DGX SOFTWARE WITH CENTOS

Installation Guide
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Chapter 1.
INTRODUCTION

The NVIDIA® DGX™ systems (DGX-1 and DGX-2 servers and NVIDIA DGX Station™ workstation) are shipped with DGX™ OS which incorporates the NVIDIA DGX software stack built upon the Ubuntu Linux distribution. Instead of running the Ubuntu distribution, you can run CentOS on the DGX system and still take advantage of the advanced DGX features.

This document explains how to install and configure the NVIDIA DGX software stack on DGX systems installed with CentOS.

Important NVIDIA acknowledges the wide use of CentOS and understands that it is a community-developed derivative of the NVIDIA supported Red Hat Enterprise Linux. Support for CentOS is available directly from the CentOS community. NVIDIA ensures that NVIDIA provided software runs on tested CentOS versions and will try to identify and correct issues related to NVIDIA provided software.

While it may be possible to use other derived Linux distributions besides CentOS, not all have been tested and qualified by NVIDIA. Refer to the DGX Software for Red Hat Enterprise Linux 7 Release Notes for the list of tested and qualified software and Linux distributions.

1.1. Related Documentation

- NVIDIA DGX Software for Red Hat Enterprise Linux - Release Notes
- NVIDIA DGX-1 User Guide
- NVIDIA DGX-2 User Guide
- NVIDIA DGX Station User Guide

1.2. Prerequisites

The following are required (or recommended where indicated).
1.2.1. Access to Repositories

The repositories can be accessed from the internet.

If you are using a proxy server, then follow the instructions in the section Configuring a System Proxy to make sure the system can access the necessary URIs.

You can use `yum-config-manager` to conveniently enable certain repositories. To use `yum-config-manager`, first install the yum utilities.

```
sudo yum -y install yum-utils
```

1.2.1.1. NVIDIA Repositories

- **NVIDIA DGX Software Repository**
  After installing CentOS on the DGX system, you must enable the NVIDIA DGX software repository. The repository includes the NVIDIA drivers and software for supporting DGX systems.
  
  See the section Enabling the Repositories for instructions on how to enable the repositories.

1.2.1.2. CentOS Repositories

Installation of the DGX Software over CentOS requires access to several additional repositories.

- **CentOS Software Collections Repository**: `centos-release-scl`
  This repository is required by the NVSM tool for Python 3.

- **CentOS Testing Repository**: `centos-sclo-rh-testing`
  This repository is required by the NVSM tool for Python 3.

1.2.2. Network File System

A network file system (NFS) is recommended to take advantage of the cache file system provided by the DGX software stack for the DGX servers or if you intend to configure the SSDs for data storage in the DGX Station as an NFS cache.

1.2.3. BMC Password

The DGX BMC comes with default login credentials as specified in Appendix B: Changing the BMC Login.

**Important**

NVIDIA recommends disabling the default username and creating a unique BMC username and strong password as soon as possible. Refer to Appendix B: Changing the BMC Login for instructions.
Chapter 2.
INSTALLING CENTOS

There are several methods for installing CentOS as described in the CentOS Installation Guide (https://docs.centos.org/en-US/centos/install-guide/).

See the DGX Software for Red Hat Enterprise Linux Release Notes for the Linux distributions that are qualified and tested for use with the DGX Software.

For convenience, this section describes how to install CentOS using the Quick Install method, and shows when to reclaim disk space in the process. It describes a minimal installation. If you have a preferred method for installing CentOS, then you can skip this section but be sure to reclaim disk space occupied by the existing Ubuntu installation.

The interactive method described here installs CentOS on DGX using a connected monitor and keyboard and USB stick with the ISO image, or remotely through the remote console of the BMC.

2.1. Obtaining CentOS

Obtain the CentOS ISO image and store on your local disk or create a boot USB drive formatted for UEFI. See Downloading CentOS (https://docs.centos.org/en-US/centos/install-guide/downloading/#chap-download) for instructions.

2.2. Booting CentOS ISO Locally

1. Plug the USB flash drive containing the CentOS ISO image into the DGX.
2. Connect a monitor and keyboard directly to the DGX.
3. Boot the system and press F11 when the NVIDIA logo appears to get to the boot menu.
4. Select the UEFI volume name that corresponds to the inserted USB flash drive, and boot the system from it.
5. Follow the instructions at Installing CentOS
2.3. Booting the CentOS ISO Remotely on the DGX-1 or DGX-2

Skip this chapter if you are using a monitor and keyboard for installing locally on the DGX-1 or DGX-2, or if you are installing the software on the DGX Station. The DGX Station cannot be booted remotely.

2.3.1. Booting the ISO Image on the DGX-1 Remotely

Skip this chapter if you are using a monitor and keyboard for installing locally. For instructions applicable to the NVIDIA DGX-2, see Booting the ISO Image on the DGX-2 Remotely

1. Connect to the BMC and change user privileges.
   a) Open a Java-enabled web browser within your LAN and go to http://<BMC-ip-address>/, then log in.
      Use Firefox or Internet Explorer. Google Chrome is not officially supported by the BMC.
   b) From the top menu, click Configuration and then select User Management.
   c) Select the user name that you created for the BMC, then click Modify User.
   d) In the Modify User dialog, select the VMedia checkbox to add it to the extended privileges for the user, then click Modify.

2. Set up the ISO image as virtual media and reboot the system.
   a) From the top menu, click Remote Control and select Console Redirection.
b) Click **Java Console** to open the remote JViewer window. Make sure pop-up blockers are disabled for this site.

c) From the JViewer top menu bar, click **Media** and then select **Virtual Media Wizard**.

![Virtual Media Wizard](image)

- **b) Click **Java Console** to open the remote JViewer window. Make sure pop-up blockers are disabled for this site.**
- **c) From the JViewer top menu bar, click **Media** and then select **Virtual Media Wizard**.

