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      6.2.4 cuFFT: Release 12.4 ........................................... 24
      6.2.5 cuFFT: Release 12.3 Update 1 ............................... 24
      6.2.6 cuFFT: Release 12.3 ........................................... 25
      6.2.7 cuFFT: Release 12.2 ........................................... 25
      6.2.8 cuFFT: Release 12.1 Update 1 ............................... 25
      6.2.9 cuFFT: Release 12.1 ........................................... 26
      6.2.10 cuFFT: Release 12.0 Update 1 ............................. 26
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  6.4.6 cuSPARSE: Release 12.3 ...................................... 30
  6.4.7 cuSPARSE: Release 12.2 Update 1 ............................ 31
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  6.4.9 cuSPARSE: Release 12.0 Update 1 ............................ 31
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NVIDIA CUDA Toolkit Release Notes

The Release Notes for the CUDA Toolkit.

The release notes for the NVIDIA® CUDA® Toolkit can be found online at https://docs.nvidia.com/cuda/cuda-toolkit-release-notes/index.html.

**Note:** The release notes have been reorganized into two major sections: the general CUDA release notes, and the CUDA libraries release notes including historical information for 12.x releases.
Chapter 1. CUDA Toolkit Major Component Versions

CUDA Components  
Starting with CUDA 11, the various components in the toolkit are versioned independently.  
For CUDA 12.6, the table below indicates the versions:

<table>
<thead>
<tr>
<th>Component Name</th>
<th>Version Information</th>
<th>Supported Architectures</th>
<th>Supported Platforms</th>
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<tbody>
<tr>
<td>CUDA C++ Core Compute Libraries</td>
<td>Thrust</td>
<td>2.5.0</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
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<tr>
<td></td>
<td>CUB</td>
<td>2.5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>libc++</td>
<td>2.5.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooperative Groups</td>
<td>12.6.37</td>
<td></td>
</tr>
<tr>
<td>CUDA Compatibility</td>
<td></td>
<td>12.6.36890662</td>
<td>aarch64-jetson</td>
</tr>
<tr>
<td>CUDA Runtime (cudart)</td>
<td></td>
<td>12.6.37</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
</tr>
<tr>
<td>cuobjdump</td>
<td></td>
<td>12.6.20</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
</tr>
<tr>
<td>CUPTI</td>
<td></td>
<td>12.6.37</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
</tr>
<tr>
<td>CUDA cuxxfilt (demangler)</td>
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</tr>
<tr>
<td>CUDA Demo Suite</td>
<td></td>
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<td>x86_64</td>
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<tr>
<td>CUDA GDB</td>
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<th>Component Name</th>
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<th>Supported Platforms</th>
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<tr>
<td>CUDA Nsight Eclipse Plugin</td>
<td>12.6.20</td>
<td>x86_64</td>
<td>Linux</td>
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<tr>
<td>CUDA NVCC</td>
<td>12.6.20</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows, WSL</td>
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<td>CUDA nvdisasm</td>
<td>12.6.20</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows</td>
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<tr>
<td>CUDA NVML Headers</td>
<td>12.6.37</td>
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<td>Linux, Windows, WSL</td>
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<td>CUDA nvprof</td>
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<td>Linux, Windows</td>
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<td>CUDA NVVP</td>
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<td>CUDA OpenCL</td>
<td>12.6.37</td>
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<td>Linux, Windows</td>
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<td>12.6.37</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
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<td>Linux, Windows, WSL</td>
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<tr>
<td>CUDA cuBLAS</td>
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<td>Linux</td>
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<td>11.2.6.28</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows, WSL</td>
</tr>
<tr>
<td>CUDA cuFile</td>
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<thead>
<tr>
<th>Component Name</th>
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<th>Supported Architectures</th>
<th>Supported Platforms</th>
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<tr>
<td>CUDA cuRAND</td>
<td>10.3.7.37</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows, WSL</td>
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<td>CUDA cuSOLVER</td>
<td>11.6.4.38</td>
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<td>Linux, Windows, WSL</td>
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<td>CUDA cuSPARSE</td>
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<td>Linux, Windows, WSL</td>
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<td>CUDA NPP</td>
<td>12.3.1.23</td>
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<td>CUDA nvFatbin</td>
<td>12.6.20</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows, WSL</td>
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<td>CUDA nvJitLink</td>
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<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows, WSL</td>
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<td>CUDA nvJPEG</td>
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<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows, WSL</td>
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<td>Nsight Compute</td>
<td>2024.3.0.15</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux, Windows, WSL (Windows 11)</td>
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<td>Nsight Systems</td>
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<td>Linux, Windows, WSL</td>
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<td>2024.3.0.24164</td>
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<td>Windows</td>
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<td>nvidia_fs(^1)</td>
<td>2.22.3</td>
<td>x86_64, arm64-sbsa, aarch64-jetson</td>
<td>Linux</td>
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<td>Visual Studio Integration</td>
<td>12.6.20</td>
<td>x86_64 (Windows)</td>
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<td>NVIDIA Linux Driver</td>
<td>560.28.03</td>
<td>x86_64, arm64-sbsa</td>
<td>Linux</td>
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<td>NVIDIA Windows Driver</td>
<td>560.76</td>
<td>x86_64 (Windows)</td>
<td>Windows, WSL</td>
</tr>
</tbody>
</table>

**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

\(^1\) Only available on select Linux distros
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-compatibility/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.

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

<table>
<thead>
<tr>
<th>CUDA Toolkit</th>
<th>Minimum Required Driver Version for CUDA Minor Version Compatibility*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Linux x86_64 Driver Version</td>
</tr>
<tr>
<td>CUDA 12.x</td>
<td>&gt;=525.60.13</td>
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<tr>
<td>CUDA 11.8.x</td>
<td>&gt;=450.80.02</td>
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<td>CUDA 11.6.x</td>
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<td>CUDA 11.5.x</td>
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<td>CUDA 11.4.x</td>
<td>&gt;=450.36.06**</td>
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<tr>
<td>CUDA 11.0 (11.0.3)</td>
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</tbody>
</table>

* 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.

** 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

<table>
<thead>
<tr>
<th>CUDA Toolkit</th>
<th>Toolkit Driver Version</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Linux x86_64 Driver Version</td>
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<td>CUDA 12.2 GA</td>
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<td>CUDA 12.0 Update 1</td>
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</table>

For convenience, the NVIDIA driver is installed as part of the CUDA Toolkit installation. Note that this driver is for development purposes and is not recommended for use in production with Tesla GPUs.

