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Chapter 1.
INTRODUCTION TO THE NVIDIA DGX-2 SYSTEM

The NVIDIA® DGX-2™ System is the world’s first two-petaFLOPS system that engages 16 fully interconnected GPUs for accelerated deep learning performance. The DGX-2 System is powered by NVIDIA® DGX™ software stack and an architecture designed for Deep Learning, and High-Performance Computing and analytics.
1.1 ABOUT THIS DOCUMENT

This document is for users and administrators of the DGX-2 System. It is organized as follows:

- **Chapters 1-4**: Overview of the DGX-2 System, including basic first-time setup and operation
- **Chapters 5-6**: Network and storage configuration instructions.
- **Chapters 7-9**: Software and firmware update instructions
- **Chapters 9**: How to use the BMC
- **Chapter 10**: How to configure and use the DGX-2 System as a Kernel Virtual Machine host

1.2 HARDWARE OVERVIEW

1.2.1 Major Components

The following diagram shows the major components of the DGX-2 System.

![NVIDIA DGX-2 Diagram](image)

<table>
<thead>
<tr>
<th>ID</th>
<th>Component</th>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GPU</td>
<td>16</td>
<td>NVIDIA® Tesla V100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- 2 petaFLOPS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- 512GB total GPU memory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- 81920 NVIDIA CUDA® Cores</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- 10240 NVIDIA Tensor Cores</td>
</tr>
<tr>
<td>2</td>
<td>GPU Boards</td>
<td>2</td>
<td>Each board consists of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Twelve NVSwitches</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.4 TB/sec bi-directional bandwidth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30TB NVMe SSDs Internal Storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Two Intel Xeon Platinum CPUs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.5 TB System Memory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Eight EDR Infiniband/100 GigE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1600 Gb/sec Total Bi-directional Bandwidth</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Two High-Speed Ethernet 10/25/40/100 GigE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Two GPU Boards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 V100 32GB GPUs per board</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 NVSwitches per board</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>512GB Total HBM2 Memory Interconnected by Plane Card</td>
</tr>
</tbody>
</table>
1.2.2 Other Components not in Exploded View

<table>
<thead>
<tr>
<th>Component</th>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>6</td>
<td>3000 W each</td>
</tr>
<tr>
<td>Storage (RAID 1)</td>
<td>2</td>
<td>960GB NVMe SSDs</td>
</tr>
<tr>
<td>(OS)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.2.3 Mechanical Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Form Factor</td>
<td>10U Rackmount</td>
</tr>
<tr>
<td>Height</td>
<td>17.32” (440 mm)</td>
</tr>
<tr>
<td>Width</td>
<td>19” (482.6 mm)</td>
</tr>
<tr>
<td>Depth</td>
<td>31.3” (795 mm)</td>
</tr>
<tr>
<td>Gross Weight</td>
<td>360 lbs (163.29 kg)</td>
</tr>
</tbody>
</table>

1.2.4 Power Specifications

<table>
<thead>
<tr>
<th>Input</th>
<th>Specification for Each Power Supply</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-240 volts AC</td>
<td>10 kW max.</td>
<td>3000 W @ 200-240 V, 16 A, 50-60 Hz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The DGX-2 System contains six load-balancing power supplies.</td>
</tr>
</tbody>
</table>
1.2.5 Environmental Specifications

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>5 °C to 35 °C (41 °F to 95 °F)</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>20% to 85% noncondensing</td>
</tr>
<tr>
<td>Airflow</td>
<td>1000 CFM @ 35 °C</td>
</tr>
<tr>
<td>Heat Output</td>
<td>34122 BTU/hr</td>
</tr>
</tbody>
</table>

1.2.6 Front Panel Connections and Controls

<table>
<thead>
<tr>
<th>ID</th>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>Upper GPU tray fans</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>Lower GPU tray fans</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>Solid State Drives. Additional SSDs available for purchase to expand to 16.</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Motherboard tray fans</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Front console board: USB 3.0 (2x) VGA (1x)</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Power and ID buttons: Top: Power button and LED Press to turn the DGX-2 System on or off.</td>
</tr>
</tbody>
</table>
1.2.7 Rear Panel Connections and Controls

1.2.7.1 With EMI Shield Installed

<table>
<thead>
<tr>
<th>ID</th>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>EMI shield</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>Power supplies and connectors</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>I/O tray</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Motherboard tray</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>Handles to pull power supply carrier</td>
</tr>
</tbody>
</table>
1.2.7.2  With EMI Shield Removed