**d) From the CD/DVD Media: I section of the Virtual Media dialog, click **Browse** and then locate the CentOS ISO file on your system and click **Open**.**

You can ignore the device redirection warning at the bottom of the Virtual Media wizard as it does not affect the ability to re-image the system.

e) Click **Connect CD/DVD**, then click **OK** at the Information dialog.

The Virtual Media window shows that the ISO image is connected.

![Virtual Media](image)

**f) Close the window.**

The CD ROM icon in the menu bar turns green to indicate that the ISO image is attached.
g) From the top menu, click **Power** and then select **Reset Server**.

![Power menu](image)

h) Click **Yes** and then **OK** at the Power Control dialogs, then wait for the system to power down and then come back online.

3. **Boot the CD ROM image.**

Typically, the default boot order does not boot the CDROM image. This can be changed in the BIOS or as a one-time option in the boot menu. To bring up the boot menu, press F11 at the beginning of the boot process.Pressing F11 will display **Show Boot Options** at the top of the virtual display before entering the boot menu. Use the ‘soft’ keyboard (Menu # Keyboard Layout # SoftKeyboard # <Language>) to bring up a virtual keyboard if pressing the physical key has no effect.

![Boot options](image)

a) In the boot menu, select **UEFI: AMI Virtual CDROM 1.00** as the boot device and then press **ENTER**.
b) Follow the instructions at Installing CentOS.

### 2.3.2. Booting the ISO Image on the DGX-2 Remotely

Skip this chapter if you are using a monitor and keyboard for installing locally.

1. Connect to the BMC and ensure the required user privileges are set.
   a) Open a browser within your LAN and go to `https://<BMC-ip-address>/`, then log in.
   b) From the left-side menu, click **Settings** and then select **User Management**.
   c) Click the card with the user name that you created for the BMC.
   d) In the **User Management Configuration** dialog, make sure the **VMedia Access** checkbox is selected, then click **Save**.
2. Set up the ISO image as virtual media.
   a) From the left-side menu, click **Remote Control**.
   b) Select **Launch KVM**.
c) From the top menu bar in the KVM window, click **Browse File** and select the ISO image, then click **Start Media**.

The CD image should now be connected.

![KVM window with CD image connected](image)

**Stop KVM**

![Remote Control in KVM window](image)

![Start Media button highlighted](image)

**Stop KVM**

![CD image selection](image)

**CD Image: nvidia-server-1.5.388.64-chroot.iso (60 KB) Stop Media**

The CD image should now be connected.

![KVM window with CD image connected](image)

**Stop KVM**

![CD image selection](image)

**CD Image: nvidia-server-1.5.388.64-chroot.iso (60 KB) Stop Media**

d) From the top menu bar in the KVM window, click **Power** and then select **Reset Server**.

3. Boot from the virtual media.

Typically, the default boot order does not boot the CDROM image. This can be changed in the BIOS or as a one-time option in the boot menu.

a) To bring up the boot menu, press **F11** at the beginning of the boot process.

Pressing **F11** will display **Entering Boot Menu** in the virtual display before entering the boot menu.
b) In the boot menu, select **UEFI: Virtual CDROM 1.00** as the boot device and then press **ENTER**.

```
Please select boot device:

Local M.2_0 ubuntu
Local M.2_0 UEFI OS
Local M.2_1 ubuntu
Local M.2_1 UEFI OS
UEFI: Virtual CDROM 1.00
UEFI: PXE IPv4 Intel(R) I210 Gigabit Network Connection
UEFI: HTTP IPv4 Intel(R) I210 Gigabit Network Connection
UEFI: PXE IPv6 Intel(R) I210 Gigabit Network Connection
UEFI: HTTP IPv6 Intel(R) I210 Gigabit Network Connection
UEFI: Built-in EFI Shell
Enter Setup
```

↑ and ↓ to move selection
ENTER to select boot device
ESC to boot using defaults

c) Follow the instructions at [Installing CentOS](#)
2.4. Installing CentOS

2.4.1. Installing on the DGX-1 or the DGX Station

This section assumes you have booted the CentOS ISO image, either locally or remotely. For instructions applicable to the DGX-2, see Installing on the DGX-2.

1. After booting the ISO image through either the BMC or from the USB drive, start the installation.

- **On the DGX-1:** Select Install CentOS and then press Enter to start the installation.
- **On the DGX Station:** Update the `linuxefi` parameters to prevent the Nouveau driver in CentOS from being loaded and then start the installation.

The Nouveau driver does not properly support the GPUs in the DGX Station, which may cause display issues. The GPUs in the DGX Station require that drivers that are installed as explained in Installing and Loading the NVIDIA CUDA Drivers.
1. Select Install CentOS and then type e.
2. Append the nomodeset option to the linuxefi parameters.

3. Press Ctrl+X to save your changes and start the installation.

The CentOS installer starts.

For guidance on using the installer, refer to CentOS Quick Installation Guide (https://docs.centos.org/en-US/centos/install-guide/Simple_Installation/).

2. Configure the language, region, date, time, keyboard, and other configuration options you may need from the Installation Summary screen.

3. Select the software packages that you want to install.


4. Set up the system drive.

This step removes the Ubuntu installation in order to reclaim space for the CentOS installation.

a) From the Installation Summary screen, click INSTALLATION DESTINATION.
b) Select the first drive (sda) as the installation drive, then select **Automatically configure partitioning** under **Other Storage Options** and click **Done**.

If the software is being installed on the DGX Station, the number of local standard disks, their labels, capacities, and the amount of free space shown may be different than the examples shown in the screen capture.

If the software is being installed on the DGX Station, the number of local standard disks, their labels, capacities, and the amount of free space shown may be different than the examples shown in the screen capture.

The Installation Options dialog box appears.

c) At the Installation Options dialog, click **Reclaim space**.
d) At the Device Selection screen, click **Delete** all to delete all existing data on the system drive.
e) Click **Reclaim space** to permanently delete all data from the drive and to use it as the destination drive.

