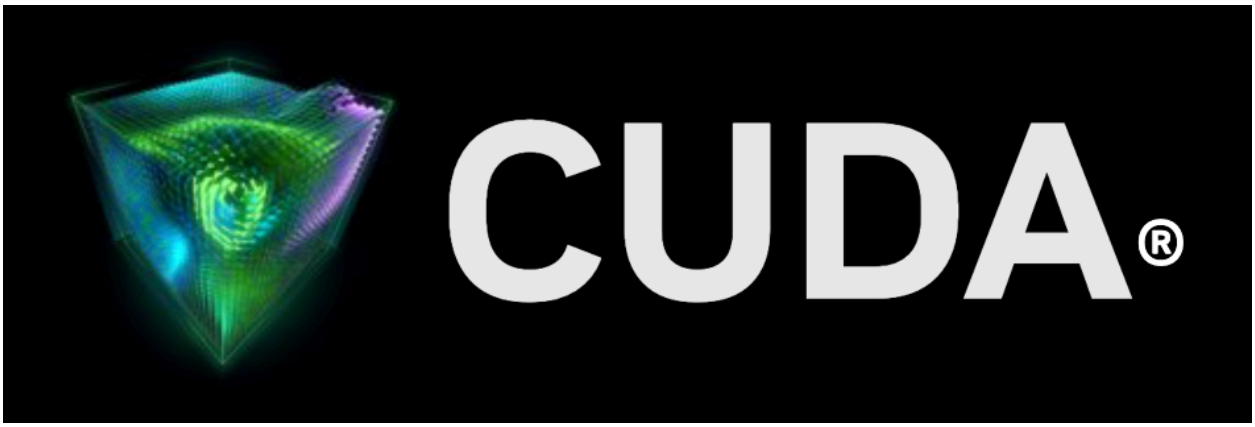

Release Notes

Release 13.0

NVIDIA Corporation

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Contents

Chapter 1. Overview

CUDA Toolkit 13.0 Update 2 - Release Notes

Welcome to the release notes for NVIDIA® CUDA® Toolkit 13.0 Update 2. This release includes enhancements and fixes across the CUDA Toolkit and its libraries.

This documentation is organized into two main sections:

- **General CUDA**

  Focuses on the core CUDA infrastructure including component versions, driver compatibility, compiler/runtime features, issues, and deprecations.

- **CUDA Libraries**

  Covers the specialized computational libraries with their feature updates, performance improvements, API changes, and version history across CUDA 13.x releases.

Chapter 2. General CUDA

2.1. CUDA Toolkit Major Components

Note: Starting with CUDA 11, individual components within the CUDA Toolkit (for example: compiler, libraries, tools) are versioned independently.

For CUDA 13.0 Update 2, the table below indicates the versions:

Table 1: CUDA 13.0 Update 2 Component Versions

Component Name		Version Information	Supported Architectures	Supported Platforms
CUDA C++ Core Compute Libraries	Thrust	3.0.1	x86_64, arm64-sbsa	Linux, Windows
	CUB	3.0.1		
	libcu++	3.0.1		
	Cooperative Groups	13.0.85		
CUDA Application Compiler (crt)		13.0.88	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA Compilation Optimizer (ctadvisor)		13.0.85	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA Runtime (cudart)		13.0.96	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA culibos		13.0.85	x86_64, arm64-sbsa	Linux
CUDA cuobjdump		13.0.85	x86_64, arm64-sbsa	Linux, Windows
CUPTI		13.0.85	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA cuxxfilt (demangler)		13.0.85	x86_64, arm64-sbsa	Linux, Windows

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Table 1 – continued from previous page

Component Name	Version Information	Supported Architectures	Supported Platforms
CUDA Documentation	13.0.85	x86_64	Linux, Windows
CUDA GDB	13.0.85	x86_64, arm64-sbsa	Linux, WSL
CUDA Nsight Eclipse Plugin	13.0.85	x86_64	Linux
CUDA NVCC	13.0.88	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA nvdisasm	13.0.85	x86_64, arm64-sbsa	Linux, Windows
CUDA NVML Headers	13.0.87	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA nvprune	13.0.85	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA NVRTC	13.0.88	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA NVTX	13.0.85	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA OpenCL	13.0.85	x86_64	Linux, Windows
CUDA Profiler API	13.0.85	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA Sandbox dev	13.0.85	x86_64, arm64-sbsa	Linux, WSL
CUDA Compute Sanitizer API	13.0.85	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA cuBLAS	13.1.0.3	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA cuFFT	12.0.0.61	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA cuFile	1.15.1.6	x86_64, arm64-sbsa	Linux
CUDA cuRAND	10.4.0.35	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA cuSOLVER	12.0.4.66	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA cuSPARSE	12.6.3.3	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA NPP	13.0.1.2	x86_64, arm64-sbsa	Linux, Windows, WSL