![Image of DGX-2 with EMI shield removed]

<table>
<thead>
<tr>
<th>ID</th>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>NVIDIA NVLink™ plane card</td>
</tr>
</tbody>
</table>

1.2.8  Motherboard Tray Ports and Controls

![Image of DGX-2 motherboard tray with ports highlighted]

<table>
<thead>
<tr>
<th>ID</th>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>(Optional) High profile PCI card slot (for network storage)</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>(Default) QSFP28 network ports (for network storage)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Left side port designation: enp134s0f0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right side port designation: enp134s0f1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>RJ45 network port (for in-band management)</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>USB 3.0 ports</td>
</tr>
<tr>
<td>ID</td>
<td>Qty</td>
<td>Description</td>
</tr>
<tr>
<td>----</td>
<td>-----</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>IPMI port (for out-of-band management (BMC))</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>VGA port</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Serial port (DB-9)</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>System ID LED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blinks blue when ID button is pressed from the front of the unit as an aid in identifying the unit needing servicing</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>BMC reset button</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>Power and BMC heartbeat LED</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On/Off - BMC is not ready</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blinking - BMC is ready</td>
</tr>
</tbody>
</table>

**1.3 NETWORK PORTS**

The following figure highlights the available network ports and their purpose.

![Network Ports Diagram](image)

<table>
<thead>
<tr>
<th>ID</th>
<th>Connectivity</th>
<th>Uses</th>
<th>Number of Ports</th>
<th>Port Type</th>
<th>Cable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BMC (remote management and monitoring)</td>
<td>Out-of-band management</td>
<td>1</td>
<td>RJ45</td>
<td>100/1000 Ethernet Cat5E/6 Ethernet</td>
</tr>
<tr>
<td>2</td>
<td>Motherboard RJ45</td>
<td>In-band management, administration</td>
<td>1</td>
<td>RJ45</td>
<td>100/1000 Ethernet Cat5E/6 Ethernet</td>
</tr>
<tr>
<td>3</td>
<td>ConnectX-5 (LP) Ethernet mode</td>
<td>Storage (NFS) System communication</td>
<td>2 (Left): enp134s0f0</td>
<td>QSFP28</td>
<td>100 GbE (QSFP28) 10/25/40 GbE</td>
</tr>
</tbody>
</table>
1.4 RECOMMENDED PORTS TO USE FOR EXTERNAL STORAGE

For clarity, the following figure reiterates the recommended ports to use for external storage. In most configurations, the storage ports (ID 1 below) should be used for connecting to high-speed NAS storage, while the cluster ports (ID 2 below) should be used for communication between nodes.

<table>
<thead>
<tr>
<th>ID</th>
<th>Connectivity</th>
<th>Uses</th>
<th>Number of Ports</th>
<th>Port Type</th>
<th>Cable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ConnectX-5 (LP)</td>
<td>Storage (NFS)</td>
<td>2</td>
<td>QSFP28</td>
<td>1/10/25/40/100 GbE</td>
</tr>
<tr>
<td></td>
<td>(Left): enp134s0f0 (Right): enp134s0f1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ConnectX-5</td>
<td>Cluster</td>
<td>8</td>
<td>QSFP28</td>
<td>EDR InfiniBand or 100 GbE</td>
</tr>
<tr>
<td></td>
<td>InfiniBand mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethernet mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>InfiniBand mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethernet mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1.5 **DGX OS SOFTWARE**

The DGX-2 System comes installed with a base OS incorporating

- An Ubuntu server distribution with supporting packages
- The NVIDIA driver
- Docker CE
- NVIDIA Container Runtime for Docker
- The following health monitoring software
  - NVIDIA System Management (NVSM)
    Provides active health monitoring and system alerts for NVIDIA DGX nodes in a data center. It also provides simple commands for checking the health of the DGX-2 SYSTEM from the command line.
  - Data Center GPU Management (DCGM)
    This software enables node-wide administration of GPUs, and can be used for cluster and data-center level management.

1.6 **ADDITIONAL DOCUMENTATION**

[Note: Some of the documentation listed below are not available at the time of publication. See https://docs.nvidia.com/dgx/ for the latest status.]