5. **Configure Ethernet.**

Select and enable the Ethernet device. This defaults to DHCP and can be changed for static IP configurations under Configure.
6. From the INSTALLATION SUMMARY screen, click **Begin installation** to start the installation.
a) While the installation process is running, set your password (ROOT PASSWORD) and create a new user (USER CREATION) from the Configuration screen.

b) When the installation completes, click **Reboot** to reboot the system.

### 2.4.2. Installing on the DGX-2

This section assumes you have booted the CentOS ISO image, either locally or remotely.

For instructions applicable to the DGX-1 and the DGX Station, see Installing on the DGX-1 or the DGX Station.

1. After booting the ISO image through either the BMC or from the USB drive, select **Install CentOS** and then press **Enter** to start the installation.
The CentOS installer starts.

For guidance on using the installer, refer to CentOS Quick Installation Guide (https://docs.centos.org/en-US/centos/install-guide/Simple_Installation/).

2. Configure the language, region, date, time, keyboard, and other configuration options you may need from the Installation Summary screen.

3. Select the software packages that you want to install.
   

4. Set up the boot disks.

   The DGX OS, which is installed in the factory before shipping out the DGX-2, creates a RAID-1 array on the two M.2 NVMe boot disks. Therefore, it is necessary to select both boot disks when installing RHEL 7 on a DGX-2.

   a) From the Installation Summary screen, click INSTALLATION DESTINATION.
b) At the Installation Destination screen, select both M.2 disks (i.e. the 894.25 GB ones) and the "I will configure partitioning" radio button, then click Done.
The Manual Partitioning window appears.

c) Expand the **Unknown** drop-down menu.

This shows the disks that CentOS has identified. They will be:

- the RAID-1 root partition (ext4, 893 GB),
- the first EFI system partition (ESP) (nvme0n1p1, 512 MB), and
- the second ESP (nvme1n1p1, 512 MB).

d) Select the **ext4** partition and reformat it as **xfs**, then set the mount point to "/" and label it as "**md0**"
e) Click **Update Settings**.

5. Create an EFI partition.
   a) Select the `nvme0n1p1` partition and reformat it as an **EFI System Partition**, then set the mount point to `/boot/efi` and click **Update Settings**.
At this point, the two partitions you configured will be under the **New CentOS Installation** drop down menu, and the `nvme1n1p1` EFI partition will still be in **Unknown**. We can’t create a second ESP because CentOS won’t allow you to create two partitions mounted on the same mount point, i.e. `/boot/efi`, even if they are on different disks. You can replicate the ESP after installing the "DGX System Management" yum group, which provides a tool to accomplish this.

b) Click **Done**.

A yellow-highlighted warning appears on the bottom of the screen.
c) Click the yellow-highlighted warning message.

The following message appears.

```
boot loader stage2 device dgx-18-04:0 is on a multi-disk array, but boot loader stage1 device nvme0n1p1 is not. A drive failure in dgx-18-04:0 could render the system unbootable.
You have not specified a swap partition. Although not strictly required in all cases, it will significantly improve performance for most installations.
```

The message appears because the DGX OS from the factory has created a RAID 1 array for the root partition, and has replicated the EFI system partitions.

d) Close the warning and then press **Done**.

A summary of the partitioning steps appears.
e) Click **Accept Changes** to get back to the main Installation Summary Screen.

There should no longer be a yellow warning icon on the **System: Installation Destination** option.

6. **Configure Ethernet.**

Select and enable the Ethernet device. This defaults to DHCP and can be changed for static IP configurations under **Configure**.

7. From the INSTALLATION SUMMARY screen, click **Begin installation** to start the installation.
a) While the installation process is running, set your password (ROOT PASSWORD) and create a new user (USER CREATION) from the Configuration screen.
b) When the installation completes, click Reboot to reboot the system.
This section requires that you have already installed CentOS® or derived operating system on the DGX server.

3.1. Configuring a System Proxy

If your network requires use of a proxy, then

- Edit the file `/etc/yum.conf` and make sure the following lines are present in the `[main]` section, using the parameters that apply to your network:
  
  ```
  proxy=http://<Proxy-Server-IP-Address>:<Proxy-Port>
  proxy_username=<Proxy-User-Name>
  proxy_password=<Proxy-Password>
  ```

- Make sure that the following domains are 'white-listed' and that the system can access them.
  
  - cdn.redhat.com
  - international.download.nvidia.com

3.2. Enabling the Repositories

Run the following commands to install the DGX software installation package and enable the NVIDIA DGX software repository.

**Attention** By running these commands you are confirming that you have read and agree to be bound by the [DGX Software License Agreement](#). You are also confirming that you understand that any pre-release software and materials available that you elect to install in a DGX may not be fully functional, may contain errors or design flaws, and may have reduced or different security, privacy, availability, and reliability standards relative to commercial versions of NVIDIA software and materials, and that you use pre-release versions at your risk.

- Install the NVIDIA DGX Package for Red Hat Enterprise Linux.

b) Enable the update repository.

- Either edit /etc/yum.repos.d/nvidia-dgx-7.repo and set enabled=1,
  ```
  [nvidia-dgx-7-updates]
  name=NVIDIA DGX EL7 Updates
  baseurl=https://international.download.nvidia.com/dgx/repos/rhel7-updates/
  enabled=1
  gpgcheck=1 gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-dgx-cosmos-support
  ```

- Or (if you have the yum-utils package installed), issue the following.
  ```
  sudo yum-config-manager --enable nvidia-dgx-7-updates
  ```

### 3.3. Installing Required Components

#### 3.3.1. Installing DGX Tools and Updating Configuration Files

1. Install DGX tools and configuration files.
   - For DGX-1, install DGX-1 Configurations.
     ```
     sudo yum groupinstall -y 'DGX-1 Configurations'
     ```
   - For the DGX-2, install DGX-2 Configurations.
     ```
     sudo yum groupinstall -y 'DGX-2 Configurations'
     ```
   - For the DGX Station, install DGX Station Configurations.
     ```
     sudo yum groupinstall -y 'DGX Station Configurations'
     ```
   The configuration changes take effect only after rebooting the system, which is covered in the next step.

