NVIDIA Datacenter Drivers

User Guide

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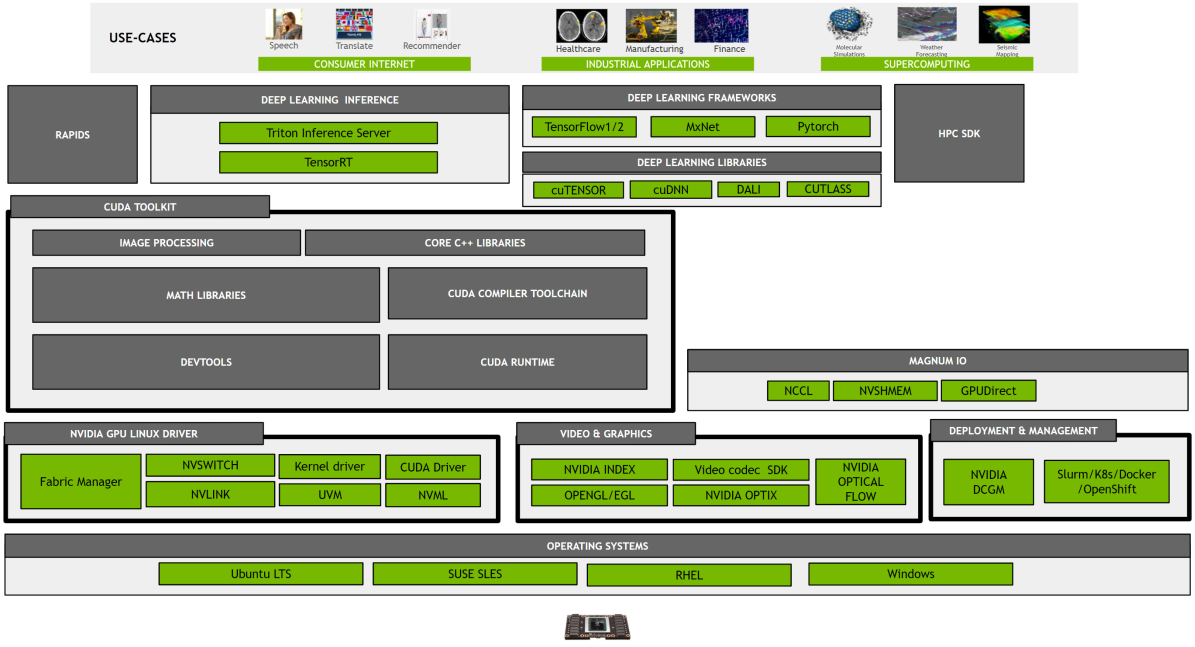
Chapter 1. Introduction

The NVIDIA compute software “stack” consists of various software products in the system software or infrastructure that are required to bootstrap a system with NVIDIA GPUs and be able to run accelerated AI or HPC workloads. A software architecture diagram of CUDA and associated components is shown below for reference:

Figure 1. Overview of CUDA Toolkit and Associated Products



While NVIDIA provides a very rich software platform including SDKs, frameworks and applications, the focus of this document is on drivers, CUDA Toolkit and the Deep Learning libraries.

Chapter 2. Driver Lifecycle

2.1. Driver Branches

Starting in 2019, NVIDIA has introduced a new enterprise software lifecycle for datacenter GPU drivers.

New Feature Branch

Major feature release, indicated by a new branch X number. This is targeted towards early adopters who want to evaluate new features (e.g. new CUDA APIs). Note that these drivers may also be shipped along with CUDA Toolkit installer packages in some cases.

Release cadence: New driver branch is released approx. every quarter.

Production Branch

Branch that is qualified for use in production for enterprise/datacenter GPUs. Bug fixes and security updates are provided for up to 1 year.