- **DGX-2 System Service Manual**
  Instructions for servicing the DGX-2 System, including how to replace select components.

- **DGX OS Server Release Notes**
  Provides software component versions as well as a list of changes and known issues in the installed OS software.

- **NGC Container Registry for DGX**
  How to access the NGC container registry for using containerized deep learning GPU-accelerated applications on your DGX-2 System.

- **NVSM Software User Guide**
  Contains instructions for using the NVIDIA System Management software.

- **DCGM Software User Guide**
  Contains instructions for using the Data Center GPU Management software.
1.7 CUSTOMER SUPPORT

Contact NVIDIA Enterprise Support for assistance in reporting, troubleshooting, or diagnosing problems with your DGX-2 System. Also contact NVIDIA Enterprise Support for assistance in installing or moving the DGX-2 System. You can contact NVIDIA Enterprise Support in the following ways.

1.7.1 NVIDIA Enterprise Support Portal

The best way to file an incident is to log on to the NVIDIA Enterprise Support portal.

1.7.2 NVIDIA Enterprise Support Email

You can also send an email to enterprisesupport@nvidia.com.

1.7.3 NVIDIA Enterprise Support - Local Time Zone Phone Numbers

Visit the NVIDIA Enterprise Support page.
Chapter 2.
CONNECTING TO THE DGX-2 CONSOLE

Connect to the DGX-2 console using either a direct connection, a remote connection through the BMC, or through an SSH connection.

<CAUTION: Connect directly to the DGX-2 console if the DGX-2 System is connected to a 172.17.xx.xx subnet.

DGX OS Server software installs Docker CE which uses the 172.17.xx.xx subnet by default for Docker containers. If the DGX-2 System is on the same subnet, you will not be able to establish a network connection to the DGX-2 System.

Refer to the section Configuring Docker IP Addresses for instructions on how to change the default Docker network settings.>
2.1 DIRECT CONNECTION

At either the front or the back of the DGX-2 System, connect a display to the VGA connector, and a keyboard to any of the USB ports.

DGX-2 Server Front

DGX-2 Server Back
2.2 REMOTE CONNECTION THROUGH THE BMC

See the section Configuring Static IP Address for the BMC if you need to configure a static IP address for the BMC.

This method requires that you have the BMC login credentials. These credentials depend on the following conditions:

Prior to first time boot: The default credentials are

Username: admin
Password: admin

After first boot setup: The administrative user username that was set up during the initial boot is used for both the BMC username and BMC password.

Username: <administrator-username>
Password: <administrator-username>

After first boot setup with changed password: The BMC password can be changed from “<system-username>”, in which case the credentials are

Username: <administrator-username>
Password: <new-bmc-password>

1. Make sure you have connected the BMC port on the DGX-2 System to your LAN.
2. Open a browser within your LAN and go to:
   https://<ipmi-ip-address>/
   Make sure popups are allowed for the BMC address.
3. Log in.
4. From the left-side navigation menu, click **Remote Control**.

The **Remote Control** page allows you to open a virtual Keyboard/Video/Mouse (KVM) on the DGX-2 System, as if you were using a physical monitor and keyboard connected to the front of the system.

5. Click **Launch KVM**.

The DGX-2 console appears in your browser.
2.3 SSH CONNECTION

You can also establish an SSH connection to the DGX-2 System through the network port. See the section Network Ports to identify the port to use, and the section Configuring Static IP Addresses for the Network Ports if you need to configure a static IP address.
Chapter 3.
SETTING UP THE DGX-2 SYSTEM

While NVIDIA service personnel will install the DGX-2 System at the site and perform the first boot setup, the first boot setup instructions are provided here for reference and to support any re-imaging of the server.

These instructions describe the setup process that occurs the first time the DGX-2 System is powered on after delivery or after the server is re-imaged.

Be prepared to accept all End User License Agreements (EULAs) and to set up your username and password.

1. Connect to the DGX-2 console as explained in Connecting to the DGX-2 Console.

2. Power on the DGX-2 System.
   a. Using the physical power button
Setting Up the DGX-2 System

- Using the Remote BMC

The system will take a few minutes to boot.

You are presented with end user license agreements (EULAs) for the NVIDIA software.
3. Accept all EULAs to proceed with the installation.
   The system boots and you are prompted to configure the DGX-2 software.