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Table 1 – continued from previous page

Component Name	Version Information	Supported Architectures	Supported Platforms
CUDA nvFatbin	13.0.85	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA nvJitLink	13.0.88	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA nvJPEG	13.0.1.86	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA nvptxcompiler	13.0.88	x86_64, arm64-sbsa	Linux, Windows, WSL
CUDA nvsdm	580.95.05	x86_64	Linux, Windows, WSL
CUDA nvvm	13.0.88	x86_64, arm64-sbsa	Linux, Windows, WSL
Nsight Compute	2025.3.1.4	x86_64, arm64-sbsa	Windows, WSL (Windows 11)
Nsight Systems	2025.3.2.474	x86_64, arm64-sbsa	Linux, Windows, WSL
Nsight Visual Studio Edition (VSE)	2025.3.1.25227	x86_64 (Windows)	Windows
nvidia_fs[1]	2.26.6	x86_64, arm64-sbsa	Linux
Visual Studio Integration	13.0.85	x86_64 (Windows)	Windows
NVIDIA Linux Driver	580.95.05	x86_64, arm64-sbsa	Linux

2.2. CUDA Driver

Running a CUDA application requires the system with at least one CUDA capable GPU and a driver that is compatible with the CUDA Toolkit. See Table 3. For more information various GPU products that are CUDA capable, visit https://developer.nvidia.com/cuda-gpus.

Each release of the CUDA Toolkit requires a minimum version of the CUDA driver. The CUDA driver is backward compatible, meaning that applications compiled against a particular version of the CUDA will continue to work on subsequent (later) driver releases.

More information on compatibility can be found at https://docs.nvidia.com/cuda/cuda-c-best-practices-guide/index.html#cuda-compatibility-and-upgrades.

Note: Starting with CUDA 11.0, the toolkit components are individually versioned, and the toolkit itself is versioned as shown in the table below.

[1] Only available on select Linux distros

The minimum required driver version for CUDA minor version compatibility is shown below. CUDA minor version compatibility is described in detail in https://docs.nvidia.com/deploy/cuda-compatibility/index.html

Table 2: CUDA Toolkit and Minimum Required Driver Version for CUDA Minor Version Compatibility

CTK Version	Driver Range for Minor Version Compatibility	
	Min	Max
13.x	>= 580	N/A
12.x	>= 525	< 580
11.x	>= 450	< 525

* Using a Minimum Required Version that is **different** from Toolkit Driver Version could be allowed in compatibility mode – please read the CUDA Compatibility Guide for details.

** Starting with CUDA 13.0, the Windows display driver is **no longer** bundled with the CUDA Toolkit package. Users must download and install the appropriate NVIDIA driver separately from the official driver download page.

For more information on supported driver versions, see the CUDA Compatibility Guide for drivers.

*** CUDA 11.0 was released with an earlier driver version, but by upgrading to Tesla Recommended Drivers 450.80.02 (Linux) / 452.39 (Windows), minor version compatibility is possible across the CUDA 11.x family of toolkits.

The version of the development NVIDIA GPU Driver packaged in each CUDA Toolkit release is shown below.

Table 3: CUDA Toolkit and Corresponding Driver Versions

CUDA Toolkit	Toolkit Driver Version	
	Linux x86_64 Driver Version	Windows x86_64 Driver Version
CUDA 13.0 Update 2	>=580.95.05	N/A
CUDA 13.0 Update 1	>=580.82.07	N/A
CUDA 13.0 GA	>=580.65.06	N/A
CUDA 12.9 Update 1	>=575.57.08	>=576.57
CUDA 12.9 GA	>=575.51.03	>=576.02
CUDA 12.8 Update 1	>=570.124.06	>=572.61
CUDA 12.8 GA	>=570.26	>=570.65
CUDA 12.6 Update 3	>=560.35.05	>=561.17
CUDA 12.6 Update 2	>=560.35.03	>=560.94
CUDA 12.6 Update 1	>=560.35.03	>=560.94
CUDA 12.6 GA	>=560.28.03	>=560.76

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Table 3 – continued from previous page