Release cadence: Two driver branches are released per year (approx. every six months)

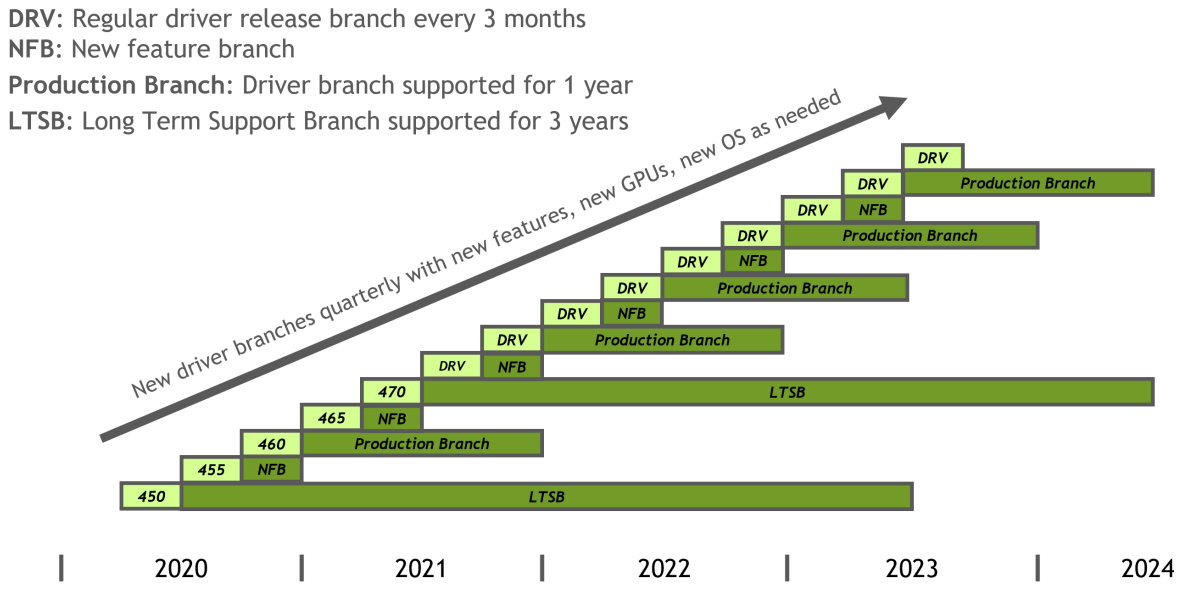
Note that during the lifetime of a production branch, quarterly bug fixes and security updates are released.

Long Term Support Branch

A production branch that will be supported and maintained for a much longer time than a normal production branch is supported. Every LTSB is a production branch, but not every production branch is an LTSB.

Customers who are looking for a longer cycle of support from their deployed branch will gain that support through LTSB releases. LTSB releases will receive bug updates and critical security updates, on a reasonable effort basis, through minor releases during the 3 years that they are supported.

Figure 2. Taxonomy of NVIDIA Driver Branches. (For illustration purposes only. See note below)



2.2. Comparison of Driver Branches

The table below summarizes the differences between the various driver branches.

Table 1. NVIDIA Driver Branches

	New Feature Branch (NFB)	Production Branch (PB)	Long Term Support Branch (LTSB)
Target Customers	Early adopters who want to evaluate new features	Use in production for enterprise/ datacenter GPUs	Use in production for enterprise/ datacenter GPUs and for customers looking for a longer cycle of support.
Major Release Cadence	At least once every 3 months	Twice a year. See also note below	At least once per hardware architecture. See also note below
Length of support	N/A	1 year	3 years
Minor release (bug updates and critical security updates)	N/A	Yes. Quarterly bug and security releases for 1 year.	Yes. Quarterly bug and security releases for 1 year.

Note:

General guidance only. The actual security update and release cadence can change at NVIDIA's discretion.

Chapter 3. Supported Drivers and CUDA Toolkit Versions

NVIDIA releases CUDA Toolkit and GPU drivers at different cadences. The NVIDIA datacenter GPU driver software lifecycle and terminology are available in the lifecycle section of this documentation.

The release information can be scraped by automation tools (for example `jq`) by parsing the release information: `releases.json`.

The table below lists the current support matrix for CUDA Toolkit and NVIDIA datacenter drivers.