4. Perform the steps to configure the DGX-2 software.
   - Select your language and location.
   - Create a user account with your name, username, and password.
     You will need these credentials to log in to the DGX-2 System as well as to log in to the BMC remotely. When logging in to the BMC, enter your username for both the User ID as well as the password. Be sure to create a unique BMC password at the first opportunity.

   ![CAUTION: Once you create your login credentials, the default admin/admin login will no longer work.]

   Note: The BMC software will not accept “sysadmin” for a user name. If you create this user name for the system log in, “sysadmin” will not be available for logging in to the BMC.

   - Choose a primary network interface for the DGX-2 System; for example, enp6s0.
     This should typically be the interface that you will use for subsequent system configuration or in-band management.

   ![Note: After you select the primary network interface, the system attempts to configure the interface for DHCP and then asks you to enter a hostname for the system. If DHCP is not available, you will have the option to configure the network manually. If you need to configure a static IP address on a network interface connected to a DHCP network, select Cancel at the Network configuration - Please enter the hostname for the system screen. The system will then present a screen with the option to configure the network manually.]

   - Choose a host name for the DGX-2 System.
     After completing the setup process, the DGX-2 System reboots automatically and then presents the login prompt.

5. Update the software to ensure you are running the latest version.
   Updating the software ensures your DGX-2 System contains important updates, including security updates. The Ubuntu Security Notice site (https://usn.ubuntu.com/) lists known Common Vulnerabilities and Exposures (CVEs), including those that can be resolved by updating the DGX OS software.
   a) Run the package manager.
Setting Up the DGX-2 System

$ sudo apt update

b) Upgrade to the latest version.

$ sudo apt full-upgrade

**Note: RAID 1 Rebuild in Progress** - When the system is booted after restoring the image, software RAID begins the process of rebuilding the RAID 1 array - creating a mirror of (or resynchronizing) the drive containing the software. System performance may be affected during the RAID 1 rebuild process, which can take an hour to complete.

During this time, the command “nvsm show health” will report a warning that the RAID volume is resyncing.

You can check the status of the RAID 1 rebuild process using “sudo mdadm -D /dev/md0”.
This chapter provides basic requirements and instructions for using the DGX-2 System, including how to perform a preliminary health check and how to prepare for running containers. Be sure to visit the DGX documentation website at https://docs.nvidia.com/dgx/ for additional product documentation.

4.1 REGISTRATION

Be sure to register your DGX-2 System with NVIDIA as soon as you receive your purchase confirmation e-mail. Registration enables your hardware warranty and allows you to set up an NVIDIA GPU Cloud for DGX account.

To register your DGX-2 System, you will need information provided in your purchase confirmation e-mail. If you do not have the information, send an e-mail to NVIDIA Enterprise Support at enterprisesupport@nvidia.com.


2. Enter all required information and then click SUBMIT to complete the registration process and receive all warranty entitlements and DGX-2 support services entitlements.
4.2 INSTALLATION AND CONFIGURATION

Your DGX-2 System will be installed by NVIDIA service personnel or an authorized installation partner.

Before installation, make sure you have completed the Site Survey and have given all relevant site information to your Installation Partner.

4.3 OBTAINING AN NVIDIA GPU CLOUD ACCOUNT

NVIDIA GPU Cloud (NGC) provides simple access to GPU-optimized software tools for deep learning and high-performance computing (HPC) that take full advantage of NVIDIA GPUs. An NGC account grants you access to these tools as well as the ability to set up a private registry to manage your customized tools.

Work with NVIDIA Enterprise Support to set up an NGC enterprise account if you are the organization administrator for your DGX-2 purchase. See the NGC Container Registry for DGX User Guide (https://docs.nvidia.com/dgx/ngc-registry-for-dgx-user-guide/) for detailed instructions on getting an NGC enterprise account.

4.4 GETTING YOUR NGC API KEY AND SELECTING CONTAINER TAGS FOR THE VERIFICATION EXAMPLES

Before using the DGX-2 System to run containers from the NGC container registry, you must visit the NGC web site to obtain your NGC API Key and to determine which containers are available to run.

4.4.1 Getting Your NGC API Key

Your NGC API Key authenticates your access to the NGC container registry with its NVIDIA tuned, tested, certified, and maintained containers for the top deep learning frameworks.

You only need to generate an API Key once. Should you lose your API Key, you can generate a new one from the NGC website. When you generate a new API Key, the old one is invalidated.

