memory or non-reloc ELF images. The default value is false. This attribute is deprecated as of CUDA 12.5, please use CU_COREDUMP_GENERATION_FLAGS instead.

- CU_COREDUMP_FILE: String of up to 1023 characters that defines the location where any coredumps generated by this context will be written. The default value is core.cuda.HOSTNAME.PID where HOSTNAME is the host name of the machine running the CUDA applications and PID is the process ID of the CUDA application.
- CU_COREDUMP_GENERATION_FLAGS: An integer with values to allow granular control the data contained in a coredump specified as a bitwise OR combination of the following values: + CU_COREDUMP_DEFAULT_FLAGS - if set by itself, coredump generation returns to its default settings of including all memory regions that it is able to access + CU_COREDUMP_SKIP_NONRELOCATED_ELF_IMAGES - Coredump will not include the data from CUDA source modules that are not relocated at runtime. + CU_COREDUMP_SKIP_GLOBAL_MEMORY - Coredump will not include device-side global data that does not belong to any context. + CU_COREDUMP_SKIP_SHARED_MEMORY - Coredump will not include grid-scale shared memory for the warp that the dumped kernel belonged to. + CU_COREDUMP_SKIP_LOCAL_MEMORY - Coredump will not include local memory from the kernel. + CU_COREDUMP_LIGHTWEIGHT_FLAGS - Enables all of the above options. Equiavlent to setting the CU_COREDUMP_LIGHTWEIGHT attribute to true. + CU_COREDUMP_SKIP_ABORT - If set, GPU exceptions will not raise an abort() in the host CPU process. Same functional goal as CU_COREDUMP_TRIGGER_HOST but better reflects the default behavior. + CU_COREDUMP_SKIP_CONSTBANK_MEMORY - Coredump will not include constbank memory. + CU_COREDUMP_GZIP_COMPRESS - The generated coredump will be compressed with gzip, and .gz suffix will be appended to the filename, if it's not a part of it already. + CU_COREDUMP_FAULTED_CONTEXTS_ONLY - The coredump will only include contexts that have encountered an exception or a trap. + CU_COREDUMP_NO_ERRBAR_AT_EXIT - By default, when coredumps are requested, the GPU will ensure memory faults and other errors prevent warps from exiting, if possible. This can potentially affect the performance of the application. Setting this flag will disable this functionality, making it possible for faulted warps to exit, but also avoiding the potential performance hit. + CU_COREDUMP_LOG_ONLY - Setting this flag will disable actual generation of the coredump file, but exception details will still be logged.

Note:

CU_COREDUMP_GENERATION_FLAGS replaces all previously set coredump flags. Mixing CU_COREDUMP_GENERATION_FLAGS with the deprecated boolean attributes (CU_COREDUMP_TRIGGER_HOST, CU_COREDUMP_LIGHTWEIGHT) can result in undefined behavior. To avoid issues, either use only CU_COREDUMP_GENERATION_FLAGS or combine all desired flag bits (including CU_COREDUMP_SKIP_ABORT) in a single call.

See also:

cuCoredumpGetAttributeGlobal, cuCoredumpGetAttribute, cuCoredumpSetAttributeGlobal

# CUresult cuCoredumpSetAttributeGlobal (CUcoredumpSettings attrib, void *value, size_t *size)

Allows caller to set a coredump attribute value globally.

## Parameters

**attrib**
- The enum defining which value to set.

**value**
- void* containing the requested data.

**size**
- The size of the memory region `value` points to.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_PERMITTED

## Description

This function should be considered an alternate interface to the CUDA-GDB environment variables defined in this document: https://docs.nvidia.com/cuda/cuda-gdb/index.html#gpu-coredump

An important design decision to note is that any coredump environment variable values set before CUDA initializes will take permanent precedence over any values set with this function. This decision was made to ensure no change in behavior for any users that may be currently using these variables to get coredumps.

`*value` shall contain the requested value specified by `set`. It is up to the caller to ensure that the data type and size of `*value` matches the request.

If the caller calls this function with `*value` equal to NULL, the size of the memory region (in bytes) expected for `set` will be placed in `size`.

The supported attributes are:

- CU_COREDUMP_ENABLE_ON_EXCEPTION: Bool where true means that GPU exceptions from this context will create a coredump at the location specified by CU_COREDUMP_FILE. The default value is false.
- CU_COREDUMP_TRIGGER_HOST: Bool where true means that the host CPU will also create a coredump. The default value is true unless set to false globally or or locally. This value is deprecated as of CUDA 12.5 - raise the CU_COREDUMP_SKIP_ABORT flag to disable host device abort() if needed.
- CU_COREDUMP_LIGHTWEIGHT: Bool where true means that any resulting coredumps will not have a dump of GPU memory or non-reloc ELF images. The default value is false. This attribute is deprecated as of CUDA 12.5, please use CU_COREDUMP_GENERATION_FLAGS instead.

- CU_COREDUMP_ENABLE_USER_TRIGGER: Bool where true means that a coredump can be created by writing to the system pipe specified by CU_COREDUMP_PIPE. The default value is false.
- CU_COREDUMP_FILE: String of up to 1023 characters that defines the location where any coredumps generated by this context will be written. The default value is core.cuda.HOSTNAME.PID where HOSTNAME is the host name of the machine running the CUDA applications and PID is the process ID of the CUDA application.
- CU_COREDUMP_PIPE: String of up to 1023 characters that defines the name of the pipe that will be monitored if user-triggered coredumps are enabled. This value may not be changed after CU_COREDUMP_ENABLE_USER_TRIGGER is set to true. The default value is corepipe.cuda.HOSTNAME.PID where HOSTNAME is the host name of the machine running the CUDA application and PID is the process ID of the CUDA application.
- CU_COREDUMP_GENERATION_FLAGS: An integer with values to allow granular control the data contained in a coredump specified as a bitwise OR combination of the following values: + CU_COREDUMP_DEFAULT_FLAGS - if set by itself, coredump generation returns to its default settings of including all memory regions that it is able to access + CU_COREDUMP_SKIP_NONRELOCATED_ELF_IMAGES - Coredump will not include the data from CUDA source modules that are not relocated at runtime. + CU_COREDUMP_SKIP_GLOBAL_MEMORY - Coredump will not include device-side global data that does not belong to any context. + CU_COREDUMP_SKIP_SHARED_MEMORY - Coredump will not include grid-scale shared memory for the warp that the dumped kernel belonged to. + CU_COREDUMP_SKIP_LOCAL_MEMORY - Coredump will not include local memory from the kernel. + CU_COREDUMP_LIGHTWEIGHT_FLAGS - Enables all of the above options. Equiavlent to setting the CU_COREDUMP_LIGHTWEIGHT attribute to true. + CU_COREDUMP_SKIP_ABORT - If set, GPU exceptions will not raise an abort() in the host CPU process. Same functional goal as CU_COREDUMP_TRIGGER_HOST but better reflects the default behavior. + CU_COREDUMP_SKIP_CONSTBANK_MEMORY - Coredump will not include constbank memory. + CU_COREDUMP_GZIP_COMPRESS - The generated coredump will be compressed with gzip, and .gz suffix will be appended to the filename, if it's not a part of it already. + CU_COREDUMP_FAULTED_CONTEXTS_ONLY - The coredump will only include contexts that have encountered an exception or a trap. + CU_COREDUMP_NO_ERRBAR_AT_EXIT - By default, when coredumps are requested, the GPU will ensure memory faults and other errors prevent warps from exiting, if possible. This can potentially affect the performance of the application. Setting this flag will disable this functionality, making it possible for faulted warps to exit, but also avoiding the potential performance hit. + CU_COREDUMP_LOG_ONLY - Setting this flag will disable actual generation of the coredump file, but exception details will still be logged.

Note:

CU_COREDUMP_GENERATION_FLAGS replaces all previously set coredump flags. Mixing CU_COREDUMP_GENERATION_FLAGS with the deprecated boolean attributes (CU_COREDUMP_TRIGGER_HOST, CU_COREDUMP_LIGHTWEIGHT) can result in undefined

behavior. To avoid issues, either use only CU_COREDUMP_GENERATION_FLAGS or combine all desired flag bits (including CU_COREDUMP_SKIP_ABORT) in a single call.

See also:

cuCoredumpGetAttribute, cuCoredumpGetAttributeGlobal, cuCoredumpSetAttribute

# 6.36. Green Contexts

This section describes the APIs for creation and manipulation of green contexts in the CUDA driver. Green contexts are a lightweight alternative to traditional contexts, that can be used to select a subset of device resources. This allows the developer to, for example, select SMs from distinct spatial partitions of the GPU and target them via CUDA stream operations, kernel launches, etc.

Here are the broad initial steps to follow to get started:

- (1) Start with an initial set of resources. For SM resources, they can be fetched via cuDeviceGetDevResource. In case of workqueues, a new configuration can be used or an existing one queried via the cuDeviceGetDevResource API.
- (2) Modify these resources by either partitioning them (in case of SMs) or changing the configuration (in case of workqueues). To partition SMs, we recommend cuDevSmResourceSplit. Changing the workqueue configuration can be done directly in place.
- (3) Finalize the specification of resources by creating a descriptor via cuDevResourceGenerateDesc.
- (4) Create a green context via cuGreenCtxCreate. This provisions the resource, such as workqueues (until this step it was only a configuration specification).
- (5) Create a stream via cuGreenCtxStreamCreate, and use it throughout your application.

SMs

There are two possible partition operations - with cuDevSmResourceSplitByCount the partitions created have to follow default SM count granularity requirements, so it will often be rounded up and aligned to a default value. On the other hand, cuDevSmResourceSplit is explicit and allows for creation of non-equal groups. It will not round up automatically - instead it is the developer's responsibility to query and set the correct values. These requirements can be queried with cuDeviceGetDevResource to determine the alignment granularity (sm.smCoscheduledAlignment). A general guideline on the default values for each compute architecture:

- On Compute Architecture 7.X, 8.X, and all Tegra SoC:
  - The smCount must be a multiple of 2.
  - The alignment (and default value of coscheduledSmCount) is 2.
- On Compute Architecture 9.0+:

- The smCount must be a multiple of 8, or coscheduledSmCount if provided.
- The alignment (and default value of coscheduledSmCount) is 8. While the maximum value for coscheduled SM count is 32 on all Compute Architecture 9.0+, it's recommended to follow cluster size requirements. The portable cluster size and the max cluster size should be used in order to benefit from this co-scheduling.

Workqueues

For `CU_DEV_RESOURCE_TYPE_WORKQUEUE_CONFIG`, the resource specifies the expected maximum number of concurrent stream-ordered workloads via the `wqConcurrencyLimit` field. The `sharingScope` field determines how workqueue resources are shared:

- `CU_WORKQUEUE_SCOPE_DEVICE_CTX`: Use all shared workqueue resources across all contexts (default driver behavior).
- `CU_WORKQUEUE_SCOPE_GREEN_CTX_BALANCED`: When possible, use non-overlapping workqueue resources with other balanced green contexts.

The maximum concurrency limit depends on CUDA_DEVICE_MAX_CONNECTIONS and can be queried from the primary context via cuCtxGetDevResource. Configurations may exceed this concurrency limit, but the driver will not guarantee that work submission remains non-overlapping.

For `CU_DEV_RESOURCE_TYPE_WORKQUEUE`, the resource represents a pre-existing workqueue that can be retrieved from existing contexts or green contexts. This allows reusing workqueue resources across different green contexts.

On Concurrency

Even if the green contexts have disjoint SM partitions, it is not guaranteed that the kernels launched in them will run concurrently or have forward progress guarantees. This is due to other resources that could cause a dependency. Using a combination of disjoint SMs and CU_WORKQUEUE_SCOPE_GREEN_CTX_BALANCED workqueue configurations can provide the best chance of avoiding interference. More resources will be added in the future to provide stronger guarantees.

Additionally, there are two known scenarios, where its possible for the workload to run on more SMs than was provisioned (but never less).

- On Volta+ MPS: When `CUDA_MPS_ACTIVE_THREAD_PERCENTAGE` is used, the set of SMs that are used for running kernels can be scaled up to the value of SMs used for the MPS client.
- On Compute Architecture 9.x: When a module with dynamic parallelism (CDP) is loaded, all future kernels running under green contexts may use and share an additional set of 2 SMs.

## struct CU_DEV_SM_RESOURCE_GROUP_PARAMS

## struct CUdevResource

## struct CUdevSmResource

## struct CUdevWorkqueueConfigResource

## struct CUdevWorkqueueResource

## enum CUdevResourceType

Type of resource

### Values

**CU_DEV_RESOURCE_TYPE_INVALID = 0**
**CU_DEV_RESOURCE_TYPE_SM = 1**
Streaming multiprocessors related information
**CU_DEV_RESOURCE_TYPE_WORKQUEUE_CONFIG = 1000**
Workqueue configuration related information
**CU_DEV_RESOURCE_TYPE_WORKQUEUE = 10000**
Pre-existing workqueue related information

## enum CUdevSmResourceGroup_flags

Flags for a CUdevSmResource group

### Values

**CU_DEV_SM_RESOURCE_GROUP_DEFAULT = 0**
**CU_DEV_SM_RESOURCE_GROUP_BACKFILL = 0x1**

## enum CUdevWorkqueueConfigScope

Sharing scope for workqueues

### Values

**CU_WORKQUEUE_SCOPE_DEVICE_CTX = 0**
Use all shared workqueue resources across all contexts. Default driver behaviour.
**CU_WORKQUEUE_SCOPE_GREEN_CTX_BALANCED = 1**
When possible, use non-overlapping workqueue resources with other balanced green contexts.

# enum CUgreenCtxCreate_flags

Flags for green context creation

## Values

**CU_GREEN_CTX_NONE = 0x0**
**CU_GREEN_CTX_DEFAULT_STREAM = 0x1**
Creates a default stream to use inside the green context

# typedef struct CUdevResourceDesc_st *CUdevResourceDesc

An opaque descriptor handle. The descriptor encapsulates multiple created and configured resources. Created via cuDevResourceGenerateDesc

# CUresult cuCtxFromGreenCtx (CUcontext *pContext, CUgreenCtx hCtx)

Returns a CUcontext handle for a green context.

## Parameters

**pContext**
Returned CUcontext with green context resources
**hCtx**
Green context to convert

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

This API returns in `pContext` a CUcontext handle that represents the specified green context `hCtx`. The returned handle can be passed to CUDA APIs that accept a CUcontext and will be treated as if it were a primary context, while still honoring the resources and configuration associated with `hCtx` as applicable.

Applications that wish to use a green context with CUDA APIs that require a CUcontext must use this API to obtain a handle to a CUcontext representing the green context. Otherwise, passing a green context to such APIs will fail with CUDA_ERROR_INVALID_CONTEXT.

The CUcontext returned by cuCtxFromGreenCtx may be passed to CUDA Driver APIs that accept a CUcontext.

- For APIs whose semantics are independent of green context resources, the operation is performed identically to how it would perform with a primary context.
- For APIs whose behavior depends on green context resources (for example, kernel launch), the operation is performed using the resources and configuration of the specified green context `hCtx`.

This call does not create a new independent context and does not change the underlying context lifetime. The validity of the returned `pContext` is tied to `hCtx`, and no additional destruction or release is required beyond correctly managing `hCtx` with the green context APIs. Destroying `pContext` via cuCtxDestroy is undefined behavior.

See also:

cuGreenCtxCreate

# CUresult cuCtxGetDevResource (CUcontext hCtx, CUdevResource *resource, CUdevResourceType type)

Get context resources.

## Parameters

**hCtx**
- Context to get resource for

**resource**
- Output pointer to a CUdevResource structure

**type**
- Type of resource to retrieve

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_RESOURCE_TYPE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_CONTEXT

## Description

Get the `type` resources available to the context represented by `hCtx` Note: The API is not supported on 32-bit platforms.

See also:

cuDevResourceGenerateDesc

# CUresult cuDeviceGetDevResource (CUdevice device, CUdevResource *resource, CUdevResourceType type)

Get device resources.

## Parameters

**device**
- Device to get resource for

**resource**
- Output pointer to a CUdevResource structure

**type**
- Type of resource to retrieve

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_RESOURCE_TYPE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_DEVICE

## Description

Get the `type` resources available to the `device`. This may often be the starting point for further partitioning or configuring of resources.

Note: The API is not supported on 32-bit platforms.

See also:

cuDevResourceGenerateDesc

# CUresult cuDevResourceGenerateDesc (CUdevResourceDesc *phDesc, CUdevResource *resources, unsigned int nbResources)

Generate a resource descriptor.

## Parameters

**phDesc**
- Output descriptor

**resources**
- Array of resources to be included in the descriptor

**nbResources**
- Number of resources passed in `resources`

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_RESOURCE_TYPE, CUDA_ERROR_INVALID_RESOURCE_CONFIGURATION

### Description

Generates a single resource descriptor with the set of resources specified in `resources`. The generated resource descriptor is necessary for the creation of green contexts via the cuGreenCtxCreate API. Resources of the same type can be passed in, provided they meet the requirements as noted below.

A successful API call must have:

- A valid output pointer for the `phDesc` descriptor as well as a valid array of `resources` pointers, with the array size passed in `nbResources`. If multiple resources are provided in `resources`, the device they came from must be the same, otherwise CUDA_ERROR_INVALID_RESOURCE_CONFIGURATION is returned. If multiple resources are provided in `resources` and they are of type CU_DEV_RESOURCE_TYPE_SM, they must be outputs (whether `result` or `remaining`) from the same split API instance and have the same smCoscheduledAlignment values, otherwise CUDA_ERROR_INVALID_RESOURCE_CONFIGURATION is returned.

Note: The API is not supported on 32-bit platforms.

See also:

cuDevSmResourceSplitByCount

## CUresult cuDevSmResourceSplit (CUdevResource *result, unsigned int nbGroups, const CUdevResource *input, CUdevResource *remainder, unsigned int flags, CU_DEV_SM_RESOURCE_GROUP_PARAMS *groupParams)

Splits a `CU_DEV_RESOURCE_TYPE_SM` resource into structured groups.

### Parameters

**result**

- Output array of `CUdevResource` resources. Can be NULL, alongside an smCount of 0, for discovery purpose.

**nbGroups**

- Specifies the number of groups in `result` and `groupParams`

**input**
- Input SM resource to be split. Must be a valid `CU_DEV_RESOURCE_TYPE_SM` resource.

**remainder**
- If splitting the input resource leaves any SMs, the remainder is placed in here.

**flags**
- Flags specifying how the API should behave. The value should be 0 for now.

**groupParams**
- Description of how the SMs should be split and assigned to the corresponding result entry.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_RESOURCE_TYPE, CUDA_ERROR_INVALID_RESOURCE_CONFIGURATION

## Description

This API will split a resource of CU_DEV_RESOURCE_TYPE_SM into `nbGroups` structured device resource groups (the `result` array), as well as an optional `remainder`, according to a set of requirements specified in the `groupParams` array. The term “structured” is a trait that specifies the `result` has SMs that are co-scheduled together. This co-scheduling can be specified via the `coscheduledSmCount` field of the `groupParams` structure, while the `smCount` will specify how many SMs are required in total for that result. The remainder is always “unstructured”, it does not have any set guarantees with respect to co-scheduling and those properties will need to either be queried via the occupancy set of APIs or further split into structured groups by this API.

The API has a discovery mode for use cases where it is difficult to know ahead of time what the SM count should be. Discovery happens when the `smCount` field of a given `groupParams` array entry is set to 0 - the smCount will be filled in by the API with the derived SM count according to the provided `groupParams` fields and constraints. Discovery can be used with both a valid result array and with a NULL `result` pointer value. The latter is useful in situations where the smCount will end up being zero, which is an invalid value to create a result entry with, but allowed for discovery purposes when the `result` is NULL.

The `groupParams` array is evaluated from index 0 to `nbGroups` - 1. For each index in the `groupParams` array, the API will evaluate which SMs may be a good fit based on constraints and assign those SMs to `result`. This evaluation order is important to consider when using discovery mode, as it helps discover the remaining SMs.

For a valid call:

- `result` should point to a `CUdevResource` array of size `nbGroups`, or alternatively, may be NULL, if the developer wishes for only the groupParams entries to be updated
- `input` should be a valid CU_DEV_RESOURCE_TYPE_SM resource that originates from querying the green context, device context, or device.

- The `remainder` group may be NULL.
- There are no API `flags` at this time, so the value passed in should be 0.
- A CU_DEV_SM_RESOURCE_GROUP_PARAMS array of size `nbGroups`. Each entry must be zero-initialized.
  - `smCount`: must be either 0 or in the range of [2,inputSmCount] where inputSmCount is the amount of SMs the `input` resource has. `smCount` must be a multiple of 2, as well as a multiple of `coscheduledSmCount`. When assigning SMs to a group (and if results are expected by having the `result` parameter set), `smCount` cannot end up with 0 or a value less than `coscheduledSmCount` otherwise CUDA_ERROR_INVALID_RESOURCE_CONFIGURATION will be returned.
  - `coscheduledSmCount`: allows grouping SMs together in order to be able to launch clusters on Compute Architecture 9.0+. The default value may be queried from the device's CU_DEV_RESOURCE_TYPE_SM resource (8 on Compute Architecture 9.0+ and 2 otherwise). The maximum is 32 on Compute Architecture 9.0+ and 2 otherwise.
  - `preferredCoscheduledSmCount`: Attempts to merge `coscheduledSmCount` groups into larger groups, in order to make use of `preferredClusterDimensions` on Compute Architecture 10.0+. The default value is set to `coscheduledSmCount`.
  - `flags`:
    - `CU_DEV_SM_RESOURCE_GROUP_BACKFILL`: lets `smCount` be a non-multiple of `coscheduledSmCount`, filling the difference between SM count and already assigned co-scheduled groupings with other SMs. This lets any resulting group behave similar to the `remainder` group for example.

Example params and their effect:

A groupParams array element is defined in the following order:

```
{ .smCount, .coscheduledSmCount, .preferredCoscheduledSmCount, .flags, \/
\* .reserved \*\/ }
```

```
// Example 1
      // Will discover how many SMs there are, that are co-scheduled in groups of
 smCoscheduledAlignment.
      // The rest is placed in the optional remainder.
      CU_DEV_SM_RESOURCE_GROUP_PARAMS params { 0, 0, 0, 0 };
```

```
// Example 2
      // Assuming the device has 10+ SMs, the result will have 10 SMs that are co-
scheduled in groups of 2 SMs.
      // The rest is placed in the optional remainder.
      CU_DEV_SM_RESOURCE_GROUP_PARAMS params { 10, 2, 0, 0 };
      // Setting the coscheduledSmCount to 2 guarantees that we can always have a
 valid result
      // as long as the SM count is less than or equal to the input resource SM
 count.
```

```
// Example 3
      // A single piece is split-off, but instead of assigning the rest to the
 remainder, a second group contains everything else
      // This assumes the device has 10+ SMs (8 of which are coscheduled in groups
 of 4),
      // otherwise the second group could end up with 0 SMs, which is not allowed.
      CU_DEV_SM_RESOURCE_GROUP_PARAMS params { {8, 4, 0, 0}, {0, 2, 0,
 CU_DEV_SM_RESOURCE_GROUP_BACKFILL } }
```

The difference between a catch-all param group as the last entry and the remainder is in two aspects:

- The remainder may be NULL / _TYPE_INVALID (if there are no SMs remaining), while a result group must always be valid.
- The remainder does not have a structure, while the result group will always need to adhere to a structure of coscheduledSmCount (even if its just 2), and therefore must always have enough coscheduled SMs to cover that requirement (even with the `CU_DEV_SM_RESOURCE_GROUP_BACKFILL` flag enabled).

Splitting an input into N groups, can be accomplished by repeatedly splitting off 1 group and re-splitting the remainder (a bisect operation). However, it's recommended to accomplish this with a single call wherever possible.

See also:

cuGreenCtxGetDevResource, cuCtxGetDevResource, cuDeviceGetDevResource

# CUresult cuDevSmResourceSplitByCount (CUdevResource *result, unsigned int *nbGroups, const CUdevResource *input, CUdevResource *remainder, unsigned int flags, unsigned int minCount)

Splits `CU_DEV_RESOURCE_TYPE_SM` resources.

## Parameters

**result**

- Output array of `CUdevResource` resources. Can be NULL to query the number of groups.

**nbGroups**

- This is a pointer, specifying the number of groups that would be or should be created as described below.

**input**

- Input SM resource to be split. Must be a valid `CU_DEV_RESOURCE_TYPE_SM` resource.

**remainder**

- If the input resource cannot be cleanly split among `nbGroups`, the remainder is placed in here. Can be ommitted (NULL) if the user does not need the remaining set.

**flags**

- Flags specifying how these partitions are used or which constraints to abide by when splitting the input. Zero is valid for default behavior.

**minCount**

- Minimum number of SMs required

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_RESOURCE_TYPE, CUDA_ERROR_INVALID_RESOURCE_CONFIGURATION

## Description

Splits `CU_DEV_RESOURCE_TYPE_SM` resources into `nbGroups`, adhering to the minimum SM count specified in `minCount` and the usage flags in `flags`. If `result` is NULL, the API simulates a split and provides the amount of groups that would be created in `nbGroups`. Otherwise, `nbGroups` must point to the amount of elements in `result` and on return, the API will overwrite `nbGroups` with the amount actually created. The groups are written to the array in `result`. `nbGroups` can be less than the total amount if a smaller number of groups is needed.

This API is used to spatially partition the input resource. The input resource needs to come from one of cuDeviceGetDevResource, cuCtxGetDevResource, or cuGreenCtxGetDevResource. A limitation of the API is that the output results cannot be split again without first creating a descriptor and a green context with that descriptor.

When creating the groups, the API will take into account the performance and functional characteristics of the input resource, and guarantee a split that will create a disjoint set of symmetrical partitions. This may lead to fewer groups created than purely dividing the total SM count by the `minCount` due to cluster requirements or alignment and granularity requirements for the minCount. These requirements can be queried with cuDeviceGetDevResource, cuCtxGetDevResource, and cuGreenCtxGetDevResource for CU_DEV_RESOURCE_TYPE_SM, using the `minSmPartitionSize` and `smCoscheduledAlignment` fields to determine minimum partition size and alignment granularity, respectively.

The `remainder` set does not have the same functional or performance guarantees as the groups in `result`. Its use should be carefully planned and future partitions of the `remainder` set are discouraged.

The following flags are supported:

- `CU_DEV_SM_RESOURCE_SPLIT_IGNORE_SM_COSCHEDULING` : Lower the minimum SM count and alignment, and treat each SM independent of its hierarchy. This allows more fine grained partitions but at the cost of advanced features (such as large clusters on compute capability 9.0+).
- `CU_DEV_SM_RESOURCE_SPLIT_MAX_POTENTIAL_CLUSTER_SIZE` : Compute Capability 9.0+ only. Attempt to create groups that may allow for maximally sized thread clusters. This can be queried post green context creation using cuOccupancyMaxPotentialClusterSize.

A successful API call must either have:

- A valid array of `result` pointers of size passed in `nbGroups`, with `input` of type `CU_DEV_RESOURCE_TYPE_SM`. Value of `minCount` must be between 0 and the SM count specified in `input`. `remainder` may be NULL.

- NULL passed in for `result`, with a valid integer pointer in `nbGroups` and `input` of type `CU_DEV_RESOURCE_TYPE_SM`. Value of `minCount` must be between 0 and the SM count specified in `input`. `remainder` may be NULL. This queries the number of groups that would be created by the API.