2. Update the kernel.
   a) Issue the following.
     ```
     $ sudo yum update
     ```
   b) Reboot the server into the updated kernel.
     ```
     $ sudo reboot
     ```

#### 3.3.2. Configuring the /raid Partition

The DGX servers and the DGX Station include multiple SSDs for data caching or data storage. Configure these SSDs as a RAID array in a partition mounted at /raid. For the DGX servers, these SSDs are intended to be used as a data cache for NFS mounted directories. For the DGX Station, these SSDs are intended to be used either for local persistent storage or as a data cache for NFS mounted directories.
3.3.2.1. Configuring the /raid Partition as an NFS Cache

If you are using the data SSDs for caching NFS reads, configure these SSDs as a RAID 0 array, mounted at /raid and update the cachefilesd configuration to use the /raid partition.

1. Configure the RAID array.
   This will create the RAID group, mount it to /raid, and create an appropriate entry in /etc/fstab.

   ```bash
   sudo configure_raid_array.py -c -f
   ```

   The RAID array must be configured before installing dgx-conf-cachefilesd, which places the proper SELinux label on the /raid directory. If you ever need to recreate the RAID array - which will wipe out any labeling on /raid - after dgx-conf-cachefilesd has already been installed, be sure to restore the label manually before restarting cachefilesd.

   ```bash
   sudo restorecon /raid
   sudo systemctl restart cachefilesd
   ```

2. Install dgx-conf-cachefilesd to update the cachefilesd configuration to use the /raid partition.

   ```bash
   sudo yum install -y dgx-conf-cachefilesd
   ```

3.3.2.2. Configuring the /raid Partition for Local Persistent Storage

If you are using the data SSDs in the DGX Station for local persistent storage, configure these SSDs as a RAID 0 or RAID 5 array, mounted at /raid.

RAID 0 provides the maximum storage capacity, but does not provide any redundancy. If a single SSD in the array fails, all data stored on the array is lost. RAID 5 provides some level of protection against failure of a single SSD but with lower storage capacity than RAID 0.

- To configure a RAID 0 array, run the following command.

  ```bash
  sudo configure_raid_array.py -c -f
  ```

- To configure a RAID 5 array, run the following command.

  ```bash
  sudo configure_raid_array.py -c -f -5
  ```

These commands will create the RAID group, mount it to /raid, and create an appropriate entry in /etc/fstab.

3.3.3. Installing and Loading the NVIDIA CUDA Drivers

1. Install the kernel-devel package
The kernel-devel package provides kernel headers required for the NVIDIA CUDA driver. Use the following command to install the kernel headers for the kernel version that is currently running on the system.

```
sudo yum install -y "kernel-devel-uname-r == $(uname -r)"
```

2. Ensure that you have installed the latest version of `gcc` installed, as older versions may not support all of the features required to build the driver.

```
sudo yum install -y gcc
```

3. Install the driver package.

This will build and install the driver kernel modules. The installation of the `dkms-nvidia` package can take approximately five minutes.

```
sudo yum install -y cuda-drivers dgx-persistence-mode
```

4. Reboot the system to load the drivers and to update system configurations.

```
sudo reboot
```

5. After the system has rebooted, verify that the drivers have been loaded and are handling the NVIDIA devices.

```
nvidia-smi
```

The output should show all available GPUs.

**Example:** Output from a DGX-1 system

```
+-----------------------------------------------------------------------+
| NVIDIA-SMI 410.79       Driver Version: 410.79    CUDA Version: 10.0  |
|----------------------------+-------------------+----------------------+
| GPU Name     Persistence-M | Bus-Id     Disp.A | Volatile Uncorr. ECC |
| Fan Temp Perf Pwr:Usage/Cap|      Memory-Usage | GPU-Util  Compute M. |
|============================+===================+======================|
|   0 Tesla V100-SXM2...  On | ...00:06:00.0 Off |                    0 |
| N/A  33C   P0   45W / 300W |   0MiB / 32480MiB |      0%      Default |
|----------------------------+-------------------+----------------------|
|   1 Tesla V100-SXM2...  On | ...00:07:00.0 Off |                    0 |
| N/A  35C   P0   44W / 300W |   0MiB / 32480MiB |      0%      Default |
|----------------------------+-------------------+----------------------|
|                            :                   :                      : |
|----------------------------+-------------------+----------------------|
|   7 Tesla V100-SXM2...  On | ...00:8A:00.0 Off |                    0 |
| N/A  34C   P0   44W / 300W |   0MiB / 32480MiB |      0%      Default |
|----------------------------+-------------------+----------------------|
| Processes:                    | GPU Memory |                  |
| GPU       PID Type Process name | Usage |
|=======================================================================|
| No running processes found
```

### 3.3.4. Installing the NVIDIA Container Runtime

1. Install Docker 1.13 from the `centos-extras` repository.

```
sudo yum install -y docker
```

2. Install the NVIDIA Container Runtime group.
sudo yum groupinstall -y 'NVIDIA Container Runtime'

3. Run the following command to verify the installation.

```bash
sudo docker run --security-opt label=type:nvidia_container_t --rm nvcr.io/nvidia/cuda nvidia-smi
```

See the section Running Containers for more information about this command. For a description of nvcr.io, see the NGC Registry Spaces documentation.