Perform the following instructions from any system with internet access and a browser.
Quick Start Instructions

2. Click Get API Key from the Registry page.
3. Click Generate API Key from the Configuration->API Key page.
4. Click Confirm at the Generate a New API Key dialog.

   Your NGC API Key is displayed at the bottom of the Configuration->API Key page with examples of how to use it.

**NGC does not save your key, so store it in a secure place.** You can copy your API Key to the clipboard by clicking the copy icon to the right of the API key.

4.4.2 Selecting CUDA Container Tags for Verification Examples

While you are logged in to the web site, select a CUDA container tag to use for the verification procedure in the next section.

1. Select Registry from the left side menu.
2. Select a CUDA container tag.
   c) Click the cuda repository (under the nvidia registry space).
   d) In the Tag section, scroll down to find the latest ‘-runtime’ version. For example, ‘10.0-runtime’.

Note this tag as you will need to specify it when running the CUDA container in the next section.

4.5 VERIFYING BASIC FUNCTIONALITY

This section walks you through the steps of performing a health check on the DGX-2 System, and verifying the Docker and NVIDIA driver installation.

1. Establish an SSH connection to the DGX-2 System.
2. Run a basic system check.
   
   **sudo nvsm show health**

   Verify that the output summary shows that all checks are Healthy and that the overall system status is Healthy.

3. Verify that Docker is installed by viewing the installed Docker version.
   
   **sudo docker --version**

   This should return the version as “Docker version 18.03-ce”, where the actual version may differ depending on the specific release of the DGX OS Server software.
4. Verify connection to the NVIDIA repository and that the NVIDIA Driver is installed.

   
   ```
   sudo docker container run --runtime=nvidia --rm 
   nvcr.io/nvidia/cuda:<cuda-tag-obtained-from-previous-section> nvidia-smi
   ```

   Docker pulls the nvidia/cuda container image layer by layer, then runs nvidia-smi.

   When completed, the output should show the NVIDIA Driver version and a description of each installed GPU.

See the NVIDIA Containers and Deep Learning Frameworks User Guide at https://docs.nvidia.com/deeplearning/dgx/user-guide/index.html for further instructions, including an example of logging into the NGC container registry and launching a deep learning container.
Chapter 5.
NETWORK CONFIGURATION

This chapter describes key network considerations and instructions for the DGX-2 System.

5.1 BMC SECURITY

NVIDIA recommends that customers follow best security practices for BMC management (IPMI port). These include, but are not limited to, such measures as:

- Restricting the DGX-2 IPMI port to an isolated, dedicated, management network
- Using a separate, firewalled subnet
- Configuring a separate VLAN for BMC traffic if a dedicated network is not available

5.2 CONFIGURING NETWORK PROXIES

If your network requires use of a proxy server, you will need to set up configuration files to ensure the DGX-2 System communicates through the proxy.

5.2.1 For the OS and Most Applications

Edit the file /etc/environment and add the following proxy addresses to the file, below the PATH line.

http_proxy="http://<username>:<password>@<host>:<port>/"
ftp_proxy="ftp://<username>:<password>@<host>:<port>/";}
Network Configuration

https_proxy="https://<username>::<password>@<host>::<port>/";
no_proxy="localhost,127.0.0.1,localaddress,.localdomain.com"
HTTP_PROXY="http://<username>::<password>@<host>::<port>/"
FTP_PROXY="ftp://<username>::<password>@<host>::<port>/";
HTTPS_PROXY="https://<username>::<password>@<host>::<port>/";
NO_PROXY="localhost,127.0.0.1,localaddress,.localdomain.com"

Where username and password are optional.

**Example:**

http_proxy="http://myproxy.server.com:8080/"
ftp_proxy="ftp://myproxy.server.com:8080/";
https_proxy="https://myproxy.server.com:8080/";

**5.2.2 For apt**

Edit (or create) a proxy config file `/etc/apt/apt.conf.d/myproxy` and include the following lines

Acquire::http::proxy "http://<username>::<password>@<host>::<port>/";
Acquire::ftp::proxy "ftp://<username>::<password>@<host>::<port>/";
Acquire::https::proxy "https://<username>::<password>@<host>::<port>/";

Where username and password are optional.