For running CUDA applications in production with Tesla GPUs, it is recommended to download the latest driver for Tesla GPUs from the NVIDIA driver downloads site at [https://www.nvidia.com/drivers](https://www.nvidia.com/drivers).

During the installation of the CUDA Toolkit, the installation of the NVIDIA driver may be skipped on Windows (when using the interactive or silent installation) or on Linux (by using meta packages).


Chapter 2. New Features

This section lists new general CUDA and CUDA compilers features.

2.1. General CUDA

▶ The default driver installation changes in this release, preferring NVIDIA GPU Open Kernel Modules to proprietary drivers. The open source drivers are now the default and recommended installation option. For additional information, refer to this blog post: https://developer.nvidia.com/blog/nvidia-transitions-fully-towards-open-source-gpu-kernel-modules/.

▶ New nvidia-open meta-packages are available to improve driver installation of NVIDIA Open GPU kernel modules.

2.2. CUDA Compiler

▶ For changes to PTX, refer to https://docs.nvidia.com/cuda/parallel-thread-execution/#ptx-isa-version-8-5.

▶ Latest host compiler Clang-18 support.

▶ Support for Stack Canaries in device code. CUDA compilers can now insert stack canaries in device code. The NVCC flag --device-stack-protector=true enables this feature. Stack canaries make it more difficult to exploit certain types of memory safety bugs involving stack-local variables. The compiler uses heuristics to assess the risk of such a bug in each function. Only those functions which are deemed high-risk make use of a stack canary.

▶ Added a new compiler option -forward-slash-prefix-opts (Windows only).

If this flag is specified, and forwarding unknown options to host toolchain is enabled (-forward-unknown-opts or -forward-unknown-to-host-linker or -forward-unknown-to-host-compiler), then a command line argument beginning with ‘/’ is forwarded to the host toolchain. For example:

```
nvcc -forward-slash-prefix-opts -forward-unknown-opts /T foo.cu
```

will forward the flag /T to the host compiler and linker. When this flag is not specified, a command line argument beginning with / is treated as an input file. For example, nvcc /T foo.cu will treat /T as an input file, and the Windows API function GetFullPathName() is used to determine the full path name.
Note: This flag is only supported on Windows.
For more details, refer to nvcc-help.

▶ An environment variable NVCC_CCBIN is introduced for NVCC: Users can set NVCC_CCBIN to specify the host compiler, but it has lower priority than command-line option -ccbin. If NVCC_CCBIN and -ccbin are both set, NVCC uses the host compiler specified by -ccbin.

### 2.3. CUDA Developer Tools

▶ For changes to nvprof and Visual Profiler, see the changelog.
▶ For new features, improvements, and bug fixes in Nsight Systems, see the changelog.
▶ For new features, improvements, and bug fixes in Nsight Visual Studio Edition, see the changelog.
▶ For new features, improvements, and bug fixes in CUPTI, see the changelog.
▶ For new features, improvements, and bug fixes in Nsight Compute, see the changelog.
▶ For new features, improvements, and bug fixes in Compute Sanitizer, see the changelog.
▶ For new features, improvements, and bug fixes in CUDA-GDB, see the changelog.
Chapter 3. Resolved Issues

3.1. CUDA Compiler

- Added NVCC_CCBIN environment variable to allow system admins to globally specify the host compiler.

  If NVCC_CCBIN is set by a system admin and -ccbin is set by a user, nvcc will choose the host compiler specified by -ccbin. If NVCC_CCBIN is set and -ccbin is not set, nvcc will choose the host compiler specified by NVCC_CCBIN. If neither of them are set, nvcc will use the default compiler.

  For more details, refer to nvcc-help.
Chapter 4. Known Issues and Limitations

▶ To upgrade using the cuda metapackage: 4752050
  ▶ On Ubuntu 20.04, first switch to open kernel modules:

  ```
sudo apt-get install -V nvidia-kernel-source-open
sudo apt-get install nvidia-open
  ```

  On dnf-based distros, module streams must be disabled:

  ```
$ echo "module_hotfixes=1" | tee -a /etc/yum.repos.d/cuda*.repo
$ sudo dnf install --allowerasing nvidia-open
$ sudo dnf module reset nvidia-driver
  ```

▶ On Azure Linux, to load NVIDIA kernel modules, the kernel_lockdown boot parameter must be disabled by removing lockdown=integrity from the GRUB bootloader entry. 4721469

▶ When installing Arm SBSA drivers on SLES 15.6, for installation to complete correctly the system must be rebooted immediately. This will allow modprobe to set permissions for /dev/nvidia* device nodes correctly. 4775942
  ▶ If this is not done, and nvidia-smi is run as root, device nodes may be created with incorrect permissions. If this happens, it can be fixed with:

  ```
$ sudo chown -R :video /dev/nvidia*
  ```
Chapter 5. Deprecated or Dropped Features

Features deprecated in the current release of the CUDA software still work in the current release, but their documentation may have been removed, and they will become officially unsupported in a future release. We recommend that developers employ alternative solutions to these features in their software.

5.1. Deprecated or Dropped Operating Systems

- Support for Microsoft Windows 10 21H2 is dropped in 12.6.
- Support for Microsoft Windows 10 21H2 (SV1) is deprecated.
- Support for Debian 11.9 is deprecated.

5.2. Deprecated Toolchains

CUDA Toolkit 12.6 deprecated support for the following host compilers:

- Microsoft Visual C/C++ (MSVC) 2017
- All GCC versions prior to GCC 7.3

5.3. CUDA Tools

- Support for the macOS host client of CUDA-GDB is deprecated. It will be dropped in an upcoming release.
Chapter 6. CUDA Libraries

This section covers CUDA Libraries release notes for 12.x releases.

- CUDA Math Libraries toolchain uses C++11 features, and a C++11-compatible standard library (libstdc++ >= 20150422) is required on the host.