The output should show all available GPUs.

```
+-----------------------------------------------------------------------+
| NVIDIA-SMI 410.79       Driver Version: 410.79    CUDA Version: 10.0  |
|----------------------------+-------------------+----------------------+
| GPU Name     Persistence-M | Bus-Id     Disp.A | Volatile Uncorr. ECC |
| Fan Temp Perf Pwr:Usage/Cap| Memory-Usage | GPU-Util  Compute M. |
|============================+===================+======================|
|   0 Tesla V100-SXM2...  On | ...00:06:00.0 Off |                    0 |
| N/A 33C   P0   45W / 300W | 0MiB / 32480MiB | 0% Default |
|----------------------------+-------------------+----------------------|
|   1 Tesla V100-SXM2...  On | ...00:07:00.0 Off |                    0 |
| N/A 35C   P0   44W / 300W | 0MiB / 32480MiB | 0% Default |
|----------------------------+-------------------+----------------------|
|   7 Tesla V100-SXM2...  On | ...00:8A:00.0 Off |                    0 |
| N/A 34C   P0   44W / 300W | 0MiB / 32480MiB | 0% Default |
|----------------------------+-------------------+----------------------|
| Processes:                                                 GPU Memory |
| GPU       PID   Type   Process name                       Usage      |
|=======================================================================|
| No running processes found                                           |
```

3.4. Installing Diagnostic Components

NVIDIA System Management (NVSM) provides the diagnostic components for NVIDIA DGX systems. NVSM is a software framework for monitoring NVIDIA DGX server nodes in a data center. It includes active health monitoring, system alerts, and log generation. The NVSM CLI can also be used for checking the health of and obtaining diagnostic information for DGX Station workstations.

The diagnostic components for NVIDIA DGX systems require Python 3. It is available from the CentOS Software Collections Repository (https://wiki.centos.org/AdditionalResources/Repositories/SCL). The Fedora EPEL repository also contains a version of Python 3; however, this combination has not been tested.


   sudo yum install centos-release-scl

2. Enable the testing repository.
   a) Install the `yum` utilities if you have not already done so.
Installing the DGX Software

www.nvidia.com

DGX Software with CentOS

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sudo yum -y install yum-utils
b) Use `yum-config-manager` to enable the testing repository.

```
sudo yum-config-manager --enable centos-sclo-rh-testing
```

3. Install Python 3.6.

```
sudo yum install -y rh-python36
```

**Important** The diagnostic components for NVIDIA DGX systems are not supported with the `python3` package. Be sure to only install the `rh-python36` package.

4. Install the DGX System Management package group.

```
sudo yum groupinstall -y 'DGX System Management'
```

For information about using NVSM, see the NVIDIA System Management documentation.

### 3.5. Replicating the EFI System Partition on DGX-2

This section applies only to the NVIDIA DGX-2.

Once the 'DGX System Management' group is installed, the 'nvsm' tool can be used to replicate the EFI system partition (ESP) onto the second M.2 drive.

**Important** Run these steps ONLY IF:
- You are installing CentOS on the NVIDIA DGX-2, and
- You installed CentOS on the RAID 1 array per instructions in the section Installing on DGX-2.

1. Start the NVSM tool.

```
sudo nvsm
```

2. Navigate to `/systems/localhost/storage/volumes/md0`.

```
nvsm-> cd /systems/localhost/storage/volumes/md0
```

3. Start the rebuild process.

```
nvsm(/systems/localhost/storage/volumes/md0)-> start rebuild
```

a) At the first prompt, specify the second M.2 disk.

```
PROMPT: In order to rebuild this volume, a spare drive is required. Please specify the spare drive to use to rebuild md0.
Name of spare drive for md0 rebuild (CTRL-C to cancel): nvme1n1
```

This should be the M.2 disk on which you did NOT install the ESP. If you followed the instructions in the section Installing on DGX-2, this should be 'nvme1n1'
b) At the second prompt, confirm that you want to proceed.

```
WARNING: Once the volume rebuild process is started, the
        process cannot be stopped.
Start RAID-1 rebuild on md0? [y/n] y
```

Upon successful completion, the following message should appear indicating that the ESP has been replicated:

```
/systems/localhost/storage/volumes/md0/rebuild started at 2019-03-07
14:40:55.844542
RAID-1 rebuild exit status: ESP_REBUILT
```

If necessary, the RAID 1 array is rebuilt after the ESP has been replicated.

```
Finished rebuilding RAID-1 on volume md0
100.0% [========================================]
Status: Done
```

### 3.6. Installing Optional Components

The DGX is fully functional after installing the components as described in [Installing Required Components](#). If you intend to launch NGC containers (which incorporate the CUDA toolkit, NCCL, cuDNN, and TensorRT) on the DGX system, which is the expected use case, then you can skip this section.

If you intend to use your DGX system as a development system for running deep learning applications on bare metal, then install the optional components as described in this section.

1. Install the CUDA toolkit.
   ```
   sudo yum install cuda
   ```

2. Install the NVIDIA Collectives Communication Library (NCCL) Runtime.
   ```
   sudo yum groupinstall 'NVIDIA Collectives Communication Library Runtime'
   ```

3. Install the CUDA Deep Neural Networks (cuDNN) Library Runtime.
   ```
   sudo yum groupinstall 'CUDA Deep Neural Networks Library Runtime'
   ```

4. Install NVIDIA TensorRT.
   ```
   sudo yum install tensorrt
   ```

### 3.7. Applying an NVIDIA Look and Feel to the Desktop User Interface

If the GNOME Desktop is installed, you can optionally apply an NVIDIA look and feel to the desktop user interface by applying the NVIDIA theme to applications and the shell, and using NVIDIA images for the desktop background and lock screen.
The GNOME Desktop must already be installed and running on your system. If SOFTWARE SELECTION was set to Server with GUI when you installed CentOS, the GNOME Desktop is already installed. If the GNOME Desktop is not installed, you must install the X Window System and GNOME package groups.