CUDA Toolkit	Toolkit Driver Version	
CUDA 12.5 Update 1	>=555.42.06	>=555.85
CUDA 12.5 GA	>=555.42.02	>=555.85
CUDA 12.4 Update 1	>=550.54.15	>=551.78
CUDA 12.4 GA	>=550.54.14	>=551.61
CUDA 12.3 Update 1	>=545.23.08	>=546.12
CUDA 12.3 GA	>=545.23.06	>=545.84
CUDA 12.2 Update 2	>=535.104.05	>=537.13
CUDA 12.2 Update 1	>=535.86.09	>=536.67
CUDA 12.2 GA	>=535.54.03	>=536.25
CUDA 12.1 Update 1	>=530.30.02	>=531.14
CUDA 12.1 GA	>=530.30.02	>=531.14
CUDA 12.0 Update 1	>=525.85.12	>=528.33
CUDA 12.0 GA	>=525.60.13	>=527.41
CUDA 11.8 GA	>=520.61.05	>=520.06
CUDA 11.7 Update 1	>=515.48.07	>=516.31
CUDA 11.7 GA	>=515.43.04	>=516.01
CUDA 11.6 Update 2	>=510.47.03	>=511.65
CUDA 11.6 Update 1	>=510.47.03	>=511.65
CUDA 11.6 GA	>=510.39.01	>=511.23
CUDA 11.5 Update 2	>=495.29.05	>=496.13
CUDA 11.5 Update 1	>=495.29.05	>=496.13
CUDA 11.5 GA	>=495.29.05	>=496.04
CUDA 11.4 Update 4	>=470.82.01	>=472.50
CUDA 11.4 Update 3	>=470.82.01	>=472.50
CUDA 11.4 Update 2	>=470.57.02	>=471.41
CUDA 11.4 Update 1	>=470.57.02	>=471.41
CUDA 11.4.0 GA	>=470.42.01	>=471.11
CUDA 11.3.1 Update 1	>=465.19.01	>=465.89
CUDA 11.3.0 GA	>=465.19.01	>=465.89
CUDA 11.2.2 Update 2	>=460.32.03	>=461.33
CUDA 11.2.1 Update 1	>=460.32.03	>=461.09
CUDA 11.2.0 GA	>=460.27.03	>=460.82

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Table 3 – continued from previous page

CUDA Toolkit	Toolkit Driver Version	
CUDA 11.1.1 Update 1	>=455.32	>=456.81
CUDA 11.1 GA	>=455.23	>=456.38
CUDA 11.0.3 Update 1	>= 450.51.06	>= 451.82
CUDA 11.0.2 GA	>= 450.51.05	>= 451.48
CUDA 11.0.1 RC	>= 450.36.06	>= 451.22
CUDA 10.2.89	>= 440.33	>= 441.22
CUDA 10.1 (10.1.105 general release, and updates)	>= 418.39	>= 418.96
CUDA 10.0.130	>= 410.48	>= 411.31
CUDA 9.2 (9.2.148 Update 1)	>= 396.37	>= 398.26
CUDA 9.2 (9.2.88)	>= 396.26	>= 397.44
CUDA 9.1 (9.1.85)	>= 390.46	>= 391.29
CUDA 9.0 (9.0.76)	>= 384.81	>= 385.54
CUDA 8.0 (8.0.61 GA2)	>= 375.26	>= 376.51
CUDA 8.0 (8.0.44)	>= 367.48	>= 369.30
CUDA 7.5 (7.5.16)	>= 352.31	>= 353.66
CUDA 7.0 (7.0.28)	>= 346.46	>= 347.62

- CUDA Toolkit driver bundling (pre-CUDA 13.0):
  - The CUDA Toolkit previously included an NVIDIA display driver for convenience.
  - This bundled driver was intended only for development purposes.
  - It is not recommended for production use, especially with Tesla GPUs.
- Recommended driver for Tesla GPUs:
  - For production environments using Tesla GPUs, download the latest certified driver from the official NVIDIA Driver Downloads site:

    https://www.nvidia.com/drivers
- Optional driver installation during Toolkit setup:
  - During CUDA Toolkit installation, users may choose to skip driver installation:
    - On Windows: via interactive or silent install options.
    - On Linux: by skipping driver meta packages.
- Change in CUDA 13.0 (Windows-specific):
  - Starting with CUDA 13.0, the Windows display driver is **no longer bundled** with the CUDA Toolkit.
  - Windows users must **manually download and install** the appropriate driver from the official NVIDIA site.
- Driver compatibility notes:

- Some compatibility tables may list “N/A” for Windows driver versions.
- Users must still ensure the installed driver meets or exceeds the minimum required version for the CUDA Toolkit.
- For details, refer to the official CUDA Compatibility Guide for Drivers:

  https://docs.nvidia.com/deploy/cuda-compatibility/index.html

2.3. New Features

CUDA 13.0 is a new major version. CUDA follows semantic versioning, and guarantees ABI stability within the major version series. CUDA Toolkit releases in the 13.x series are ABI-compatible with drivers corresponding to the same series (r580 and newer). Note that CUDA’s API can evolve over the course of a major release to include new functionality, and not all new functionality may be supported on older drivers.