Note: The API is not supported on 32-bit platforms.

See also:

cuGreenCtxGetDevResource, cuCtxGetDevResource, cuDeviceGetDevResource

# CUresult cuGreenCtxCreate (CUgreenCtx *phCtx, CUdevResourceDesc desc, CUdevice dev, unsigned int flags)

Creates a green context with a specified set of resources.

## Parameters

**phCtx**
- Pointer for the output handle to the green context

**desc**
- Descriptor generated via cuDevResourceGenerateDesc which contains the set of resources to be used

**dev**
- Device on which to create the green context.

**flags**
- One of the supported green context creation flags.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_SUPPORTED, CUDA_ERROR_OUT_OF_MEMORY

## Description

This API creates a green context with the resources specified in the descriptor `desc` and returns it in the handle represented by `phCtx`. This API will retain the primary context on device `dev`, which will is released when the green context is destroyed. It is advised to have the primary context active before calling this API to avoid the heavy cost of triggering primary context initialization and deinitialization multiple times.

The API does not set the green context current. In order to set it current, you need to explicitly set it current by first converting the green context to a CUcontext using cuCtxFromGreenCtx and subsequently calling cuCtxSetCurrent / cuCtxPushCurrent. It should be noted that a green context

can be current to only one thread at a time. There is no internal synchronization to make API calls accessing the same green context from multiple threads work.

Note: The API is not supported on 32-bit platforms.

The supported flags are:

- `CU_GREEN_CTX_NONE` : Default behavior.
- `CU_GREEN_CTX_DEFAULT_STREAM` : Creates a default stream to use inside the green context.

See also:

cuGreenCtxDestroy, cuCtxFromGreenCtx, cuCtxSetCurrent, cuCtxPushCurrent, cuDevResourceGenerateDesc, cuDevicePrimaryCtxRetain, cuCtxCreate

# CUresult cuGreenCtxDestroy (CUgreenCtx hCtx)

Destroys a green context.

## Parameters

**hCtx**
- Green context to be destroyed

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_CONTEXT_IS_DESTROYED

## Description

Destroys the green context, releasing the primary context of the device that this green context was created for. Any resources provisioned for this green context (that were initially available via the resource descriptor) are released as well. The API does not destroy streams created via cuGreenCtxStreamCreate, cuStreamCreate, or cuStreamCreateWithPriority. Users are expected to destroy these streams explicitly using cuStreamDestroy to avoid resource leaks. Once the green context is destroyed, any subsequent API calls involving these streams will return CUDA_ERROR_STREAM_DETACHED with the exception of the following APIs:

- cuStreamDestroy.

Additionally, the API will invalidate all active captures on these streams.

See also:

cuGreenCtxCreate, cuCtxDestroy

# CUresult cuGreenCtxGetDevResource (CUgreenCtx hCtx, CUdevResource *resource, CUdevResourceType type)

Get green context resources.

## Parameters

**hCtx**
- Green context to get resource for

**resource**
- Output pointer to a CUdevResource structure

**type**
- Type of resource to retrieve

## Returns

CUDA_SUCCESS CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_RESOURCE_TYPE, CUDA_ERROR_INVALID_VALUE

## Description

Get the `type` resources available to the green context represented by `hCtx`

See also:

cuDevResourceGenerateDesc

# CUresult cuGreenCtxGetId (CUgreenCtx greenCtx, unsigned long long *greenCtxId)

Returns the unique Id associated with the green context supplied.

## Parameters

**greenCtx**
- Green context for which to obtain the Id

**greenCtxId**
- Pointer to store the Id of the green context

## Returns

CUDA_SUCCESS, CUDA_ERROR_CONTEXT_IS_DESTROYED, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Returns in `greenCtxId` the unique Id which is associated with a given green context. The Id is unique for the life of the program for this instance of CUDA. If green context is supplied as NULL and the current context is set to a green context, the Id of the current green context is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGreenCtxCreate, cuGreenCtxDestroy, cuCtxGetId

## CUresult cuGreenCtxRecordEvent (CUgreenCtx hCtx, CUevent hEvent)

Records an event.

### Parameters

**hCtx**

- Green context to record event for

**hEvent**

- Event to record

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_STREAM_CAPTURE_UNSUPPORTED

### Description

Captures in `hEvent` all the activities of the green context of `hCtx` at the time of this call. `hEvent` and `hCtx` must be from the same primary context otherwise CUDA_ERROR_INVALID_HANDLE is returned. Calls such as cuEventQuery() or cuGreenCtxWaitEvent() will then examine or wait for completion of the work that was captured. Uses of `hCtx` after this call do not modify `hEvent`.

Note:

The API will return CUDA_ERROR_STREAM_CAPTURE_UNSUPPORTED if the specified green context `hCtx` has a stream in the capture mode. In such a case, the call will invalidate all the conflicting captures.

See also:

cuGreenCtxWaitEvent, cuEventRecord, cuCtxRecordEvent, cuCtxWaitEvent

# CUresult cuGreenCtxStreamCreate (CUstream *phStream, CUgreenCtx greenCtx, unsigned int flags, int priority)

Create a stream for use in the green context.

## Parameters

**phStream**
- Returned newly created stream

**greenCtx**
- Green context for which to create the stream for

**flags**
- Flags for stream creation. `CU_STREAM_NON_BLOCKING` must be specified.

**priority**
- Stream priority. Lower numbers represent higher priorities. See cuCtxGetStreamPriorityRange for more information about meaningful stream priorities that can be passed.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Creates a stream for use in the specified green context `greenCtx` and returns a handle in `phStream`. The stream can be destroyed by calling cuStreamDestroy(). Note that the API ignores the context that is current to the calling thread and creates a stream in the specified green context `greenCtx`.

The supported values for `flags` are:

- CU_STREAM_NON_BLOCKING: This must be specified. It indicates that work running in the created stream may run concurrently with work in the default stream, and that the created stream should perform no implicit synchronization with the default stream.

Specifying `priority` affects the scheduling priority of work in the stream. Priorities provide a hint to preferentially run work with higher priority when possible, but do not preempt already-running work or provide any other functional guarantee on execution order. `priority` follows a convention where lower numbers represent higher priorities. '0' represents default priority. The range of meaningful numerical priorities can be queried using cuCtxGetStreamPriorityRange. If the specified priority is outside the numerical range returned by cuCtxGetStreamPriorityRange, it will automatically be clamped to the lowest or the highest number in the range.

Note:

- Note that this function may also return error codes from previous, asynchronous launches.
- In the current implementation, only compute kernels launched in priority streams are affected by the stream's priority. Stream priorities have no effect on host-to-device and device-to-host memory operations.

See also:

cuStreamDestroy, cuGreenCtxCreate cuStreamCreate, cuStreamGetPriority, cuCtxGetStreamPriorityRange, cuStreamGetFlags, cuStreamGetDevice, cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cudaStreamCreateWithPriority

# CUresult cuGreenCtxWaitEvent (CUgreenCtx hCtx, CUevent hEvent)

Make a green context wait on an event.

## Parameters

**hCtx**
- Green context to wait

**hEvent**
- Event to wait on

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_STREAM_CAPTURE_UNSUPPORTED

## Description

Makes all future work submitted to green context `hCtx` wait for all work captured in `hEvent`. The synchronization will be performed on the device and will not block the calling CPU thread. See cuGreenCtxRecordEvent() or cuEventRecord(), for details on what is captured by an event.

Note:

- `hEvent` may be from a different context or device than `hCtx`.
- The API will return CUDA_ERROR_STREAM_CAPTURE_UNSUPPORTED and invalidate the capture if the specified event `hEvent` is part of an ongoing capture sequence or if the specified green context `hCtx` has a stream in the capture mode.

See also:

cuGreenCtxRecordEvent, cuStreamWaitEvent, cuCtxRecordEvent, cuCtxWaitEvent

# CUresult cuStreamGetDevResource (CUstream hStream, CUdevResource *resource, CUdevResourceType type)

Get stream resources.

## Parameters

**hStream**
- Stream to get resource for

**resource**
- Output pointer to a CUdevResource structure

**type**
- Type of resource to retrieve

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_RESOURCE_TYPE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

## Description

Get the `type` resources available to the `hStream` and store them in `resource`.

Note: The API will return CUDA_ERROR_INVALID_RESOURCE_TYPE is `type` is `CU_DEV_RESOURCE_TYPE_WORKQUEUE_CONFIG` or `CU_DEV_RESOURCE_TYPE_WORKQUEUE`.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGreenCtxCreate, cuGreenCtxStreamCreate, cuStreamCreate, cuDevSmResourceSplitByCount, cuDevResourceGenerateDesc, cudaStreamGetDevResource

# CUresult cuStreamGetGreenCtx (CUstream hStream, CUgreenCtx *phCtx)

Query the green context associated with a stream.

## Parameters

**hStream**
- Handle to the stream to be queried

**phCtx**
- Returned green context associated with the stream

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE,

## Description

Returns the CUDA green context that the stream is associated with, or NULL if the stream is not associated with any green context.

The stream handle `hStream` can refer to any of the following:

- a stream created via any of the CUDA driver APIs such as cuStreamCreate, cuStreamCreateWithPriority and cuGreenCtxStreamCreate, or their runtime API equivalents such as cudaStreamCreate, cudaStreamCreateWithFlags and cudaStreamCreateWithPriority. If during stream creation the context that was active in the calling thread was obtained with cuCtxFromGreenCtx, that green context is returned in `phCtx`. Otherwise, `*phCtx` is set to NULL instead.
- special stream such as the NULL stream or CU_STREAM_LEGACY. In that case if context that is active in the calling thread was obtained with cuCtxFromGreenCtx, that green context is returned. Otherwise, `*phCtx` is set to NULL instead.

Passing an invalid handle will result in undefined behavior.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuStreamDestroy, cuStreamCreate, cuStreamCreateWithPriority, cuStreamGetCtx, cuGreenCtxStreamCreate, cuStreamGetPriority, cuStreamGetFlags, cuStreamGetDevice, cuStreamWaitEvent, cuStreamQuery, cuStreamSynchronize, cuStreamAddCallback, cudaStreamCreate, cudaStreamCreateWithFlags

# 6.37. Error Log Management Functions

This section describes the error log management functions of the low-level CUDA driver application programming interface.

## CUresult cuLogsCurrent (CUlogIterator *iterator_out, unsigned int flags)

Sets log iterator to point to the end of log buffer, where the next message would be written.

### Parameters

**iterator_out**
- Location to store an iterator to the current tail of the logs

**flags**
- Reserved for future use, must be 0

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## CUresult cuLogsDumpToFile (CUlogIterator *iterator, const char *pathToFile, unsigned int flags)

Dump accumulated driver logs into a file.

### Parameters

**iterator**
- Optional auto-advancing iterator specifying the starting log to read. NULL value dumps all logs.

**pathToFile**
- Path to output file for dumping logs

**flags**
- Reserved for future use, must be 0

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

### Description

Logs generated by the driver are stored in an internal buffer and can be copied out using this API. This API dumps all driver logs starting from `iterator` into `pathToFile` provided.

Note:

- `iterator` is auto-advancing. Dumping logs will update the value of `iterator` to receive the next generated log.
- The driver reserves limited memory for storing logs. The oldest logs may be overwritten and become unrecoverable. An indication will appear in the destination outupt if the logs have been truncated. Call dump after each failed API to mitigate this risk.

# CUresult cuLogsDumpToMemory (CUlogIterator *iterator, char *buffer, size_t *size, unsigned int flags)

Dump accumulated driver logs into a buffer.

## Parameters

**iterator**
- Optional auto-advancing iterator specifying the starting log to read. NULL value dumps all logs.

**buffer**
- Pointer to dump logs

**size**
- See description

**flags**
- Reserved for future use, must be 0

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_VALUE

## Description

Logs generated by the driver are stored in an internal buffer and can be copied out using this API. This API dumps driver logs from `iterator` into `buffer` up to the size specified in `*size`. The driver will always null terminate the buffer but there will not be a null character between log entries, only a newline \n. The driver will then return the actual number of bytes written in `*size`, excluding the null terminator. If there are no messages to dump, `*size` will be set to 0 and the function will return CUDA_SUCCESS. If the provided `buffer` is not large enough to hold any messages, `*size` will be set to 0 and the function will return CUDA_ERROR_INVALID_VALUE.

Note:

- `iterator` is auto-advancing. Dumping logs will update the value of `iterator` to receive the next generated log.
- The driver reserves limited memory for storing logs. The maximum size of the buffer is 25600 bytes. The oldest logs may be overwritten and become unrecoverable. An indication will appear in the destination outupt if the logs have been truncated. Call dump after each failed API to mitigate this risk.

- If the provided value in `*size` is not large enough to hold all buffered messages, a message will be added at the head of the buffer indicating this. The driver then computes the number of messages it is able to store in `buffer` and writes it out. The final message in `buffer` will always be the most recent log message as of when the API is called.

## CUresult cuLogsRegisterCallback (CUlogsCallback callbackFunc, void *userData, CUlogsCallbackHandle *callback_out)

Register a callback function to receive error log messages.

### Parameters

**callbackFunc**
- The function to register as a callback

**userData**
- A generic pointer to user data. This is passed into the callback function.

**callback_out**
- Optional location to store the callback handle after it is registered

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

## CUresult cuLogsUnregisterCallback (CUlogsCallbackHandle callback)

Unregister a log message callback.

### Parameters

**callback**
- The callback instance to unregister from receiving log messages

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE

# 6.38. CUDA Checkpointing

CUDA API versioning support

This sections describes the checkpoint and restore functions of the low-level CUDA driver application programming interface.

The CUDA checkpoint and restore API's provide a way to save and restore GPU state for full process checkpoints when used with CPU side process checkpointing solutions. They can also be used to pause GPU work and suspend a CUDA process to allow other applications to make use of GPU resources.

Checkpoint and restore capabilities are currently restricted to Linux.

## CUresult cuCheckpointProcessCheckpoint (int pid, CUcheckpointCheckpointArgs *args)

Checkpoint a CUDA process's GPU memory contents.

### Parameters

**pid**
- The process ID of the CUDA process

**args**
- Optional checkpoint operation arguments

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE CUDA_ERROR_NOT_INITIALIZED CUDA_ERROR_ILLEGAL_STATE CUDA_ERROR_NOT_SUPPORTED

### Description

Checkpoints a CUDA process specified by `pid` that is in the LOCKED state. The GPU memory contents will be brought into host memory and all underlying references will be released. Process must be in the LOCKED state to checkpoint.

Upon successful return the process will be in the CHECKPOINTED state.

## CUresult cuCheckpointProcessGetRestoreThreadId (int pid, int *tid)

Returns the restore thread ID for a CUDA process.

### Parameters

**pid**
- The process ID of the CUDA process

**tid**
- Returned restore thread ID

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE CUDA_ERROR_NOT_INITIALIZED CUDA_ERROR_NOT_SUPPORTED

### Description

Returns in `*tid` the thread ID of the CUDA restore thread for the process specified by `pid`.

## CUresult cuCheckpointProcessGetState (int pid, CUprocessState *state)

Returns the process state of a CUDA process.

### Parameters

**pid**
- The process ID of the CUDA process

**state**
- Returned CUDA process state

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE CUDA_ERROR_NOT_INITIALIZED CUDA_ERROR_NOT_SUPPORTED

### Description

Returns in `*state` the current state of the CUDA process specified by `pid`.

## CUresult cuCheckpointProcessLock (int pid, CUcheckpointLockArgs *args)

Lock a running CUDA process.

### Parameters

**pid**
- The process ID of the CUDA process

**args**
- Optional lock operation arguments

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE CUDA_ERROR_NOT_INITIALIZED CUDA_ERROR_ILLEGAL_STATE CUDA_ERROR_NOT_SUPPORTED CUDA_ERROR_NOT_READY

### Description

Lock the CUDA process specified by `pid` which will block further CUDA API calls. Process must be in the RUNNING state in order to lock.

Upon successful return the process will be in the LOCKED state.

If timeoutMs is specified and the timeout is reached the process will be left in the RUNNING state upon return.

## CUresult cuCheckpointProcessRestore (int pid, CUcheckpointRestoreArgs *args)

Restore a CUDA process's GPU memory contents from its last checkpoint.

### Parameters

**pid**
- The process ID of the CUDA process

**args**
- Optional restore operation arguments

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE CUDA_ERROR_NOT_INITIALIZED CUDA_ERROR_ILLEGAL_STATE CUDA_ERROR_NOT_SUPPORTED

### Description

Restores a CUDA process specified by `pid` from its last checkpoint. Process must be in the CHECKPOINTED state to restore.

GPU UUID pairs can be specified in `args` to remap the process old GPUs onto new GPUs. The GPU to restore onto needs to have enough memory and be of the same chip type as the old GPU. If an array of GPU UUID pairs is specified, it must contain every checkpointed GPU.

Upon successful return the process will be in the LOCKED state.

CUDA process restore requires persistence mode to be enabled or cuInit to have been called before execution.

See also:

cuInit

## CUresult cuCheckpointProcessUnlock (int pid, CUcheckpointUnlockArgs *args)

Unlock a CUDA process to allow CUDA API calls.

### Parameters

**pid**
- The process ID of the CUDA process

**args**
- Optional unlock operation arguments

### Returns

CUDA_SUCCESS CUDA_ERROR_INVALID_VALUE CUDA_ERROR_NOT_INITIALIZED CUDA_ERROR_ILLEGAL_STATE CUDA_ERROR_NOT_SUPPORTED

### Description

Unlocks a process specified by `pid` allowing it to resume making CUDA API calls. Process must be in the LOCKED state.

Upon successful return the process will be in the RUNNING state.

# 6.39. Profiler Control [DEPRECATED]

This section describes the profiler control functions of the low-level CUDA driver application programming interface.

## CUresult cuProfilerInitialize (const char *configFile, const char *outputFile, CUoutput_mode outputMode)

Initialize the profiling.

### Parameters

**configFile**
- Name of the config file that lists the counters/options for profiling.

**outputFile**
- Name of the outputFile where the profiling results will be stored.

**outputMode**
- outputMode, can be CU_OUT_KEY_VALUE_PAIR or CU_OUT_CSV.

### Returns

CUDA_ERROR_NOT_SUPPORTED

### Description

Deprecated

Note that this function is deprecated and should not be used. Starting with CUDA 12.0, it always returns error code CUDA_ERROR_NOT_SUPPORTED.

Using this API user can initialize the CUDA profiler by specifying the configuration file, output file and output file format. This API is generally used to profile different set of counters by looping the kernel launch. The `configFile` parameter can be used to select profiling options including profiler counters. Refer to the "Compute Command Line Profiler User Guide" for supported profiler options and counters.

Limitation: The CUDA profiler cannot be initialized with this API if another profiling tool is already active, as indicated by the CUDA_ERROR_PROFILER_DISABLED return code.

Typical usage of the profiling APIs is as follows:

for each set of counters/options { cuProfilerInitialize(); //Initialize profiling, set the counters or options in the config file ... cuProfilerStart(); // code to be profiled cuProfilerStop(); ... cuProfilerStart(); // code to be profiled cuProfilerStop(); ... }

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuProfilerStart, cuProfilerStop,

# 6.40. Profiler Control

This section describes the profiler control functions of the low-level CUDA driver application programming interface.

## CUresult cuProfilerStart (void)

Enable profiling.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_CONTEXT

### Description

Enables profile collection by the active profiling tool for the current context. If profiling is already enabled, then cuProfilerStart() has no effect.

cuProfilerStart and cuProfilerStop APIs are used to programmatically control the profiling granularity by allowing profiling to be done only on selective pieces of code.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuProfilerInitialize, cuProfilerStop, cudaProfilerStart

## CUresult cuProfilerStop (void)

Disable profiling.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_CONTEXT

### Description

Disables profile collection by the active profiling tool for the current context. If profiling is already disabled, then cuProfilerStop() has no effect.

cuProfilerStart and cuProfilerStop APIs are used to programmatically control the profiling granularity by allowing profiling to be done only on selective pieces of code.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuProfilerInitialize, cuProfilerStart, cudaProfilerStop

# 6.41. OpenGL Interoperability

This section describes the OpenGL interoperability functions of the low-level CUDA driver application programming interface. Note that mapping of OpenGL resources is performed with the graphics API agnostic, resource mapping interface described in Graphics Interoperability.

# OpenGL Interoperability [DEPRECATED]

## enum CUGLDeviceList

CUDA devices corresponding to an OpenGL device

### Values

**CU_GL_DEVICE_LIST_ALL = 0x01**
The CUDA devices for all GPUs used by the current OpenGL context

**CU_GL_DEVICE_LIST_CURRENT_FRAME = 0x02**
The CUDA devices for the GPUs used by the current OpenGL context in its currently rendering frame

**CU_GL_DEVICE_LIST_NEXT_FRAME = 0x03**
The CUDA devices for the GPUs to be used by the current OpenGL context in the next frame

## CUresult cuGLGetDevices (unsigned int *pCudaDeviceCount, CUdevice *pCudaDevices, unsigned int cudaDeviceCount, CUGLDeviceList deviceList)

Gets the CUDA devices associated with the current OpenGL context.

### Parameters

**pCudaDeviceCount**
- Returned number of CUDA devices.

**pCudaDevices**
- Returned CUDA devices.

**cudaDeviceCount**
- The size of the output device array pCudaDevices.

**deviceList**
- The set of devices to return.

### Returns

CUDA_SUCCESS, CUDA_ERROR_NO_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_GRAPHICS_CONTEXT, CUDA_ERROR_OPERATING_SYSTEM

### Description

Returns in `*pCudaDeviceCount` the number of CUDA-compatible devices corresponding to the current OpenGL context. Also returns in `*pCudaDevices` at most cudaDeviceCount of the CUDA-compatible devices corresponding to the current OpenGL context. If any of the

GPUs being used by the current OpenGL context are not CUDA capable then the call will return CUDA_ERROR_NO_DEVICE.

The `deviceList` argument may be any of the following:

- CU_GL_DEVICE_LIST_ALL: Query all devices used by the current OpenGL context.
- CU_GL_DEVICE_LIST_CURRENT_FRAME: Query the devices used by the current OpenGL context to render the current frame (in SLI).
- CU_GL_DEVICE_LIST_NEXT_FRAME: Query the devices used by the current OpenGL context to render the next frame (in SLI). Note that this is a prediction, it can't be guaranteed that this is correct in all cases.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuWGLGetDevice, cudaGLGetDevices

# CUresult cuGraphicsGLRegisterBuffer (CUgraphicsResource *pCudaResource, GLuint buffer, unsigned int Flags)

Registers an OpenGL buffer object.

## Parameters

**pCudaResource**
- Pointer to the returned object handle

**buffer**
- name of buffer object to be registered

**Flags**
- Register flags

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_OPERATING_SYSTEM

## Description

Registers the buffer object specified by `buffer` for access by CUDA. A handle to the registered object is returned as `pCudaResource`. The register flags `Flags` specify the intended usage, as follows:

- CU_GRAPHICS_REGISTER_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- CU_GRAPHICS_REGISTER_FLAGS_READ_ONLY: Specifies that CUDA will not write to this resource.
- CU_GRAPHICS_REGISTER_FLAGS_WRITE_DISCARD: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnregisterResource, cuGraphicsMapResources, cuGraphicsResourceGetMappedPointer, cudaGraphicsGLRegisterBuffer

# CUresult cuGraphicsGLRegisterImage (CUgraphicsResource *pCudaResource, GLuint image, GLenum target, unsigned int Flags)

Register an OpenGL texture or renderbuffer object.

## Parameters

**pCudaResource**
- Pointer to the returned object handle

**image**
- name of texture or renderbuffer object to be registered

**target**
- Identifies the type of object specified by `image`

**Flags**
- Register flags

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_OPERATING_SYSTEM

## Description

Registers the texture or renderbuffer object specified by `image` for access by CUDA. A handle to the registered object is returned as `pCudaResource`.

`target` must match the type of the object, and must be one of GL_TEXTURE_2D, GL_TEXTURE_RECTANGLE, GL_TEXTURE_CUBE_MAP, GL_TEXTURE_3D, GL_TEXTURE_2D_ARRAY, or GL_RENDERBUFFER.

The register flags `Flags` specify the intended usage, as follows:

- CU_GRAPHICS_REGISTER_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- CU_GRAPHICS_REGISTER_FLAGS_READ_ONLY: Specifies that CUDA will not write to this resource.
- CU_GRAPHICS_REGISTER_FLAGS_WRITE_DISCARD: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.
- CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST: Specifies that CUDA will bind this resource to a surface reference.
- CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER: Specifies that CUDA will perform texture gather operations on this resource.

The following image formats are supported. For brevity's sake, the list is abbreviated. For ex., {GL_R, GL_RG} X {8, 16} would expand to the following 4 formats {GL_R8, GL_R16, GL_RG8, GL_RG16} :

- GL_RED, GL_RG, GL_RGBA, GL_LUMINANCE, GL_ALPHA, GL_LUMINANCE_ALPHA, GL_INTENSITY
- {GL_R, GL_RG, GL_RGBA} X {8, 16, 16F, 32F, 8UI, 16UI, 32UI, 8I, 16I, 32I}
- {GL_LUMINANCE, GL_ALPHA, GL_LUMINANCE_ALPHA, GL_INTENSITY} X {8, 16, 16F_ARB, 32F_ARB, 8UI_EXT, 16UI_EXT, 32UI_EXT, 8I_EXT, 16I_EXT, 32I_EXT}

The following image classes are currently disallowed:

- Textures with borders
- Multisampled renderbuffers

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnregisterResource, cuGraphicsMapResources, cuGraphicsSubResourceGetMappedArray, cudaGraphicsGLRegisterImage

# CUresult cuWGLGetDevice (CUdevice *pDevice, HGPUNV hGpu)

Gets the CUDA device associated with hGpu.

## Parameters

**pDevice**
- Device associated with hGpu

**hGpu**
- Handle to a GPU, as queried via WGL_NV_gpu_affinity()

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

## Description

Returns in `*pDevice` the CUDA device associated with a `hGpu`, if applicable.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGLMapBufferObject, cuGLRegisterBufferObject, cuGLUnmapBufferObject, cuGLUnregisterBufferObject, cuGLUnmapBufferObjectAsync, cuGLSetBufferObjectMapFlags, cudaWGLGetDevice

# 6.41.1. OpenGL Interoperability [DEPRECATED]

OpenGL Interoperability

This section describes deprecated OpenGL interoperability functionality.

# enum CUGLmap_flags

Flags to map or unmap a resource

## Values

**CU_GL_MAP_RESOURCE_FLAGS_NONE = 0x00**
**CU_GL_MAP_RESOURCE_FLAGS_READ_ONLY = 0x01**
**CU_GL_MAP_RESOURCE_FLAGS_WRITE_DISCARD = 0x02**

# CUresult cuGLCtxCreate (CUcontext *pCtx, unsigned int Flags, CUdevice device)

Create a CUDA context for interoperability with OpenGL.