6.1. cuBLAS Library

6.1.1. cuBLAS: Release 12.6

- **Known Issues**
  - Computing matrix multiplication and an epilogue with INT8 inputs, INT8 outputs, and FP32 scaling factors can have numerical errors in cases when a second kernel is used to compute the epilogue. This happens because the first GEMM kernel converts the intermediate result from FP32 into INT8 and stores it for the subsequent epilogue kernel to use. If a value is outside of the range of INT8 before the epilogue and the epilogue would bring it into the range of INT8, there will be numerical errors. This issue has existed since before CUDA 12 and there is no known workaround. CUB-6831

  - `cublasLtMatmul` could ignore the user specified Bias or Aux data types (`CUBLASLT_MATMUL_DESC_BIAS_DATA_TYPE` and `CUBLASLT_MATMUL_DESC_EPILOGUE_AUX_DATA_TYPE`) for FP8 matmul operations if these data types do not match the documented limitations in `cublasLtMatmulDescAttributes_t`. 4750343

- **Resolved Issues**
  - `cublasLtMatmul` produced incorrect results when data types of matrices A and B were different FP8 (for example, A is CUDA_R_8F_E4M3 and B is CUDA_R_8F_E5M2) and matrix D layout was CUBLASLT_ORDER_ROW. 4640468

  - `cublasLt` may return not supported on Hopper GPUs in some cases when A, B, and C are of type CUDA_R_8I and the compute type is CUBLAS_COMPUTE_32I. 4381102

  - cuBLAS could produce floating point exceptions when running GEMM with K equal to 0. 4614629
6.1.2. cuBLAS: Release 12.5 Update 1

► New Features
  ► Performance improvement to matrix multiplication targeting large language models, specifically for small batch sizes on Hopper GPUs.

► Known Issues
  ► The bias epilogue (without ReLU or GeLU) may be not supported on Hopper GPUs for strided batch cases. A workaround is to implement batching manually. This will be fixed in a future release.
  ► cublasGemmGroupedBatchedEx and cublas<t>gemmGroupedBatched have large CPU overheads. This will be addressed in an upcoming release.

► Resolved Issues
  ► Under rare circumstances, executing SYMM/HEMM concurrently with GEMM on Hopper GPUs might have caused race conditions in the host code, which could lead to an Illegal Memory Access CUDA error. 4403010
  ► cublasLtMatmul could produce an Illegal Instruction CUDA error on Pascal GPUs under the following conditions: batch is greater than 1, and beta is not equal to 0, and the computations are out-of-place (C != D). 4566993

6.1.3. cuBLAS: Release 12.5

► New Features
  ► cuBLAS adds an experimental API to support mixed precision grouped batched GEMMs. This enables grouped batched GEMMs with FP16 or BF16 inputs/outputs with the FP32 compute type. Refer to cublasGemmGroupedBatchedEx for more details.

► Known Issues
  ► cublasLtMatmul ignores inputs to CUBLASLT_MATMUL_DESC_D_SCALE_POINTER and CUBLASLT_MATMUL_DESC_EPILOGUE_AUX_SCALE_POINTER if the elements of the respective matrix are not of FP8 types.

► Resolved Issues
  ► cublasLtMatmul ignored the mismatch between the provided scale type and the implied by the documentation, assuming the latter. For instance, an unsupported configuration of cublasLtMatmul with the scale type being FP32 and all other types being FP16 would run with the implicit assumption that the scale type is FP16 and produce incorrect results.
  ► cuBLAS SYMV failed for large n dimension: 131072 and above for ssymv, 92673 and above for csymv and dsymv, and 65536 and above for zsymv.
6.1.4. cuBLAS: Release 12.4 Update 1

**Known Issues**

- Setting a cuBLAS handle stream to `cudaStreamPerThread` and setting the workspace via `cublasSetWorkspace` will cause any subsequent `cublasSetWorkspace` calls to fail. This will be fixed in an upcoming release.
- `cublasLtMatmul` ignores mismatches between the provided scale type and the scale type implied by the documentation and assumes the latter. For example, an unsupported configuration of `cublasLtMatmul` with the scale type being FP32 and all other types being FP16 would run with the implicit assumption that the scale type is FP16 which can produce incorrect results. This will be fixed in an upcoming release.

**Resolved Issues**

- `cublasLtMatmul` ignored the `CUBLASLT_MATMUL_DESC_AMAX_D_POINTER` for unsupported configurations instead of returning an error. In particular, computing absolute maximum of D is currently supported only for FP8 Matmul when the output data type is also FP8 (`CUDA_R_8F_E4M3` or `CUDA_R_8F_E5M2`).
- Reduced host-side overheads for some of the cuBLASLt APIs: `cublasLtMatmul()`, `cublasLtMatmulAlgoCheck()`, and `cublasLtMatmulAlgoGetHeuristic()`. The issue was introduced in CUDA Toolkit 12.4.
- `cublasLtMatmul()` and `cublasLtMatmulAlgoGetHeuristic()` could have resulted in floating point exceptions (FPE) on some Hopper-based GPUs, including Multi-Instance GPU (MIG). The issue was introduced in cuBLAS 11.8.

6.1.5. cuBLAS: Release 12.4

**New Features**

- cuBLAS adds experimental APIs to support grouped batched GEMM for single precision and double precision. Single precision also supports the math mode, `CUBLAS_TF32_TENSOR_OP_MATH`. Grouped batch mode allows you to concurrently solve GEMMs of different dimensions (m, n, k), leading dimensions (lda, ldb, ldc), transpositions (transa, transb), and scaling factors (alpha, beta). Please see `gemmGroupedBatched` for more details.

**Known Issues**

- When the current context has been created using `cuGreenCtxCreate()`, cuBLAS does not properly detect the number of SMs available. The user may provide the corrected SM count to cuBLAS using an API such as `cublasSetSmCountTarget()`.
- BLAS level 2 and 3 functions might not treat alpha in a BLAS compliant manner when alpha is zero and the pointer mode is set to `CUBLAS_POINTER_MODE_DEVICE`. This is the same known issue documented in cuBLAS 12.3 Update 1.
- `cublasLtMatmul` with K equals 1 and epilogue `CUBLASLT_EPILOGUE_D{RELU, GELU}_BGRAD` could out-of-bound access the workspace. The issue exists since cuBLAS 11.3 Update 1.
- `cublasLtMatmul` with K equals 1 and epilogue `CUBLASLT_EPILOGUE_D{RELU, GELU}` could produce illegal memory access if no workspace is provided. The issue exists since cuBLAS 11.6.
When captured in CUDA Graph stream capture, cuBLAS routines can create memory nodes through the use of stream-ordered allocation APIs, cudaMallocAsync and cudaFreeAsync. However, as there is currently no support for memory nodes in child graphs or graphs launched from the device, attempts to capture cuBLAS routines in such scenarios may fail. To avoid this issue, use the cublasSetWorkspace() function to provide user-owned workspace memory.

6.1.6. cuBLAS: Release 12.3 Update 1

► New Features
  ► Improved performance of heuristics cache for workloads that have a high eviction rate.