Table 2. CUDA and Drivers

	R470	R535	R550
Branch Designation	Long Term Support Branch	Long Term Support Branch	Production Branch
End of Life	July 2024	June 2026	February 2025
Maximum CUDA Version Supported	CUDA 11.0+ This driver branch supports CUDA 11.x (through CUDA minor version compatibility).	CUDA 12.0+ This driver branch supports CUDA 12.x (through CUDA minor version compatibility).	CUDA 12.0+ This driver branch supports CUDA 12.x (through CUDA minor version compatibility).

Note: All other previous driver branches not listed in the table above (such as R525, R515, R510, R495, R465, R460, R455, R450, R440, R418, R410) are end of life.

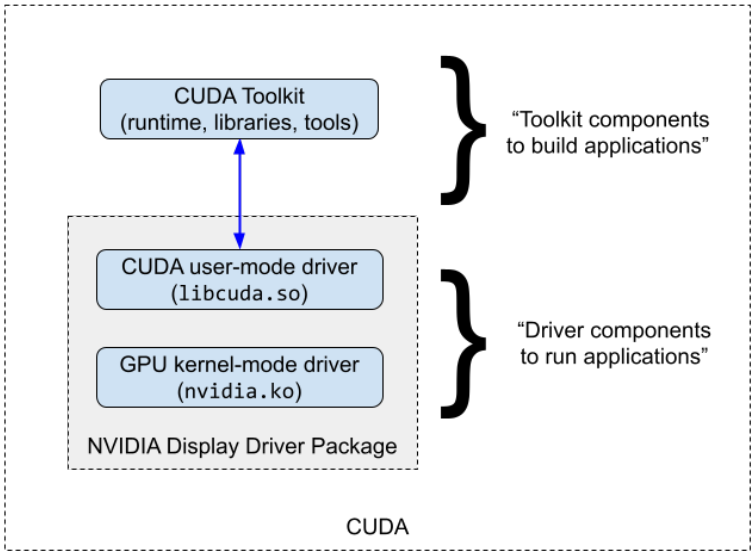
Chapter 4. Software Deployment Workflow

The CUDA software environment consists of three parts:

- CUDA Toolkit (libraries, runtime and tools) - User-mode SDK used to build CUDA applications
- CUDA driver - User-mode driver component used to run CUDA applications (e.g. libcuda.so on Linux systems)
- NVIDIA GPU device driver - Kernel-mode driver component for NVIDIA GPUs

On Linux systems, the CUDA driver and kernel mode components are delivered together in the NVIDIA display driver package. This is shown in the figure below.

Figure 3. CUDA



The CUDA Toolkit is generally optional when GPU nodes are only used to run applications (as opposed to develop applications) as the CUDA application typically packages (by statically or dynamically linking against) the CUDA runtime and libraries needed.

Typical Workflow

A typical suggested workflow for bootstrapping a GPU node in a cluster:

1. Install the NVIDIA drivers (do not install CUDA Toolkit as this brings in additional dependencies that may not be necessary or desired)
2. Install the CUDA Toolkit using meta-packages. This provides additional control over what is installed on the system.
3. Install other components such as cuDNN or TensorRT as desired depending on the application requirements and dependencies.

4.1. Datacenter Driver Installation

Note: The full content of this section is available at: https://docs.nvidia.com/datacenter/tesla/tesla-installation-notes/index.html.

NVIDIA drivers are available in three formats for use with Linux distributions:

- Runfile installers
- Package managers
- Containerized drivers

NVIDIA provides Linux distribution specific packages for drivers that can be used by customers to deploy drivers into a production environment. The links above provide detailed information and steps on how to install driver packages for supported Linux distributions, but a summary is provided below.

4.1.1. Installation Using Package Managers

Using package managers is the recommended method of installing drivers as this provides additional control over choice of driver branches, precompiled kernel modules, driver upgrades and additional dependencies such as Fabric Manager/NSCQ for NVSwitch systems.

On Ubuntu LTS

```
$ sudo apt-get -y install cuda-drivers-<branch-number>
```

Where the branch-number = the specific datacenter branch of interest (e.g. 450, 460)

On RHEL 8

```
$ sudo dnf module install nvidia-driver:<stream>/<profile>
```

For example, `nvidia-driver:latest-dkms/fm` will install the latest drivers and also install the Fabric Manager dependencies to bootstrap an NVSwitch system such as HGX A100.