1. Install the DGX Desktop Theme package group.
   
   ```bash
   sudo yum groupinstall -y 'DGX Desktop Theme'
   ```

2. Start gnome-tweaks.

3. In the Appearance window that opens, under Tweaks, click Extensions.

4. In the Extensions window that opens, set Extensions in the title bar and User themes to ON.
5. Stop and restart `gnome-tweaks`.
6. In the **Appearance** window that opens, apply the NVIDIA theme to applications and the shell, and use NVIDIA images for the desktop background and lock screen.
   a) Under **Themes**, in the drop-down lists for **Applications** and **Shell**, click **Nvidia**.
   b) Under **Background** and **Lock Screen**, click the **Image** file selector.
   c) In the **Image** window that opens, select an NVIDIA DGX Station background image, for example, `NVIDIA_DGX_Station_Background_B.JPG`, and click **Open**.
3.8. Managing CPU Mitigations

DGX Software for CentOS includes security updates to mitigate CPU speculative side-channel vulnerabilities. These mitigations can decrease the performance of deep learning and machine learning workloads.

If your installation of DGX systems incorporates other measures to mitigate these vulnerabilities, such as measures at the cluster level, you can disable the CPU mitigations for individual DGX nodes and thereby increase performance. This capability is available starting with DGX Software for CentOS software version EL7-20.02.

3.8.1. Determining the CPU Mitigation State of the DGX System

If you do not know whether CPU mitigations are enabled or disabled, issue the following.

```
$ cat /sys/devices/system/cpu/vulnerabilities/*
```

CPU mitigations are enabled if the output consists of multiple lines prefixed with `Mitigation:`.

Example
Installing the DGX Software

KVM: Mitigation: Split huge pages
Mitigation: PTE Inversion; VMX: conditional cache flushes, SMT vulnerable
Mitigation: Clear CPU buffers; SMT vulnerable
Mitigation: PTI
Mitigation: Speculative Store Bypass disabled via prctl and seccomp
Mitigation: usercopy/swapgs barriers and __user pointer sanitization
Mitigation: Full generic retpoline, IBPB: conditional, IBRS_FW, STIBP:
   conditional, RSB filling
Mitigation: Clear CPU buffers; SMT vulnerable

CPU mitigations are disabled if the output consists of multiple lines prefixed with Vulnerable.

Example

KVM: Vulnerable
Mitigation: PTE Inversion; VMX: vulnerable
Vulnerable; SMT vulnerable
Vulnerable
Vulnerable
Vulnerable: __user pointer sanitization and usercopy barriers only; no swapgs barriers
Vulnerable, IBPB: disabled, STIBP: disabled
Vulnerable

3.8.2. Disabling CPU Mitigations

Caution Performing the following instructions will disable the CPU mitigations provided by the DGX Software for CentOS.

1. Apply the dgx*-no-mitigations profile.
   ▶ On a DGX-2 system, issue
   
   $ sudo tuned-adm profile dgx2-no-mitigations

   ▶ On a DGX-1 system, issue
   
   $ sudo tuned-adm profile dgx-no-mitigations

   ▶ On a DGX Station workstation, issue
   
   $ sudo tuned-adm profile dgxstation-no-mitigations

2. Reboot the system.

3. Verify CPU mitigations are disabled.

   $ cat /sys/devices/system/cpu/vulnerabilities/*

   The output should include several Vulnerable lines. See Determining the CPU Mitigation State of the DGX System for example output.

3.8.3. Re-enabling CPU Mitigations

1. Apply the dgx*-performance package.
   ▶ On a DGX-2 system, issue
2. Reboot the system.
3. Verify CPU mitigations are enabled.

```bash
$ cat /sys/devices/system/cpu/vulnerabilities/*
```

The output should include several Mitigations lines. See Determining the CPU Mitigation State of the DGX System for example output.
Chapter 4.
RUNNING CONTAINERS

The following is an example of running the CUDA container from the NGC registry.

```
sudo docker run --security-opt label=type:nvidia_container_t --rm nvcr.io/nvidia/cuda:10.0-runtime nvidia-smi
```

To accommodate SELinux, the DGX software stack includes a package (nvidia-container-selinux) that defines a policy for allowing containers to access NVIDIA GPUs. The `--security-opt` option in the command sets the corresponding label type permitting the specified container to access NVIDIA GPUs. If SELinux is removed or disabled, then the `--security-opt` option is not needed.
Chapter 5.
CONFIGURING STORAGE - NFS MOUNT AND CACHE

The DGX servers and the DGX Station include multiple SSDs for data caching or data storage.

- The DGX-1 server contains four SSDs to be used in a RAID 0 configuration.
- The DGX-2 server contains 8 or 16 SSDs to be used in a RAID 0 configuration.
- The DGX Station contains three SSDs to be used in a RAID 0 or RAID 5 configuration.

For the DGX servers, these SSDs are intended to be used as a data cache for NFS mounted directories. For the DGX Station, these SSDs are intended to be used either for local persistent storage or as a data cache for NFS mounted directories. If you are using these SSDs as a data cache for NFS mounted directories, you must set up your own NFS mounted directories for long-term data storage.

The following instructions describe how to mount the NFS directories onto the DGX System, and how to cache the NFS using the DGX SSDs for improved performance.

Make sure that you have an NFS server with one or more exports with data to be accessed by the DGX System, and that there is network access between the DGX System and the NFS server.

1. Configure an NFS mount for the DGX.
   a) Edit the filesystem tables configuration.

      `sudo vi /etc/fstab`

   b) Add a new line for the NFS mount, using the local mount point of /mnt.

      ```
      <nfs_server>:<export_path> /mnt nfs
      rw,noatime,rsize=32768,wsize=32768,nolock,tcp,intr,fsc,nofail 0 0
      ```

      /mnt is used here as an example mount point.
      
      Consult your Network Administrator for the correct values for <nfs_server> and <export_path>.
The nfs arguments presented here are a list of recommended values based on typical use cases. However, "fsc" must always be included as that argument specifies use of FS-Cache.