► Known Issues
  ► BLAS level 2 and 3 functions might not treat alpha in a BLAS compliant manner when alpha is zero and the pointer mode is set to CUBLAS_POINTER_MODE_DEVICE. The expected behavior is that the corresponding computations would be skipped. You may encounter the following issues: (1) HER{,2,X,K,2K} may zero the imaginary part on the diagonal elements of the output matrix; and (2) HER{,2,X,K,2K}, SYR{,2,X,K,2K} and others may produce NaN resulting from performing computation on matrices A and B which would otherwise be skipped. If strict compliance with BLAS is required, the user may manually check for alpha value before invoking the functions or switch to CUBLAS_POINTER_MODE_HOST.

► Resolved Issues
  ► cuBLASLt matmul operations might have computed the output incorrectly under the following conditions: the data type of matrices A and B is FP8, the data type of matrices C and D is FP32, FP16, or BF16, the beta value is 1.0, the C and D matrices are the same, the epilogue contains GELU activation function.
  ► When an application compiled with cuBLASLt from CUDA Toolkit 12.2 update 1 or earlier runs with cuBLASLt from CUDA Toolkit 12.2 update 2 or CUDA Toolkit 12.3, matrix multiply descriptors initialized using cublasLtMatmulDescInit() sometimes did not respect attribute changes using cublasLtMatmulDescSetAttribute().
  ► Fixed creation of cuBLAS or cuBLASLt handles on Hopper GPUs under the Multi-Process Service (MPS).
  ► cublasLtMatmul with K equals 1 and epilogue CUBLASLT_EPILOGUE_BGRAD\{A,B\} might have returned incorrect results for the bias gradient.

6.1.7. cuBLAS: Release 12.3

► New Features
  ► Improved performance on NVIDIA L40S Ada GPUs.

► Known Issues
  ► cuBLASLt matmul operations may compute the output incorrectly under the following conditions: the data type of matrices A and B is FP8, the data type of matrices C and D is FP32, FP16, or BF16, the beta value is 1.0, the C and D matrices are the same, the epilogue contains GELU activation function.
When an application compiled with cuBLASLt from CUDA Toolkit 12.2 update 1 or earlier runs with cuBLASLt from CUDA Toolkit 12.2 update 2 or later, matrix multiply descriptors initialized using \texttt{cublasLtMatmulDescInit()} may not respect attribute changes using \texttt{cublasLtMatmulDescSetAttribute()}. To workaround this issue, create the matrix multiply descriptor using \texttt{cublasLtMatmulDescCreate()} instead of \texttt{cublasLtMatmulDescInit()}. This will be fixed in an upcoming release.

### 6.1.8. cuBLAS: Release 12.2 Update 2

**New Features**

- cuBLASLt will now attempt to decompose problems that cannot be run by a single gemm kernel. It does this by partitioning the problem into smaller chunks and executing the gemm kernel multiple times. This improves functional coverage for very large m, n, or batch size cases and makes the transition from the cuBLAS API to the cuBLASLt API more reliable.

**Known Issues**

- cuBLASLt matmul operations may compute the output incorrectly under the following conditions: the data type of matrices A and B is FP8, the data type of matrices C and D is FP32, FP16, or BF16, the beta value is 1.0, the C and D matrices are the same, the epilogue contains GELU activation function.

### 6.1.9. cuBLAS: Release 12.2

**Known Issues**

- cuBLAS initialization fails on Hopper architecture GPUs when MPS is in use with \texttt{CUDA_MPS_ACTIVE_THREAD_PERCENTAGE} set to a value less than 100%. There is currently no workaround for this issue.

- Some Hopper kernels produce incorrect results for batched matmuls with \texttt{CUBLASLT_EPILOGUE_RELU_BIAS} or \texttt{CUBLASLT_EPILOGUE_GELU_BIAS} and a non-zero \texttt{CUBLASLT_MATMUL_DESC_BIAS_BATCH_STRIDE}. The kernels apply the first batch’s bias vector to all batches. This will be fixed in a future release.

### 6.1.10. cuBLAS: Release 12.1 Update 1

**New Features**

- Support for FP8 on NVIDIA Ada GPUs.

- Improved performance on NVIDIA L4 Ada GPUs.

- Introduced an API that instructs the cuBLASLt library to not use some CPU instructions. This is useful in some rare cases where certain CPU instructions used by cuBLASLt heuristics negatively impact CPU performance. Refer to \url{https://docs.nvidia.com/cuda/cublas/index.html#disabling-cpu-instructions}.

**Known Issues**
When creating a matrix layout using the \texttt{cublasLtMatrixLayoutCreate()} function, the object pointed at by \texttt{cublasLtMatrixLayout\_t} is smaller than \texttt{cublasLtMatrixLayoutOpaque\_t} (but enough to hold the internal structure). As a result, the object should not be dereferenced or copied explicitly, as this might lead to out of bound accesses. If one needs to serialize the layout or copy it, it is recommended to manually allocate an object of size sizeof(\texttt{cublasLtMatrixLayoutOpaque\_t}) bytes, and initialize it using \texttt{cublasLtMatrixLayoutInit()} function. The same applies to \texttt{cublasLtMatmulDesc\_t} and \texttt{cublasLtMatrixTransformDesc\_t}. The issue will be fixed in future releases by ensuring that \texttt{cublasLtMatrixLayoutCreate()} allocates at least sizeof(\texttt{cublasLtMatrixLayoutOpaque\_t}) bytes.

### 6.1.11. cuBLAS: Release 12.0 Update 1

- **New Features**
  - Improved performance on NVIDIA H100 SXM and NVIDIA H100 PCIe GPUs.
- **Known Issues**
  - For optimal performance on NVIDIA Hopper architecture, cuBLAS needs to allocate a bigger internal workspace (64 MiB) than on the previous architectures (8 MiB). In the current and previous releases, cuBLAS allocates 256 MiB. This will be addressed in a future release. A possible workaround is to set the \texttt{CUBLAS\_WORKSPACE\_CONFIG} environment variable to :32768:2 when running cuBLAS on NVIDIA Hopper architecture.
- **Resolved Issues**
  - Reduced cuBLAS host-side overheads caused by not using the cublasLt heuristics cache. This began in the CUDA Toolkit 12.0 release.
  - Added forward compatible single precision complex GEMM that does not require workspace.