2.3.1. General CUDA

- Enabled opt-in fixed-point emulation for FP64 matmuls (D/ZGEMM) which improves performance and power-efficiency. The implementation follows the Ozaki-1 Scheme and leverages an automatic dynamic precision framework to ensure FP64-level accuracy. See here for more details on fixed-point emulation along with the table of supported compute-capabilities and the CUDA library samples for example usages.

2.3.2. CUDA Compiler

- For changes to PTX, refer to https://docs.nvidia.com/cuda/parallel-thread-execution/#ptx-isa-version-9-0.

2.3.3. CUDA Developer Tools

For details on new features, improvements, and bug fixes, see the changelogs for:

- Nsight Systems.
- Nsight Visual Studio Edition.
- CUPTI.
- Nsight Compute.
- Compute Sanitizer.
- CUDA-C++-Programming-Guide.

2.4. Known Issues

2.4.1. General CUDA

- Certain Linux kernels with KASLR enabled have a known issue in HMM initialization, causing CUDA initialization to fail. This issue is indicated by the following debug message:

```
[64689.125237] nvidia-uvm: uvm_pmm_gpu.c:3176 devmem_alloc_
↪pagemap[pid:92821] request_free_mem_region() err -34
```

  Fixes to this issue are being handled in upstream kernels. In the meantime, you can use one of the following workarounds:

  - Option 1: Disable KASLR (Preferred option)

    If using GRUB, edit /etc/default/grub and add `nokaslr` to `GRUB_CMDLINE_LINUX_DEFAULT`:

```
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash nokaslr"
```

    Then, update GRUB and reboot:

```
sudo update-grub
sudo reboot
```

  - Option 2: Disable HMM for UVM

    1. Create or edit /etc/modprobe.d/uvm.conf.
    2. Add or update the following line:

```
options nvidia_uvm uvm_disable_hmm=1
```

    3. Unload and reload the `nvidia_uvm` kernel module or reboot the system:

```
sudo modprobe -r nvidia_uvm
sudo modprobe nvidia_uvm
```

2.5. Deprecated or Dropped Features

2.5.1. General CUDA

- CUDA 13.0 deprecates the following legacy vector types:
  - `double4`
  - `long4`
  - `ulong4`
  - `longlong4`
  - `ulonglong4`

These types are being replaced by new aligned variants:

- `*_16a` and `*_32a` (e.g., `double4_16a`, `double4_32a`)

Deprecation warnings can be managed as follows:

- Globally silenced by defining `__NV_NO_VECTOR_DEPRECATION_DIAG`
- Locally suppressed using the macro pair `__NV_SILENCE_HOST_DEPRECATION_BEGIN` / `__NV_SILENCE_HOST_DEPRECATION_END`

These legacy types are planned for removal in CUDA 14.0.

- The **CUDA installer** for Windows **no longer** bundles the display driver. Users must install the display driver separately, either before or after installing the CUDA Toolkit.
- **Multi-device launch APIs** and related references for Cooperative Groups **have been removed**. These APIs were previously marked as deprecated in CUDA 12.x:
  - `cudaLaunchCooperativeKernelMultiDevice` has been removed from `cuda_runtime_api.h`.
  - The accompanying parameter struct `cudaLaunchParam` has been removed from `driver_types.h`.
  - `this_multi_grid` and `multi_grid_group` have been removed from `cooperative_groups.h`.
- **Changes to cudaDeviceProperties structure**:

  In CUDA 13.0, several deprecated fields have been removed from the `cudaDeviceProperties` structure. To ensure forward compatibility, use the recommended replacement APIs listed below:

  Removed Fields and Their Replacements

Removed Field	Replacement API
clockRate	`cudaDeviceGetAttribute(cudaDevAttrClockRate)`
deviceOverlap	Use the `asyncEngineCount` field
kernelExecTimeoutEnabled	`cudaDeviceGetAttribute(cudaDevAttrKernelExecTimeout)`
computeMode	`cudaDeviceGetAttribute(cudaDevAttrComputeMode)`
maxTexture1DLinear	`cudaDeviceGetTexture1DLinearMaxWidth()`
memoryClockRate	`cudaDeviceGetAttribute(cudaDevAttrMemoryClockRate)`
singleToDoublePrecisionPerfRatio	`cudaDeviceGetAttribute(cudaDevAttrSingleToDoublePrecisionPerfRat`
cooperativeMultiDeviceLaunch	*No replacement available*

  Removed cudaDeviceAttr Types (No Replacement Available)

  - `cudaDevAttrCooperativeMultiDeviceLaunch`
  - `cudaDevAttrMaxTimelineSemaphoreInteropSupported`
- The following legacy header files related to deprecated texture and surface references have been removed from the CUDA 13.0 runtime:

- cuda_surface_types.h
- cuda_texture_types.h
- surface_functions.h
- texture_fetch_functions.h

2.5.2. Deprecated Architectures

- Architecture support for Maxwell, Pascal, and Volta is considered feature-complete. Offline compilation and library support for these architectures have been removed in CUDA Toolkit 13.0 major version release. The use of CUDA Toolkits through the 12.x series to build applications for these architectures will continue to be supported, but newer toolkits will be unable to target these architectures.

2.5.3. Deprecated or Dropped Operating Systems

- Support for Ubuntu 20.04 has been dropped starting with this release. Users are advised to migrate to Ubuntu 22.04 LTS or later.

2.5.4. Deprecated or Dropped CUDA Toolchains

CUDA Tools

- The profiling tools **NVIDIA Visual Profiler** and **nvprof** have been removed in CUDA 13.0. Users are encouraged to migrate to the next-generation tools:
  - NVIDIA Nsight Systems for GPU and CPU sampling and tracing
  - NVIDIA Nsight Compute for detailed GPU kernel profiling
- The pre-built CUDA Demo Suite applications have been removed in CUDA 13.0. Users are encouraged to build CUDA Samples from source, available on GitHub.
- The `nv-p2p` APIs are deprecated starting with CUDA 13.0 and will be removed in CUDA 14.0. These APIs remain functional in CUDA 13.0 but will no longer receive enhancements or bug fixes.
- The following CUPTI APIs and features have been removed in CUDA 13.0:
  - CUPTI Event API (`cupti_events.h`)
  - CUPTI Metric API (`cupti_metrics.h`)
  - PC Sampling Activity API (`cupti_activity.h`)
  - Source/SASS-level metrics (`cupti_activity.h`)
- The following APIs have been deprecated in CUDA 13.0:
  - CUPTI Profiling API (`cupti_profiler_target.h`)
  - Perfworks Metric API (`nvperf_host.h`)

  Users are encouraged to transition to the following replacements:
  - CUPTI Range Profiling API (`cupti_range_profiler.h`)

- CUPTI Profiler Host API (`cupti_profiler_host.h`)

CUDA Compiler

- The following host compilers are no longer supported as of CUDA 13.0:
  - Intel ICC 2021.7
  - Microsoft Visual Studio 2017 (MSVC 2017)

Chapter 3. CUDA Libraries

This section covers CUDA Libraries release notes for 13.x releases.

Note: Documentation will be updated to accurately reflect supported C++ standard libraries for CUDA Math Libraries.

3.1. cuBLAS Library

3.1.1. cuBLAS: Release 13.0 Update 2

- **New Features**
  - Enabled opt-in fixed-point emulation for FP64 matmuls (D/ZGEMM) which improves performance and power-efficiency. The implementation follows the Ozaki-1 Scheme and leverages an automatic dynamic precision framework to ensure FP64-level accuracy. See here for more details on fixed-point emulation along with the table of supported compute-capabilities and the CUDA library samples for example usages.
  - Improved performance on NVIDIA DGX Spark for FP16/BF16 and FP8 GEMMs.
  - Added support for BF16x9 FP32 emulation to `cublas[SC]syr[2]k` and `cublasCher[2]k` routines. With the math mode set to `CUBLAS_FP32_EMULATED_BF16X9_MATH`, for large enough problems, cuBLAS will automatically dispatch SYRK and HERK to BF16x9-accelerated algorithms.
- **Resolved Issues**
  - Fixed undefined behavior caused by dereferencing a `nullptr` when passing an uninitialized matrix layout descriptor for `Cdesc` in `cublasLtMatmul`. [*CUB-8911*]
  - Improved performance of `cublas[SCDZ]syr[2]k` and `cublas[CZ]her[2]k` on Hopper GPUs when dimension `N` is large. [*CUB-8293*, *5384826*]
- **Known Issues**
  - `cublasLtMatmul` with INT8 inputs, INT32 accumulation, and INT32 outputs might return `CUBLAS_STATUS_NOT_SUPPORTED` when dimension `N` is larger than 65,536 or when the batch count is larger than 1. The issue has existed since CUDA Toolkit 13.0 Update 1 and will be fixed in a later release. [*5541380*]