**c) Save the changes.**

2. **Verify the NFS server is reachable.**

```bash
ping <nfs_server>
```

Use the server IP address or the server name provided by your network administrator.

3. **Mount the NFS export.**

```bash
sudo mount /mnt
```

/mnt is the example mount point used in step 1.

4. **Verify caching is enabled.**

```bash
cat /proc/fs/nfsfs/volumes
```

Look for the text `FSC=yes` in the output. The NFS will be mounted and cached on the DGX System automatically upon subsequent reboot cycles.
The NVIDIA DGX server includes a base management controller (BMC) for out-of-band management of the DGX system. NVIDIA recommends disabling the default username and creating a unique username and password as soon as possible.

A.1. Changing the BMC Login on the DGX-1

1. Log into the BMC.
   a) Open a browser within your LAN and go to http://<BMC-ip-address>/.
      Use Firefox or Internet Explorer. Google Chrome is not officially supported by the DGX-1 BMC.
   b) Log in, using qct.admin/qct.admin for the User ID/Password.
2. Select Configuration # Users.
3. Add a new user.
   a) Select an empty field and click Add User.

   ![User Management](image)

   The list below shows the current list of available users. To delete or modify a user, select the user name from the list and click "Delete User" or "Modify User". To add a new user, select an unconfigured slot and click "Add User".

   Number of configured users: 2

<table>
<thead>
<tr>
<th>UserID</th>
<th>Username</th>
<th>User Access</th>
<th>Network Privilege</th>
<th>SNMPv3 Status</th>
<th>Email ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>anonymous</td>
<td>Disabled</td>
<td>Administrator</td>
<td>Disabled</td>
<td>~</td>
</tr>
<tr>
<td>2</td>
<td>qct.admin</td>
<td>Enabled</td>
<td>Administrator</td>
<td>Disabled</td>
<td>~</td>
</tr>
<tr>
<td>3</td>
<td>~</td>
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</tr>
</tbody>
</table>

   b) Enter new user information and click Add.
4. Log out and then log back in as the new user.
5. Select Configuration # Users.
   a) Select the user qct.admin user and select Modify User
User Management

The list below shows the current list of available users. To delete or modify a user, select the user name from the list and click "Delete User" or "Modify User". To add a new user, select an unconfigured slot and click "Add User"

<table>
<thead>
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<tbody>
<tr>
<td>1</td>
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<td>Administrator</td>
<td>Disabled</td>
<td>~</td>
</tr>
<tr>
<td>2</td>
<td>qctadmin</td>
<td>Enabled</td>
<td>Administrator</td>
<td>Disabled</td>
<td>~</td>
</tr>
<tr>
<td>3</td>
<td>admin</td>
<td>Enabled</td>
<td>Administrator</td>
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</tr>
</tbody>
</table>

b) Deselect Enable in User Access and click Modify.
c) Ensure User Access is disabled for the user qct.admin.
7. Log out.

A.2. Changing the BMC Login on the DGX-2

1. Log into the BMC.
   a) Open a browser within your LAN and go to https://<BMC-ip-address>/.
   b) Log in, using admin/admin for the User ID/Password.
2. Select Settings from the left-side navigation menu.
3. Select the User Management card.
4. Click the green Help icon (?) for information about configuring users, then add a new user with unique username and strong password.

5. Log out and then log back in as the new user.

6. Select **Settings # User Management**.

7. Disable the **admin** and **anonymous** users.
Appendix B. INSTALLING MELLANOX INFINIBAND DRIVERS

Unlike the DGX OS shipped with the NVIDIA DGX server, the DGX software stack for Red Hat-derived operating systems does not include the Mellanox OpenFabrics Enterprise Distribution (MLNX_OFED) for Linux. This is to avoid an installation where the MLNX_OFED kernel may be out of sync with the Red Hat distribution kernel, resulting in system instability.

To use InfiniBand on the DGX server, do the following.

1. Either visit the Mellanox site and download and install the latest MLNX_OFED driver, or use the in-box drivers.

   The in-box drivers provide a much lower level of performance than the official Mellanox drivers.

   Be sure that the MLNX_OFED package supports the latest version of the installed Red Hat Enterprise Linux release.

   ▸ To check the latest Red Hat Enterprise Linux 7 version, visit https://access.redhat.com/articles/3078
   ▸ To check the MLNX_OFED package OS support, visit https://docs.mellanox.com/category/mlnxofedib, click the latest MLNX_OFED software version and then use the side menu to navigate to Release Notes->General Support in MLNX_OFED and view Supported Operating Systems.

2. After installing the MLNX_OFED drivers, install the NVIDIA peer memory module.

   `sudo yum install nvidia-peer-memory-dkms`
Appendix C.
USING CUSTOM DGX SOFTWARE UTILITIES
FOR THE DGX STATION

The DGX Software includes custom utilities for maintaining the DGX Station persistent storage. Custom utilities for managing and obtaining diagnostic information for the DGX Station were included only in version EL7-20.01 of the DGX Software.

C.1. Rebuilding the DGX Station RAID Array

After adding SSDs to the, you must rebuild the RAID array to add the new SSDs to the array. After replacing a failed SSD in the RAID array, you must rebuild the array to add the new SSD to a RAID 0 array or to regenerate the lost data on the new SSD in a RAID 5 array.

If the DGX Station RAID array is degraded because an SSD failed, replace the SSD as explained in DGX Station User Guide.

The DGX Station software includes the custom script `configure_raid_array.py` for rebuilding the RAID array.

To rebuild the array, run the following command:

```
$ sudo configure_raid_array.py -r
```

The time required to rebuild a RAID 5 array depends on factors such as system load, SSD capacity, and the number of SSDs in the array. Rebuilding the array of three 1.92-terabyte SSDs in the DGX Station may require several hours.