**Example:**

Acquire::http::proxy "http://myproxy.server.com:8080/";
Acquire::ftp::proxy "ftp://myproxy.server.com:8080/";
Acquire::https::proxy "https://myproxy.server.com:8080/";

**5.2.3 For Docker**

To ensure that Docker can access the NGC container registry through a proxy, Docker uses environment variables. For best practice recommendations on configuring proxy environment variables for Docker,

see [https://docs.docker.com/engine/admin/systemd/#http-proxy](https://docs.docker.com/engine/admin/systemd/#http-proxy).

**5.3 CONFIGURING DOCKER IP ADDRESSES**

To ensure that the DGX-2 System can access the network interfaces for Docker containers, Docker should be configured to use a subnet distinct from other network resources used by the DGX-2 System.
By default, Docker uses the 172.17.0.0/16 subnet. Consult your network administrator to find out which IP addresses are used by your network. **If your network does not conflict with the default Docker IP address range, then no changes are needed and you can skip this section.**

However, if your network uses the addresses within this range for the DGX-2 System, you should change the default Docker network addresses.

You can change the default Docker network addresses by either modifying the /etc/docker/daemon.json file or modifying the /etc/systemd/system/docker.service.d/docker-override.conf file. These instructions provide an example of modifying the /etc/systemd/system/docker.service.d/docker-override.conf to override the default Docker network addresses.

1. Open the docker-override.conf file for editing.

   ```
   $ sudo vi /etc/systemd/system/docker.service.d/docker-override.conf
   [Service]
   ExecStart=
   ExecStart=/usr/bin/dockerd -H fd:// -s overlay2
   LimitMEMLOCK=infinity
   LimitSTACK=67108864
   ```

2. Make the changes indicated in bold below, setting the correct bridge IP address and IP address ranges for your network. Consult your IT administrator for the correct addresses.

   ```
   [Service]
   ExecStart=
   ExecStart=/usr/bin/dockerd -H fd:// -s overlay2 --bip=192.168.127.1/24
             --fixed-cidr=192.168.127.128/25
   LimitMEMLOCK=infinity
   LimitSTACK=67108864
   ```

   Save and close the /etc/systemd/system/docker.service.d/docker-override.conf file when done.

3. Reload the systemctl daemon.

   ```
   $ sudo systemctl daemon-reload
   ```

4. Restart Docker.

   ```
   $ sudo systemctl restart docker
   ```
5.4 OPENING PORTS

Make sure that the ports listed in the following table are open and available on your firewall to the DGX-2 System:

<table>
<thead>
<tr>
<th>Port (Protocol)</th>
<th>Direction</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 (TCP)</td>
<td>Inbound</td>
<td>SSH</td>
</tr>
<tr>
<td>53 (UDP)</td>
<td>Outbound</td>
<td>DNS</td>
</tr>
<tr>
<td>80 (TCP)</td>
<td>Outbound</td>
<td>HTTP, package updates</td>
</tr>
<tr>
<td>443 (TCP)</td>
<td>Outbound</td>
<td>For internet (HTTP/HTTPS) connection to NVIDIA GPU Cloud</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If port 443 is proxied through a corporate firewall, then WebSocket protocol traffic must be supported</td>
</tr>
<tr>
<td>443 (TCP)</td>
<td>Inbound</td>
<td>For BMC web services, remote console services, and cd-media service.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If port 443 is proxied through a corporate firewall, then WebSocket protocol traffic must be supported</td>
</tr>
</tbody>
</table>

5.5 CONNECTIVITY REQUIREMENTS

To run NVIDIA NGC containers from the NGC container registry, your network must be able to access the following URLs:

- http://security.ubuntu.com/ubuntu/
- http://international.download.nvidia.com/dgx/repos/
- https://apt.dockerproject.org/repo/
- https://download.docker.com/linux/ubuntu/
- https://nvcr.io/

To verify connection to nvcr.io, run

```
$ wget https://nvcr.io/v2
```

You should see connecting verification followed by a 401 error.

```
Resolving nvcr.io (nvcr.io)... 52.8.131.152, 52.9.8.8
Connecting to nvcr.io (nvcr.io)|52.8.131.152|:443... connected.
HTTP request sent, awaiting response... 401 Unauthorized
```
5.6 CONFIGURING STATIC IP ADDRESS FOR THE BMC

This section explains how to set a static IP address for the BMC. You will need to do this if your network does not support DHCP.