- On multi-device Blackwell GeForce systems, FP8 matmuls might fail to launch. The issue can be alleviated by running a process per device. [*CUB-9487*]

3.1.2. cuBLAS: Release 13.0 Update 1

- **New Features**
  - Improved performance:
    - Block-scaled FP4 GEMMs on NVIDIA Blackwell and Blackwell Ultra GPUs
    - SYMV on NVIDIA Blackwell GPUs [*5171345*]
    - `cublasLtMatmul` for small cases when run concurrently with other CUDA kernels [*5238629*]
    - TF32 GEMMs on Thor GPUs [*5313616*]
    - Programmatic Dependent Launch (PDL) is now supported in some cuBLAS kernels for architectures `sm_90` and above, decreasing kernel launch latencies when executed alongside other PDL kernels.
- **Resolved Issues**
  - Fixed an issue where some `cublasSsyrkx` kernels produced incorrect results when `beta = 0` on NVIDIA Blackwell GPUs. [*CUB-8846*]
  - Resolved issues in `cublasLtMatmul` with INT8 inputs, INT32 accumulation, and INT32 outputs where:
    - `cublasLtMatmul` could have produced incorrect results when A and B matrices used regular ordering (*CUBLASLT_ORDER_COL* or *CUBLASLT_ORDER_ROW*). [*CUB-8874*]
    - `cublasLtMatmul` could have been run with unsupported configurations of `alpha`/`beta`, which must be 0 or 1. [*CUB-8873*]

3.1.3. cuBLAS: Release 13.0

- **New Features**
  - The `cublasGemmEx`, `cublasGemmBatchedEx`, and `cublasGemmStridedBatchedEx` functions now accept `CUBLAS_GEMM_AUTOTUNE` as a valid value for the `algo` parameter. When this option is used, the library benchmarks a selection of available algorithms internally and chooses the optimal one based on the given problem configuration. The selected algorithm is cached within the current `cublasHandle_t`, so subsequent calls with the same problem descriptor will reuse the cached configuration for improved performance.

    This is an experimental feature. Users are encouraged to transition to the cuBLASLt API, which provides fine-grained control over algorithm selection through the heuristics API and includes support for additional data types such as FP8 and block-scaled formats, as well as kernel fusion. (see autotuning example in cuBLASLt).
  - Improved performance of BLAS Level 3 non-GEMM kernels (SYRK, HERK, TRMM, SYMM, HEMM) for FP32 and CF32 precisions on NVIDIA Blackwell GPUs.
  - This release adds support of SM110 GPUs for arm64-sbsa on Linux.
- **Known Issues**

- `cublasLtMatmul` previously ignored user-specified auxiliary (Aux) data types for ReLU epilogues and defaulted to using a bitmask. The correct behavior is now enforced: an error is returned if an invalid Aux data type is specified for ReLU epilogues. *[CUB-7984]*

- **Deprecations**
  - The experimental feature for atomic synchronization along the rows (`CUBLASLT_MATMUL_DESC_ATOMIC_SYNC_NUM_CHUNKS_D_ROWS`) and columns (`CUBLASLT_MATMUL_DESC_ATOMIC_SYNC_NUM_CHUNKS_D_COLS`) of the output matrix which was deprecated in 12.8 has now been **removed**.
  - Starting with this release, cuBLAS will return `CUBLAS_STATUS_NOT_SUPPORTED` if any of the following descriptor attributes are set but the corresponding scale is not supported:
    - `CUBLASLT_MATMUL_DESC_A_SCALE_POINTER`
    - `CUBLASLT_MATMUL_DESC_B_SCALE_POINTER`
    - `CUBLASLT_MATMUL_DESC_D_SCALE_POINTER`
    - `CUBLASLT_MATMUL_DESC_D_OUT_SCALE_POINTER`
    - `CUBLASLT_MATMUL_DESC_EPILOGUE_AUX_SCALE_POINTER`
  - Previously, this restriction applied only to non-narrow precision matmuls. It now also applies to narrow precision matmuls when a scale is set for a non-narrow precision tensor.