## Parameters

**pCtx**
- Returned CUDA context

**Flags**
- Options for CUDA context creation

**device**
- Device on which to create the context

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Deprecated This function is deprecated as of Cuda 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA context with an OpenGL context in order to achieve maximum interoperability performance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxCreate, cuGLInit, cuGLMapBufferObject, cuGLRegisterBufferObject, cuGLUnmapBufferObject, cuGLUnregisterBufferObject, cuGLMapBufferObjectAsync, cuGLUnmapBufferObjectAsync, cuGLSetBufferObjectMapFlags, cuWGLGetDevice

# CUresult cuGLInit (void)

Initializes OpenGL interoperability.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_UNKNOWN

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Initializes OpenGL interoperability. This function is deprecated and calling it is no longer required. It may fail if the needed OpenGL driver facilities are not available.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGLMapBufferObject, cuGLRegisterBufferObject, cuGLUnmapBufferObject, cuGLUnregisterBufferObject, cuGLMapBufferObjectAsync, cuGLUnmapBufferObjectAsync, cuGLSetBufferObjectMapFlags, cuWGLGetDevice

## CUresult cuGLMapBufferObject (CUdeviceptr *dptr, size_t *size, GLuint buffer)

Maps an OpenGL buffer object.

### Parameters

**dptr**
- Returned mapped base pointer

**size**
- Returned size of mapping

**buffer**
- The name of the buffer object to map

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_MAP_FAILED

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Maps the buffer object specified by `buffer` into the address space of the current CUDA context and returns in `*dptr` and `*size` the base pointer and size of the resulting mapping.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

All streams in the current CUDA context are synchronized with the current GL context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsMapResources

## CUresult cuGLMapBufferObjectAsync (CUdeviceptr *dptr, size_t *size, GLuint buffer, CUstream hStream)

Maps an OpenGL buffer object.

### Parameters

**dptr**
- Returned mapped base pointer

**size**
- Returned size of mapping

**buffer**
- The name of the buffer object to map

**hStream**
- Stream to synchronize

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_MAP_FAILED

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Maps the buffer object specified by `buffer` into the address space of the current CUDA context and returns in `*dptr` and `*size` the base pointer and size of the resulting mapping.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

Stream `hStream` in the current CUDA context is synchronized with the current GL context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsMapResources

## CUresult cuGLRegisterBufferObject (GLuint buffer)

Registers an OpenGL buffer object.

### Parameters

**buffer**

- The name of the buffer object to register.

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_ALREADY_MAPPED

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Registers the buffer object specified by `buffer` for access by CUDA. This function must be called before CUDA can map the buffer object. There must be a valid OpenGL context bound to the current thread when this function is called, and the buffer name is resolved by that context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsGLRegisterBuffer

## CUresult cuGLSetBufferObjectMapFlags (GLuint buffer, unsigned int Flags)

Set the map flags for an OpenGL buffer object.

### Parameters

**buffer**

- Buffer object to unmap

**Flags**

- Map flags

### Returns

CUDA_SUCCESS, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_INVALID_CONTEXT,

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Sets the map flags for the buffer object specified by `buffer`.

Changes to `Flags` will take effect the next time `buffer` is mapped. The `Flags` argument may be any of the following:

- CU_GL_MAP_RESOURCE_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA kernels. This is the default value.
- CU_GL_MAP_RESOURCE_FLAGS_READ_ONLY: Specifies that CUDA kernels which access this resource will not write to this resource.
- CU_GL_MAP_RESOURCE_FLAGS_WRITE_DISCARD: Specifies that CUDA kernels which access this resource will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

If `buffer` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned. If `buffer` is presently mapped for access by CUDA, then CUDA_ERROR_ALREADY_MAPPED is returned.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceSetMapFlags

## CUresult cuGLUnmapBufferObject (GLuint buffer)

Unmaps an OpenGL buffer object.

### Parameters

**buffer**

- Buffer object to unmap

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Unmaps the buffer object specified by `buffer` for access by CUDA.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

All streams in the current CUDA context are synchronized with the current GL context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnmapResources

## CUresult cuGLUnmapBufferObjectAsync (GLuint buffer, CUstream hStream)

Unmaps an OpenGL buffer object.

### Parameters

**buffer**
- Name of the buffer object to unmap

**hStream**
- Stream to synchronize

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Unmaps the buffer object specified by `buffer` for access by CUDA.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

Stream `hStream` in the current CUDA context is synchronized with the current GL context.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnmapResources

## CUresult cuGLUnregisterBufferObject (GLuint buffer)

Unregister an OpenGL buffer object.

### Parameters

**buffer**

- Name of the buffer object to unregister

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Unregisters the buffer object specified by `buffer`. This releases any resources associated with the registered buffer. After this call, the buffer may no longer be mapped for access by CUDA.

There must be a valid OpenGL context bound to the current thread when this function is called. This must be the same context, or a member of the same shareGroup, as the context that was bound when the buffer was registered.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnregisterResource

# 6.42. Direct3D 9 Interoperability

This section describes the Direct3D 9 interoperability functions of the low-level CUDA driver application programming interface. Note that mapping of Direct3D 9 resources is performed with the graphics API agnostic, resource mapping interface described in Graphics Interoperability.

## Direct3D 9 Interoperability [DEPRECATED]

## enum CUd3d9DeviceList

CUDA devices corresponding to a D3D9 device

### Values

**CU_D3D9_DEVICE_LIST_ALL = 0x01**
The CUDA devices for all GPUs used by a D3D9 device

**CU_D3D9_DEVICE_LIST_CURRENT_FRAME = 0x02**
The CUDA devices for the GPUs used by a D3D9 device in its currently rendering frame

**CU_D3D9_DEVICE_LIST_NEXT_FRAME = 0x03**
The CUDA devices for the GPUs to be used by a D3D9 device in the next frame

## CUresult cuD3D9CtxCreate (CUcontext *pCtx, CUdevice *pCudaDevice, unsigned int Flags, IDirect3DDevice9 *pD3DDevice)

Create a CUDA context for interoperability with Direct3D 9.

### Parameters

**pCtx**
- Returned newly created CUDA context

**pCudaDevice**
- Returned pointer to the device on which the context was created

**Flags**
- Context creation flags (see cuCtxCreate() for details)

**pD3DDevice**
- Direct3D device to create interoperability context with

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

### Description

Creates a new CUDA context, enables interoperability for that context with the Direct3D device `pD3DDevice`, and associates the created CUDA context with the calling thread. The created CUcontext will be returned in `*pCtx`. Direct3D resources from this device may be registered and mapped through the lifetime of this CUDA context. If `pCudaDevice` is non-NULL then the CUdevice on which this CUDA context was created will be returned in `*pCudaDevice`.

On success, this call will increase the internal reference count on `pD3DDevice`. This reference count will be decremented upon destruction of this context through cuCtxDestroy(). This context will cease to function if `pD3DDevice` is destroyed or encounters an error.

Note that this function is never required for correct functionality. Use of this function will result in accelerated interoperability only when the operating system is Windows Vista or Windows 7, and the device `pD3DDdevice` is not an IDirect3DDevice9Ex. In all other circumstances, this function is not necessary.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D9GetDevice, cuGraphicsD3D9RegisterResource

## CUresult cuD3D9CtxCreateOnDevice (CUcontext *pCtx, unsigned int flags, IDirect3DDevice9 *pD3DDevice, CUdevice cudaDevice)

Create a CUDA context for interoperability with Direct3D 9.

### Parameters

**pCtx**
- Returned newly created CUDA context

**flags**
- Context creation flags (see cuCtxCreate() for details)

**pD3DDevice**
- Direct3D device to create interoperability context with

**cudaDevice**
- The CUDA device on which to create the context. This device must be among the devices returned when querying CU_D3D9_DEVICES_ALL from cuD3D9GetDevices.

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

### Description

Creates a new CUDA context, enables interoperability for that context with the Direct3D device `pD3DDevice`, and associates the created CUDA context with the calling thread. The created CUcontext will be returned in `*pCtx`. Direct3D resources from this device may be registered and mapped through the lifetime of this CUDA context.

On success, this call will increase the internal reference count on `pD3DDevice`. This reference count will be decremented upon destruction of this context through cuCtxDestroy(). This context will cease to function if `pD3DDevice` is destroyed or encounters an error.

Note that this function is never required for correct functionality. Use of this function will result in accelerated interoperability only when the operating system is Windows Vista or Windows 7, and the device `pD3DDdevice` is not an IDirect3DDevice9Ex. In all other circumstances, this function is not necessary.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D9GetDevices, cuGraphicsD3D9RegisterResource

## CUresult cuD3D9GetDevice (CUdevice *pCudaDevice, const char *pszAdapterName)

Gets the CUDA device corresponding to a display adapter.

### Parameters

**pCudaDevice**

- Returned CUDA device corresponding to pszAdapterName

**pszAdapterName**

- Adapter name to query for device

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_UNKNOWN

### Description

Returns in `*pCudaDevice` the CUDA-compatible device corresponding to the adapter name `pszAdapterName` obtained from EnumDisplayDevices() or IDirect3D9::GetAdapterIdentifier().

If no device on the adapter with name `pszAdapterName` is CUDA-compatible, then the call will fail.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D9CtxCreate, cudaD3D9GetDevice

## CUresult cuD3D9GetDevices (unsigned int *pCudaDeviceCount, CUdevice *pCudaDevices, unsigned int cudaDeviceCount, IDirect3DDevice9 *pD3D9Device, CUd3d9DeviceList deviceList)

Gets the CUDA devices corresponding to a Direct3D 9 device.

### Parameters

**pCudaDeviceCount**
- Returned number of CUDA devices corresponding to `pD3D9Device`

**pCudaDevices**
- Returned CUDA devices corresponding to `pD3D9Device`

**cudaDeviceCount**
- The size of the output device array `pCudaDevices`

**pD3D9Device**
- Direct3D 9 device to query for CUDA devices

**deviceList**
- The set of devices to return. This set may be CU_D3D9_DEVICE_LIST_ALL for all devices, CU_D3D9_DEVICE_LIST_CURRENT_FRAME for the devices used to render the current frame (in SLI), or CU_D3D9_DEVICE_LIST_NEXT_FRAME for the devices used to render the next frame (in SLI).

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NO_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_UNKNOWN

### Description

Returns in `*pCudaDeviceCount` the number of CUDA-compatible device corresponding to the Direct3D 9 device `pD3D9Device`. Also returns in `*pCudaDevices` at most `cudaDeviceCount` of the CUDA-compatible devices corresponding to the Direct3D 9 device `pD3D9Device`.

If any of the GPUs being used to render `pDevice` are not CUDA capable then the call will return CUDA_ERROR_NO_DEVICE.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D9CtxCreate, cudaD3D9GetDevices

## CUresult cuD3D9GetDirect3DDevice (IDirect3DDevice9 **ppD3DDevice)

Get the Direct3D 9 device against which the current CUDA context was created.

### Parameters

**ppD3DDevice**

- Returned Direct3D device corresponding to CUDA context

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT CUDA_ERROR_INVALID_GRAPHICS_CONTEXT

### Description

Returns in `*ppD3DDevice` the Direct3D device against which this CUDA context was created in cuD3D9CtxCreate().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D9GetDevice, cudaD3D9GetDirect3DDevice

# CUresult cuGraphicsD3D9RegisterResource (CUgraphicsResource *pCudaResource, IDirect3DResource9 *pD3DResource, unsigned int Flags)

Register a Direct3D 9 resource for access by CUDA.

## Parameters

**pCudaResource**
- Returned graphics resource handle

**pD3DResource**
- Direct3D resource to register

**Flags**
- Parameters for resource registration

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Registers the Direct3D 9 resource `pD3DResource` for access by CUDA and returns a CUDA handle to `pD3Dresource` in `pCudaResource`. The handle returned in `pCudaResource` may be used to map and unmap this resource until it is unregistered. On success this call will increase the internal reference count on `pD3DResource`. This reference count will be decremented when this resource is unregistered through cuGraphicsUnregisterResource().

This call is potentially high-overhead and should not be called every frame in interactive applications.

The type of `pD3DResource` must be one of the following.

- IDirect3DVertexBuffer9: may be accessed through a device pointer
- IDirect3DIndexBuffer9: may be accessed through a device pointer
- IDirect3DSurface9: may be accessed through an array. Only stand-alone objects of type IDirect3DSurface9 may be explicitly shared. In particular, individual mipmap levels and faces of cube maps may not be registered directly. To access individual surfaces associated with a texture, one must register the base texture object.

- IDirect3DBaseTexture9: individual surfaces on this texture may be accessed through an array.

The `Flags` argument may be used to specify additional parameters at register time. The valid values for this parameter are

- CU_GRAPHICS_REGISTER_FLAGS_NONE: Specifies no hints about how this resource will be used.
- CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST: Specifies that CUDA will bind this resource to a surface reference.
- CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER: Specifies that CUDA will perform texture gather operations on this resource.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- The primary rendertarget may not be registered with CUDA.
- Resources allocated as shared may not be registered with CUDA.
- Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- Surfaces of depth or stencil formats cannot be shared.

A complete list of supported formats is as follows:

- D3DFMT_L8
- D3DFMT_L16
- D3DFMT_A8R8G8B8
- D3DFMT_X8R8G8B8
- D3DFMT_G16R16
- D3DFMT_A8B8G8R8
- D3DFMT_A8
- D3DFMT_A8L8
- D3DFMT_Q8W8V8U8
- D3DFMT_V16U16
- D3DFMT_A16B16G16R16F
- D3DFMT_A16B16G16R16
- D3DFMT_R32F
- D3DFMT_G16R16F
- D3DFMT_A32B32G32R32F
- D3DFMT_G32R32F
- D3DFMT_R16F

If Direct3D interoperability is not initialized for this context using cuD3D9CtxCreate then CUDA_ERROR_INVALID_CONTEXT is returned. If `pD3DResource` is of incorrect type or

is already registered then CUDA_ERROR_INVALID_HANDLE is returned. If `pD3DResource` cannot be registered then CUDA_ERROR_UNKNOWN is returned. If `Flags` is not one of the above specified value then CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D9CtxCreate, cuGraphicsUnregisterResource, cuGraphicsMapResources, cuGraphicsSubResourceGetMappedArray, cuGraphicsResourceGetMappedPointer, cudaGraphicsD3D9RegisterResource

## 6.42.1. Direct3D 9 Interoperability [DEPRECATED]

Direct3D 9 Interoperability

This section describes deprecated Direct3D 9 interoperability functionality.

## enum CUd3d9map_flags

Flags to map or unmap a resource

### Values

**CU_D3D9_MAPRESOURCE_FLAGS_NONE = 0x00**
**CU_D3D9_MAPRESOURCE_FLAGS_READONLY = 0x01**
**CU_D3D9_MAPRESOURCE_FLAGS_WRITEDISCARD = 0x02**

## enum CUd3d9register_flags

Flags to register a resource

### Values

**CU_D3D9_REGISTER_FLAGS_NONE = 0x00**
**CU_D3D9_REGISTER_FLAGS_ARRAY = 0x01**

## CUresult cuD3D9MapResources (unsigned int count, IDirect3DResource9 **ppResource)

Map Direct3D resources for access by CUDA.

### Parameters

**count**
- Number of resources in ppResource

**ppResource**
- Resources to map for CUDA usage

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_UNKNOWN

### Description

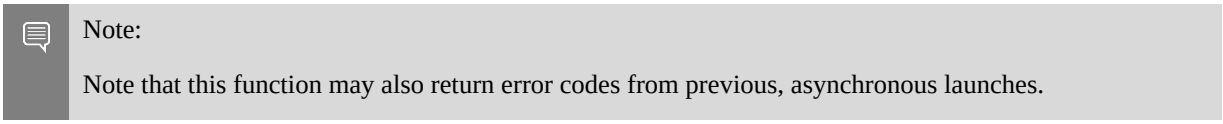
Deprecated This function is deprecated as of CUDA 3.0.

Maps the `count` Direct3D resources in `ppResource` for access by CUDA.

The resources in `ppResource` may be accessed in CUDA kernels until they are unmapped. Direct3D should not access any resources while they are mapped by CUDA. If an application does so the results are undefined.

This function provides the synchronization guarantee that any Direct3D calls issued before cuD3D9MapResources() will complete before any CUDA kernels issued after cuD3D9MapResources() begin.

If any of `ppResource` have not been registered for use with CUDA or if `ppResource` contains any duplicate entries, then CUDA_ERROR_INVALID_HANDLE is returned. If any of `ppResource` are presently mapped for access by CUDA, then CUDA_ERROR_ALREADY_MAPPED is returned.




See also:

cuGraphicsMapResources

## CUresult cuD3D9RegisterResource (IDirect3DResource9 *pResource, unsigned int Flags)

Register a Direct3D resource for access by CUDA.

### Parameters

**pResource**
- Resource to register for CUDA access

**Flags**
- Flags for resource registration

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Deprecated This function is deprecated as of CUDA 3.0.

Registers the Direct3D resource `pResource` for access by CUDA.

If this call is successful, then the application will be able to map and unmap this resource until it is unregistered through cuD3D9UnregisterResource(). Also on success, this call will increase the internal reference count on `pResource`. This reference count will be decremented when this resource is unregistered through cuD3D9UnregisterResource().

This call is potentially high-overhead and should not be called every frame in interactive applications.

The type of `pResource` must be one of the following.

- IDirect3DVertexBuffer9: Cannot be used with `Flags` set to CU_D3D9_REGISTER_FLAGS_ARRAY.
- IDirect3DIndexBuffer9: Cannot be used with `Flags` set to CU_D3D9_REGISTER_FLAGS_ARRAY.
- IDirect3DSurface9: Only stand-alone objects of type IDirect3DSurface9 may be explicitly shared. In particular, individual mipmap levels and faces of cube maps may not be registered directly. To access individual surfaces associated with a texture, one must register the base texture object. For restrictions on the `Flags` parameter, see type IDirect3DBaseTexture9.
- IDirect3DBaseTexture9: When a texture is registered, all surfaces associated with the all mipmap levels of all faces of the texture will be accessible to CUDA.

The `Flags` argument specifies the mechanism through which CUDA will access the Direct3D resource. The following values are allowed.

- CU_D3D9_REGISTER_FLAGS_NONE: Specifies that CUDA will access this resource through a CUdeviceptr. The pointer, size, and (for textures), pitch for each subresource of this allocation may be queried through cuD3D9ResourceGetMappedPointer(), cuD3D9ResourceGetMappedSize(), and cuD3D9ResourceGetMappedPitch() respectively. This option is valid for all resource types.
- CU_D3D9_REGISTER_FLAGS_ARRAY: Specifies that CUDA will access this resource through a CUarray queried on a sub-resource basis through cuD3D9ResourceGetMappedArray(). This option is only valid for resources of type IDirect3DSurface9 and subtypes of IDirect3DBaseTexture9.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- The primary rendertarget may not be registered with CUDA.
- Resources allocated as shared may not be registered with CUDA.
- Any resources allocated in D3DPOOL_SYSTEMMEM or D3DPOOL_MANAGED may not be registered with CUDA.
- Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- Surfaces of depth or stencil formats cannot be shared.

If Direct3D interoperability is not initialized on this context, then CUDA_ERROR_INVALID_CONTEXT is returned. If `pResource` is of incorrect type (e.g. is a non-stand-alone IDirect3DSurface9) or is already registered, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` cannot be registered then CUDA_ERROR_UNKNOWN is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsD3D9RegisterResource

## CUresult cuD3D9ResourceGetMappedArray (CUarray *pArray, IDirect3DResource9 *pResource, unsigned int Face, unsigned int Level)

Get an array through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

**pArray**
- Returned array corresponding to subresource

**pResource**
- Mapped resource to access

**Face**
- Face of resource to access

**Level**
- Level of resource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pArray` an array through which the subresource of the mapped Direct3D resource `pResource` which corresponds to `Face` and `Level` may be accessed. The value set in `pArray` may change every time that `pResource` is mapped.

If `pResource` is not registered then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` was not registered with usage flags CU_D3D9_REGISTER_FLAGS_ARRAY then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped then CUDA_ERROR_NOT_MAPPED is returned.

For usage requirements of `Face` and `Level` parameters, see cuD3D9ResourceGetMappedPointer().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsSubResourceGetMappedArray

## CUresult cuD3D9ResourceGetMappedPitch (size_t *pPitch, size_t *pPitchSlice, IDirect3DResource9 *pResource, unsigned int Face, unsigned int Level)

Get the pitch of a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

**pPitch**
- Returned pitch of subresource

**pPitchSlice**
- Returned Z-slice pitch of subresource

**pResource**
- Mapped resource to access

**Face**
- Face of resource to access

**Level**
- Level of resource to access

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

## Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pPitch` and `*pPitchSlice` the pitch and Z-slice pitch of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `Face` and `Level`. The values set in `pPitch` and `pPitchSlice` may change every time that `pResource` is mapped.

The pitch and Z-slice pitch values may be used to compute the location of a sample on a surface as follows.

For a 2D surface, the byte offset of the sample at position x, y from the base pointer of the surface is:

y * pitch + (bytes per pixel) * x

For a 3D surface, the byte offset of the sample at position x, y, z from the base pointer of the surface is:

z* slicePitch + y * pitch + (bytes per pixel) * x

Both parameters `pPitch` and `pPitchSlice` are optional and may be set to NULL.

If `pResource` is not of type IDirect3DBaseTexture9 or one of its sub-types or if `pResource` has not been registered for use with CUDA, then cudaErrorInvalidResourceHandle is returned. If `pResource` was not registered with usage flags CU_D3D9_REGISTER_FLAGS_NONE, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped for access by CUDA then CUDA_ERROR_NOT_MAPPED is returned.

For usage requirements of `Face` and `Level` parameters, see cuD3D9ResourceGetMappedPointer().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsSubResourceGetMappedArray

# CUresult cuD3D9ResourceGetMappedPointer (CUdeviceptr *pDevPtr, IDirect3DResource9 *pResource, unsigned int Face, unsigned int Level)

Get the pointer through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

## Parameters

**pDevPtr**
- Returned pointer corresponding to subresource

**pResource**
- Mapped resource to access

**Face**
- Face of resource to access

**Level**
- Level of resource to access

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

## Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pDevPtr` the base pointer of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `Face` and `Level`. The value set in `pDevPtr` may change every time that `pResource` is mapped.

If `pResource` is not registered, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` was not registered with usage flags CU_D3D9_REGISTER_FLAGS_NONE, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped, then CUDA_ERROR_NOT_MAPPED is returned.

If `pResource` is of type IDirect3DCubeTexture9, then `Face` must one of the values enumerated by type D3DCUBEMAP_FACES. For all other types `Face` must be 0. If `Face` is invalid, then CUDA_ERROR_INVALID_VALUE is returned.

If `pResource` is of type IDirect3DBaseTexture9, then `Level` must correspond to a valid mipmap level. At present only mipmap level 0 is supported. For all other types `Level` must be 0. If `Level` is invalid, then CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceGetMappedPointer

## CUresult cuD3D9ResourceGetMappedSize (size_t *pSize, IDirect3DResource9 *pResource, unsigned int Face, unsigned int Level)

Get the size of a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

**pSize**
- Returned size of subresource

**pResource**
- Mapped resource to access

**Face**
- Face of resource to access

**Level**
- Level of resource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pSize` the size of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `Face` and `Level`. The value set in `pSize` may change every time that `pResource` is mapped.

If `pResource` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` was not registered with usage flags CU_D3D9_REGISTER_FLAGS_NONE, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped for access by CUDA, then CUDA_ERROR_NOT_MAPPED is returned.

For usage requirements of `Face` and `Level` parameters, see cuD3D9ResourceGetMappedPointer.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceGetMappedPointer

## CUresult cuD3D9ResourceGetSurfaceDimensions (size_t *pWidth, size_t *pHeight, size_t *pDepth, IDirect3DResource9 *pResource, unsigned int Face, unsigned int Level)

Get the dimensions of a registered surface.

### Parameters

**pWidth**
- Returned width of surface

**pHeight**
- Returned height of surface

**pDepth**
- Returned depth of surface

**pResource**
- Registered resource to access

**Face**
- Face of resource to access

**Level**
- Level of resource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Deprecated This function is deprecated as of CUDA 3.0.

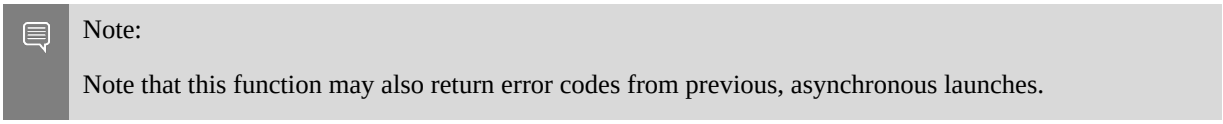
Returns in `*pWidth`, `*pHeight`, and `*pDepth` the dimensions of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `Face` and `Level`.

Because anti-aliased surfaces may have multiple samples per pixel, it is possible that the dimensions of a resource will be an integer factor larger than the dimensions reported by the Direct3D runtime.

The parameters `pWidth`, `pHeight`, and `pDepth` are optional. For 2D surfaces, the value returned in `*pDepth` will be 0.

If `pResource` is not of type IDirect3DBaseTexture9 or IDirect3DSurface9 or if `pResource` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned.

For usage requirements of `Face` and `Level` parameters, see cuD3D9ResourceGetMappedPointer().


Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsSubResourceGetMappedArray

## CUresult cuD3D9ResourceSetMapFlags (IDirect3DResource9 *pResource, unsigned int Flags)

Set usage flags for mapping a Direct3D resource.

### Parameters

**pResource**

- Registered resource to set flags for

**Flags**

- Parameters for resource mapping

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED

### Description

Deprecated This function is deprecated as of Cuda 3.0.

Set `Flags` for mapping the Direct3D resource `pResource`.

Changes to `Flags` will take effect the next time `pResource` is mapped. The `Flags` argument may be any of the following:

- CU_D3D9_MAPRESOURCE_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA kernels. This is the default value.
- CU_D3D9_MAPRESOURCE_FLAGS_READONLY: Specifies that CUDA kernels which access this resource will not write to this resource.
- CU_D3D9_MAPRESOURCE_FLAGS_WRITEDISCARD: Specifies that CUDA kernels which access this resource will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

If `pResource` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is presently mapped for access by CUDA, then CUDA_ERROR_ALREADY_MAPPED is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceSetMapFlags

## CUresult cuD3D9UnmapResources (unsigned int count, IDirect3DResource9 **ppResource)

Unmaps Direct3D resources.

### Parameters

**count**

- Number of resources to unmap for CUDA

**ppResource**

- Resources to unmap for CUDA

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED, CUDA_ERROR_UNKNOWN

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Unmaps the `count` Direct3D resources in `ppResource`.

This function provides the synchronization guarantee that any CUDA kernels issued before cuD3D9UnmapResources() will complete before any Direct3D calls issued after cuD3D9UnmapResources() begin.

If any of `ppResource` have not been registered for use with CUDA or if `ppResource` contains any duplicate entries, then CUDA_ERROR_INVALID_HANDLE is returned. If any of `ppResource` are not presently mapped for access by CUDA, then CUDA_ERROR_NOT_MAPPED is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnmapResources

### CUresult cuD3D9UnregisterResource (IDirect3DResource9 *pResource)

Unregister a Direct3D resource.

#### Parameters

**pResource**
- Resource to unregister

#### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_UNKNOWN

#### Description

Deprecated This function is deprecated as of CUDA 3.0.

Unregisters the Direct3D resource `pResource` so it is not accessible by CUDA unless registered again.