### 6.1.12. cuBLAS: Release 12.0

- **New Features**
  - \texttt{cublasLtMatmul} now supports FP8 with a non-zero beta.
  - Added \texttt{int64} APIs to enable larger problem sizes; refer to \texttt{64-bit integer interface}.
  - Added more Hopper-specific kernels for \texttt{cublasLtMatmul} with epilogues:
    - \texttt{CUBLASLT\_EPILOGUE\_BGRAD\{}A,B\}\texttt{\}}
    - \texttt{CUBLASLT\_EPILOGUE\{}RELU,GELU\}_AUX
    - \texttt{CUBLASLT\_EPILOGUE\_D\{}RELU,GELU\}
  - Improved Hopper performance on arm64-sbsa by adding Hopper kernels that were previously supported only on the x86_64 architecture for Windows and Linux.
- **Known Issues**
  - There are no forward compatible kernels for single precision complex gemms that do not require workspace. Support will be added in a later release.
- **Resolved Issues**
Fixed an issue on NVIDIA Ampere architecture and newer GPUs where `cublasLtMatmul` with epilogue `CUBLASLT_EPILOGUE_BGRAD{A,B}` and a nontrivial reduction scheme (that is, not `CUBLASLT_REDUCTION_SCHEME_NONE`) could return incorrect results for the bias gradient.

- `cublasLtMatmul` for gemv-like cases (that is, m or n equals 1) might ignore bias with the `CUBLASLT_EPILOGUE_RELU_BIAS` and `CUBLASLT_EPILOGUE_BIAS` epilogues.

**Deprecations**
- Disallow including `cublas.h` and `cublas_v2.h` in the same translation unit.
- Removed:
  - `CUBLAS_MATMUL_STAGES_16x80` and `CUBLAS_MATMUL_STAGES_64x80` from `cublasLtMatmulStages_t`. No kernels utilize these stages anymore.
  - `cublasLt3mMode_t`, `CUBLASLT_MATMUL_PREF_MATH_MODE_MASK`, and `CUBLASLT_MATMUL_PREF_GAUSSIAN_MODE_MASK` from `cublasLtMatmulPreferenceAttributes_t`. Instead, use the corresponding flags from `cublasLtNumericalImplFlags_t`.
  - `CUBLASLT_MATMUL_PREF_POINTER_MODE_MASK`, `CUBLASLT_MATMUL_PREF_EPILOGUE_MASK`, and `CUBLASLT_MATMUL_PREF_SM_COUNT_TARGET` from `cublasLtMatmulPreferenceAttributes_t`. The corresponding parameters are taken directly from `cublasLtMatmulDesc_t`.
  - `CUBLASLT_POINTER_MODE_MASK_NO_FILTERING` from `cublasLtPointerModeMask_t`. This mask was only applicable to `CUBLASLT_MATMUL_PREF_MATH_MODE_MASK` which was removed.

### 6.2. cuFFT Library

#### 6.2.1. cuFFT: Release 12.6

- **Known Issues**
  - FFT of size 1 with `istride/ostride > 1` is currently not supported for FP16. There is a known memory issue for this use case in CTK 12.1 or before. A `CUFFT_INVALID_SIZE` error is thrown in CTK 12.2 or after. #662222

#### 6.2.2. cuFFT: Release 12.5

- **New Features**
  - Added Just-In-Time Link-Time Optimized (JIT LTO) kernels for improved performance in R2C and C2R FFTs for many sizes.
  - We recommend testing your R2C / C2R use cases with and without JIT LTO kernels and comparing the resulting performance. You can enable JIT LTO kernels using the per-plan properties `cuFFT API`. 

**6.2. cuFFT Library**
6.2.3. cuFFT: Release 12.4 Update 1

- **Resolved Issues**
  - A routine from the cuFFT LTO EA library was added by mistake to the cuFFT Advanced API header (cufftXt.h) in CUDA 12.4. This routine has now been removed from the header.

6.2.4. cuFFT: Release 12.4

- **New Features**
  - Added Just-In-Time Link-Time Optimized (JIT LTO) kernels for improved performance in FFTs with 64-bit indexing.
  - Added per-plan properties to the cuFFT API. These new routines can be leveraged to give users more control over the behavior of cuFFT. Currently they can be used to enable JIT LTO kernels for 64-bit FFTs.
  - Improved accuracy for certain single-precision (fp32) FFT cases, especially involving FFTs for larger sizes.

- **Known Issues**
  - A routine from the cuFFT LTO EA library was added by mistake to the cuFFT Advanced API header (cufftXt.h). This routine is not supported by cuFFT, and will be removed from the header in a future release.

- **Resolved Issues**
  - Fixed an issue that could cause overwriting of user data when performing out-of-place real-to-complex (R2C) transforms with user-specified output strides (i.e. using the ostride component of the Advanced Data Layout API).
  - Fixed inconsistent behavior between libcufftw and FFTW when both inembed and onembed are nullptr / NULL. From now on, as in FFTW, passing nullptr / NULL as inembed/onembed parameter is equivalent to passing n, that is, the logical size for that dimension.

6.2.5. cuFFT: Release 12.3 Update 1

- **Known Issues**
  - Executing a real-to-complex (R2C) or complex-to-real (C2R) plan in a context different to the one used to create the plan could cause undefined behavior. This issue will be fixed in an upcoming release of cuFFT.

- **Resolved Issues**
  - Complex-to-complex (C2C) execution functions (cufftExec and similar) now properly error-out in case of error during kernel launch, for example due to a missing CUDA context.
6.2.6. cuFFT: Release 12.3

▶ New Features
   ▶ Callback kernels are more relaxed in terms of resource usage, and will use fewer registers.
   ▶ Improved accuracy for double precision prime and composite FFT sizes with factors larger than 127.
   ▶ Slightly improved planning times for some FFT sizes.

6.2.7. cuFFT: Release 12.2

▶ New Features
   ▶ cufftSetStream can be used in multi-GPU plans with a stream from any GPU context, instead of from the primary context of the first GPU listed in cufftXtSetGPUs.
   ▶ Improved performance of 1000+ of FFTs of sizes ranging from 62 to 16380. The improved performance spans hundreds of single precision and double precision cases for FFTs with contiguous data layout, across multiple GPU architectures (from Maxwell to Hopper GPUs) via PTX JIT.
   ▶ Reduced the size of the static libraries when compared to cuFFT in the 12.1 release.

▶ Resolved Issues
   ▶ cuFFT no longer exhibits a race condition when threads simultaneously create and access plans with more than 1023 plans alive.
   ▶ cuFFT no longer exhibits a race condition when multiple threads call cufftXtSetGPUs concurrently.