3.2. cuFFT Library

3.2.1. cuFFT: Release 13.0 Update 1

- **Known Issues**
  - In CUDA 13.0, a correctness issue affects a specific subset of kernels, namely half and bfloat precision size 1 strided R2C and C2R kernels. A fix will be included in a future CUDA release.

3.2.2. cuFFT: Release 13.0

- **New Features**
  - Added new error codes:
    - `CUFFT_MISSING_DEPENDENCY`
    - `CUFFT_NVRTC_FAILURE`
    - `CUFFT_NVJITLINK_FAILURE`
    - `CUFFT_NVSHMEM_FAILURE`
  - Introduced `CUFFT_PLAN_NULL`, a value that can be assigned to a `cufftHandle` to indicate a null handle. It is safe to call `cufftDestroy` on a null handle.
  - Improved performance for single-precision C2C multi-dimensional FFTs and large power-of-2 FFTs.
- **Known Issues**

- An issue identified in CUDA 13.0 affects the correctness of a specific subset of cuFFT kernels, specifically half-precision and bfloat16 size-1 strided R2C and C2R transforms. A fix will be included in a future CUDA release.

- **Deprecations**
  - Removed support for Maxwell, Pascal, and Volta GPUs, corresponding to compute capabilities earlier than Turing.
  - Removed legacy cuFFT error codes:
    - `CUFFT_INCOMPLETE_PARAMETER_LIST`
    - `CUFFT_PARSE_ERROR`
    - `CUFFT_LICENSE_ERROR`
  - Removed the `libcufft_static_nocallback.a` static library. Users should link against `libcufft_static.a` instead, as both are functionally equivalent.

3.3. cuSOLVER Library

3.3.1. cuSOLVER: Release 13.0 Update 1

- **Resolved Issues**
  - Fixed a race condition in *cusolverDnXgeev* that could occur when using multiple host threads with either separate handles per thread or a shared handle, which caused execution to abort and returned CUSOLVER_STATUS_INTERNAL_ERROR.

3.3.2. cuSOLVER: Release 13.0

- **New Features**
  - cuSOLVER offers a new math mode to leverage improved performance of emulated FP32 arithmetic on Nvidia Blackwell GPUs.

    To enable and control this feature, the following new APIs have been added:
    - `cusolverDnSetMathMode()`
    - `cusolverDnGetMathMode()`
    - `cusolverDnSetEmulationStrategy()`
    - `cusolverDnGetEmulationStrategy()`
  - Performance improvements for `cusolverDnXsyevBatched()` have been made by introducing an internal algorithm switch on Blackwell GPUs for matrices of size `n <= 32`.

    To revert to the previous algorithm for all problem sizes, use cusolverDnSetAdvOptions().

    For more details, refer to the cusolverDnXsyevBatched() documentation.
- **Deprecations**

- `cuSOLVERMg` is deprecated and may be removed in an upcoming major release. Users are encouraged to use cuSOLVERMp for multi-GPU functionality across both single and multi-node environments. To disable the deprecation warning, add the compiler flag `-DDISABLE_CUSOLVERMG_DEPRECATED`.
- `cuSOLVERSp` and `cuSOLVERRf` are fully deprecated and may be removed in an upcoming major release. Users are encouraged to use the cuDSS library for better performance and ongoing support.

  For help with the transition, refer to the cuDSS samples or CUDA samples for migrating from `cuSOLVERSp` to `cuDSS`.

  To disable the deprecation warning, add the compiler flag: `-DDISABLE_CUSOLVER_DEPRECATED`.

- **Resolved Issues**
  - The supported input matrix size for `cusolverDnXsyevd`, `cusolverDnXsyevdx`, `cusolverDnXsyevBatched`, `cusolverDn<t>syevd`, and `cusolverDn<t>syevdx` is no longer limited to `n <= 32768`.

    This update also applies to routines that share the same internal implementation: `cusolverDnXgesvdr`, `cusolverDnXgesvdp`, `cusolverDn<t>sygvd`, `cusolverDn<t>sygvdx`, and `cusolverDn<t>gesvdaStridedBatched`.

3.4. cuSPARSE Library

3.4.1. cuSPARSE: Release 13.0 Update 1

- **New Features**
  - Added support for the BSR format in the generic SpMV API *(CUSPARSE-2518)*.
- **Deprecation**
  - Deprecated the legacy BSR SpMV API (replaced by the generic SpMV API).
- **Resolved Issues**
  - Enabled all generic APIs to support zero-dimension matrices/vectors (m, n, k = 0) *(CUSPARSE-2378)*.
  - Enabled all generic APIs to support small-dimension matrices/vectors (small m, n, or k) *(CUSPARSE-2379)*.
  - Fixed incorrect results in mixed-precision CSR/COO SpMV computations *(CUSPARSE-2349)*.