If `pResource` is not registered, then CUDA_ERROR_INVALID_HANDLE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnregisterResource

## 6.43. Direct3D 10 Interoperability

This section describes the Direct3D 10 interoperability functions of the low-level CUDA driver application programming interface. Note that mapping of Direct3D 10 resources is performed with the graphics API agnostic, resource mapping interface described in Graphics Interoperability.

### Direct3D 10 Interoperability [DEPRECATED]

### enum CUd3d10DeviceList

CUDA devices corresponding to a D3D10 device

### Values

**CU_D3D10_DEVICE_LIST_ALL = 0x01**
The CUDA devices for all GPUs used by a D3D10 device

**CU_D3D10_DEVICE_LIST_CURRENT_FRAME = 0x02**
The CUDA devices for the GPUs used by a D3D10 device in its currently rendering frame

**CU_D3D10_DEVICE_LIST_NEXT_FRAME = 0x03**
The CUDA devices for the GPUs to be used by a D3D10 device in the next frame

## CUresult cuD3D10GetDevice (CUdevice *pCudaDevice, IDXGIAdapter *pAdapter)

Gets the CUDA device corresponding to a display adapter.

### Parameters

**pCudaDevice**
- Returned CUDA device corresponding to `pAdapter`

**pAdapter**
- Adapter to query for CUDA device

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_UNKNOWN

### Description

Returns in `*pCudaDevice` the CUDA-compatible device corresponding to the adapter `pAdapter` obtained from IDXGIFactory::EnumAdapters.

If no device on `pAdapter` is CUDA-compatible then the call will fail.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D10GetDevices, cudaD3D10GetDevice

# CUresult cuD3D10GetDevices (unsigned int *pCudaDeviceCount, CUdevice *pCudaDevices, unsigned int cudaDeviceCount, ID3D10Device *pD3D10Device, CUd3d10DeviceList deviceList)

Gets the CUDA devices corresponding to a Direct3D 10 device.

## Parameters

**pCudaDeviceCount**
- Returned number of CUDA devices corresponding to `pD3D10Device`

**pCudaDevices**
- Returned CUDA devices corresponding to `pD3D10Device`

**cudaDeviceCount**
- The size of the output device array `pCudaDevices`

**pD3D10Device**
- Direct3D 10 device to query for CUDA devices

**deviceList**
- The set of devices to return. This set may be CU_D3D10_DEVICE_LIST_ALL for all devices, CU_D3D10_DEVICE_LIST_CURRENT_FRAME for the devices used to render the current frame (in SLI), or CU_D3D10_DEVICE_LIST_NEXT_FRAME for the devices used to render the next frame (in SLI).

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NO_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_UNKNOWN

## Description

Returns in `*pCudaDeviceCount` the number of CUDA-compatible device corresponding to the Direct3D 10 device `pD3D10Device`. Also returns in `*pCudaDevices` at most `cudaDeviceCount` of the CUDA-compatible devices corresponding to the Direct3D 10 device `pD3D10Device`.

If any of the GPUs being used to render `pDevice` are not CUDA capable then the call will return CUDA_ERROR_NO_DEVICE.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D10GetDevice, cudaD3D10GetDevices

# CUresult cuGraphicsD3D10RegisterResource (CUgraphicsResource *pCudaResource, ID3D10Resource *pD3DResource, unsigned int Flags)

Register a Direct3D 10 resource for access by CUDA.

## Parameters

**pCudaResource**
- Returned graphics resource handle

**pD3DResource**
- Direct3D resource to register

**Flags**
- Parameters for resource registration

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Registers the Direct3D 10 resource `pD3DResource` for access by CUDA and returns a CUDA handle to `pD3Dresource` in `pCudaResource`. The handle returned in `pCudaResource` may be used to map and unmap this resource until it is unregistered. On success this call will increase the internal reference count on `pD3DResource`. This reference count will be decremented when this resource is unregistered through cuGraphicsUnregisterResource().

This call is potentially high-overhead and should not be called every frame in interactive applications.

The type of `pD3DResource` must be one of the following.

- ID3D10Buffer: may be accessed through a device pointer.
- ID3D10Texture1D: individual subresources of the texture may be accessed via arrays
- ID3D10Texture2D: individual subresources of the texture may be accessed via arrays
- ID3D10Texture3D: individual subresources of the texture may be accessed via arrays

The `Flags` argument may be used to specify additional parameters at register time. The valid values for this parameter are

- CU_GRAPHICS_REGISTER_FLAGS_NONE: Specifies no hints about how this resource will be used.

- CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST: Specifies that CUDA will bind this resource to a surface reference.
- CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER: Specifies that CUDA will perform texture gather operations on this resource.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- The primary rendertarget may not be registered with CUDA.
- Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- Surfaces of depth or stencil formats cannot be shared.

A complete list of supported DXGI formats is as follows. For compactness the notation A_{B,C,D} represents A_B, A_C, and A_D.

- DXGI_FORMAT_A8_UNORM
- DXGI_FORMAT_B8G8R8A8_UNORM
- DXGI_FORMAT_B8G8R8X8_UNORM
- DXGI_FORMAT_R16_FLOAT
- DXGI_FORMAT_R16G16B16A16_{FLOAT,SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R16G16_{FLOAT,SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R16_{SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R32_FLOAT
- DXGI_FORMAT_R32G32B32A32_{FLOAT,SINT,UINT}
- DXGI_FORMAT_R32G32_{FLOAT,SINT,UINT}
- DXGI_FORMAT_R32_{SINT,UINT}
- DXGI_FORMAT_R8G8B8A8_{SINT,SNORM,UINT,UNORM,UNORM_SRGB}
- DXGI_FORMAT_R8G8_{SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R8_{SINT,SNORM,UINT,UNORM}

If `pD3DResource` is of incorrect type or is already registered then CUDA_ERROR_INVALID_HANDLE is returned. If `pD3DResource` cannot be registered then CUDA_ERROR_UNKNOWN is returned. If `Flags` is not one of the above specified value then CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnregisterResource, cuGraphicsMapResources, cuGraphicsSubResourceGetMappedArray, cuGraphicsResourceGetMappedPointer, cudaGraphicsD3D10RegisterResource

## 6.43.1. Direct3D 10 Interoperability [DEPRECATED]

Direct3D 10 Interoperability

This section describes deprecated Direct3D 10 interoperability functionality.

### enum CUD3D10map_flags

Flags to map or unmap a resource

#### Values

**CU_D3D10_MAPRESOURCE_FLAGS_NONE = 0x00**
**CU_D3D10_MAPRESOURCE_FLAGS_READONLY = 0x01**
**CU_D3D10_MAPRESOURCE_FLAGS_WRITEDISCARD = 0x02**

### enum CUD3D10register_flags

Flags to register a resource

#### Values

**CU_D3D10_REGISTER_FLAGS_NONE = 0x00**
**CU_D3D10_REGISTER_FLAGS_ARRAY = 0x01**

### CUresult cuD3D10CtxCreate (CUcontext *pCtx, CUdevice *pCudaDevice, unsigned int Flags, ID3D10Device *pD3DDevice)

Create a CUDA context for interoperability with Direct3D 10.

#### Parameters

**pCtx**
- Returned newly created CUDA context

**pCudaDevice**
- Returned pointer to the device on which the context was created

**Flags**
- Context creation flags (see cuCtxCreate() for details)

**pD3DDevice**
- Direct3D device to create interoperability context with

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

### Description

Deprecated This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA context with a D3D10 device in order to achieve maximum interoperability performance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D10GetDevice, cuGraphicsD3D10RegisterResource

## CUresult cuD3D10CtxCreateOnDevice (CUcontext *pCtx, unsigned int flags, ID3D10Device *pD3DDevice, CUdevice cudaDevice)

Create a CUDA context for interoperability with Direct3D 10.

### Parameters

**pCtx**

- Returned newly created CUDA context

**flags**

- Context creation flags (see cuCtxCreate() for details)

**pD3DDevice**

- Direct3D device to create interoperability context with

**cudaDevice**

- The CUDA device on which to create the context. This device must be among the devices returned when querying CU_D3D10_DEVICES_ALL from cuD3D10GetDevices.

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

### Description

Deprecated This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA context with a D3D10 device in order to achieve maximum interoperability performance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D10GetDevices, cuGraphicsD3D10RegisterResource

## CUresult cuD3D10GetDirect3DDevice (ID3D10Device **ppD3DDevice)

Get the Direct3D 10 device against which the current CUDA context was created.

### Parameters

**ppD3DDevice**
- Returned Direct3D device corresponding to CUDA context

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT

### Description

Deprecated This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA context with a D3D10 device in order to achieve maximum interoperability performance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D10GetDevice

# CUresult cuD3D10MapResources (unsigned int count, ID3D10Resource **ppResources)

Map Direct3D resources for access by CUDA.

## Parameters

**count**

- Number of resources to map for CUDA

**ppResources**

- Resources to map for CUDA

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_UNKNOWN

## Description

Deprecated This function is deprecated as of CUDA 3.0.

Maps the `count` Direct3D resources in `ppResources` for access by CUDA.

The resources in `ppResources` may be accessed in CUDA kernels until they are unmapped. Direct3D should not access any resources while they are mapped by CUDA. If an application does so, the results are undefined.

This function provides the synchronization guarantee that any Direct3D calls issued before cuD3D10MapResources() will complete before any CUDA kernels issued after cuD3D10MapResources() begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries, then CUDA_ERROR_INVALID_HANDLE is returned. If any of `ppResources` are presently mapped for access by CUDA, then CUDA_ERROR_ALREADY_MAPPED is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsMapResources

# CUresult cuD3D10RegisterResource (ID3D10Resource *pResource, unsigned int Flags)

Register a Direct3D resource for access by CUDA.

## Parameters

**pResource**
- Resource to register

**Flags**
- Parameters for resource registration

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Deprecated This function is deprecated as of CUDA 3.0.

Registers the Direct3D resource `pResource` for access by CUDA.

If this call is successful, then the application will be able to map and unmap this resource until it is unregistered through cuD3D10UnregisterResource(). Also on success, this call will increase the internal reference count on `pResource`. This reference count will be decremented when this resource is unregistered through cuD3D10UnregisterResource().

This call is potentially high-overhead and should not be called every frame in interactive applications.

The type of `pResource` must be one of the following.

- ID3D10Buffer: Cannot be used with `Flags` set to CU_D3D10_REGISTER_FLAGS_ARRAY.
- ID3D10Texture1D: No restrictions.
- ID3D10Texture2D: No restrictions.
- ID3D10Texture3D: No restrictions.

The `Flags` argument specifies the mechanism through which CUDA will access the Direct3D resource. The following values are allowed.

- CU_D3D10_REGISTER_FLAGS_NONE: Specifies that CUDA will access this resource through a CUdeviceptr. The pointer, size, and (for textures), pitch for each subresource of this allocation may be queried through cuD3D10ResourceGetMappedPointer(), cuD3D10ResourceGetMappedSize(), and cuD3D10ResourceGetMappedPitch() respectively. This option is valid for all resource types.
- CU_D3D10_REGISTER_FLAGS_ARRAY: Specifies that CUDA will access this resource through a CUarray queried on a sub-resource basis through cuD3D10ResourceGetMappedArray().

This option is only valid for resources of type ID3D10Texture1D, ID3D10Texture2D, and ID3D10Texture3D.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- The primary rendertarget may not be registered with CUDA.
- Resources allocated as shared may not be registered with CUDA.
- Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- Surfaces of depth or stencil formats cannot be shared.

If Direct3D interoperability is not initialized on this context then CUDA_ERROR_INVALID_CONTEXT is returned. If `pResource` is of incorrect type or is already registered, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` cannot be registered, then CUDA_ERROR_UNKNOWN is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsD3D10RegisterResource

## CUresult cuD3D10ResourceGetMappedArray (CUarray *pArray, ID3D10Resource *pResource, unsigned int SubResource)

Get an array through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

**pArray**
- Returned array corresponding to subresource

**pResource**
- Mapped resource to access

**SubResource**
- Subresource of pResource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pArray` an array through which the subresource of the mapped Direct3D resource `pResource`, which corresponds to `SubResource` may be accessed. The value set in `pArray` may change every time that `pResource` is mapped.

If `pResource` is not registered, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` was not registered with usage flags CU_D3D10_REGISTER_FLAGS_ARRAY, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped, then CUDA_ERROR_NOT_MAPPED is returned.

For usage requirements of the `SubResource` parameter, see cuD3D10ResourceGetMappedPointer().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsSubResourceGetMappedArray

## CUresult cuD3D10ResourceGetMappedPitch (size_t *pPitch, size_t *pPitchSlice, ID3D10Resource *pResource, unsigned int SubResource)

Get the pitch of a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

**pPitch**
- Returned pitch of subresource

**pPitchSlice**
- Returned Z-slice pitch of subresource

**pResource**
- Mapped resource to access

**SubResource**
- Subresource of pResource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

## Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pPitch` and `*pPitchSlice` the pitch and Z-slice pitch of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `SubResource`. The values set in `pPitch` and `pPitchSlice` may change every time that `pResource` is mapped.

The pitch and Z-slice pitch values may be used to compute the location of a sample on a surface as follows.

For a 2D surface, the byte offset of the sample at position x, y from the base pointer of the surface is:

y * pitch + (bytes per pixel) * x

For a 3D surface, the byte offset of the sample at position x, y, z from the base pointer of the surface is:

z* slicePitch + y * pitch + (bytes per pixel) * x

Both parameters `pPitch` and `pPitchSlice` are optional and may be set to NULL.

If `pResource` is not of type IDirect3DBaseTexture10 or one of its sub-types or if `pResource` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` was not registered with usage flags CU_D3D10_REGISTER_FLAGS_NONE, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped for access by CUDA, then CUDA_ERROR_NOT_MAPPED is returned.

For usage requirements of the `SubResource` parameter, see cuD3D10ResourceGetMappedPointer().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsSubResourceGetMappedArray

# CUresult cuD3D10ResourceGetMappedPointer (CUdeviceptr *pDevPtr, ID3D10Resource *pResource, unsigned int SubResource)

Get a pointer through which to access a subresource of a Direct3D resource which has been mapped for access by CUDA.

## Parameters

**pDevPtr**

- Returned pointer corresponding to subresource

**pResource**
- Mapped resource to access

**SubResource**
- Subresource of pResource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pDevPtr` the base pointer of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `SubResource`. The value set in `pDevPtr` may change every time that `pResource` is mapped.

If `pResource` is not registered, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` was not registered with usage flags CU_D3D10_REGISTER_FLAGS_NONE, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped, then CUDA_ERROR_NOT_MAPPED is returned.

If `pResource` is of type ID3D10Buffer, then `SubResource` must be 0. If `pResource` is of any other type, then the value of `SubResource` must come from the subresource calculation in D3D10CalcSubResource().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceGetMappedPointer

## CUresult cuD3D10ResourceGetMappedSize (size_t *pSize, ID3D10Resource *pResource, unsigned int SubResource)

Get the size of a subresource of a Direct3D resource which has been mapped for access by CUDA.

### Parameters

**pSize**
- Returned size of subresource

**pResource**
- Mapped resource to access

**SubResource**
- Subresource of pResource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pSize` the size of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `SubResource`. The value set in `pSize` may change every time that `pResource` is mapped.

If `pResource` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` was not registered with usage flags CU_D3D10_REGISTER_FLAGS_NONE, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is not mapped for access by CUDA, then CUDA_ERROR_NOT_MAPPED is returned.

For usage requirements of the `SubResource` parameter, see cuD3D10ResourceGetMappedPointer().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceGetMappedPointer

## CUresult cuD3D10ResourceGetSurfaceDimensions (size_t *pWidth, size_t *pHeight, size_t *pDepth, ID3D10Resource *pResource, unsigned int SubResource)

Get the dimensions of a registered surface.

### Parameters

**pWidth**
- Returned width of surface

**pHeight**
- Returned height of surface

**pDepth**
- Returned depth of surface

**pResource**
- Registered resource to access

**SubResource**
- Subresource of pResource to access

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Returns in `*pWidth`, `*pHeight`, and `*pDepth` the dimensions of the subresource of the mapped Direct3D resource `pResource`, which corresponds to `SubResource`.

Because anti-aliased surfaces may have multiple samples per pixel, it is possible that the dimensions of a resource will be an integer factor larger than the dimensions reported by the Direct3D runtime.

The parameters `pWidth`, `pHeight`, and `pDepth` are optional. For 2D surfaces, the value returned in `*pDepth` will be 0.

If `pResource` is not of type IDirect3DBaseTexture10 or IDirect3DSurface10 or if `pResource` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned.

For usage requirements of the `SubResource` parameter, see cuD3D10ResourceGetMappedPointer().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsSubResourceGetMappedArray

## CUresult cuD3D10ResourceSetMapFlags (ID3D10Resource *pResource, unsigned int Flags)

Set usage flags for mapping a Direct3D resource.

### Parameters

**pResource**
- Registered resource to set flags for

**Flags**
- Parameters for resource mapping

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Set flags for mapping the Direct3D resource `pResource`.

Changes to flags will take effect the next time `pResource` is mapped. The `Flags` argument may be any of the following.

- CU_D3D10_MAPRESOURCE_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA kernels. This is the default value.
- CU_D3D10_MAPRESOURCE_FLAGS_READONLY: Specifies that CUDA kernels which access this resource will not write to this resource.
- CU_D3D10_MAPRESOURCE_FLAGS_WRITEDISCARD: Specifies that CUDA kernels which access this resource will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

If `pResource` has not been registered for use with CUDA, then CUDA_ERROR_INVALID_HANDLE is returned. If `pResource` is presently mapped for access by CUDA then CUDA_ERROR_ALREADY_MAPPED is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsResourceSetMapFlags

## CUresult cuD3D10UnmapResources (unsigned int count, ID3D10Resource **ppResources)

Unmap Direct3D resources.

### Parameters

**count**

- Number of resources to unmap for CUDA

**ppResources**

- Resources to unmap for CUDA

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED, CUDA_ERROR_UNKNOWN

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Unmaps the `count` Direct3D resources in `ppResources`.

This function provides the synchronization guarantee that any CUDA kernels issued before cuD3D10UnmapResources() will complete before any Direct3D calls issued after cuD3D10UnmapResources() begin.

If any of `ppResources` have not been registered for use with CUDA or if `ppResources` contains any duplicate entries, then CUDA_ERROR_INVALID_HANDLE is returned. If any of `ppResources` are not presently mapped for access by CUDA, then CUDA_ERROR_NOT_MAPPED is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnmapResources

## CUresult cuD3D10UnregisterResource (ID3D10Resource *pResource)

Unregister a Direct3D resource.

### Parameters

**pResource**

- Resources to unregister

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_UNKNOWN

### Description

Deprecated This function is deprecated as of CUDA 3.0.

Unregisters the Direct3D resource `pResource` so it is not accessible by CUDA unless registered again.

If `pResource` is not registered, then CUDA_ERROR_INVALID_HANDLE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnregisterResource

## 6.44. Direct3D 11 Interoperability

This section describes the Direct3D 11 interoperability functions of the low-level CUDA driver application programming interface. Note that mapping of Direct3D 11 resources is performed with the graphics API agnostic, resource mapping interface described in Graphics Interoperability.

### Direct3D 11 Interoperability [DEPRECATED]

### enum CUd3d11DeviceList

CUDA devices corresponding to a D3D11 device

#### Values

**CU_D3D11_DEVICE_LIST_ALL = 0x01**
The CUDA devices for all GPUs used by a D3D11 device

**CU_D3D11_DEVICE_LIST_CURRENT_FRAME = 0x02**
The CUDA devices for the GPUs used by a D3D11 device in its currently rendering frame

**CU_D3D11_DEVICE_LIST_NEXT_FRAME = 0x03**
The CUDA devices for the GPUs to be used by a D3D11 device in the next frame

# CUresult cuD3D11GetDevice (CUdevice *pCudaDevice, IDXGIAdapter *pAdapter)

Gets the CUDA device corresponding to a display adapter.

## Parameters

**pCudaDevice**
- Returned CUDA device corresponding to `pAdapter`

**pAdapter**
- Adapter to query for CUDA device

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NO_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_UNKNOWN

## Description

Returns in `*pCudaDevice` the CUDA-compatible device corresponding to the adapter `pAdapter` obtained from IDXGIFactory::EnumAdapters.

If no device on `pAdapter` is CUDA-compatible the call will return CUDA_ERROR_NO_DEVICE.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D11GetDevices, cudaD3D11GetDevice

# CUresult cuD3D11GetDevices (unsigned int *pCudaDeviceCount, CUdevice *pCudaDevices, unsigned int cudaDeviceCount, ID3D11Device *pD3D11Device, CUd3d11DeviceList deviceList)

Gets the CUDA devices corresponding to a Direct3D 11 device.

## Parameters

**pCudaDeviceCount**
- Returned number of CUDA devices corresponding to `pD3D11Device`

**pCudaDevices**
- Returned CUDA devices corresponding to `pD3D11Device`

**cudaDeviceCount**
- The size of the output device array `pCudaDevices`

**pD3D11Device**
- Direct3D 11 device to query for CUDA devices

**deviceList**
- The set of devices to return. This set may be CU_D3D11_DEVICE_LIST_ALL for all devices, CU_D3D11_DEVICE_LIST_CURRENT_FRAME for the devices used to render the current frame (in SLI), or CU_D3D11_DEVICE_LIST_NEXT_FRAME for the devices used to render the next frame (in SLI).

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_NO_DEVICE, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_NOT_FOUND, CUDA_ERROR_UNKNOWN

## Description

Returns in `*pCudaDeviceCount` the number of CUDA-compatible device corresponding to the Direct3D 11 device `pD3D11Device`. Also returns in `*pCudaDevices` at most `cudaDeviceCount` of the CUDA-compatible devices corresponding to the Direct3D 11 device `pD3D11Device`.

If any of the GPUs being used to render `pDevice` are not CUDA capable then the call will return CUDA_ERROR_NO_DEVICE.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D11GetDevice, cudaD3D11GetDevices

# CUresult cuGraphicsD3D11RegisterResource (CUgraphicsResource *pCudaResource, ID3D11Resource *pD3DResource, unsigned int Flags)

Register a Direct3D 11 resource for access by CUDA.

## Parameters

**pCudaResource**
- Returned graphics resource handle

**pD3DResource**
- Direct3D resource to register

**Flags**
- Parameters for resource registration

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Registers the Direct3D 11 resource `pD3DResource` for access by CUDA and returns a CUDA handle to `pD3Dresource` in `pCudaResource`. The handle returned in `pCudaResource` may be used to map and unmap this resource until it is unregistered. On success this call will increase the internal reference count on `pD3DResource`. This reference count will be decremented when this resource is unregistered through cuGraphicsUnregisterResource().

This call is potentially high-overhead and should not be called every frame in interactive applications.

The type of `pD3DResource` must be one of the following.

- ID3D11Buffer: may be accessed through a device pointer.
- ID3D11Texture1D: individual subresources of the texture may be accessed via arrays
- ID3D11Texture2D: individual subresources of the texture may be accessed via arrays
- ID3D11Texture3D: individual subresources of the texture may be accessed via arrays

The `Flags` argument may be used to specify additional parameters at register time. The valid values for this parameter are

- CU_GRAPHICS_REGISTER_FLAGS_NONE: Specifies no hints about how this resource will be used.
- CU_GRAPHICS_REGISTER_FLAGS_SURFACE_LDST: Specifies that CUDA will bind this resource to a surface reference.

- CU_GRAPHICS_REGISTER_FLAGS_TEXTURE_GATHER: Specifies that CUDA will perform texture gather operations on this resource.

Not all Direct3D resources of the above types may be used for interoperability with CUDA. The following are some limitations.

- The primary rendertarget may not be registered with CUDA.
- Textures which are not of a format which is 1, 2, or 4 channels of 8, 16, or 32-bit integer or floating-point data cannot be shared.
- Surfaces of depth or stencil formats cannot be shared.

A complete list of supported DXGI formats is as follows. For compactness the notation A_{B,C,D} represents A_B, A_C, and A_D.

- DXGI_FORMAT_A8_UNORM
- DXGI_FORMAT_B8G8R8A8_UNORM
- DXGI_FORMAT_B8G8R8X8_UNORM
- DXGI_FORMAT_R16_FLOAT
- DXGI_FORMAT_R16G16B16A16_{FLOAT,SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R16G16_{FLOAT,SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R16_{SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R32_FLOAT
- DXGI_FORMAT_R32G32B32A32_{FLOAT,SINT,UINT}
- DXGI_FORMAT_R32G32_{FLOAT,SINT,UINT}
- DXGI_FORMAT_R32_{SINT,UINT}
- DXGI_FORMAT_R8G8B8A8_{SINT,SNORM,UINT,UNORM,UNORM_SRGB}
- DXGI_FORMAT_R8G8_{SINT,SNORM,UINT,UNORM}
- DXGI_FORMAT_R8_{SINT,SNORM,UINT,UNORM}

If `pD3DResource` is of incorrect type or is already registered then CUDA_ERROR_INVALID_HANDLE is returned. If `pD3DResource` cannot be registered then CUDA_ERROR_UNKNOWN is returned. If `Flags` is not one of the above specified value then CUDA_ERROR_INVALID_VALUE is returned.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuGraphicsUnregisterResource, cuGraphicsMapResources, cuGraphicsSubResourceGetMappedArray, cuGraphicsResourceGetMappedPointer, cudaGraphicsD3D11RegisterResource

## 6.44.1. Direct3D 11 Interoperability [DEPRECATED]

Direct3D 11 Interoperability

This section describes deprecated Direct3D 11 interoperability functionality.

## CUresult cuD3D11CtxCreate (CUcontext *pCtx, CUdevice *pCudaDevice, unsigned int Flags, ID3D11Device *pD3DDevice)

Create a CUDA context for interoperability with Direct3D 11.

### Parameters

**pCtx**
- Returned newly created CUDA context

**pCudaDevice**
- Returned pointer to the device on which the context was created

**Flags**
- Context creation flags (see cuCtxCreate() for details)

**pD3DDevice**
- Direct3D device to create interoperability context with

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

### Description

Deprecated This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA context with a D3D11 device in order to achieve maximum interoperability performance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D11GetDevice, cuGraphicsD3D11RegisterResource

# CUresult cuD3D11CtxCreateOnDevice (CUcontext *pCtx, unsigned int flags, ID3D11Device *pD3DDevice, CUdevice cudaDevice)

Create a CUDA context for interoperability with Direct3D 11.

## Parameters

**pCtx**
- Returned newly created CUDA context

**flags**
- Context creation flags (see cuCtxCreate() for details)

**pD3DDevice**
- Direct3D device to create interoperability context with

**cudaDevice**
- The CUDA device on which to create the context. This device must be among the devices returned when querying CU_D3D11_DEVICES_ALL from cuD3D11GetDevices.

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY, CUDA_ERROR_UNKNOWN

## Description

Deprecated This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA context with a D3D11 device in order to achieve maximum interoperability performance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D11GetDevices, cuGraphicsD3D11RegisterResource

## CUresult cuD3D11GetDirect3DDevice (ID3D11Device **ppD3DDevice)

Get the Direct3D 11 device against which the current CUDA context was created.

### Parameters

**ppD3DDevice**
- Returned Direct3D device corresponding to CUDA context

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT

### Description

Deprecated This function is deprecated as of CUDA 5.0.