6.2.8. cuFFT: Release 12.1 Update 1

▶ Known Issues
   ▶ cuFFT exhibits a race condition when one thread calls cufftCreate (or cufftDestroy) and another thread calls any API (except cufftCreate or cufftDestroy), and when the total number of plans alive exceeds 1023.
   ▶ cuFFT exhibits a race condition when multiple threads call cufftXtSetGPUs concurrently on different plans.
6.2.9. cuFFT: Release 12.1

► New Features
  ► Improved performance on Hopper GPUs for hundreds of FFTs of sizes ranging from 14 to 28800. The improved performance spans over 542 cases across single and double precision for FFTs with contiguous data layout.

► Known Issues
  ► Starting from CUDA 11.8, CUDA Graphs are no longer supported for callback routines that load data in out-of-place mode transforms. An upcoming release will update the cuFFT callback implementation, removing this limitation. cuFFT deprecated callback functionality based on separate compiled device code in cuFFT 11.4.

► Resolved Issues
  ► cuFFT no longer produces errors with compute-sanitizer at program exit if the CUDA context used at plan creation was destroyed prior to program exit.

6.2.10. cuFFT: Release 12.0 Update 1

► Resolved Issues
  ► Scratch space requirements for multi-GPU, single-batch, 1D FFTs were reduced.

6.2.11. cuFFT: Release 12.0

► New Features
  ► PTX JIT kernel compilation allowed the addition of many new accelerated cases for Maxwell, Pascal, Volta and Turing architectures.

► Known Issues
  ► cuFFT plan generation time increases due to PTX JIT compiling. Refer to Plan Initialization Time.

► Resolved Issues
  ► cuFFT plans had an unintentional small memory overhead (of a few kB) per plan. This is resolved.

6.3. cuSOLVER Library

6.3.1. cuSOLVER: Release 12.6

► New Features
  ► Performance improvements of cusolverDnXgesvdp().
6.3.2. cuSOLVER: Release 12.5 Update 1

► Resolved Issues
  ► The potential out-of-bound accesses on buffer0nDevice by calls of cusolverDnXlarft have been resolved.

6.3.3. cuSOLVER: Release 12.5

► New Features
  ► Performance improvements of cusolverDnXgesvd and cusolverDn<t>gesvd if jobu != 'N' or jobvt != 'N'.
  ► Performance improvements of cusolverDnXgesvdp if jobz = CU-SOLVER_EIG_MODE_NOVECTOR.
  ► Lower workspace requirement of cusolverDnXgesvdp for tall-and-skinny-matrices.

► Known Issues
  ► With CUDA Toolkit 12.4 Update 1, values ldt > k in calls of cusolverDnXlarft can result in out-of-bound memory accesses on buffer0nDevice. As a workaround it is possible to allocate a larger device workspace buffer of size workspaceInBytesOnDevice=ALIGN_32((ldt*k + n*k)*sizeofCudaDataType(dataTypeT)), with

```cpp
auto ALIGN_32=[](int64_t val) {
    return ((val + 31)/32)*32;
};
```

and

```cpp
auto sizeofCudaDataType=[](cudaDataType dt) {
    if (dt == CUDA_R_32F) return sizeof(float);
    if (dt == CUDA_R_64F) return sizeof(double);
    if (dt == CUDA_C_32F) return sizeof(cuComplex);
    if (dt == CUDA_C_64F) return sizeof(cuDoubleComplex);
};
```

6.3.4. cuSOLVER: Release 12.4 Update 1

► New Features
  ► The performance of cusolverDnXlarft has been improved. For large matrices, the speedup might exceed 100x. The performance on H100 is now consistently better than on A100. The change in cusolverDnXlarft also results in a modest speedup in cusolverDn<t>ormqr, cusolverDn<t>ormtr, and cusolverDnXsyevd.
  ► The performance of cusolverDnXgesvd when singular vectors are sought has been improved. The job configuration that computes both left and right singular vectors is up to 1.5x faster.

► Resolved Issues
  ► cusolverDnXtrtri_bufferSize now returns the correct workspace size in bytes.
Deprecations

Using long-deprecated cusolverDnPotrf, cusolverDnPotrs, cusolverDnGeqrf, cusolverDnGetrf, cusolverDnGetrs, cusolverDnSyevd, cusolverDnSyevdx, cusolverDnGesvd, and their accompanying bufferSize functions will result in a deprecation warning. The warning can be turned off by using the -DDISABLE_CUSOLVER_DEPRECATED flag while compiling; however, users should use cusolverDnXpotrf, cusolverDnXpotrs, cusolverDnXgeqrf, cusolverDnXgetrf, cusolverDnXgetrs, cusolverDnXsyevd, cusolverDnXsyevdx, cusolverDnXgesvd, and the corresponding bufferSize functions instead.

6.3.5. cuSOLVER: Release 12.4

New Features

cusolverDnXlarft and cusolverDnXlarft_bufferSize APIs were introduced. cusolverDnXlarft forms the triangular factor of a real block reflector, while cusolverDnXlarft_bufferSize returns its required workspace sizes in bytes.

Known Issues

cusolverDnXtrtri_bufferSize returns an incorrect required device workspace size. As a workaround the returned size can be multiplied by the size of the data type (for example, 8 bytes if matrix A is of type double) to obtain the correct workspace size.

6.3.6. cuSOLVER: Release 12.2 Update 2

Resolved Issues

Fixed an issue with cusolverDn<t>gesvd(), cusolverDnGesvd(), and cusolverDnXgesvd(), which could cause wrong results for matrices larger than 18918 if jobu or jobvt was unequal to ‘N’.

6.3.7. cuSOLVER: Release 12.2

New Features

A new API to ensure deterministic results or allow non-deterministic results for improved performance. See cusolverDnSetDeterministicMode() and cusolverDnGetDeterministicMode(). Affected functions are: cusolverDn<t>geqrf(), cusolverDn<t>syevd(), cusolverDn<t>syevdx(), cusolverDn<t>gesvdj(), cusolverDnXgeqrf(), cusolverDnXsyevd(), cusolverDnXsyevdx(), cusolverDnXgesvd(), cusolverDnXgesvdr(), and cusolverDnXgesvdp().