3.4.2. cuSPARSE: Release 13.0

- **New Features**
  - Added support for 64-bit index matrices in SpGEMM computation. *(CUSPARSE-2365)*
- **Known Issues**
  - cuSPARSE logging APIs can crash on Windows.
  - `CUSPARSE_SPMM_CSR_ALG3` does not return deterministic results as stated in the documentation.
- **Deprecation**
  - Dropped support for pre-Turing architectures (Maxwell, Volta, and Pascal).
- **Resolved Issues**
  - Fixed a bug in `cusparseSparseToDense_bufferSize` that caused it to request up to 16× more memory than required. *[CUSPARSE-2352]*
  - Fixed unwanted 16-byte alignment requirements on the external buffer. Most routines will now work with any alignment. In the generic API, only `cusparseSpGEMM` routines are still affected. *[CUSPARSE-2352]*
  - Fixed incorrect results from `cusparseCsr2cscEx2` when any of the input matrix dimensions are zero, such as when `m = 0` or `n = 0`. *[CUSPARSE-2319]*
  - Fixed incorrect results from CSR SpMV when any of the input matrix dimensions are zero, such as when `m = 0` or `n = 0`. *[CUSPARSE-1800]*

3.5. Math Library

3.5.1. CUDA Math: Release 13.0

- **New Features**
  - Single and double precision math functions received targeted performance and accuracy improvements through algorithmic simplifications, reduced branching, and tighter approximations.
    - `atan2f`, `atan2`: Up to 10% faster with minor improvements in accuracy.
    - `sinhf`, `coshf`, `acoshf`, `asinhf`, `asinh`: Up to 50% speedups with minor improvements in accuracy.
    - `cbrtf`, `rcbrtf`: 15% faster with minor improvements in accuracy.
    - `erfinvf`, `erfcinvf`, `normcdfinvf`: Minor accuracy improvements, performance neutral.
    - `ldexpf`, `ldexp`: Up to 3x faster in single precision and 30% faster in double precision, with no accuracy loss.
    - `modff`, `modf`: Up to 50% faster in single precision and 10% faster in double precision, with no accuracy loss.

3.6. nvJPEG Library

3.6.1. nvJPEG: Release 13.0 Update 1

Resolved Issues

- Fixed a race condition in certain cases during progressive encoding (*5307748*).
- Fixed an uninitialized read when encoding images as 4:1:0 JPEG bitstreams (*5308008*).

3.6.2. nvJPEG: Release 13.0

- **Deprecations**
  - Removed the `nvjpegEncoderParamsCopyHuffmanTables` API.

Resolved Issues

- nvJPEG is now more robust and no longer crashes or exhibits undefined behavior when decoding malformed or truncated bitstreams. *[5168024, 5133845, 5143450]*
- `nvjpegEncodeYUV` now avoids reading outside of allocated device memory in certain cases. *[5133826]*
- Optimized memory usage when encoding RGB inputs using the hardware encoder.
- Fixed issues related to rounding in various transform, sampling, and conversion steps, improving image quality for both encoder and decoder. *[5064901, 3976092]*
- Various bug fixes for improved security.

3.7. NPP Library

3.7.1. NPP: Release 13.0

- **Deprecations**
  - **Removal of Legacy Non-Context APIs**

    All legacy NPP APIs without the *_Ctx* suffix have been deprecated and are now removed starting with this release. Developers should transition to the context-aware (*_Ctx*) versions to ensure continued support and compatibility with the latest CUDA releases.
  - **Deprecation of ``nppGetStreamContext()``**

    The `nppGetStreamContext()` API has been deprecated and removed. Developers are strongly encouraged to adopt application-managed stream contexts by explicitly managing the `NppStreamContext` structure. For guidance, refer to the NPP Documentation – General Conventions and the usage demonstrated in the StreamContexts example.
- **Resolved Issues**

- Fixed an issue in `nppiFloodFillRange_8u_C1IR_Ctx` where the flood fill operation did not correctly fill the full target area. *[5141474]*
- Resolved a bug in the `nppiDebayer()` API that affected proper reconstruction of color data during Bayer pattern conversion. *[5138782]*

Chapter 4. Notices

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