This function is deprecated and should no longer be used. It is no longer necessary to associate a CUDA context with a D3D11 device in order to achieve maximum interoperability performance.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuD3D11GetDevice

# 6.45. VDPAU Interoperability

This section describes the VDPAU interoperability functions of the low-level CUDA driver application programming interface.

## CUresult cuGraphicsVDPAURegisterOutputSurface (CUgraphicsResource *pCudaResource, VdpOutputSurface vdpSurface, unsigned int flags)

Registers a VDPAU VdpOutputSurface object.

### Parameters

**pCudaResource**
- Pointer to the returned object handle

**vdpSurface**
- The VdpOutputSurface to be registered

**flags**
- Map flags

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_INVALID_CONTEXT,

## Description

Registers the VdpOutputSurface specified by `vdpSurface` for access by CUDA. A handle to the registered object is returned as `pCudaResource`. The surface's intended usage is specified using `flags`, as follows:

- CU_GRAPHICS_MAP_RESOURCE_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_READ_ONLY: Specifies that CUDA will not write to this resource.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_WRITE_DISCARD: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

The VdpOutputSurface is presented as an array of subresources that may be accessed using pointers returned by cuGraphicsSubResourceGetMappedArray. The exact number of valid `arrayIndex` values depends on the VDPAU surface format. The mapping is shown in the table below. `mipLevel` must be 0.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxCreate, cuVDPAUCtxCreate, cuGraphicsVDPAURegisterVideoSurface, cuGraphicsUnregisterResource, cuGraphicsResourceSetMapFlags, cuGraphicsMapResources, cuGraphicsUnmapResources, cuGraphicsSubResourceGetMappedArray, cuVDPAUGetDevice, cudaGraphicsVDPAURegisterOutputSurface

# CUresult cuGraphicsVDPAURegisterVideoSurface (CUgraphicsResource *pCudaResource, VdpVideoSurface vdpSurface, unsigned int flags)

Registers a VDPAU VdpVideoSurface object.

## Parameters

**pCudaResource**
- Pointer to the returned object handle

**vdpSurface**
- The VdpVideoSurface to be registered

**flags**
- Map flags

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_INVALID_CONTEXT,

## Description

Registers the VdpVideoSurface specified by `vdpSurface` for access by CUDA. A handle to the registered object is returned as `pCudaResource`. The surface's intended usage is specified using `flags`, as follows:

- CU_GRAPHICS_MAP_RESOURCE_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_READ_ONLY: Specifies that CUDA will not write to this resource.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_WRITE_DISCARD: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

The VdpVideoSurface is presented as an array of subresources that may be accessed using pointers returned by cuGraphicsSubResourceGetMappedArray. The exact number of valid `arrayIndex` values depends on the VDPAU surface format. The mapping is shown in the table below. `mipLevel` must be 0.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxCreate, cuVDPAUCtxCreate, cuGraphicsVDPAURegisterOutputSurface, cuGraphicsUnregisterResource, cuGraphicsResourceSetMapFlags, cuGraphicsMapResources, cuGraphicsUnmapResources, cuGraphicsSubResourceGetMappedArray, cuVDPAUGetDevice, cudaGraphicsVDPAURegisterVideoSurface

# CUresult cuVDPAUCtxCreate (CUcontext *pCtx, unsigned int flags, CUdevice device, VdpDevice vdpDevice, VdpGetProcAddress *vdpGetProcAddress)

Create a CUDA context for interoperability with VDPAU.

## Parameters

**pCtx**
- Returned CUDA context

**flags**
- Options for CUDA context creation

**device**
- Device on which to create the context

**vdpDevice**
- The VdpDevice to interop with

**vdpGetProcAddress**
- VDPAU's VdpGetProcAddress function pointer

## Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

## Description

Creates a new CUDA context, initializes VDPAU interoperability, and associates the CUDA context with the calling thread. It must be called before performing any other VDPAU interoperability operations. It may fail if the needed VDPAU driver facilities are not available. For usage of the `flags` parameter, see cuCtxCreate().

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxCreate, cuGraphicsVDPAURegisterVideoSurface, cuGraphicsVDPAURegisterOutputSurface, cuGraphicsUnregisterResource, cuGraphicsResourceSetMapFlags, cuGraphicsMapResources, cuGraphicsUnmapResources, cuGraphicsSubResourceGetMappedArray, cuVDPAUGetDevice

## CUresult cuVDPAUGetDevice (CUdevice *pDevice, VdpDevice vdpDevice, VdpGetProcAddress *vdpGetProcAddress)

Gets the CUDA device associated with a VDPAU device.

### Parameters

**pDevice**
- Device associated with vdpDevice

**vdpDevice**
- A VdpDevice handle

**vdpGetProcAddress**
- VDPAU's VdpGetProcAddress function pointer

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE

### Description

Returns in `*pDevice` the CUDA device associated with a `vdpDevice`, if applicable.

Note:

Note that this function may also return error codes from previous, asynchronous launches.

See also:

cuCtxCreate, cuVDPAUCtxCreate, cuGraphicsVDPAURegisterVideoSurface, cuGraphicsVDPAURegisterOutputSurface, cuGraphicsUnregisterResource, cuGraphicsResourceSetMapFlags, cuGraphicsMapResources, cuGraphicsUnmapResources, cuGraphicsSubResourceGetMappedArray, cudaVDPAUGetDevice

# 6.46. EGL Interoperability

This section describes the EGL interoperability functions of the low-level CUDA driver application programming interface.

# CUresult cuEGLStreamConsumerAcquireFrame (CUeglStreamConnection *conn, CUgraphicsResource *pCudaResource, CUstream *pStream, unsigned int timeout)

Acquire an image frame from the EGLStream with CUDA as a consumer.

## Parameters

**conn**
- Connection on which to acquire

**pCudaResource**
- CUDA resource on which the stream frame will be mapped for use.

**pStream**
- CUDA stream for synchronization and any data migrations implied by CUeglResourceLocationFlags.

**timeout**
- Desired timeout in usec for a new frame to be acquired. If set as CUDA_EGL_INFINITE_TIMEOUT, acquire waits infinitely. After timeout occurs CUDA consumer tries to acquire an old frame if available and EGL_SUPPORT_REUSE_NV flag is set.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_LAUNCH_TIMEOUT,

## Description

Acquire an image frame from EGLStreamKHR. This API can also acquire an old frame presented by the producer unless explicitly disabled by setting EGL_SUPPORT_REUSE_NV flag to EGL_FALSE during stream initialization. By default, EGLStream is created with this flag set to EGL_TRUE. cuGraphicsResourceGetMappedEglFrame can be called on `pCudaResource` to get CUeglFrame.

See also:

cuEGLStreamConsumerConnect, cuEGLStreamConsumerDisconnect, cuEGLStreamConsumerAcquireFrame, cuEGLStreamConsumerReleaseFrame, cudaEGLStreamConsumerAcquireFrame

# CUresult cuEGLStreamConsumerConnect (CUeglStreamConnection *conn, EGLStreamKHR stream)

Connect CUDA to EGLStream as a consumer.

## Parameters

**conn**
- Pointer to the returned connection handle

**stream**
- EGLStreamKHR handle

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_CONTEXT,

## Description

Connect CUDA as a consumer to EGLStreamKHR specified by `stream`.

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

See also:

cuEGLStreamConsumerConnect, cuEGLStreamConsumerDisconnect, cuEGLStreamConsumerAcquireFrame, cuEGLStreamConsumerReleaseFrame, cudaEGLStreamConsumerConnect

# CUresult cuEGLStreamConsumerConnectWithFlags (CUeglStreamConnection *conn, EGLStreamKHR stream, unsigned int flags)

Connect CUDA to EGLStream as a consumer with given flags.

## Parameters

**conn**
- Pointer to the returned connection handle

**stream**
- EGLStreamKHR handle

**flags**
- Flags denote intended location - system or video.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_CONTEXT,

### Description

Connect CUDA as a consumer to EGLStreamKHR specified by `stream` with specified `flags` defined by CUeglResourceLocationFlags.

The flags specify whether the consumer wants to access frames from system memory or video memory. Default is CU_EGL_RESOURCE_LOCATION_VIDMEM.

See also:

cuEGLStreamConsumerConnect, cuEGLStreamConsumerDisconnect, cuEGLStreamConsumerAcquireFrame, cuEGLStreamConsumerReleaseFrame, cudaEGLStreamConsumerConnectWithFlags

## CUresult cuEGLStreamConsumerDisconnect (CUeglStreamConnection *conn)

Disconnect CUDA as a consumer to EGLStream .

### Parameters

**conn**

- Conection to disconnect.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_CONTEXT,

### Description

Disconnect CUDA as a consumer to EGLStreamKHR.

See also:

cuEGLStreamConsumerConnect, cuEGLStreamConsumerDisconnect, cuEGLStreamConsumerAcquireFrame, cuEGLStreamConsumerReleaseFrame, cudaEGLStreamConsumerDisconnect

# CUresult cuEGLStreamConsumerReleaseFrame (CUeglStreamConnection *conn, CUgraphicsResource pCudaResource, CUstream *pStream)

Releases the last frame acquired from the EGLStream.

## Parameters

**conn**
- Connection on which to release

**pCudaResource**
- CUDA resource whose corresponding frame is to be released

**pStream**
- CUDA stream on which release will be done.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE,

## Description

Release the acquired image frame specified by `pCudaResource` to EGLStreamKHR. If EGL_SUPPORT_REUSE_NV flag is set to EGL_TRUE, at the time of EGL creation this API doesn't release the last frame acquired on the EGLStream. By default, EGLStream is created with this flag set to EGL_TRUE.

See also:

cuEGLStreamConsumerConnect, cuEGLStreamConsumerDisconnect, cuEGLStreamConsumerAcquireFrame, cuEGLStreamConsumerReleaseFrame, cudaEGLStreamConsumerReleaseFrame

# CUresult cuEGLStreamProducerConnect (CUeglStreamConnection *conn, EGLStreamKHR stream, EGLint width, EGLint height)

Connect CUDA to EGLStream as a producer.

## Parameters

**conn**
- Pointer to the returned connection handle

**stream**
- EGLStreamKHR handle

**width**
- width of the image to be submitted to the stream

**height**
- height of the image to be submitted to the stream

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_CONTEXT,

### Description

Connect CUDA as a producer to EGLStreamKHR specified by `stream`.

The EGLStreamKHR is an EGL object that transfers a sequence of image frames from one API to another.

See also:

cuEGLStreamProducerConnect, cuEGLStreamProducerDisconnect, cuEGLStreamProducerPresentFrame, cudaEGLStreamProducerConnect

## CUresult cuEGLStreamProducerDisconnect (CUeglStreamConnection *conn)

Disconnect CUDA as a producer to EGLStream .

### Parameters

**conn**
- Conection to disconnect.

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_INVALID_CONTEXT,

### Description

Disconnect CUDA as a producer to EGLStreamKHR.

See also:

cuEGLStreamProducerConnect, cuEGLStreamProducerDisconnect, cuEGLStreamProducerPresentFrame, cudaEGLStreamProducerDisconnect

# CUresult cuEGLStreamProducerPresentFrame (CUeglStreamConnection *conn, CUeglFrame eglframe, CUstream *pStream)

Present a CUDA eglFrame to the EGLStream with CUDA as a producer.

## Parameters

**conn**

- Connection on which to present the CUDA array

**eglframe**

- CUDA Eglstream Proucer Frame handle to be sent to the consumer over EglStream.

**pStream**

- CUDA stream on which to present the frame.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE,

## Description

When a frame is presented by the producer, it gets associated with the EGLStream and thus it is illegal to free the frame before the producer is disconnected. If a frame is freed and reused it may lead to undefined behavior.

If producer and consumer are on different GPUs (iGPU and dGPU) then frametype CU_EGL_FRAME_TYPE_ARRAY is not supported. CU_EGL_FRAME_TYPE_PITCH can be used for such cross-device applications.

The CUeglFrame is defined as:

```
typedef struct CUeglFrame_st {
            union {
                CUarray pArray[MAX_PLANES];
                void*   pPitch[MAX_PLANES];
            } frame;
            unsigned int width;
            unsigned int height;
            unsigned int depth;
            unsigned int pitch;
            unsigned int planeCount;
            unsigned int numChannels;
            CUeglFrameType frameType;
            CUeglColorFormat eglColorFormat;
            CUarray_format cuFormat;
        } CUeglFrame;
```

For CUeglFrame of type CU_EGL_FRAME_TYPE_PITCH, the application may present sub-region of a memory allocation. In that case, the pitched pointer will specify the start address of the sub-region in the allocation and corresponding CUeglFrame fields will specify the dimensions of the sub-region.

See also:

cuEGLStreamProducerConnect, cuEGLStreamProducerDisconnect, cuEGLStreamProducerReturnFrame, cudaEGLStreamProducerPresentFrame

# CUresult cuEGLStreamProducerReturnFrame (CUeglStreamConnection *conn, CUeglFrame *eglframe, CUstream *pStream)

Return the CUDA eglFrame to the EGLStream released by the consumer.

## Parameters

**conn**
- Connection on which to return

**eglframe**
- CUDA Eglstream Proucer Frame handle returned from the consumer over EglStream.

**pStream**
- CUDA stream on which to return the frame.

## Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_LAUNCH_TIMEOUT

## Description

This API can potentially return CUDA_ERROR_LAUNCH_TIMEOUT if the consumer has not returned a frame to EGL stream. If timeout is returned the application can retry.

See also:

cuEGLStreamProducerConnect, cuEGLStreamProducerDisconnect, cuEGLStreamProducerPresentFrame, cudaEGLStreamProducerReturnFrame

# CUresult cuEventCreateFromEGLSync (CUevent *phEvent, EGLSyncKHR eglSync, unsigned int flags)

Creates an event from EGLSync object.

## Parameters

**phEvent**
- Returns newly created event

**eglSync**
- Opaque handle to EGLSync object

**flags**
- Event creation flags

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_OUT_OF_MEMORY

### Description

Creates an event *phEvent from an EGLSyncKHR eglSync with the flags specified via `flags`. Valid flags include:

- CU_EVENT_DEFAULT: Default event creation flag.
- CU_EVENT_BLOCKING_SYNC: Specifies that the created event should use blocking synchronization. A CPU thread that uses cuEventSynchronize() to wait on an event created with this flag will block until the event has actually been completed.

Once the `eglSync` gets destroyed, cuEventDestroy is the only API that can be invoked on the event.

cuEventRecord and TimingData are not supported for events created from EGLSync.

The EGLSyncKHR is an opaque handle to an EGL sync object. typedef void* EGLSyncKHR

See also:

cuEventQuery, cuEventSynchronize, cuEventDestroy

## CUresult cuGraphicsEGLRegisterImage (CUgraphicsResource *pCudaResource, EGLImageKHR image, unsigned int flags)

Registers an EGL image.

### Parameters

**pCudaResource**
- Pointer to the returned object handle

**image**
- An EGLImageKHR image which can be used to create target resource.

**flags**
- Map flags

### Returns

CUDA_SUCCESS, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_ALREADY_MAPPED, CUDA_ERROR_INVALID_CONTEXT,

## Description

Registers the EGLImageKHR specified by `image` for access by CUDA. A handle to the registered object is returned as `pCudaResource`. Additional Mapping/Unmapping is not required for the registered resource and cuGraphicsResourceGetMappedEglFrame can be directly called on the `pCudaResource`.

The application will be responsible for synchronizing access to shared objects. The application must ensure that any pending operation which access the objects have completed before passing control to CUDA. This may be accomplished by issuing and waiting for glFinish command on all GLcontexts (for OpenGL and likewise for other APIs). The application will be also responsible for ensuring that any pending operation on the registered CUDA resource has completed prior to executing subsequent commands in other APIs accesing the same memory objects. This can be accomplished by calling cuCtxSynchronize or cuEventSynchronize (preferably).

The surface's intended usage is specified using `flags`, as follows:

- CU_GRAPHICS_MAP_RESOURCE_FLAGS_NONE: Specifies no hints about how this resource will be used. It is therefore assumed that this resource will be read from and written to by CUDA. This is the default value.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_READ_ONLY: Specifies that CUDA will not write to this resource.
- CU_GRAPHICS_MAP_RESOURCE_FLAGS_WRITE_DISCARD: Specifies that CUDA will not read from this resource and will write over the entire contents of the resource, so none of the data previously stored in the resource will be preserved.

The EGLImageKHR is an object which can be used to create EGLImage target resource. It is defined as a void pointer. typedef void* EGLImageKHR

See also:

cuGraphicsEGLRegisterImage, cuGraphicsUnregisterResource, cuGraphicsResourceSetMapFlags, cuGraphicsMapResources, cuGraphicsUnmapResources, cudaGraphicsEGLRegisterImage

# CUresult cuGraphicsResourceGetMappedEglFrame (CUeglFrame *eglFrame, CUgraphicsResource resource, unsigned int index, unsigned int mipLevel)

Get an eglFrame through which to access a registered EGL graphics resource.

## Parameters

**eglFrame**
- Returned eglFrame.

**resource**
- Registered resource to access.

**index**
- Index for cubemap surfaces.

**mipLevel**
- Mipmap level for the subresource to access.

### Returns

CUDA_SUCCESS, CUDA_ERROR_DEINITIALIZED, CUDA_ERROR_NOT_INITIALIZED, CUDA_ERROR_INVALID_CONTEXT, CUDA_ERROR_INVALID_VALUE, CUDA_ERROR_INVALID_HANDLE, CUDA_ERROR_NOT_MAPPED

### Description

Returns in `*eglFrame` an eglFrame pointer through which the registered graphics resource `resource` may be accessed. This API can only be called for registered EGL graphics resources.

The CUeglFrame is defined as:

```
typedef struct CUeglFrame_st {
          union {
              CUarray pArray[MAX_PLANES];
              void*   pPitch[MAX_PLANES];
          } frame;
          unsigned int width;
          unsigned int height;
          unsigned int depth;
          unsigned int pitch;
          unsigned int planeCount;
          unsigned int numChannels;
          CUeglFrameType frameType;
          CUeglColorFormat eglColorFormat;
          CUarray_format cuFormat;
      } CUeglFrame;
```

If `resource` is not registered then CUDA_ERROR_NOT_MAPPED is returned. *

See also:

cuGraphicsMapResources, cuGraphicsSubResourceGetMappedArray, cuGraphicsResourceGetMappedPointer, cudaGraphicsResourceGetMappedEglFrame

## 6.8. Difference between the driver and runtime APIs

The driver and runtime APIs are very similar and can for the most part be used interchangeably. However, there are some key differences worth noting between the two.

### Complexity vs. control

The runtime API eases device code management by providing implicit primary context initialization and management, and implicit module management. This leads to simpler code, but it also lacks the level of control that the driver API has.

In comparison, the driver API offers more fine-grained control, especially over module loading. Kernel launches are much more complex to implement, as the execution configuration and kernel parameters must be specified with explicit function calls. However, unlike the runtime, where all the kernels are automatically loaded during initialization and stay loaded for as long as the program runs, with the driver API it is possible to only keep the modules that are currently needed loaded, or even dynamically reload modules. The driver API is also language-independent as it only deals with cubin objects.

### Context management

Unless an execution context cudaExecutionContext_t is specified, the runtime API decides itself which context to use for a thread: if a context has been made current to the calling thread through the driver API, the runtime will use that, but if there is no such context, it uses the device execution context which is a "primary context." Primary contexts are created as needed, one per device per process, are reference-counted, and are then destroyed when there are no more references to them. Within one process, all users of the runtime API will share the primary context, unless a context has been made current to each thread or an explicit execution context is specified to the runtime APIs.

Using the runtime API with primary contexts has its tradeoffs, however. It can cause trouble for users writing plug-ins for larger software packages, for example, because if all plug-ins run in the same process, they will all share a context but will likely have no way to communicate with each other. So, if one of them calls `cudaDeviceReset()` after finishing all its CUDA work, the other plug-ins will fail because the context they were using was destroyed without their knowledge. To avoid this issue, CUDA clients can use the driver API to create and set the current context, and then use the runtime API to work with it. However, contexts may consume significant resources, such as device memory, extra host threads, and performance costs of context switching on the device. This runtime-driver context sharing is important when using the driver API in conjunction with libraries built on the runtime API, such as cuBLAS or cuFFT.

## 6.15. Difference between the driver and runtime APIs

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## Context management

Unless an execution context cudaExecutionContext_t is specified, the runtime API decides itself which context to use for a thread: if a context has been made current to the calling thread through the driver API, the runtime will use that, but if there is no such context, it uses the device execution context which is a "primary context." Primary contexts are created as needed, one per device per process, are reference-counted, and are then destroyed when there are no more references to them. Within one process, all users of the runtime API will share the primary context, unless a context has been made current to each thread or an explicit execution context is specified to the runtime APIs.

Using the runtime API with primary contexts has its tradeoffs, however. It can cause trouble for users writing plug-ins for larger software packages, for example, because if all plug-ins run in the same process, they will all share a context but will likely have no way to communicate with each other. So, if one of them calls `cudaDeviceReset()` after finishing all its CUDA work, the other plug-ins will fail because the context they were using was destroyed without their knowledge. To avoid this issue, CUDA clients can use the driver API to create and set the current context, and then use the runtime API to work with it. However, contexts may consume significant resources, such as device memory, extra host threads, and performance costs of context switching on the device. This runtime-driver context sharing is important when using the driver API in conjunction with libraries built on the runtime API, such as cuBLAS or cuFFT.

# Chapter 7. Data Structures

Here are the data structures with brief descriptions:


**CU_DEV_SM_RESOURCE_GROUP_PARAMS**
**CUaccessPolicyWindow_v1**
**CUarrayMapInfo_v1**
**CUasyncNotificationInfo**
**CUcheckpointCheckpointArgs**
**CUcheckpointGpuPair**
**CUcheckpointLockArgs**
**CUcheckpointRestoreArgs**
**CUcheckpointUnlockArgs**
**CUctxCigParam**
**CUctxCreateParams**
**CUDA_ARRAY3D_DESCRIPTOR_v2**
**CUDA_ARRAY_DESCRIPTOR_v2**
**CUDA_ARRAY_MEMORY_REQUIREMENTS_v1**
**CUDA_ARRAY_SPARSE_PROPERTIES_v1**
**CUDA_BATCH_MEM_OP_NODE_PARAMS_v1**
**CUDA_BATCH_MEM_OP_NODE_PARAMS_v2**
**CUDA_CHILD_GRAPH_NODE_PARAMS**
**CUDA_CONDITIONAL_NODE_PARAMS**
**CUDA_EVENT_RECORD_NODE_PARAMS**
**CUDA_EVENT_WAIT_NODE_PARAMS**
**CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v1**
**CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v2**
**CUDA_EXT_SEM_WAIT_NODE_PARAMS_v1**
**CUDA_EXT_SEM_WAIT_NODE_PARAMS_v2**
**CUDA_EXTERNAL_MEMORY_BUFFER_DESC_v1**
**CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1**
**CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_v1**
**CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1**
**CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1**
**CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1**
**CUDA_GRAPH_INSTANTIATE_PARAMS**

**CUDA_HOST_NODE_PARAMS_v1**
**CUDA_HOST_NODE_PARAMS_v2**
**CUDA_KERNEL_NODE_PARAMS_v1**
**CUDA_KERNEL_NODE_PARAMS_v2**
**CUDA_KERNEL_NODE_PARAMS_v3**
**CUDA_LAUNCH_PARAMS_v1**
**CUDA_MEM_ALLOC_NODE_PARAMS_v1**
**CUDA_MEM_ALLOC_NODE_PARAMS_v2**
**CUDA_MEM_FREE_NODE_PARAMS**
**CUDA_MEMCPY2D_v2**
**CUDA_MEMCPY3D_PEER_v1**
**CUDA_MEMCPY3D_v2**
**CUDA_MEMCPY_NODE_PARAMS**
**CUDA_MEMSET_NODE_PARAMS_v1**
**CUDA_MEMSET_NODE_PARAMS_v2**
**CUDA_POINTER_ATTRIBUTE_P2P_TOKENS_v1**
**CUDA_RESOURCE_DESC_v1**
**CUDA_RESOURCE_VIEW_DESC_v1**
**CUDA_TEXTURE_DESC_v1**
**CUdevprop_v1**
**CUdevResource**
**CUdevSmResource**
**CUdevWorkqueueConfigResource**
**CUdevWorkqueueResource**
**CUeglFrame_v1**
**CUexecAffinityParam_v1**
**CUexecAffinitySmCount_v1**
**CUextent3D_v1**
**CUgraphEdgeData**
**CUgraphExecUpdateResultInfo_v1**
**CUgraphNodeParams**
**CUipcEventHandle_v1**
**CUipcMemHandle_v1**
**CUlaunchAttribute**
**CUlaunchAttributeValue**
**CUlaunchConfig**
**CUlaunchMemSyncDomainMap**
**CUlogicalEndpointFabricHandle**
**CUlogicalEndpointProp**
**CUmemAccessDesc_v1**
**CUmemAllocationProp_v1**
**CUmemcpy3DOperand_v1**
**CUmemcpyAttributes_v1**

**CUmemDecompressParams**
Structure describing the parameters that compose a single decompression operation
**CUmemFabricHandle_v1**
**CUmemLocation_v1**
**CUmemPoolProps_v1**
**CUmemPoolPtrExportData_v1**
**CUmulticastObjectProp_v1**
**CUoffset3D_v1**
**CUstreamBatchMemOpParams_v1**
**CUstreamCigCaptureParams**
**CUstreamCigParam**
**CUtensorMap**

# 7.1. CU_DEV_SM_RESOURCE_GROUP_PARAMS Struct Reference

Input data for splitting SMs

## unsigned int CU_DEV_SM_RESOURCE_GROUP_PARAMS::coscheduledSmCo

The amount of co-scheduled SMs grouped together for locality purposes.

## unsigned int CU_DEV_SM_RESOURCE_GROUP_PARAMS::flags

The flags set on this SM resource group. For possible values see CUdevSmResourceGroup_flags.

## unsigned int CU_DEV_SM_RESOURCE_GROUP_PARAMS::preferredCosched

When possible, combine co-scheduled groups together into larger groups of this size.

## unsigned int CU_DEV_SM_RESOURCE_GROUP_PARAMS::smCount

The amount of SMs available in this resource.

# 7.2. CUaccessPolicyWindow_v1 Struct Reference

Specifies an access policy for a window, a contiguous extent of memory beginning at base_ptr and ending at base_ptr + num_bytes. num_bytes is limited by CU_DEVICE_ATTRIBUTE_MAX_ACCESS_POLICY_WINDOW_SIZE. Partition into many segments and assign segments such that: sum of "hit segments" / window == approx. ratio. sum of "miss segments" / window == approx 1-ratio. Segments and ratio specifications are fitted to the capabilities of the architecture. Accesses in a hit segment apply the hitProp access policy. Accesses in a miss segment apply the missProp access policy.

## void *CUaccessPolicyWindow_v1::base_ptr

Starting address of the access policy window. CUDA driver may align it.

## CUaccessProperty CUaccessPolicyWindow_v1::hitProp

CUaccessProperty set for hit.

## float CUaccessPolicyWindow_v1::hitRatio

hitRatio specifies percentage of lines assigned hitProp, rest are assigned missProp.

## CUaccessProperty CUaccessPolicyWindow_v1::missProp

CUaccessProperty set for miss. Must be either NORMAL or STREAMING

## size_t CUaccessPolicyWindow_v1::num_bytes

Size in bytes of the window policy. CUDA driver may restrict the maximum size and alignment.