You can monitor the progress of a long-running rebuild by examining the contents of the `/proc/mdstat` file:

```
$ cat /proc/mdstat
Personalities : [raid0] [linear] [multipath] [raid1] [raid6] [raid5] [raid4] [raid10]
md0 : active raid5 sdb[0] sdd[3] sdc[1]
      3750486016 blocks super 1.2 level 5, 512k chunk, algorithm 2 [3/2] [UU_]
```
In this example, the rebuild is 4.0% complete and the rebuild is estimated to finish in 438.3 minutes.

The RAID array is rebuilt with its existing RAID level.

- If the array is a RAID 0 array, all data that was on the array is erased after array is rebuilt.
- If the array is a RAID 5 array, the data on the array is preserved after array is rebuilt.

If you have rebuilt a RAID 0 array and have a backup of data on the array that you want to preserve, restore the data from the backup.

C.2. Changing the RAID Level of the RAID Array

During the initial installation of the DGX software on CentOS, the data SSDs in the DGX Station are configured as a RAID 0 or RAID 5 array. If your requirements for redundancy or storage capacity change, you can change the RAID level of the array from the level that was initially configured.

Before changing the RAID level of the DGX Station RAID array, back up all data on the array that you want to preserve. Changing the RAID level of the DGX Station RAID array erases all data stored on the array.

The DGX Station software includes the custom script `configure_raid_array.py`, which you can use to change the level of the RAID array without unmounting the RAID volume.

- To change the RAID level to RAID 5, run the following command:

  ```
  $ sudo configure_raid_array.py -m raid5
  ```

  After you change the RAID level to RAID 5, the RAID array is rebuilt. A RAID array that is being rebuilt is online and ready to be used, but a check on the health of the DGX Station reports the status of the RAID volume as unhealthy. Therefore, avoid checking the health of the DGX Station while the RAID array is being rebuilt. For more information, see EL7-20.01 Only: Checking the Health of the DGX Station.

  The time required to rebuild the RAID array depends on the workload on the system. On an idle system, the rebuild might be complete within 30 minutes.

- To change the RAID level to RAID 0, run the following command:

  ```
  $ sudo configure_raid_array.py -m raid0
  ```
To confirm that the RAID level was changed as required, run the `lsblk` command. The entry in the **TYPE** column for each SSD in the RAID array indicates the RAID level of the array.

The following example shows that the RAID level of the array is RAID 0. The name of the RAID volume is `md0` and the mount point of the volume is `/raid`.

```
~$ lsblk
NAME   MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINT
sda      8:0    0  1.8T  0 disk
|_sda1   8:1    0  487M  0 part /boot/efi
|_sda2   8:2    0  1.8T  0 part /
sdb      8:16   0  1.8T  0 disk
|_md0    9:0    0  5.2T  0 raid0 /raid
sdc      8:32   0  1.8T  0 disk
|_md0    9:0    0  5.2T  0 raid0 /raid
sdd      8:48   0  1.8T  0 disk
|_md0    9:0    0  5.2T  0 raid0 /raid
```

### C.3. EL7-20.01 Only: Checking the Health of the DGX Station

Starting with release EL7-20.02, the NVIDIA System Health Checker (**nvhealth**) tool is replaced by NVIDIA System Management (NVSM). For information about how to use NVSM to perform this task, see Show Health in NVIDIA System Management User Guide.

The DGX Station provides the NVIDIA System Health Checker (**nvhealth**) tool to exercise the system and verify its health. The output of **nvhealth** is an itemized list of checks and their status, typically Healthy or Unhealthy. On a healthy system, all checks should return Healthy. You should investigate any checks that return Unhealthy to determine their root cause and resolve them.

To check the health of the DGX Station, run the following command:

```
$ sudo nvhealth [-k output-file]
```

**output-file**

The name and the path of the file in which the raw state of the system is written. The **nvhealth** command displays this file name at the end of the output from the command.

If you omit the output file, the information is written to the file `/tmp/nvhealth-log.random-string.jsonl`, for example, `/tmp/nvhealth-log.6wf3WriAC3.jsonl`.

If you run the **nvhealth** command while the RAID array is being rebuilt after a change in RAID level to RAID 5, **nvhealth** reports the status of the RAID volume as
unhealthy. To avoid this potentially misleading result, wait until RAID array is rebuilt before running `nvhealth`.

To check the progress of the rebuild and show the percentage complete and an estimate of the time to completion, run this command:

```
# cat /proc/mdstat
```

```
Personalities : [raid6] [raid5] [raid4] [linear] [multipath] [raid0] [raid1] [raid10] md0 : active raid5 sdb[0] sdc[1] sdd[2] 181764096 blocks super 1.2 level 5, 512k chunk, algorithm 2 [4/3] [[UUU]] [===>.................] recovery = 17.2% (10426232/60588032) finish=45.8min speed=18238K/sec
```

C.4. EL7-20.01 Only: Collecting Information for Troubleshooting the DGX Station

Starting with release EL7-20.02, the tool to collect troubleshooting information (`nvsysinfo`) tool is replaced by NVIDIA System Management (NVSM). For information about how to use NVSM to perform this task, see Dump Health in NVIDIA System Management User Guide.

To help diagnose and resolve issues, the DGX Station provides a tool to collect troubleshooting information for NVIDIA Support Enterprise Services.

The tool verifies basic functionality and performance of the DGX Station and collects the following information in an xz-compressed tar archive:

- Log files
- Hardware inventory
- SW inventory

To collect information for troubleshooting the DGX Station, run the following command:

```
sudo nvsysinfo [-o output-file]
```

`output-file`

The path of the file in which the information is written.

If you omit the output file, the name of the file to which the information is written is `/tmp/nvsysinfo-host-name-timestamp.tar.xz`.

Use any method that is convenient for you to send the file to NVIDIA Support Enterprise Services. For example, send the file as an e-mail attachment.
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