For more information on the supported streams/profiles, refer to this section in the documentation.

4.2. CUDA Toolkit Installation

The CUDA Toolkit packages are modular and offer the user control over what components of the CUDA Toolkit are installed on the system. CUDA supports a number of meta-packages that are available here.

Since the `cuda` or `cuda-<release>` packages also install the drivers, these packages may not be appropriate for datacenter deployments.

Instead, other packages such as `cuda-toolkit-<release>` should be used as this package has no dependency on the driver. The following example only installs the CUDA Toolkit 11.4 packages and does not install the driver.

```
$ sudo apt-get -y install cuda-toolkit-11-4
```

Table 3. Supported CUDA Meta Packages

Meta-Package	Purpose
`cuda`	Installs all CUDA Toolkit and Driver packages. Handles upgrading to the next version of the `cuda` package when it's released.
`cuda-11-4`	Installs all CUDA Toolkit and Driver packages. Remains at version 11.4 until an additional version of CUDA is installed.
`cuda-toolkit-11-4`	Installs all CUDA Toolkit packages required to develop CUDA applications. Does not include the driver.
`cuda-tools-11-4`	Installs all CUDA command line and visual tools.
`cuda-runtime-11-4`	Installs all CUDA Toolkit packages required to run

Meta-Package	Purpose
	CUDA applications, as well as the Driver packages.
`cuda-compiler-11-4`	Installs all CUDA compiler packages.
`cuda-libraries-11-4`	Installs all runtime CUDA Library packages.
`cuda-libraries-dev-11-4`	Installs all development CUDA Library packages.
`cuda-drivers`	Installs all Driver packages. Handles upgrading to the next version of the Driver packages when they're released.

4.3. cuDNN Installation

NVIDIA cuDNN can also be installed from the CUDA network repository using Linux package managers by using the `libcudnn` and `libcudnn-dev` packages. Some examples on supported Linux distributions are shown below:

Ubuntu LTS

```
$ CUDNN_VERSION=8.1.1.33 \
   && sudo apt-get -y install \
   libcudnn8=$CUDNN_VERSION-1+cuda11.2 libcudnn8-dev=$CUDNN_VERSION-1+cuda11.2
```

Chapter 5. Software Support Matrix

5.1. CUDA Toolkit, Driver and Architecture Matrix

The CUDA driver provides an API that is backwards compatible. Thus, new NVIDIA drivers will always work with (applications compiled with) an older CUDA toolkit. This behavior of CUDA is documented here. Each CUDA Toolkit however, requires a minimum version of the NVIDIA driver. Corollarily, when using tools such as `nvidia-smi`, the NVIDIA driver reports a maximum version of CUDA supported and thus is able to run applications built with CUDA Toolkits up to that version.

CUDA Toolkit and drivers may also deprecate and drop support for GPU architectures over the product life cycle of the CUDA Toolkit. See the `-arch` and `-gencode` options in the CUDA compiler (`nvcc`) toolchain documentation.

Table 4. CUDA and Architecture Matrix

Architecture	CUDA Capabilities	First CUDA Toolkit Support	Last CUDA Toolkit Support	Last Driver Support
Fermi	2.0	CUDA 3.0	CUDA 8.0	R390
Kepler	3.0 3.2	CUDA 6.0	CUDA 10.2	R470
Kepler	3.5 3.7	CUDA 6.0	CUDA 11.x	R470
Maxwell	5.0 5.2 5.3	CUDA 6.5	Ongoing	Ongoing
Pascal	6.0 6.1	CUDA 8.0	Ongoing	Ongoing
Volta	7.0	CUDA 9.0	Ongoing	Ongoing

Architecture	CUDA Capabilities	First CUDA Toolkit Support	Last CUDA Toolkit Support	Last Driver Support
Turing	7.5	CUDA 10.0	Ongoing	Ongoing
Ampere	8.0 8.6	CUDA 11.0	Ongoing	Ongoing
Ada	8.9	CUDA 11.8	Ongoing	Ongoing
Hopper	9.0	CUDA 11.8 CUDA 12.0	Ongoing	Ongoing

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