# 7.3. CUarrayMapInfo_v1 Struct Reference

Specifies the CUDA array or CUDA mipmapped array memory mapping information

## unsigned int CUarrayMapInfo_v1::deviceBitMask

Device ordinal bit mask

## unsigned int CUarrayMapInfo_v1::extentDepth

Depth in elements

## unsigned int CUarrayMapInfo_v1::extentHeight

Height in elements

## unsigned int CUarrayMapInfo_v1::extentWidth

Width in elements

## unsigned int CUarrayMapInfo_v1::flags

flags for future use, must be zero now.

## unsigned int CUarrayMapInfo_v1::layer

For CUDA layered arrays must be a valid layer index. Otherwise, must be zero

## unsigned int CUarrayMapInfo_v1::level

For CUDA mipmapped arrays must a valid mipmap level. For CUDA arrays must be zero

## CUmemHandleType CUarrayMapInfo_v1::memHandleType

Memory handle type

## CUmemOperationType CUarrayMapInfo_v1::memOperationType

Memory operation type

## unsigned long long CUarrayMapInfo_v1::offset

Offset within mip tail

Offset within the memory

## unsigned int CUarrayMapInfo_v1::offsetX

Starting X offset in elements

### unsigned int CUarrayMapInfo_v1::offsetY

Starting Y offset in elements

### unsigned int CUarrayMapInfo_v1::offsetZ

Starting Z offset in elements

### unsigned int CUarrayMapInfo_v1::reserved

Reserved for future use, must be zero now.

### CUresourcetype CUarrayMapInfo_v1::resourceType

Resource type

### unsigned long long CUarrayMapInfo_v1::size

Extent in bytes

### CUarraySparseSubresourceType CUarrayMapInfo_v1::subresourceType

Sparse subresource type

## 7.4. CUasyncNotificationInfo Struct Reference

Information passed to the user via the async notification callback

### unsigned long long CUasyncNotificationInfo::bytesOverBudget

The number of bytes that the process has allocated above its device memory budget

### CUasyncNotificationInfo::@4 CUasyncNotificationInfo::info

Information about the notification. `type` must be checked in order to interpret this field.

### CUasyncNotificationInfo::@4::@5 CUasyncNotificationInfo::overBudget

Information about notifications of type `CU_ASYNC_NOTIFICATION_TYPE_OVER_BUDGET`

### CUasyncNotificationType CUasyncNotificationInfo::type

The type of notification being sent

## 7.5. CUcheckpointCheckpointArgs Struct Reference

CUDA checkpoint optional checkpoint arguments

### cuuint64_t CUcheckpointCheckpointArgs::reserved

Reserved for future use, must be zeroed

## 7.6. CUcheckpointGpuPair Struct Reference

CUDA checkpoint GPU UUID pairs for device remapping during restore

### CUuuid CUcheckpointGpuPair::newUuid

UUID of the GPU to restore onto

### CUuuid CUcheckpointGpuPair::oldUuid

UUID of the GPU that was checkpointed

## 7.7. CUcheckpointLockArgs Struct Reference

CUDA checkpoint optional lock arguments

### unsigned int CUcheckpointLockArgs::reserved0

Reserved for future use, must be zero

### cuuint64_t CUcheckpointLockArgs::reserved1

Reserved for future use, must be zeroed

### unsigned int CUcheckpointLockArgs::timeoutMs

Timeout in milliseconds to attempt to lock the process, 0 indicates no timeout

## 7.8. CUcheckpointRestoreArgs Struct Reference

CUDA checkpoint optional restore arguments

### CUcheckpointGpuPair *CUcheckpointRestoreArgs::gpuPairs

Pointer to array of gpu pairs that indicate how to remap GPUs during restore

### unsigned int CUcheckpointRestoreArgs::gpuPairsCount

Number of gpu pairs to remap

### char CUcheckpointRestoreArgs::reserved

Reserved for future use, must be zeroed

## 7.9. CUcheckpointUnlockArgs Struct Reference

CUDA checkpoint optional unlock arguments

### cuuint64_t CUcheckpointUnlockArgs::reserved

Reserved for future use, must be zeroed

# 7.10. CUctxCigParam Struct Reference

CIG Context Create Params

## void *CUctxCigParam::sharedData

Graphics client data handle (ID3D12CommandQueue or Nvidia specific data blob).

## CUcigDataType CUctxCigParam::sharedDataType

Type of shared data from graphics client (D3D12 or Vulkan).

# 7.11. CUctxCreateParams Struct Reference

Params for creating CUDA context. Both execAffinityParams and cigParams cannot be non-NULL at the same time. If both are NULL, the context will be created as a regular CUDA context.

## CUctxCigParam *CUctxCreateParams::cigParams

CIG (CUDA in Graphics) parameters for sharing data from D3D12/Vulkan graphics clients. Mutually exclusive with execAffinityParams.

## CUexecAffinityParam *CUctxCreateParams::execAffinityParams

Array of execution affinity parameters to limit context resources (e.g., SM count). Only supported Volta+ MPS. Mutually exclusive with cigParams.

## int CUctxCreateParams::numExecAffinityParams

Number of elements in execAffinityParams array. Must be 0 if execAffinityParams is NULL.

# 7.12. CUDA_ARRAY3D_DESCRIPTOR_v2 Struct Reference

3D array descriptor

### size_t CUDA_ARRAY3D_DESCRIPTOR_v2::Depth

Depth of 3D array

### unsigned int CUDA_ARRAY3D_DESCRIPTOR_v2::Flags

Flags

### CUarray_format CUDA_ARRAY3D_DESCRIPTOR_v2::Format

Array format

### size_t CUDA_ARRAY3D_DESCRIPTOR_v2::Height

Height of 3D array

### unsigned int CUDA_ARRAY3D_DESCRIPTOR_v2::NumChannels

Channels per array element

### size_t CUDA_ARRAY3D_DESCRIPTOR_v2::Width

Width of 3D array

## 7.13. CUDA_ARRAY_DESCRIPTOR_v2 Struct Reference

Array descriptor

### CUarray_format CUDA_ARRAY_DESCRIPTOR_v2::Format

Array format

### size_t CUDA_ARRAY_DESCRIPTOR_v2::Height

Height of array

### unsigned int CUDA_ARRAY_DESCRIPTOR_v2::NumChannels

Channels per array element

### size_t CUDA_ARRAY_DESCRIPTOR_v2::Width

Width of array

## 7.14. CUDA_ARRAY_MEMORY_REQUIREMENTS Struct Reference

CUDA array memory requirements

### size_t CUDA_ARRAY_MEMORY_REQUIREMENTS_v1::alignment

alignment requirement

### size_t CUDA_ARRAY_MEMORY_REQUIREMENTS_v1::size

Total required memory size

## 7.15. CUDA_ARRAY_SPARSE_PROPERTIES_v1 Struct Reference

CUDA array sparse properties

### unsigned int CUDA_ARRAY_SPARSE_PROPERTIES_v1::depth

Depth of sparse tile in elements

### unsigned int CUDA_ARRAY_SPARSE_PROPERTIES_v1::flags

Flags will either be zero or CU_ARRAY_SPARSE_PROPERTIES_SINGLE_MIPTAIL

### unsigned int CUDA_ARRAY_SPARSE_PROPERTIES_v1::height

Height of sparse tile in elements

### unsigned int CUDA_ARRAY_SPARSE_PROPERTIES_v1::miptailFirstLevel

First mip level at which the mip tail begins.

### unsigned long long CUDA_ARRAY_SPARSE_PROPERTIES_v1::miptailSize

Total size of the mip tail.

### unsigned int CUDA_ARRAY_SPARSE_PROPERTIES_v1::width

Width of sparse tile in elements

## 7.16. CUDA_BATCH_MEM_OP_NODE_PARAMS_ Struct Reference

Batch memory operation node parameters

Used in the legacy cuGraphAddBatchMemOpNode api. New code should use cuGraphAddNode()

## 7.18. CUDA_CHILD_GRAPH_NODE_PARAMS Struct Reference

Child graph node parameters

### CUgraph CUDA_CHILD_GRAPH_NODE_PARAMS::graph

The child graph to clone into the node for node creation, or a handle to the graph owned by the node for node query. The graph must not contain conditional nodes. Graphs containing memory allocation or memory free nodes must set the ownership to be moved to the parent.

### CUgraphChildGraphNodeOwnership CUDA_CHILD_GRAPH_NODE_PARAMS::ownership

The ownership relationship of the child graph node.

## 7.19. CUDA_CONDITIONAL_NODE_PARAMS Struct Reference

Conditional node parameters

### CUcontext CUDA_CONDITIONAL_NODE_PARAMS::ctx

Context on which to run the node. Must match context used to create the handle and all body nodes.

### CUgraphConditionalHandle CUDA_CONDITIONAL_NODE_PARAMS::handle

Conditional node handle. Handles must be created in advance of creating the node using cuGraphConditionalHandleCreate.

### CUgraph *CUDA_CONDITIONAL_NODE_PARAMS::phGraph_out

CUDA-owned array populated with conditional node child graphs during creation of the node. Valid for the lifetime of the conditional node. The contents of the graph(s) are subject to the following constraints:

- Allowed node types are kernel nodes, empty nodes, child graphs, memsets, memcopies, and conditionals. This applies recursively to child graphs and conditional bodies.

- All kernels, including kernels in nested conditionals or child graphs at any level, must belong to the same CUDA context.

These graphs may be populated using graph node creation APIs or cuStreamBeginCaptureToGraph.

CU_GRAPH_COND_TYPE_IF: phGraph_out[0] is executed when the condition is non-zero. If `size` == 2, phGraph_out[1] will be executed when the condition is zero. CU_GRAPH_COND_TYPE_WHILE: phGraph_out[0] is executed as long as the condition is non-zero. CU_GRAPH_COND_TYPE_SWITCH: phGraph_out[n] is executed when the condition is equal to n. If the condition >= `size`, no body graph is executed.

### unsigned int CUDA_CONDITIONAL_NODE_PARAMS::size

Size of graph output array. Allowed values are 1 for CU_GRAPH_COND_TYPE_WHILE, 1 or 2 for CU_GRAPH_COND_TYPE_IF, or any value greater than zero for CU_GRAPH_COND_TYPE_SWITCH.

### CUgraphConditionalNodeType CUDA_CONDITIONAL_NODE_PARAMS::type

Type of conditional node.

## 7.20. CUDA_EVENT_RECORD_NODE_PARAMS Struct Reference

Event record node parameters

### CUevent CUDA_EVENT_RECORD_NODE_PARAMS::event

The event to record when the node executes

## 7.21. CUDA_EVENT_WAIT_NODE_PARAMS Struct Reference

Event wait node parameters

### CUevent CUDA_EVENT_WAIT_NODE_PARAMS::event

The event to wait on from the node

## 7.22. CUDA_EXT_SEM_SIGNAL_NODE_PARAMS Struct Reference

Semaphore signal node parameters

### CUexternalSemaphore *CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v1::extSemArray

Array of external semaphore handles.

### unsigned int CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v1::numExtSems

Number of handles and parameters supplied in extSemArray and paramsArray.

### const CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS *CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v1::paramsArray

Array of external semaphore signal parameters.

## 7.23. CUDA_EXT_SEM_SIGNAL_NODE_PARAMS Struct Reference

Semaphore signal node parameters

### CUexternalSemaphore *CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v2::extSemArray

Array of external semaphore handles.

### unsigned int CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v2::numExtSems

Number of handles and parameters supplied in extSemArray and paramsArray.

### const CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS *CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v2::paramsArray

Array of external semaphore signal parameters.

## 7.24. CUDA_EXT_SEM_WAIT_NODE_PARAMS_v Struct Reference

Semaphore wait node parameters

### CUexternalSemaphore *CUDA_EXT_SEM_WAIT_NODE_PARAMS_v1::extSemArray

Array of external semaphore handles.

### unsigned int CUDA_EXT_SEM_WAIT_NODE_PARAMS_v1::numExtSems

Number of handles and parameters supplied in extSemArray and paramsArray.

### const CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS *CUDA_EXT_SEM_WAIT_NODE_PARAMS_v1::paramsArray

Array of external semaphore wait parameters.

# 7.25. CUDA_EXT_SEM_WAIT_NODE_PARAMS_v Struct Reference

Semaphore wait node parameters

## CUexternalSemaphore *CUDA_EXT_SEM_WAIT_NODE_PARAMS_v2::extSemArray

Array of external semaphore handles.

## unsigned int CUDA_EXT_SEM_WAIT_NODE_PARAMS_v2::numExtSems

Number of handles and parameters supplied in extSemArray and paramsArray.

## const CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS *CUDA_EXT_SEM_WAIT_NODE_PARAMS_v2::paramsArray

Array of external semaphore wait parameters.

# 7.26. CUDA_EXTERNAL_MEMORY_BUFFER_DES Struct Reference

External memory buffer descriptor

## unsigned int CUDA_EXTERNAL_MEMORY_BUFFER_DESC_v1::flags

Flags reserved for future use. Must be zero.

## unsigned long long CUDA_EXTERNAL_MEMORY_BUFFER_DESC_v1::offset

Offset into the memory object where the buffer's base is

### unsigned long long CUDA_EXTERNAL_MEMORY_BUFFER_DESC_v1::size

Size of the buffer

## 7.27. CUDA_EXTERNAL_MEMORY_HANDLE_DE Struct Reference

External memory handle descriptor

### int CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::fd

File descriptor referencing the memory object. Valid when type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_FD

### unsigned int CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::flags

Flags must either be zero or CUDA_EXTERNAL_MEMORY_DEDICATED

### void *CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::handle

Valid NT handle. Must be NULL if 'name' is non-NULL

### const void *CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::name

Name of a valid memory object. Must be NULL if 'handle' is non-NULL.

### const void *CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::nvSciBuf

A handle representing an NvSciBuf Object. Valid when type is CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF

## unsigned long long CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::size

Size of the memory allocation

## CUexternalMemoryHandleType CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::type

Type of the handle

## CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::@19::@20 CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1::win32

Win32 handle referencing the semaphore object. Valid when type is one of the following:

- CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32
- CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32_KMT
- CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_HEAP
- CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D12_RESOURCE
- CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE
- CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT
  Exactly one of 'handle' and 'name' must be non-NULL. If type is one of the following: CU_EXTERNAL_MEMORY_HANDLE_TYPE_OPAQUE_WIN32_KMT CU_EXTERNAL_MEMORY_HANDLE_TYPE_D3D11_RESOURCE_KMT then 'name' must be NULL.

# 7.28. CUDA_EXTERNAL_MEMORY_MIPMAPPED Struct Reference

External memory mipmap descriptor

## struct CUDA_ARRAY3D_DESCRIPTOR CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_v

Format, dimension and type of base level of the mipmap chain

## unsigned int CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_v

Total number of levels in the mipmap chain

## unsigned long long CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_v

Offset into the memory object where the base level of the mipmap chain is.

# 7.29. CUDA_EXTERNAL_SEMAPHORE_HANDLE_ Struct Reference

External semaphore handle descriptor

## int CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::fd

File descriptor referencing the semaphore object. Valid when type is one of the following:

- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_FD
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_FD

## unsigned int CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::flags

Flags reserved for the future. Must be zero.

## void *CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::handle

Valid NT handle. Must be NULL if 'name' is non-NULL

## const void *CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::name

Name of a valid synchronization primitive. Must be NULL if 'handle' is non-NULL.

### const void *CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::nvSci

Valid NvSciSyncObj. Must be non NULL

### CUexternalSemaphoreHandleType CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::type

Type of the handle

### CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::@21::@ CUDA_EXTERNAL_SEMAPHORE_HANDLE_DESC_v1::win32

Win32 handle referencing the semaphore object. Valid when type is one of the following:

- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D12_FENCE
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_FENCE
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_TIMELINE_SEMAPHORE_WIN32 Exactly one of 'handle' and 'name' must be non-NULL. If type is one of the following:
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_OPAQUE_WIN32_KMT
- CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_D3D11_KEYED_MUTEX_KMT then 'name' must be NULL.

## 7.30. CUDA_EXTERNAL_SEMAPHORE_SIGNAL_ Struct Reference

External semaphore signal parameters

### void *CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::fen

Pointer to NvSciSyncFence. Valid if CUexternalSemaphoreHandleType is of type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC.

## CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::@23
## CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::fence

Parameters for fence objects

## unsigned int
## CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::flags

Only when CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS is used to signal a CUexternalSemaphore of type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC, the valid flag is CUDA_EXTERNAL_SEMAPHORE_SIGNAL_SKIP_NVSCIBUF_MEMSYNC which indicates that while signaling the CUexternalSemaphore, no memory synchronization operations should be performed for any external memory object imported as CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF. For all other types of CUexternalSemaphore, flags must be zero.

## unsigned long long
## CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::key

Value of key to release the mutex with

## CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::@23
## CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::keye

Parameters for keyed mutex objects

## unsigned long long
## CUDA_EXTERNAL_SEMAPHORE_SIGNAL_PARAMS_v1::valu

Value of fence to be signaled

# 7.31. CUDA_EXTERNAL_SEMAPHORE_WAIT_PA Struct Reference

External semaphore wait parameters

## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::@27::@
## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::fence

Parameters for fence objects

## unsigned int
## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::flags

Only when CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS is used to wait on a CUexternalSemaphore of type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC, the valid flag is CUDA_EXTERNAL_SEMAPHORE_WAIT_SKIP_NVSCIBUF_MEMSYNC which indicates that while waiting for the CUexternalSemaphore, no memory synchronization operations should be performed for any external memory object imported as CU_EXTERNAL_MEMORY_HANDLE_TYPE_NVSCIBUF. For all other types of CUexternalSemaphore, flags must be zero.

## unsigned long long
## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::key

Value of key to acquire the mutex with

## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::@27::@
## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::keyedM

Parameters for keyed mutex objects

## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::@27::@
## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::nvSciS

Pointer to NvSciSyncFence. Valid if CUexternalSemaphoreHandleType is of type CU_EXTERNAL_SEMAPHORE_HANDLE_TYPE_NVSCISYNC.

## unsigned int
## CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::timeout

Timeout in milliseconds to wait to acquire the mutex

### unsigned long long CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1::value

Value of fence to be waited on

## 7.32. CUDA_GRAPH_INSTANTIATE_PARAMS Struct Reference

Graph instantiation parameters

### cuuint64_t CUDA_GRAPH_INSTANTIATE_PARAMS::flags

Instantiation flags

### CUgraphNode CUDA_GRAPH_INSTANTIATE_PARAMS::hErrNode_out

The node which caused instantiation to fail, if any

### CUstream CUDA_GRAPH_INSTANTIATE_PARAMS::hUploadStream

Upload stream

### CUgraphInstantiateResult CUDA_GRAPH_INSTANTIATE_PARAMS::result_out

Whether instantiation was successful. If it failed, the reason why

## 7.33. CUDA_HOST_NODE_PARAMS_v1 Struct Reference

Host node parameters

### CUhostFn CUDA_HOST_NODE_PARAMS_v1::fn

The function to call when the node executes

### void *CUDA_HOST_NODE_PARAMS_v1::userData

Argument to pass to the function

## 7.34. CUDA_HOST_NODE_PARAMS_v2 Struct Reference

Host node parameters

### CUhostFn CUDA_HOST_NODE_PARAMS_v2::fn

The function to call when the node executes

### unsigned int CUDA_HOST_NODE_PARAMS_v2::syncMode

The sync mode to use for the host task

### void *CUDA_HOST_NODE_PARAMS_v2::userData

Argument to pass to the function

## 7.35. CUDA_KERNEL_NODE_PARAMS_v1 Struct Reference

GPU kernel node parameters

### unsigned int CUDA_KERNEL_NODE_PARAMS_v1::blockDimX

X dimension of each thread block

## unsigned int CUDA_KERNEL_NODE_PARAMS_v1::blockDimY

Y dimension of each thread block

## unsigned int CUDA_KERNEL_NODE_PARAMS_v1::blockDimZ

Z dimension of each thread block

## **CUDA_KERNEL_NODE_PARAMS_v1::extra

Extra options

## CUfunction CUDA_KERNEL_NODE_PARAMS_v1::func

Kernel to launch

## unsigned int CUDA_KERNEL_NODE_PARAMS_v1::gridDimX

Width of grid in blocks

## unsigned int CUDA_KERNEL_NODE_PARAMS_v1::gridDimY

Height of grid in blocks

## unsigned int CUDA_KERNEL_NODE_PARAMS_v1::gridDimZ

Depth of grid in blocks

## **CUDA_KERNEL_NODE_PARAMS_v1::kernelParams

Array of pointers to kernel parameters

### unsigned int CUDA_KERNEL_NODE_PARAMS_v1::sharedMemBytes

Dynamic shared-memory size per thread block in bytes

## 7.36. CUDA_KERNEL_NODE_PARAMS_v2 Struct Reference

GPU kernel node parameters

### unsigned int CUDA_KERNEL_NODE_PARAMS_v2::blockDimX

X dimension of each thread block

### unsigned int CUDA_KERNEL_NODE_PARAMS_v2::blockDimY

Y dimension of each thread block

### unsigned int CUDA_KERNEL_NODE_PARAMS_v2::blockDimZ

Z dimension of each thread block

### CUcontext CUDA_KERNEL_NODE_PARAMS_v2::ctx

Context for the kernel task to run in. The value NULL will indicate the current context should be used by the api. This field is ignored if func is set.

### **CUDA_KERNEL_NODE_PARAMS_v2::extra

Extra options

### CUfunction CUDA_KERNEL_NODE_PARAMS_v2::func

Kernel to launch

### unsigned int CUDA_KERNEL_NODE_PARAMS_v2::gridDimX

Width of grid in blocks

### unsigned int CUDA_KERNEL_NODE_PARAMS_v2::gridDimY

Height of grid in blocks

### unsigned int CUDA_KERNEL_NODE_PARAMS_v2::gridDimZ

Depth of grid in blocks

### CUkernel CUDA_KERNEL_NODE_PARAMS_v2::kern

Kernel to launch, will only be referenced if func is NULL

### **CUDA_KERNEL_NODE_PARAMS_v2::kernelParams

Array of pointers to kernel parameters

### unsigned int CUDA_KERNEL_NODE_PARAMS_v2::sharedMemBytes

Dynamic shared-memory size per thread block in bytes

## 7.37. CUDA_KERNEL_NODE_PARAMS_v3 Struct Reference

GPU kernel node parameters

### unsigned int CUDA_KERNEL_NODE_PARAMS_v3::blockDimX

X dimension of each thread block

## unsigned int CUDA_KERNEL_NODE_PARAMS_v3::blockDimY

Y dimension of each thread block

## unsigned int CUDA_KERNEL_NODE_PARAMS_v3::blockDimZ

Z dimension of each thread block

## CUcontext CUDA_KERNEL_NODE_PARAMS_v3::ctx

Context for the kernel task to run in. The value NULL will indicate the current context should be used by the api. This field is ignored if func is set.

## **CUDA_KERNEL_NODE_PARAMS_v3::extra

Extra options

## CUfunction CUDA_KERNEL_NODE_PARAMS_v3::func

Kernel to launch

## unsigned int CUDA_KERNEL_NODE_PARAMS_v3::gridDimX

Width of grid in blocks

## unsigned int CUDA_KERNEL_NODE_PARAMS_v3::gridDimY

Height of grid in blocks

## unsigned int CUDA_KERNEL_NODE_PARAMS_v3::gridDimZ

Depth of grid in blocks

### CUkernel CUDA_KERNEL_NODE_PARAMS_v3::kern

Kernel to launch, will only be referenced if func is NULL

### **CUDA_KERNEL_NODE_PARAMS_v3::kernelParams

Array of pointers to kernel parameters

### unsigned int CUDA_KERNEL_NODE_PARAMS_v3::sharedMemBytes

Dynamic shared-memory size per thread block in bytes

## 7.38. CUDA_LAUNCH_PARAMS_v1 Struct Reference

Kernel launch parameters

### unsigned int CUDA_LAUNCH_PARAMS_v1::blockDimX

X dimension of each thread block

### unsigned int CUDA_LAUNCH_PARAMS_v1::blockDimY

Y dimension of each thread block

### unsigned int CUDA_LAUNCH_PARAMS_v1::blockDimZ

Z dimension of each thread block

### CUfunction CUDA_LAUNCH_PARAMS_v1::function

Kernel to launch

### unsigned int CUDA_LAUNCH_PARAMS_v1::gridDimX

Width of grid in blocks

### unsigned int CUDA_LAUNCH_PARAMS_v1::gridDimY

Height of grid in blocks

### unsigned int CUDA_LAUNCH_PARAMS_v1::gridDimZ

Depth of grid in blocks

### CUstream CUDA_LAUNCH_PARAMS_v1::hStream

Stream identifier

### **CUDA_LAUNCH_PARAMS_v1::kernelParams

Array of pointers to kernel parameters

### unsigned int CUDA_LAUNCH_PARAMS_v1::sharedMemBytes

Dynamic shared-memory size per thread block in bytes

## 7.39. CUDA_MEM_ALLOC_NODE_PARAMS_v1 Struct Reference

Memory allocation node parameters

### size_t CUDA_MEM_ALLOC_NODE_PARAMS_v1::accessDescCount

in: number of memory access descriptors. Must not exceed the number of GPUs.

### const CUmemAccessDesc *CUDA_MEM_ALLOC_NODE_PARAMS_v1::accessDescs

in: array of memory access descriptors. Used to describe peer GPU access

### size_t CUDA_MEM_ALLOC_NODE_PARAMS_v1::bytesize

in: size in bytes of the requested allocation

### CUdeviceptr CUDA_MEM_ALLOC_NODE_PARAMS_v1::dptr

out: address of the allocation returned by CUDA

### struct CUmemPoolProps CUDA_MEM_ALLOC_NODE_PARAMS_v1::poolProps

in: location where the allocation should reside (specified in location). handleTypes must be CU_MEM_HANDLE_TYPE_NONE. IPC is not supported.

## 7.40. CUDA_MEM_ALLOC_NODE_PARAMS_v2 Struct Reference

Memory allocation node parameters

### size_t CUDA_MEM_ALLOC_NODE_PARAMS_v2::accessDescCount

in: number of memory access descriptors. Must not exceed the number of GPUs.

### const CUmemAccessDesc *CUDA_MEM_ALLOC_NODE_PARAMS_v2::accessDescs

in: array of memory access descriptors. Used to describe peer GPU access

### size_t CUDA_MEM_ALLOC_NODE_PARAMS_v2::bytesize

in: size in bytes of the requested allocation

### CUdeviceptr CUDA_MEM_ALLOC_NODE_PARAMS_v2::dptr

out: address of the allocation returned by CUDA

### struct CUmemPoolProps CUDA_MEM_ALLOC_NODE_PARAMS_v2::poolProps

in: location where the allocation should reside (specified in location). handleTypes must be CU_MEM_HANDLE_TYPE_NONE. IPC is not supported.