Use one of the methods described in the following sections:

- Configuring a BMC Static IP Address Using ipmitool
- Configuring a BMC Static IP Address Using the System BIOS
- Configuring a BMC Static IP Address Using the BMC Dashboard

5.6.1 Configuring a BMC Static IP Address Using ipmitool

This section describes how to set a static IP address for the BMC from the Ubuntu command line.

Note: If you cannot access the DGX-2 System remotely, then connect a display (1440x900 or lower resolution) and keyboard directly to the DGX-2 System.

To view the current settings, enter the following command.

```
$ sudo ipmitool lan print 1
```

To set a static IP address for the BMC, do the following.

1. Set the IP address source to static.

```
$ sudo ipmitool lan set 1 ipsrc static
```

2. Set the appropriate address information.

   • To set the IP address (“Station IP address” in the BIOS settings), enter the following and replace the italicized text with your information.

```
$ sudo ipmitool lan set 1 ipaddr 10.31.241.190
```

   • To set the subnet mask, enter the following and replace the italicized text with your information.

```
$ sudo ipmitool lan set 1 netmask 255.255.255.0
```
To set the default gateway IP (“Router IP address” in the BIOS settings), enter the following and replace the italicized text with your information.

```bash
$ sudo ipmitool lan set 1 defgw ipaddr 10.31.241.1
```

## 5.6.2 Configuring a BMC Static IP Address Using the System BIOS

This section describes how to set a static IP address for the BMC when you cannot access the DGX-2 System remotely. This process involves setting the BMC IP address during system boot.

1. Connect a keyboard and display (1440 x 900 maximum resolution) to the DGX-2 System, then turn on the DGX-2 System.
2. When you see the SBIOS version screen, press **Del** or **F2** to enter the BIOS Setup Utility screen.
3. At the BIOS Setup Utility screen, navigate to the **Server Mgmt** tab on the top menu, then scroll to **BMC network configuration** and press **Enter**.
4. Scroll to **Configuration Address Source** and press Enter, then at the **Configuration Address source** pop-up, select **Static** and then press Enter.

5. Set the addresses for the Station IP address, Subnet mask, and Router IP address as needed by performing the following for each:
a) Scroll to the specific item and press Enter.
b) Enter the appropriate information at the pop-up, then press Enter.

6. When finished making all your changes, press F10 to save & exit
   You can now access the BMC over the network.

5.6.3 Configuring a BMC Static IP Address Using the BMC Dashboard

These instructions describe IPv4 addressing, but IPv6 addressing to the BMC can be configured if needed through the corresponding IPv6 fields.

1. Log into the BMC, then click Settings->Network Settings->Network IP Settings.
2. Clear the Enable IPv4 DHCP check box, then enter the appropriate values for the IPv4 Address, IPv4 Subnet, and IPv4 Gateway fields.
3. Click **Save** when done.

5.7 CONFIGURING STATIC IP ADDRESSES FOR THE NETWORK PORTS

During the initial boot setup process for the DGX-2 System, you had an opportunity to configure static IP addresses for a single network interface. If you did not set this up at that time, you can configure the static IP addresses from the Ubuntu command line using the following instructions.

**Note:** If you cannot access the DGX-2 System remotely, then connect a display (1440x900 or lower resolution) and keyboard directly to the DGX-2 System.

1. Determine the port designation that you want to configure, based on the physical ethernet port that you have connected to your network.
2. Edit the network configuration yaml file.

```
$ sudo vi /etc/netplan/01-netcfg.yaml
```

```
network:
  version: 2
  renderer: networkd
  ethernets:
    <port-designation>:
      dhcp4: no
      dhcp6: no
      addresses: 10.10.10.2/24
      gateway4: 10.10.10.1
      nameservers:
        search: [<mydomain>, <other-domain>]
        addresses: [10.10.10.1, 1.1.1.1]
```

Consult your network administrator for the appropriate information for the items in bold, such as network, gateway, and nameserver addresses, and use the port designations that you determined in step 1.

3. When finished with your edits, press ESC to switch to command mode, then save the file to the disk and exit the editor.

4. Apply the changes.

```
$ sudo netplan apply
```
Network Configuration

Note: If you are not returned to the command line prompt after a minute, then reboot the system.

For additional information, see https://help.ubuntu.com/lts/serverguide/network-configuration.html.en.