Known Issues

Concurrent executions of cusolverDn<t>getrf() or cusolverDnXgetrf() in different non-blocking CUDA streams on the same device might result in a deadlock.
6.4. cuSPARSE Library

6.4.1. cuSPARSE: Release 12.6

▶ Known Issues

► cusparseSpMV_preprocess() runs SpMV computation if it is called two or more times on
the same matrix. CUSPARSE-1897

► cusparseSpMV_preprocess() will not run if cusparseSpMM_preprocess() was exe-
cuted on the same matrix, and vice versa. CUSPARSE-1897

► The same external_buffer must be used for all cusparseSpMV calls. CUSPARSE-1897

6.4.2. cuSPARSE: Release 12.5 Update 1

▶ New Features

► Added support for BSR format in cusparseSpMM.

▶ Resolved Issues

► cusparseSpMM() would sometimes get incorrect results when alpha=0, num_batches>1,
batch_stride indicates that there is padding between batches.

► cusparseSpMM_bufferSize() would return the wrong size when the sparse matrix is
Blocked Ellpack and the dense matrices have only a single column (n=1).

► cusparseSpMM returned the wrong result when k=0 (for example when A has zero columns).
The correct behavior is doing C *= beta. The bug behavior was not modifying
C at all.

► cusparseCreateSlicedEll would return an error when the slice size is greater than the
matrix number of rows.

► Sliced-ELLPACK cusparseSpSV produced wrong results for diagonal matrices.

► Sliced-ELLPACK cusparseSpSV_analysis() failed due to insufficient resources for some
matrices and some slice sizes.

6.4.3. cuSPARSE: Release 12.5

▶ New Features

► Added support for mixed input types in SpMV: single precision input matrix, double precision
input vector, double precision output vector.

▶ Resolved Issues

► cusparseSpMV() introduces invalid memory accesses when the output vector is not aligned
to 16 bytes.
6.4.4. cuSPARSE: Release 12.4

► New Features
  ► Added the preprocessing step for sparse matrix-vector multiplication cusparseSpMV_preprocess().
  ► Added support for mixed real and complex types for cusparseSpMM().
  ► Added a new API cusparseSpSM_updateMatrix() to update the sparse matrix between the analysis and solving phase of cusparseSpSM().

► Known Issues
  ► cusparseSpMV() introduces invalid memory accesses when the output vector is not aligned to 16 bytes.

► Resolved Issues
  ► cusparseSpSVV() provided incorrect results when the sparse vector has many non-zeros.

6.4.5. cuSPARSE: Release 12.3 Update 1

► New Features
  ► Added support for block sizes of 64 and 128 in cusparseSDDMM().
  ► Added a preprocessing step cusparseSDDMM_preprocess() for BSR cusparseSDDMM() that helps improve performance of the main computing stage.

6.4.6. cuSPARSE: Release 12.3

► New Features
  ► The cusparseSpSV_bufferSize() and cusparseSpSV_analysis() routines now accept NULL pointers for the dense vector.
  ► The cusparseSpSM_bufferSize() and cusparseSpSM_analysis() routines now accept dense matrix descriptors with NULL pointer for values.

► Known Issues
  ► The cusparseSpSV_analysis() and cusparseSpSM_analysis() routines are blocking calls/not asynchronous.
  ► Wrong results can occur for cusparseSpSV() using sliced ELLPACK format and transpose/conjugate operation on matrix A.

► Resolved Issues
  ► cusparseSpSV() provided indeterministic results in some cases.
  ► Fixed an issue that caused cusparseSpSV_analysis() to hang sometimes in a multi-thread environment.
  ► Fixed an issue with cusparseSpSV() that sometimes yielded wrong output when the output vector/matrix or input matrix contained NaN.
6.4.7. cuSPARSE: Release 12.2 Update 1

- **New Features**
  - The library now provides the opportunity to dump sparse matrices to files during the creation of the descriptor for debugging purposes. See logging API https://docs.nvidia.com/cuda/cusparse/index.html#cusparse-logging-api.

- **Resolved Issues**
  - Removed CUSPARSE_SPMM_CSR_ALG3 fallback to avoid confusion in the algorithm selection process.
  - Clarified the supported operations for cusparseSDDMM().
  - cusparseCreateConstSlicedEll() now uses const pointers.
  - Fixed wrong results in rare edge cases of cusparseCsr2CscEx2() with base 1 indexing.
  - cusparseSpSM_bufferSize() could ask slightly less memory than needed.
  - cusparseSpMV() now checks the validity of the buffer pointer only when it is strictly needed.

- **Deprecations**
  - Several legacy APIs have been officially deprecated. A compile-time warning has been added to all of them.

6.4.8. cuSPARSE: Release 12.1 Update 1

- **New Features**
  - Introduced Block Sparse Row (BSR) sparse matrix storage for the Generic APIs with support for SDDMM routine (cusparseSDDMM).
  - Introduced Sliced Ellpack (SELL) sparse matrix storage format for the Generic APIs with support for sparse matrix-vector multiplication (cusparseSpMV) and triangular solver with a single right-hand side (cusparseSpSV).
  - Added a new API call (cusparseSpSV_updateMatrix) to update matrix values and/or the matrix diagonal in the sparse triangular solver with a single right-hand side after the analysis step.

6.4.9. cuSPARSE: Release 12.0 Update 1

- **New Features**
  - cusparseSDDMM() now supports mixed precision computation.
  - Improved cusparseSpMM() alg2 mixed-precision performance on some matrices on NVIDIA Ampere architecture GPUs.
  - Improved cusparseSpMV() performance with a new load balancing algorithm.
  - cusparseSpSV() and cusparseSpSM() now support in-place computation, namely the output and input vectors/matrices have the same memory address.
6.4.10. cuSPARSE: Release 12.0

- **Resolved Issues**
  - cuSparseSpSM() could produce wrong results if the leading dimension (ld) of the RHS matrix is greater than the number of columns/rows.

- **New Features**
  - JIT LTO functionalities (cusparseSpMMOp()) switched from driver to nvJitLto library. Starting from CUDA 12.0 the user needs to link to libnvJitLto.so, see cuSPARSE documentation. JIT LTO performance has also been improved for cusparseSpMMOpPlan().
  - Introduced const descriptors for the Generic APIs, for example, cusparseConstSpVecGet(). Now the Generic APIs interface clearly declares when a descriptor and its data are modified by the cuSPARSE functions.
  - Added two new algorithms to cusparseSpGEMM() with lower memory utilization. The first algorithm computes a strict bound on the number of intermediate product, while the second one allows partitioning the computation in chunks.
  - Added int8_t support to cusparseGather(), cusparseScatter(), and cusparseCsr2cscEx2().
  - Improved cusparseSpSV() performance for both the analysis and the solving phases.
  - Improved cusparseSpSM() performance for both the analysis and the solving phases.
  - Improved cusparseSDDMM() performance and added support for batch computation.
  - Improved cusparseCsr2cscEx2() performance.