## 7.41. CUDA_MEM_FREE_NODE_PARAMS Struct Reference

Memory free node parameters

### CUdeviceptr CUDA_MEM_FREE_NODE_PARAMS::dptr

in: the pointer to free

## 7.42. CUDA_MEMCPY2D_v2 Struct Reference

2D memory copy parameters

### CUarray CUDA_MEMCPY2D_v2::dstArray

Destination array reference

### CUdeviceptr CUDA_MEMCPY2D_v2::dstDevice

Destination device pointer

### void *CUDA_MEMCPY2D_v2::dstHost

Destination host pointer

### CUmemorytype CUDA_MEMCPY2D_v2::dstMemoryType

Destination memory type (host, device, array)

## size_t CUDA_MEMCPY2D_v2::dstPitch

Destination pitch (ignored when dst is array)

## size_t CUDA_MEMCPY2D_v2::dstXInBytes

Destination X in bytes

## size_t CUDA_MEMCPY2D_v2::dstY

Destination Y

## size_t CUDA_MEMCPY2D_v2::Height

Height of 2D memory copy

## CUarray CUDA_MEMCPY2D_v2::srcArray

Source array reference

## CUdeviceptr CUDA_MEMCPY2D_v2::srcDevice

Source device pointer

## const void *CUDA_MEMCPY2D_v2::srcHost

Source host pointer

## CUmemorytype CUDA_MEMCPY2D_v2::srcMemoryType

Source memory type (host, device, array)

## size_t CUDA_MEMCPY2D_v2::srcPitch

Source pitch (ignored when src is array)

## size_t CUDA_MEMCPY2D_v2::srcXInBytes

Source X in bytes

### size_t CUDA_MEMCPY2D_v2::srcY

Source Y

### size_t CUDA_MEMCPY2D_v2::WidthInBytes

Width of 2D memory copy in bytes

## 7.43. CUDA_MEMCPY3D_PEER_v1 Struct Reference

3D memory cross-context copy parameters

### size_t CUDA_MEMCPY3D_PEER_v1::Depth

Depth of 3D memory copy

### CUarray CUDA_MEMCPY3D_PEER_v1::dstArray

Destination array reference

### CUcontext CUDA_MEMCPY3D_PEER_v1::dstContext

Destination context (ignored with dstMemoryType is CU_MEMORYTYPE_ARRAY)

### CUdeviceptr CUDA_MEMCPY3D_PEER_v1::dstDevice

Destination device pointer

### size_t CUDA_MEMCPY3D_PEER_v1::dstHeight

Destination height (ignored when dst is array; may be 0 if Depth==1)

### void *CUDA_MEMCPY3D_PEER_v1::dstHost

Destination host pointer

### size_t CUDA_MEMCPY3D_PEER_v1::dstLOD

Destination LOD

## CUmemorytype CUDA_MEMCPY3D_PEER_v1::dstMemoryType

Destination memory type (host, device, array)

## size_t CUDA_MEMCPY3D_PEER_v1::dstPitch

Destination pitch (ignored when dst is array)

## size_t CUDA_MEMCPY3D_PEER_v1::dstXInBytes

Destination X in bytes

## size_t CUDA_MEMCPY3D_PEER_v1::dstY

Destination Y

## size_t CUDA_MEMCPY3D_PEER_v1::dstZ

Destination Z

## size_t CUDA_MEMCPY3D_PEER_v1::Height

Height of 3D memory copy

## CUarray CUDA_MEMCPY3D_PEER_v1::srcArray

Source array reference

## CUcontext CUDA_MEMCPY3D_PEER_v1::srcContext

Source context (ignored with srcMemoryType is CU_MEMORYTYPE_ARRAY)

## CUdeviceptr CUDA_MEMCPY3D_PEER_v1::srcDevice

Source device pointer

## size_t CUDA_MEMCPY3D_PEER_v1::srcHeight

Source height (ignored when src is array; may be 0 if Depth==1)

### const void *CUDA_MEMCPY3D_PEER_v1::srcHost

Source host pointer

### size_t CUDA_MEMCPY3D_PEER_v1::srcLOD

Source LOD

### CUmemorytype CUDA_MEMCPY3D_PEER_v1::srcMemoryType

Source memory type (host, device, array)

### size_t CUDA_MEMCPY3D_PEER_v1::srcPitch

Source pitch (ignored when src is array)

### size_t CUDA_MEMCPY3D_PEER_v1::srcXInBytes

Source X in bytes

### size_t CUDA_MEMCPY3D_PEER_v1::srcY

Source Y

### size_t CUDA_MEMCPY3D_PEER_v1::srcZ

Source Z

### size_t CUDA_MEMCPY3D_PEER_v1::WidthInBytes

Width of 3D memory copy in bytes

## 7.44. CUDA_MEMCPY3D_v2 Struct Reference

3D memory copy parameters

### size_t CUDA_MEMCPY3D_v2::Depth

Depth of 3D memory copy

## CUarray CUDA_MEMCPY3D_v2::dstArray

Destination array reference

## CUdeviceptr CUDA_MEMCPY3D_v2::dstDevice

Destination device pointer

## size_t CUDA_MEMCPY3D_v2::dstHeight

Destination height (ignored when dst is array; may be 0 if Depth==1)

## void *CUDA_MEMCPY3D_v2::dstHost

Destination host pointer

## size_t CUDA_MEMCPY3D_v2::dstLOD

Destination LOD

## CUmemorytype CUDA_MEMCPY3D_v2::dstMemoryType

Destination memory type (host, device, array)

## size_t CUDA_MEMCPY3D_v2::dstPitch

Destination pitch (ignored when dst is array)

## size_t CUDA_MEMCPY3D_v2::dstXInBytes

Destination X in bytes

## size_t CUDA_MEMCPY3D_v2::dstY

Destination Y

## size_t CUDA_MEMCPY3D_v2::dstZ

Destination Z

## size_t CUDA_MEMCPY3D_v2::Height

Height of 3D memory copy

## void *CUDA_MEMCPY3D_v2::reserved0

Must be NULL

## void *CUDA_MEMCPY3D_v2::reserved1

Must be NULL

## CUarray CUDA_MEMCPY3D_v2::srcArray

Source array reference

## CUdeviceptr CUDA_MEMCPY3D_v2::srcDevice

Source device pointer

## size_t CUDA_MEMCPY3D_v2::srcHeight

Source height (ignored when src is array; may be 0 if Depth==1)

## const void *CUDA_MEMCPY3D_v2::srcHost

Source host pointer

## size_t CUDA_MEMCPY3D_v2::srcLOD

Source LOD

## CUmemorytype CUDA_MEMCPY3D_v2::srcMemoryType

Source memory type (host, device, array)

## size_t CUDA_MEMCPY3D_v2::srcPitch

Source pitch (ignored when src is array)

### size_t CUDA_MEMCPY3D_v2::srcXInBytes

Source X in bytes

### size_t CUDA_MEMCPY3D_v2::srcY

Source Y

### size_t CUDA_MEMCPY3D_v2::srcZ

Source Z

### size_t CUDA_MEMCPY3D_v2::WidthInBytes

Width of 3D memory copy in bytes

## 7.45. CUDA_MEMCPY_NODE_PARAMS Struct Reference

Memcpy node parameters

### CUcontext CUDA_MEMCPY_NODE_PARAMS::copyCtx

Context on which to run the node

### struct CUDA_MEMCPY3D CUDA_MEMCPY_NODE_PARAMS::copyParams

Parameters for the memory copy

### int CUDA_MEMCPY_NODE_PARAMS::flags

Must be zero

### int CUDA_MEMCPY_NODE_PARAMS::reserved

Must be zero

# 7.46. CUDA_MEMSET_NODE_PARAMS_v1 Struct Reference

Memset node parameters

## CUdeviceptr CUDA_MEMSET_NODE_PARAMS_v1::dst

Destination device pointer

## unsigned int CUDA_MEMSET_NODE_PARAMS_v1::elementSize

Size of each element in bytes. Must be 1, 2, or 4.

## size_t CUDA_MEMSET_NODE_PARAMS_v1::height

Number of rows

## size_t CUDA_MEMSET_NODE_PARAMS_v1::pitch

Pitch of destination device pointer. Unused if height is 1

## unsigned int CUDA_MEMSET_NODE_PARAMS_v1::value

Value to be set

## size_t CUDA_MEMSET_NODE_PARAMS_v1::width

Width of the row in elements

# 7.47. CUDA_MEMSET_NODE_PARAMS_v2 Struct Reference

Memset node parameters

### CUcontext CUDA_MEMSET_NODE_PARAMS_v2::ctx

Context on which to run the node

### CUdeviceptr CUDA_MEMSET_NODE_PARAMS_v2::dst

Destination device pointer

### unsigned int CUDA_MEMSET_NODE_PARAMS_v2::elementSize

Size of each element in bytes. Must be 1, 2, or 4.

### size_t CUDA_MEMSET_NODE_PARAMS_v2::height

Number of rows

### size_t CUDA_MEMSET_NODE_PARAMS_v2::pitch

Pitch of destination device pointer. Unused if height is 1

### unsigned int CUDA_MEMSET_NODE_PARAMS_v2::value

Value to be set

### size_t CUDA_MEMSET_NODE_PARAMS_v2::width

Width of the row in elements

## 7.48. CUDA_POINTER_ATTRIBUTE_P2P_TOKENS Struct Reference

GPU Direct v3 tokens

# 7.49. CUDA_RESOURCE_DESC_v1 Struct Reference

CUDA Resource descriptor

## CUdeviceptr CUDA_RESOURCE_DESC_v1::devPtr

Device pointer

## unsigned int CUDA_RESOURCE_DESC_v1::flags

Flags (must be zero)

## CUarray_format CUDA_RESOURCE_DESC_v1::format

Array format

## CUarray CUDA_RESOURCE_DESC_v1::hArray

CUDA array

## size_t CUDA_RESOURCE_DESC_v1::height

Height of the array in elements

## CUmipmappedArray CUDA_RESOURCE_DESC_v1::hMipmappedArray

CUDA mipmapped array

## unsigned int CUDA_RESOURCE_DESC_v1::numChannels

Channels per array element

## size_t CUDA_RESOURCE_DESC_v1::pitchInBytes

Pitch between two rows in bytes

### CUresourcetype CUDA_RESOURCE_DESC_v1::resType

Resource type

### size_t CUDA_RESOURCE_DESC_v1::sizeInBytes

Size in bytes

### size_t CUDA_RESOURCE_DESC_v1::width

Width of the array in elements

## 7.50. CUDA_RESOURCE_VIEW_DESC_v1 Struct Reference

Resource view descriptor

### size_t CUDA_RESOURCE_VIEW_DESC_v1::depth

Depth of the resource view

### unsigned int CUDA_RESOURCE_VIEW_DESC_v1::firstLayer

First layer index

### unsigned int CUDA_RESOURCE_VIEW_DESC_v1::firstMipmapLevel

First defined mipmap level

### CUresourceViewFormat CUDA_RESOURCE_VIEW_DESC_v1::format

Resource view format

### size_t CUDA_RESOURCE_VIEW_DESC_v1::height

Height of the resource view

### unsigned int CUDA_RESOURCE_VIEW_DESC_v1::lastLayer

Last layer index

### unsigned int CUDA_RESOURCE_VIEW_DESC_v1::lastMipmapLevel

Last defined mipmap level

### size_t CUDA_RESOURCE_VIEW_DESC_v1::width

Width of the resource view

## 7.51. CUDA_TEXTURE_DESC_v1 Struct Reference

Texture descriptor

### CUaddress_mode CUDA_TEXTURE_DESC_v1::addressMode

Address modes

### float CUDA_TEXTURE_DESC_v1::borderColor

Border Color

### CUfilter_mode CUDA_TEXTURE_DESC_v1::filterMode

Filter mode

### unsigned int CUDA_TEXTURE_DESC_v1::flags

Flags

### unsigned int CUDA_TEXTURE_DESC_v1::maxAnisotropy

Maximum anisotropy ratio

### float CUDA_TEXTURE_DESC_v1::maxMipmapLevelClamp

Mipmap maximum level clamp

### float CUDA_TEXTURE_DESC_v1::minMipmapLevelClamp

Mipmap minimum level clamp

### CUfilter_mode CUDA_TEXTURE_DESC_v1::mipmapFilterMode

Mipmap filter mode

### float CUDA_TEXTURE_DESC_v1::mipmapLevelBias

Mipmap level bias

## 7.52. CUdevprop_v1 Struct Reference

Legacy device properties

### int CUdevprop_v1::clockRate

Clock frequency in kilohertz

### int CUdevprop_v1::maxGridSize

Maximum size of each dimension of a grid

### int CUdevprop_v1::maxThreadsDim

Maximum size of each dimension of a block

## int CUdevprop_v1::maxThreadsPerBlock

Maximum number of threads per block

## int CUdevprop_v1::memPitch

Maximum pitch in bytes allowed by memory copies

## int CUdevprop_v1::regsPerBlock

32-bit registers available per block

## int CUdevprop_v1::sharedMemPerBlock

Shared memory available per block in bytes

## int CUdevprop_v1::SIMDWidth

Warp size in threads

## int CUdevprop_v1::textureAlign

Alignment requirement for textures

## int CUdevprop_v1::totalConstantMemory

Constant memory available on device in bytes

# 7.53. CUdevResource Struct Reference

A tagged union describing different resources identified by the type field. This structure should not be directly modified outside of the API that created it.

```
struct {
           CUdevResourceType type;
           union {
               CUdevSmResource sm;
                 CUdevWorkqueueConfigResource wqConfig;
                 CUdevWorkqueueResource wq;
           };
       };
```

- If `type` is `CU_DEV_RESOURCE_TYPE_INVALID`, this resoure is not valid and cannot be further accessed.

- If `type` is `CU_DEV_RESOURCE_TYPE_SM`, the CUdevSmResource structure `sm` is filled in. For example, `sm.smCount` will reflect the amount of streaming multiprocessors available in this resource.
- If `type` is `CU_DEV_RESOURCE_TYPE_WORKQUEUE_CONFIG`, the CUdevWorkqueueConfigResource structure `wqConfig` is filled in.
- If `type` is `CU_DEV_RESOURCE_TYPE_WORKQUEUE`, the CUdevWorkqueueResource structure `wq` is filled in.

# 7.54. CUdevSmResource Struct Reference

Data for SM-related resources All parameters in this structure are OUTPUT only. Do not write to any of the fields in this structure.

## unsigned int CUdevSmResource::flags

The flags set on this SM resource. For possible values see CUdevSmResourceGroup_flags.

## unsigned int CUdevSmResource::minSmPartitionSize

The minimum number of streaming multiprocessors required to partition this resource.

## unsigned int CUdevSmResource::smCoscheduledAlignment

The number of streaming multiprocessors in this resource that are guaranteed to be co-scheduled on the same GPU processing cluster. smCount will be a multiple of this value, unless the backfill flag is set.

## unsigned int CUdevSmResource::smCount

The amount of streaming multiprocessors available in this resource.

# 7.55. CUdevWorkqueueConfigResource Struct Reference

Data for workqueue configuration related resources

## CUdevice CUdevWorkqueueConfigResource::device

The device on which the workqueue resources are available

### CUdevWorkqueueConfigScope CUdevWorkqueueConfigResource::sharingScope

The sharing scope for the workqueue resources

### unsigned int CUdevWorkqueueConfigResource::wqConcurrencyLimit

The expected maximum number of concurrent stream-ordered workloads

## 7.56. CUdevWorkqueueResource Struct Reference

Handle to a pre-existing workqueue related resource

### unsigned char CUdevWorkqueueResource::reserved

Reserved for future use

## 7.57. CUeglFrame_v1 Struct Reference

CUDA EGLFrame structure Descriptor - structure defining one frame of EGL.

Each frame may contain one or more planes depending on whether the surface * is Multiplanar or not.

### CUarray_format CUeglFrame_v1::cuFormat

CUDA Array Format

### unsigned int CUeglFrame_v1::depth

Depth of first plane

### CUeglColorFormat CUeglFrame_v1::eglColorFormat

CUDA EGL Color Format

### CUeglFrameType CUeglFrame_v1::frameType

Array or Pitch

### unsigned int CUeglFrame_v1::height

Height of first plane

### unsigned int CUeglFrame_v1::numChannels

Number of channels for the plane

### CUarray CUeglFrame_v1::pArray

Array of CUarray corresponding to each plane

### unsigned int CUeglFrame_v1::pitch

Pitch of first plane

### unsigned int CUeglFrame_v1::planeCount

Number of planes

### void *CUeglFrame_v1::pPitch

Array of Pointers corresponding to each plane

### unsigned int CUeglFrame_v1::width

Width of first plane

## 7.58. CUexecAffinityParam_v1 Struct Reference

Execution Affinity Parameters

### struct CUexecAffinitySmCount CUexecAffinityParam_v1::smCount

Value for CU_EXEC_AFFINITY_TYPE_SM_COUNT

### CUexecAffinityType CUexecAffinityParam_v1::type

Type of execution affinity.

## 7.59. CUexecAffinitySmCount_v1 Struct Reference

Value for CU_EXEC_AFFINITY_TYPE_SM_COUNT

### unsigned int CUexecAffinitySmCount_v1::val

The number of SMs the context is limited to use.

## 7.60. CUextent3D_v1 Struct Reference

Struct representing width/height/depth of a CUarray in elements

## 7.61. CUgraphEdgeData Struct Reference

Optional annotation for edges in a CUDA graph. Note, all edges implicitly have annotations and default to a zero-initialized value if not specified. A zero-initialized struct indicates a standard full serialization of two nodes with memory visibility.

### unsigned char CUgraphEdgeData::from_port

This indicates when the dependency is triggered from the upstream node on the edge. The meaning is specfic to the node type. A value of 0 in all cases means full completion of the upstream node, with memory visibility to the downstream node or portion thereof (indicated by `to_port`). Only kernel nodes define non-zero ports. A kernel node can use the following output port types: CU_GRAPH_KERNEL_NODE_PORT_DEFAULT, CU_GRAPH_KERNEL_NODE_PORT_PROGRAMMATIC, or CU_GRAPH_KERNEL_NODE_PORT_LAUNCH_ORDER.

### unsigned char CUgraphEdgeData::reserved

These bytes are unused and must be zeroed. This ensures compatibility if additional fields are added in the future.

### unsigned char CUgraphEdgeData::to_port

This indicates what portion of the downstream node is dependent on the upstream node or portion thereof (indicated by `from_port`). The meaning is specific to the node type. A value of 0 in all cases means the entirety of the downstream node is dependent on the upstream work. Currently no node types define non-zero ports. Accordingly, this field must be set to zero.

### unsigned char CUgraphEdgeData::type

This should be populated with a value from CUgraphDependencyType. (It is typed as char due to compiler-specific layout of bitfields.) See CUgraphDependencyType.

## 7.62. CUgraphExecUpdateResultInfo_v1 Struct Reference

Result information returned by cuGraphExecUpdate

### CUgraphNode CUgraphExecUpdateResultInfo_v1::errorFromNode

The from node of error edge when the topologies do not match. Otherwise NULL.

### CUgraphNode CUgraphExecUpdateResultInfo_v1::errorNode

The "to node" of the error edge when the topologies do not match. The error node when the error is associated with a specific node. NULL when the error is generic.

### CUgraphExecUpdateResult CUgraphExecUpdateResultInfo_v1::result

Gives more specific detail when a cuda graph update fails.

## 7.63. CUgraphNodeParams Struct Reference

Graph node parameters. See cuGraphAddNode.

## struct CUDA_MEM_ALLOC_NODE_PARAMS_v2 CUgraphNodeParams::alloc

Memory allocation node parameters.

## char CUgraphNodeParams::asBytes

Padding as bytes

## struct CUDA_CONDITIONAL_NODE_PARAMS CUgraphNodeParams::conditional

Conditional node parameters.

## struct CUDA_EVENT_RECORD_NODE_PARAMS CUgraphNodeParams::eventRecord

Event record node parameters.

## struct CUDA_EVENT_WAIT_NODE_PARAMS CUgraphNodeParams::eventWait

Event wait node parameters.

## struct CUDA_EXT_SEM_SIGNAL_NODE_PARAMS_v2 CUgraphNodeParams::extSemSignal

External semaphore signal node parameters.

## struct CUDA_EXT_SEM_WAIT_NODE_PARAMS_v2 CUgraphNodeParams::extSemWait

External semaphore wait node parameters.

## struct CUDA_MEM_FREE_NODE_PARAMS CUgraphNodeParams::free

Memory free node parameters.

## struct CUDA_CHILD_GRAPH_NODE_PARAMS CUgraphNodeParams::graph

Child graph node parameters.

## struct CUDA_HOST_NODE_PARAMS_v2 CUgraphNodeParams::host

Host node parameters.

## struct CUDA_KERNEL_NODE_PARAMS_v3 CUgraphNodeParams::kernel

Kernel node parameters.

## struct CUDA_MEMCPY_NODE_PARAMS CUgraphNodeParams::memcpy

Memcpy node parameters.

## struct CUDA_BATCH_MEM_OP_NODE_PARAMS_v2 CUgraphNodeParams::memOp

MemOp node parameters.

## struct CUDA_MEMSET_NODE_PARAMS_v2 CUgraphNodeParams::memset

Memset node parameters.

## int CUgraphNodeParams::reserved0

Reserved. Must be zero.

## long long CUgraphNodeParams::reserved1

Padding. Unused bytes must be zero.

### long long CUgraphNodeParams::reserved2

Reserved bytes. Must be zero.

### CUgraphNodeType CUgraphNodeParams::type

Type of the node

## 7.64. CUipcEventHandle_v1 Struct Reference

CUDA IPC event handle

## 7.65. CUipcMemHandle_v1 Struct Reference

CUDA IPC mem handle

## 7.66. CUlaunchAttribute Struct Reference

Launch attribute

### CUlaunchAttributeID CUlaunchAttribute::id

Attribute to set

### CUlaunchAttribute::value

Value of the attribute

## 7.67. CUlaunchAttributeValue Union Reference

Launch attributes union; used as value field of CUlaunchAttribute

### struct CUaccessPolicyWindow CUlaunchAttributeValue::accessPolicyWindow

Value of launch attribute CU_LAUNCH_ATTRIBUTE_ACCESS_POLICY_WINDOW.

## CUlaunchAttributeValue::@6 CUlaunchAttributeValue::clusterDim

Value of launch attribute CU_LAUNCH_ATTRIBUTE_CLUSTER_DIMENSION that represents the desired cluster dimensions for the kernel. Opaque type with the following fields:

- `x` - The X dimension of the cluster, in blocks. Must be a divisor of the grid X dimension.
- `y` - The Y dimension of the cluster, in blocks. Must be a divisor of the grid Y dimension.
- `z` - The Z dimension of the cluster, in blocks. Must be a divisor of the grid Z dimension.

## CUclusterSchedulingPolicy CUlaunchAttributeValue::clusterSchedulingPolicyPreference

Value of launch attribute CU_LAUNCH_ATTRIBUTE_CLUSTER_SCHEDULING_POLICY_PREFERENCE. Cluster scheduling policy preference for the kernel.

## int CUlaunchAttributeValue::cooperative

Value of launch attribute CU_LAUNCH_ATTRIBUTE_COOPERATIVE. Nonzero indicates a cooperative kernel (see cuLaunchCooperativeKernel).

## CUlaunchAttributeValue::@10 CUlaunchAttributeValue::deviceUpdatableKernelNode

Value of launch attribute CU_LAUNCH_ATTRIBUTE_DEVICE_UPDATABLE_KERNEL_NODE. with the following fields:

- `int` deviceUpdatable - Whether or not the resulting kernel node should be device-updatable.
- `CUgraphDeviceNode` devNode - Returns a handle to pass to the various device-side update functions.

## CUlaunchAttributeValue::@8 CUlaunchAttributeValue::launchCompletionEvent

Value of launch attribute CU_LAUNCH_ATTRIBUTE_LAUNCH_COMPLETION_EVENT with the following fields:

- `CUevent` event - Event to fire when the last block launches
- `int` flags; - Event record flags, see cuEventRecordWithFlags. Does not accept CU_EVENT_RECORD_EXTERNAL.

## CUlaunchMemSyncDomain CUlaunchAttributeValue::memSyncDomain

Value of launch attribute CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN. See::CUlaunchMemSyncDomain

## struct CUlaunchMemSyncDomainMap CUlaunchAttributeValue::memSyncDomainMap

Value of launch attribute CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN_MAP. See CUlaunchMemSyncDomainMap.

## CUlaunchAttributePortableClusterMode CUlaunchAttributeValue::portableClusterSizeMode

Value of launch attribute CU_LAUNCH_ATTRIBUTE_PORTABLE_CLUSTER_SIZE_MODE.

## CUlaunchAttributeValue::@9 CUlaunchAttributeValue::preferredClusterDim

Value of launch attribute CU_LAUNCH_ATTRIBUTE_PREFERRED_CLUSTER_DIMENSION that represents the desired preferred cluster dimensions for the kernel. Opaque type with the following fields:

- `x` - The X dimension of the preferred cluster, in blocks. Must be a divisor of the grid X dimension, and must be a multiple of the `x` field of CUlaunchAttributeValue::clusterDim.
- `y` - The Y dimension of the preferred cluster, in blocks. Must be a divisor of the grid Y dimension, and must be a multiple of the `y` field of CUlaunchAttributeValue::clusterDim.
- `z` - The Z dimension of the preferred cluster, in blocks. Must be equal to the `z` field of CUlaunchAttributeValue::clusterDim.

## int CUlaunchAttributeValue::priority

Value of launch attribute CU_LAUNCH_ATTRIBUTE_PRIORITY. Execution priority of the kernel.

## CUlaunchAttributeValue::@7 CUlaunchAttributeValue::programmaticEvent

Value of launch attribute CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_EVENT with the following fields:

- `CUevent` event - Event to fire when all blocks trigger it.
- `Event` record flags, see cuEventRecordWithFlags. Does not accept :CU_EVENT_RECORD_EXTERNAL.
- `triggerAtBlockStart` - If this is set to non-0, each block launch will automatically trigger the event.

## int CUlaunchAttributeValue::programmaticStreamSerializationAllowed

Value of launch attribute CU_LAUNCH_ATTRIBUTE_PROGRAMMATIC_STREAM_SERIALIZATION.

## unsigned int CUlaunchAttributeValue::sharedMemCarveout

Value of launch attribute CU_LAUNCH_ATTRIBUTE_PREFERRED_SHARED_MEMORY_CARVEOUT.

## CUsharedMemoryMode CUlaunchAttributeValue::sharedMemoryMode

Value of launch attribute CU_LAUNCH_ATTRIBUTE_SHARED_MEMORY_MODE. See CUsharedMemoryMode for acceptable values.

## CUsynchronizationPolicy CUlaunchAttributeValue::syncPolicy

Value of launch attribute CU_LAUNCH_ATTRIBUTE_SYNCHRONIZATION_POLICY. CUsynchronizationPolicy for work queued up in this stream

# 7.68. CUlaunchConfig Struct Reference

CUDA extensible launch configuration

## CUlaunchAttribute *CUlaunchConfig::attrs

List of attributes; nullable if CUlaunchConfig::numAttrs == 0

### unsigned int CUlaunchConfig::blockDimX

X dimension of each thread block

### unsigned int CUlaunchConfig::blockDimY

Y dimension of each thread block

### unsigned int CUlaunchConfig::blockDimZ

Z dimension of each thread block

### unsigned int CUlaunchConfig::gridDimX

Width of grid in blocks

### unsigned int CUlaunchConfig::gridDimY

Height of grid in blocks

### unsigned int CUlaunchConfig::gridDimZ

Depth of grid in blocks

### CUstream CUlaunchConfig::hStream

Stream identifier

### unsigned int CUlaunchConfig::numAttrs

Number of attributes populated in CUlaunchConfig::attrs

### unsigned int CUlaunchConfig::sharedMemBytes

Dynamic shared-memory size per thread block in bytes

## 7.69. CUlaunchMemSyncDomainMap Struct Reference

Memory Synchronization Domain map

See cudaLaunchMemSyncDomain.

By default, kernels are launched in domain 0. Kernel launched with CU_LAUNCH_MEM_SYNC_DOMAIN_REMOTE will have a different domain ID. User may also alter the domain ID with CUlaunchMemSyncDomainMap for a specific stream / graph node / kernel launch. See CU_LAUNCH_ATTRIBUTE_MEM_SYNC_DOMAIN_MAP.

Domain ID range is available through CU_DEVICE_ATTRIBUTE_MEM_SYNC_DOMAIN_COUNT.

### unsigned char CUlaunchMemSyncDomainMap::default_

The default domain ID to use for designated kernels

### unsigned char CUlaunchMemSyncDomainMap::remote

The remote domain ID to use for designated kernels

## 7.70. CUlogicalEndpointFabricHandle Struct Reference

Fabric handle for a logical endpoint

## 7.71. CUlogicalEndpointProp Struct Reference

Properties of a logical endpoint construction

### CUdevice CUlogicalEndpointProp::device

Owner device of the unicast logical endpoint

### unsigned int CUlogicalEndpointProp::flags

A bitmask of flags defined in CUlogicalEndpointFlag

### unsigned int CUlogicalEndpointProp::ipcHandleTypes

A bitmask of IPC handle types defined in CUlogicalEndpointIpcHandleType

### unsigned int CUlogicalEndpointProp::numDevices

Number of devices in the multicast logical endpoint team

### unsigned long long CUlogicalEndpointProp::size

Size of the logical endpoint

### CUlogicalEndpointType CUlogicalEndpointProp::type

Type of the logical endpoint defined in CUlogicalEndpointType

## 7.72. CUmemAccessDesc_v1 Struct Reference

Memory access descriptor

### CUmemAccess_flags CUmemAccessDesc_v1::flags

CUmemProt accessibility flags to set on the request

### struct CUmemLocation CUmemAccessDesc_v1::location

Location on which the request is to change it's accessibility

## 7.73. CUmemAllocationProp_v1 Struct Reference

Specifies the allocation properties for a allocation.

### unsigned char CUmemAllocationProp_v1::compressionType

Allocation hint for requesting compressible memory. On devices that support Compute Data Compression, compressible memory can be used to accelerate accesses to data with unstructured sparsity and other compressible data patterns. Applications are expected to query allocation property of the handle obtained with cuMemCreate using cuMemGetAllocationPropertiesFromHandle to validate if the obtained allocation is compressible or not. Note that compressed memory may not be mappable on all devices.

### struct CUmemLocation CUmemAllocationProp_v1::location

Location of allocation

### CUmemAllocationHandleType CUmemAllocationProp_v1::requestedHandleTypes

requested CUmemAllocationHandleType

### CUmemAllocationType CUmemAllocationProp_v1::type

Allocation type

### unsigned short CUmemAllocationProp_v1::usage

Bitmask indicating intended usage for this allocation

### void *CUmemAllocationProp_v1::win32HandleMetaData

Windows-specific POBJECT_ATTRIBUTES required when CU_MEM_HANDLE_TYPE_WIN32 is specified. This object attributes structure includes security attributes that define the scope of which exported allocations may be transferred to other processes. In all other cases, this field is required to be zero.

## 7.74. CUmemcpy3DOperand_v1 Struct Reference

Struct representing an operand for copy with cuMemcpy3DBatchAsync

### CUmemcpy3DOperand_v1::@39::@41 CUmemcpy3DOperand_v1::array

Struct representing an operand when CUmemcpy3DOperand::type is CU_MEMCPY_OPERAND_TYPE_ARRAY

### CUarray CUmemcpy3DOperand_v1::array

referenced array

### size_t CUmemcpy3DOperand_v1::layerHeight

Height of each layer in elements.

### struct CUmemLocation CUmemcpy3DOperand_v1::locHint

Hint location for the operand. Ignored when the pointers are not managed memory or memory allocated outside CUDA.

### struct CUoffset3D CUmemcpy3DOperand_v1::offset

offset into the array in elements

### CUmemcpy3DOperand_v1::@39::@40 CUmemcpy3DOperand_v1::ptr

Struct representing an operand when CUmemcpy3DOperand::type is CU_MEMCPY_OPERAND_TYPE_POINTER

### size_t CUmemcpy3DOperand_v1::rowLength

Length of each row in elements.

## 7.75. CUmemcpyAttributes_v1 Struct Reference

Attributes specific to copies within a batch. For more details on usage see cuMemcpyBatchAsync.

### struct CUmemLocation CUmemcpyAttributes_v1::dstLocHint

Hint location for the destination operand. Ignored when the pointers are not managed memory or memory allocated outside CUDA.

### unsigned int CUmemcpyAttributes_v1::flags

Additional flags for copies with this attribute. See CUmemcpyFlags

### CUmemcpySrcAccessOrder CUmemcpyAttributes_v1::srcAccessOrder

Source access ordering to be observed for copies with this attribute.

### struct CUmemLocation CUmemcpyAttributes_v1::srcLocHint

Hint location for the source operand. Ignored when the pointers are not managed memory or memory allocated outside CUDA.

## 7.76. CUmemDecompressParams Struct Reference

Structure describing the parameters that compose a single decompression operation.

### CUmemDecompressAlgorithm CUmemDecompressParams::algo

The decompression algorithm to use.

### void *CUmemDecompressParams::dst

Pointer to a buffer where the decompressed data will be written. The number of bytes written to this location will be recorded in the memory pointed to by CUmemDecompressParams_st.dstActBytes

### cuuint32_t *CUmemDecompressParams::dstActBytes

After the decompression operation has completed, the actual number of bytes written to CUmemDecompressParams.dst will be recorded as a 32-bit unsigned integer in the memory at this address.

### size_t CUmemDecompressParams::dstNumBytes

The number of bytes that the decompression operation will be expected to write to CUmemDecompressParams_st.dst. This value is optional; if present, it may be used by the CUDA driver as a heuristic for scheduling the individual decompression operations.

### const void *CUmemDecompressParams::src

Pointer to a buffer of at least CUmemDecompressParams_st.srcNumBytes compressed bytes.

### size_t CUmemDecompressParams::srcNumBytes

The number of bytes to be read and decompressed from CUmemDecompressParams_st.src.

# 7.77. CUmemFabricHandle_v1 Struct Reference

Fabric handle - An opaque handle representing a memory allocation that can be exported to processes in same or different nodes. For IPC between processes on different nodes they must be connected via the NVSwitch fabric.

# 7.78. CUmemLocation_v1 Struct Reference

Specifies a memory location.

## int CUmemLocation_v1::id

Identifier for CUmemLocationType::CU_MEM_LOCATION_TYPE_DEVICE, CUmemLocationType::CU_MEM_LOCATION_TYPE_HOST, CUmemLocationType::CU_MEM_LOCATION_TYPE_HOST_NUMA.

## CUmemLocationType CUmemLocation_v1::type

Specifies the location type, which modifies the meaning of id.

# 7.79. CUmemPoolProps_v1 Struct Reference

Specifies the properties of allocations made from the pool.

## CUmemAllocationType CUmemPoolProps_v1::allocType

Allocation type. Currently must be specified as CU_MEM_ALLOCATION_TYPE_PINNED

## CUmemAllocationHandleType CUmemPoolProps_v1::handleTypes

Handle types that will be supported by allocations from the pool.

## struct CUmemLocation CUmemPoolProps_v1::location

Location where allocations should reside.

### size_t CUmemPoolProps_v1::maxSize

Maximum pool size. When set to 0, defaults to a system dependent value.

### unsigned char CUmemPoolProps_v1::reserved

reserved for future use, must be 0

### unsigned short CUmemPoolProps_v1::usage

Bitmask indicating intended usage for the pool.

### void *CUmemPoolProps_v1::win32SecurityAttributes

Windows-specific LPSECURITYATTRIBUTES required when CU_MEM_HANDLE_TYPE_WIN32 is specified. This security attribute defines the scope of which exported allocations may be transferred to other processes. In all other cases, this field is required to be zero.

## 7.80. CUmemPoolPtrExportData_v1 Struct Reference

Opaque data for exporting a pool allocation

## 7.81. CUmulticastObjectProp_v1 Struct Reference

Specifies the properties for a multicast object.

### unsigned long long CUmulticastObjectProp_v1::flags

Flags for future use, must be zero now

### unsigned long long CUmulticastObjectProp_v1::handleTypes

Bitmask of exportable handle types (see CUmemAllocationHandleType) for this object

### unsigned int CUmulticastObjectProp_v1::numDevices

The number of devices in the multicast team that will bind memory to this object

### size_t CUmulticastObjectProp_v1::size

The maximum amount of memory that can be bound to this multicast object per device

## 7.82. CUoffset3D_v1 Struct Reference

Struct representing a 3D offset

## 7.83. CUstreamBatchMemOpParams_v1 Union Reference

Per-operation parameters for cuStreamBatchMemOp

### CUstreamBatchMemOpParams_v1::CUstreamMemOpFlushRemoteV
### CUstreamBatchMemOpParams_v1::flushRemoteWrites

Params for CU_STREAM_MEM_OP_FLUSH_REMOTE_WRITES operations.

### CUstreamBatchMemOpParams_v1::CUstreamMemOpMemoryBarrie
### CUstreamBatchMemOpParams_v1::memoryBarrier

Params for CU_STREAM_MEM_OP_BARRIER operations.

### CUstreamBatchMemOpType CUstreamBatchMemOpParams_v1::operation

Operation. This is the first field of all the union elemets and acts as a TAG to determine which union member is valid.

### CUstreamBatchMemOpParams_v1::CUstreamMemOpWaitValuePar
### CUstreamBatchMemOpParams_v1::waitValue

Params for CU_STREAM_MEM_OP_WAIT_VALUE_32 and CU_STREAM_MEM_OP_WAIT_VALUE_64 operations.

### CUstreamBatchMemOpParams_v1::CUstreamMemOpWriteValuePa
### CUstreamBatchMemOpParams_v1::writeValue

Params for CU_STREAM_MEM_OP_WRITE_VALUE_32 and CU_STREAM_MEM_OP_WRITE_VALUE_64 operations.

## 7.84. CUstreamCigCaptureParams Struct Reference

Params for capturing CUDA stream to CIG streamCigParams must be non-NULL.

### CUstreamCigParam *CUstreamCigCaptureParams::streamCigParams

CIG (CUDA in Graphics) parameters for sharing command list data from D3D12 graphics clients.

## 7.85. CUstreamCigParam Struct Reference

CIG Stream Capture Params

### void *CUstreamCigParam::streamSharedData

Graphics client data handle (ID3D12CommandList/ID3D12GraphicsCommandList).

### CUstreamCigDataType CUstreamCigParam::streamSharedDataType

Type of shared data from graphics client (D3D12).

## 7.86. CUtensorMap Struct Reference

Tensor map descriptor. Requires compiler support for aligning to 128 bytes.

# 7.17. Difference between the driver and runtime APIs

The driver and runtime APIs are very similar and can for the most part be used interchangeably. However, there are some key differences worth noting between the two.

## Complexity vs. control

The runtime API eases device code management by providing implicit primary context initialization and management, and implicit module management. This leads to simpler code, but it also lacks the level of control that the driver API has.

In comparison, the driver API offers more fine-grained control, especially over module loading. Kernel launches are much more complex to implement, as the execution configuration and kernel parameters must be specified with explicit function calls. However, unlike the runtime, where all the kernels are automatically loaded during initialization and stay loaded for as long as the program runs, with the driver API it is possible to only keep the modules that are currently needed loaded, or even dynamically reload modules. The driver API is also language-independent as it only deals with cubin objects.

## Context management

Unless an execution context cudaExecutionContext_t is specified, the runtime API decides itself which context to use for a thread: if a context has been made current to the calling thread through the driver API, the runtime will use that, but if there is no such context, it uses the device execution context which is a "primary context." Primary contexts are created as needed, one per device per process, are reference-counted, and are then destroyed when there are no more references to them. Within one process, all users of the runtime API will share the primary context, unless a context has been made current to each thread or an explicit execution context is specified to the runtime APIs.

Using the runtime API with primary contexts has its tradeoffs, however. It can cause trouble for users writing plug-ins for larger software packages, for example, because if all plug-ins run in the same process, they will all share a context but will likely have no way to communicate with each other. So, if one of them calls `cudaDeviceReset()` after finishing all its CUDA work, the other plug-ins will fail because the context they were using was destroyed without their knowledge. To avoid this issue, CUDA clients can use the driver API to create and set the current context, and then use the runtime API to work with it. However, contexts may consume significant resources, such as device memory, extra host threads, and performance costs of context switching on the device. This runtime-driver context sharing is important when using the driver API in conjunction with libraries built on the runtime API, such as cuBLAS or cuFFT.

# Chapter 8. Data Fields

Here is a list of all documented struct and union fields with links to the struct/union documentation for each field:

## A

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- CUDA_MEM_ALLOC_NODE_PARAMS_v1
- CUDA_MEM_ALLOC_NODE_PARAMS_v2

**accessDescs**
- CUDA_MEM_ALLOC_NODE_PARAMS_v2
- CUDA_MEM_ALLOC_NODE_PARAMS_v1

**accessPolicyWindow**
- CUlaunchAttributeValue

**addressMode**
- CUDA_TEXTURE_DESC_v1

**algo**
- CUmemDecompressParams

**alignment**
- CUDA_ARRAY_MEMORY_REQUIREMENTS_v1

**alloc**
- CUgraphNodeParams

**allocType**
- CUmemPoolProps_v1

**array**
- CUmemcpy3DOperand_v1

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- CUDA_EXTERNAL_MEMORY_MIPMAPPED_ARRAY_DESC_v1

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- CUgraphNodeParams

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- CUlaunchConfig

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- CUaccessPolicyWindow_v1

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- CUDA_KERNEL_NODE_PARAMS_v1
- CUDA_KERNEL_NODE_PARAMS_v3
- CUlaunchConfig
- CUDA_KERNEL_NODE_PARAMS_v2
- CUDA_LAUNCH_PARAMS_v1

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- CUDA_KERNEL_NODE_PARAMS_v3
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- CUDA_LAUNCH_PARAMS_v1
- CUDA_KERNEL_NODE_PARAMS_v1

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- CUDA_KERNEL_NODE_PARAMS_v2
- CUDA_KERNEL_NODE_PARAMS_v3
- CUDA_KERNEL_NODE_PARAMS_v1

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- CUdevprop_v1

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CUeglFrame_v1
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CUDA_MEMCPY3D_PEER_v1
CUDA_ARRAY3D_DESCRIPTOR_v2
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CUlogicalEndpointProp
CUdevWorkqueueConfigResource
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**dstContext**
CUDA_MEMCPY3D_PEER_v1

**dstDevice**
CUDA_MEMCPY2D_v2
CUDA_MEMCPY3D_v2
CUDA_MEMCPY3D_PEER_v1

**dstHeight**
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CUDA_MEMCPY3D_v2
CUDA_MEMCPY3D_PEER_v1

**dstMemoryType**
CUDA_MEMCPY2D_v2
CUDA_MEMCPY3D_v2
CUDA_MEMCPY3D_PEER_v1

**dstNumBytes**
CUmemDecompressParams

**dstPitch**
CUDA_MEMCPY3D_v2
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CUgraphExecUpdateResultInfo_v1

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- CUDA_ARRAY_DESCRIPTOR_v2

**height**
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- CUDA_ARRAY_SPARSE_PROPERTIES_v1

**Height**
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**hStream**
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**numChannels**
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**numExecAffinityParams**
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CUctxCigParam

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- CUDA_EXTERNAL_MEMORY_BUFFER_DESC_v1
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- CUDA_MEMCPY2D_v2
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**srcLocHint**
- CUmemcpyAttributes_v1

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**srcMemoryType**
- CUDA_MEMCPY2D_v2
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**srcNumBytes**
- CUmemDecompressParams

**srcPitch**
- CUDA_MEMCPY3D_PEER_v1
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**srcXInBytes**
- CUDA_MEMCPY2D_v2
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**srcY**
- CUDA_MEMCPY3D_v2
- CUDA_MEMCPY2D_v2
- CUDA_MEMCPY3D_PEER_v1

**srcZ**
- CUDA_MEMCPY3D_v2
- CUDA_MEMCPY3D_PEER_v1

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- CUstreamCigParam

**streamSharedDataType**
- CUstreamCigParam

**subresourceType**
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**syncPolicy**
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- CUDA_EXTERNAL_SEMAPHORE_WAIT_PARAMS_v1
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**to_port**
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**totalConstantMemory**
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**type**
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- CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1
- CUexecAffinityParam_v1
- CUgraphEdgeData
- CUDA_CONDITIONAL_NODE_PARAMS
- CUasyncNotificationInfo
- CUmemAllocationProp_v1
- CUlogicalEndpointProp
- CUgraphNodeParams
- CUmemLocation_v1

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- CUDA_HOST_NODE_PARAMS_v1
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- CUDA_ARRAY_DESCRIPTOR_v2
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**width**
- CUDA_RESOURCE_DESC_v1

CUDA_MEMSET_NODE_PARAMS_v2
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**WidthInBytes**

CUDA_MEMCPY2D_v2
CUDA_MEMCPY3D_v2
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CUDA_EXTERNAL_MEMORY_HANDLE_DESC_v1
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**win32HandleMetaData**

CUmemAllocationProp_v1

**win32SecurityAttributes**

CUmemPoolProps_v1

**wqConcurrencyLimit**

CUdevWorkqueueConfigResource

**writeValue**

CUstreamBatchMemOpParams_v1

# Chapter 9. Deprecated List

**Global CU_CTX_BLOCKING_SYNC**

This flag was deprecated as of CUDA 4.0 and was replaced with CU_CTX_SCHED_BLOCKING_SYNC.

**Global CU_CTX_MAP_HOST**

This flag was deprecated as of CUDA 11.0 and it no longer has any effect. All contexts as of CUDA 3.2 behave as though the flag is enabled.

**Global CU_DEVICE_P2P_ATTRIBUTE_ACCESS_ACCESS_SUPPORTED**

use CU_DEVICE_P2P_ATTRIBUTE_CUDA_ARRAY_ACCESS_SUPPORTED instead

**Global CU_JIT_NEW_SM3X_OPT**

This jit option is deprecated and should not be used.

**Global CU_JIT_LTO**

Enable link-time optimization (-dlto) for device code (Disabled by default).

This option is not supported on 32-bit platforms.

Option type: int

Applies to: compiler and linker

**Global CU_JIT_FTZ**

Control single-precision denormals (-ftz) support (0: false, default). 1 : flushes denormal values to zero 0 : preserves denormal values Option type: int

Applies to: link-time optimization specified with CU_JIT_LTO

**Global CU_JIT_PREC_DIV**

Control single-precision floating-point division and reciprocals (-prec-div) support (1: true, default). 1 : Enables the IEEE round-to-nearest mode 0 : Enables the fast approximation mode Option type: int

Applies to: link-time optimization specified with CU_JIT_LTO

**Global CU_JIT_PREC_SQRT**

Control single-precision floating-point square root (-prec-sqrt) support (1: true, default). 1 : Enables the IEEE round-to-nearest mode 0 : Enables the fast approximation mode Option type: int

Applies to: link-time optimization specified with CU_JIT_LTO

**Global CU_JIT_FMA**

Enable/Disable the contraction of floating-point multiplies and adds/subtracts into floating-point multiply-add (-fma) operations (1: Enable, default; 0: Disable). Option type: int

Applies to: link-time optimization specified with CU_JIT_LTO

**Global CU_JIT_REFERENCED_KERNEL_NAMES**

Array of kernel names that should be preserved at link time while others can be removed.

Must contain CU_JIT_REFERENCED_KERNEL_COUNT entries.

Note that kernel names can be mangled by the compiler in which case the mangled name needs to be specified.

Wildcard "*" can be used to represent zero or more characters instead of specifying the full or mangled name.

It is important to note that the wildcard "*" is also added implicitly. For example, specifying "foo" will match "foobaz", "barfoo", "barfoobaz" and thus preserve all kernels with those names. This can be avoided by providing a more specific name like "barfoobaz".

Option type: const char **

Applies to: dynamic linker only

**Global CU_JIT_REFERENCED_KERNEL_COUNT**

Number of entries in CU_JIT_REFERENCED_KERNEL_NAMES array.

Option type: unsigned int

Applies to: dynamic linker only

**Global CU_JIT_REFERENCED_VARIABLE_NAMES**

Array of variable names (__device__ and/or __constant__) that should be preserved at link time while others can be removed.

Must contain CU_JIT_REFERENCED_VARIABLE_COUNT entries.

Note that variable names can be mangled by the compiler in which case the mangled name needs to be specified.

Wildcard "*" can be used to represent zero or more characters instead of specifying the full or mangled name.

It is important to note that the wildcard "*" is also added implicitly. For example, specifying "foo" will match "foobaz", "barfoo", "barfoobaz" and thus preserve all variables with those names. This can be avoided by providing a more specific name like "barfoobaz".

Option type: const char **

Applies to: link-time optimization specified with CU_JIT_LTO

**Global CU_JIT_REFERENCED_VARIABLE_COUNT**

Number of entries in CU_JIT_REFERENCED_VARIABLE_NAMES array.

Option type: unsigned int

Applies to: link-time optimization specified with CU_JIT_LTO

**Global CU_JIT_OPTIMIZE_UNUSED_DEVICE_VARIABLES**

This option serves as a hint to enable the JIT compiler/linker to remove constant (__constant__) and device (__device__) variables unreferenced in device code (Disabled by default).

Note that host references to constant and device variables using APIs like cuModuleGetGlobal() with this option specified may result in undefined behavior unless the variables are explicitly specified using CU_JIT_REFERENCED_VARIABLE_NAMES.

Option type: int

Applies to: link-time optimization specified with CU_JIT_LTO

**Global CU_JIT_INPUT_NVVM**

High-level intermediate code for link-time optimization

Applicable options: NVVM compiler options, PTX compiler options

**Global CUDA_ERROR_PROFILER_NOT_INITIALIZED**

This error return is deprecated as of CUDA 5.0. It is no longer an error to attempt to enable/disable the profiling via cuProfilerStart or cuProfilerStop without initialization.

**Global CUDA_ERROR_PROFILER_ALREADY_STARTED**

This error return is deprecated as of CUDA 5.0. It is no longer an error to call cuProfilerStart() when profiling is already enabled.

**Global CUDA_ERROR_PROFILER_ALREADY_STOPPED**

This error return is deprecated as of CUDA 5.0. It is no longer an error to call cuProfilerStop() when profiling is already disabled.

**Global CUDA_ERROR_CONTEXT_ALREADY_CURRENT**

This error return is deprecated as of CUDA 3.2. It is no longer an error to attempt to push the active context via cuCtxPushCurrent().

**Global CUsharedconfig**

**Global cuDeviceComputeCapability**

**Global cuDeviceGetProperties**

**Global cuCtxAttach**

**Global cuCtxDetach**

**Global cuCtxGetSharedMemConfig**

**Global cuCtxSetSharedMemConfig**

**Global cuModuleGetSurfRef**

**Global cuModuleGetTexRef**

**Global cuFuncSetBlockShape**

**Global cuFuncSetSharedMemConfig**

**Global cuFuncSetSharedSize**

**Global cuLaunch**

**Global cuLaunchCooperativeKernelMultiDevice**

This function is deprecated as of CUDA 11.3.

**Global cuLaunchGrid**

**Global cuLaunchGridAsync**

**Global cuParamSetf**

**Global cuParamSeti**

**Global cuParamSetSize**

**Global cuParamSetTexRef**

**Global cuParamSetv**

**Global cuTexRefCreate**

**Global cuTexRefDestroy**

**Global cuTexRefGetAddress**

**Global cuTexRefGetAddressMode**

**Global cuTexRefGetArray**

**Global cuTexRefGetBorderColor**

**Global cuTexRefGetFilterMode**

**Global cuTexRefGetFlags**

**Global cuTexRefGetFormat**

**Global cuTexRefGetMaxAnisotropy**

**Global cuTexRefGetMipmapFilterMode**

**Global cuTexRefGetMipmapLevelBias**

**Global cuTexRefGetMipmapLevelClamp**

**Global cuTexRefGetMipmappedArray**

**Global cuTexRefSetAddress**

**Global cuTexRefSetAddress2D**

**Global cuTexRefSetAddressMode**

**Global cuTexRefSetArray**

**Global cuTexRefSetBorderColor**

**Global cuTexRefSetFilterMode**

**Global cuTexRefSetFlags**

**Global cuTexRefSetFormat**

**Global cuTexRefSetMaxAnisotropy**

**Global cuTexRefSetMipmapFilterMode**

**Global cuTexRefSetMipmapLevelBias**

**Global cuTexRefSetMipmapLevelClamp**

**Global cuTexRefSetMipmappedArray**

**Global cuSurfRefGetArray**

**Global cuSurfRefSetArray**

**Global cuProfilerInitialize**

**Global cuGLCtxCreate**

This function is deprecated as of Cuda 5.0.

**Global cuGLInit**

This function is deprecated as of Cuda 3.0.

**Global cuGLMapBufferObject**

This function is deprecated as of Cuda 3.0.

**Global cuGLMapBufferObjectAsync**

This function is deprecated as of Cuda 3.0.

**Global cuGLRegisterBufferObject**

This function is deprecated as of Cuda 3.0.

**Global cuGLSetBufferObjectMapFlags**

This function is deprecated as of Cuda 3.0.

**Global cuGLUnmapBufferObject**

This function is deprecated as of Cuda 3.0.

**Global cuGLUnmapBufferObjectAsync**

This function is deprecated as of Cuda 3.0.

**Global cuGLUnregisterBufferObject**

This function is deprecated as of Cuda 3.0.

**Global cuD3D9MapResources**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9RegisterResource**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedArray**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedPitch**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedPointer**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetMappedSize**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceGetSurfaceDimensions**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9ResourceSetMapFlags**

This function is deprecated as of Cuda 3.0.

**Global cuD3D9UnmapResources**

This function is deprecated as of CUDA 3.0.

**Global cuD3D9UnregisterResource**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10CtxCreate**

This function is deprecated as of CUDA 5.0.

**Global cuD3D10CtxCreateOnDevice**

This function is deprecated as of CUDA 5.0.

**Global cuD3D10GetDirect3DDevice**

This function is deprecated as of CUDA 5.0.

**Global cuD3D10MapResources**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10RegisterResource**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceGetMappedArray**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceGetMappedPitch**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceGetMappedPointer**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceGetMappedSize**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceGetSurfaceDimensions**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10ResourceSetMapFlags**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10UnmapResources**

This function is deprecated as of CUDA 3.0.

**Global cuD3D10UnregisterResource**

This function is deprecated as of CUDA 3.0.

**Global cuD3D11CtxCreate**

This function is deprecated as of CUDA 5.0.

**Global cuD3D11CtxCreateOnDevice**

This function is deprecated as of CUDA 5.0.

**Global cuD3D11GetDirect3DDevice**

This function is deprecated as of CUDA 5.0.

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