- **Resolved Issues**
  - cusparseSpSV() and cusparseSpSM() could produce wrong results.
  - cusparseDnMatGetStridedBatch() did not accept batchStride == 0.

- **Deprecations**
  - Removed deprecated CUDA 11.x APIs, enumerators, and descriptors.

6.5. Math Library

6.5.1. CUDA Math: Release 12.6

- **Known Issues**
  - As a result of ongoing compatibility testing NVIDIA identified that a number of CUDA Math Integer SIMD APIs silently produced wrong results if used on the CPU in programs compiled with MSVC 17.10. The root cause is found to be the coding error in the header-based implementation of the APIs exposed to the undefined behavior during narrowing integer conversion when doing a host-based emulation of the GPU functionality. The issue will be fixed in a future release of CUDA. Applications affected are those calling __vimax3_s16x2, __vimin3_s16x2, __vibmax_s16x2, and __vibmin_s16x2 on the CPU and not in CUDA kernels. 4731352
6.5.2. CUDA Math: Release 12.5

- **Known Issues**
  - As a result of ongoing testing we updated the interval bounds in which double precision \texttt{lgamma()} function may experience greater than the documented 4 ulp accuracy loss. New interval shall read \((-23.0001; -2.2637).\) This finding is applicable to CUDA 12.5 and all previous versions. 4662420

6.5.3. CUDA Math: Release 12.4

- **Resolved Issues**
  - Host-specific code in \texttt{cuda_fp16/bf16} headers is now free from type-punning and shall work correctly in the presence of optimizations based on strict-aliasing rules. 4311216

6.5.4. CUDA Math: Release 12.3

- **New Features**
  - Performance of SIMD Integer CUDA Math APIs was improved.
- **Resolved Issues**
  - The \texttt{__hisinf()} Math APIs from \texttt{cuda_fp16.h} and \texttt{cuda_bf16.h} headers were silently producing wrong results if compiled with the \texttt{-std=c++20} compiler option because of an underlying \texttt{nvcc} compiler issue, resolved in version 12.3.
- **Known Issues**
  - Users of \texttt{cuda_fp16.h} and \texttt{cuda_bf16.h} headers are advised to disable host compilers strict aliasing rules based optimizations (e.g. pass \texttt{-fno-strict-aliasing} to host GCC compiler) as these may interfere with the type-punning idioms used in the \texttt{__half, __half2, __nv_bfloat16, __nv_bfloat162} types implementations and expose the user program to undefined behavior. Note, the headers suppress GCC diagnostics through: \#pragma GCC diagnostic ignored \texttt{-Wstrict-aliasing}. This behavior may improve in future versions of the headers.

6.5.5. CUDA Math: Release 12.2

- **New Features**
  - CUDA Math APIs for \texttt{__half} and \texttt{__nv_bfloat16} types received usability improvements, including host side <emulated> support for many of the arithmetic operations and conversions.
  - \texttt{__half} and \texttt{__nv_bfloat16} types have implicit conversions to/from integral types, which are now available with host compilers by default. These may cause build issues due to ambiguous overloads resolution. Users are advised to update their code to select proper overloads. To opt-out user may want to define the following macros (these macros will be removed in the future CUDA release):
Resolved Issues

During ongoing testing, NVIDIA identified that due to an algorithm error the results of 64-bit floating-point division in default round-to-nearest-even mode could produce spurious overflow to infinity. NVIDIA recommends that all developers requiring strict IEEE754 compliance update to CUDA Toolkit 12.2 or newer. The affected algorithm was present in both offline compilation as well as just-in-time (JIT) compilation. As JIT compilation is handled by the driver, NVIDIA recommends updating to driver version greater than or equal to R535 (R536 on Windows) when IEEE754 compliance is required and when using JIT. This is a software algorithm fix and is not tied to specific hardware.

Updated the observed worst case error bounds for single precision intrinsic functions __expf(), __exp10f() and double precision functions asinh(), acosh().

6.5.6. CUDA Math: Release 12.1

New Features

Performance and accuracy improvements in atanf, acosf, asinf, sinpif, cospif, powf, erff, and tgammaf.

6.5.7. CUDA Math: Release 12.0

New Features


Known Issues

Double precision inputs that cause the double precision division algorithm in the default 'round to nearest even mode' produce spurious overflow: an infinite result is delivered where DBL_MAX 0x7FEF_FFFF_FFFF_FFFF is expected. Affected CUDA Math APIs: __ddiv_rn(). Affected CUDA language operation: double precision / operation in the device code.

Deprecations

All previously deprecated undocumented APIs are removed from CUDA 12.0.

6.6. NVIDIA Performance Primitives (NPP)

6.6.1. NPP: Release 12.4

New Features

Enhanced large file support with size_t.
6.6.2. NPP: Release 12.0

▶ **Deprecations**
  - Deprecating non-CTX API support from next release.

▶ **Resolved Issues**
  - A performance issue with the NPP ResizeSqrPixel API is now fixed and shows improved performance.

6.7. nvJPEG Library

6.7.1. nvJPEG: Release 12.4

▶ **New Features**
  - IDCT performance optimizations for single image CUDA decode.
  - Zero Copy behavior has been changed: Setting NVJPEG_FLAGS_REduced_MEMORY_DECODEZERO_COPY flag will no longer enable NVJPEG_FLAGS_REduced_MEMORY_DECODE.

6.7.2. nvJPEG: Release 12.3 Update 1

▶ **New Features**
  - New APIs: nvjpegBufferPinnedResize and nvjpegBufferDeviceResize which can be used to resize pinned and device buffers before using them.

6.7.3. nvJPEG: Release 12.2

▶ **New Features**
  - Added support for JPEG Lossless decode (process 14, FO prediction).
  - nvJPEG is now supported on L4T.

6.7.4. nvJPEG: Release 12.0

▶ **New Features**
  - Improved the GPU Memory optimisation for the nvJPEG codec.

▶ **Resolved Issues**
  - An issue that causes runtime failures when nvJPEGDecMultipleInstances was tested with a large number of threads is resolved.
  - An issue with CMYK four component color conversion is now resolved.
Known Issues

Backend NVJPEG_BACKEND_GPU_HYBRID - Unable to handle bistreams with extra scans lengths.

Deprecations

The reuse of Huffman table in Encoder (nvjpegEncoderParamsCopyHuffmanTables).
Chapter 7. Notices

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