5.8 SWITCHING BETWEEN INFINIBAND AND ETHERNET

The NVIDIA DGX-2 System is equipped with eight QSFP28 network ports on the I/O board, typically used for cluster communications. By default these are configured as InfiniBand ports, but you have the option to convert these to Ethernet ports.

For these changes to work properly, the configured port must connect to a networking switch that matches the port configuration. In other words, if the port configuration is set to InfiniBand, then the external switch should be an InfiniBand switch with the corresponding InfiniBand cables. Likewise, if the port configuration is set to Ethernet, then the switch should also be Ethernet.

5.8.1 Starting the Mellanox Software Tools

1. Start the mst driver.

   $ sudo mst start

2. To verify that the Mellanox Software Tools (MST) services are running, enter the following.

   $ sudo mst status

   - The following output indicates the services are not running.

     MST modules:
     ------------
     MST PCI module is not loaded
     MST PCI configuration module is not loaded

   - The following output indicates the services are running.

     MST modules:
     ------------
MST PCI module is not loaded
MST PCI configuration module loaded

MST devices:

---------
/dev/mst/mt4119_pciconf0 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:35:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf1 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:3a:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf2 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:58:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf3 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:5d:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf4 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:b8:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf5 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:bd:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf6 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:e1:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf7 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:e6:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00
/dev/mst/mt4119_pciconf0 - PCI configuration cycles access.
   domain:bus:dev.fn=0000:86:00.0 addr.reg=88 data.reg=92
   Chip revision is: 00

$
## 5.8.2 Determining the Current Port Configuration

To determine the current port configuration, enter the following:

```
$ sudo mlxconfig query | egrep -e Device\|LINK_TYPE
```

<table>
<thead>
<tr>
<th>Device #1:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:bd:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #2:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:b8:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #3:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:3a:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #4:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:e1:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #5:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:35:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #6:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:5d:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #7:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:e6:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #8:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:58:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>IB(1)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device #9:</th>
<th>Device type: ConnectX5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device:</td>
<td>0000:86:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1</td>
</tr>
<tr>
<td></td>
<td>ETH(2)</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P2</td>
</tr>
<tr>
<td></td>
<td>ETH(2)</td>
</tr>
</tbody>
</table>

This output shows the first eight cards are configured for InfiniBand and correspond to the network cluster ports. The last card has two ports which correspond to the two network storage ports. These are configured for Ethernet should not be changed.

Map the Device bus numbers from your output to the device name from the `mst status` output on your system. For example, this example output shows that the device name for bus `bd` is `/dev/mst/mt4119_pciconf5`. You will need the device name when changing the configuration.
5.8.3 Switching the Port from InfiniBand to Ethernet

Make sure that you have started the Mellanox Software Tools (MST) services as explained in the section Starting the Mellanox Software Tools, and have identified the correct ports to change.

1. Change the configuration for the network cluster ports to Ethernet by setting LINK_TYPE_P1=2 for each port.

   The following example configures the 8 network cluster ports.

   ```
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf0 set LINK_TYPE_P1=2
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf1 set LINK_TYPE_P1=2
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf2 set LINK_TYPE_P1=2
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf3 set LINK_TYPE_P1=2
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf4 set LINK_TYPE_P1=2
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf5 set LINK_TYPE_P1=2
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf6 set LINK_TYPE_P1=2
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf7 set LINK_TYPE_P1=2
   ```

2. Reboot the server.

3. Verify the configuration changes have been applied.

   ```
   $ sudo mlxconfig query | grep -e Device\|LINK_TYPE
   Device #1:
   Device type: ConnectX4
   Device: 0000:bd:00.0
   LINK_TYPE_P1 ETH (1)
   Device #2:
   Device type: ConnectX4
   Device: 0000:b8:00.0
   LINK_TYPE_P1 ETH (1)
   Device #3:
   Device type: ConnectX4
   Device: 0000:3a:00.0
   LINK_TYPE_P1 ETH (1)
   Device #4:
   Device type: ConnectX4
   Device: 0000:e1:00.0
   LINK_TYPE_P1 ETH (1)
   Device #5:
   Device type: ConnectX4
   Device: 0000:35:00.0
   LINK_TYPE_P1 ETH (1)
   Device #6:
   Device type: ConnectX4
   Device: 0000:5d:00.0
   LINK_TYPE_P1 ETH (1)
   Device #7:
   Device type: ConnectX4
   ```
5.8.4 Switching the Port from Ethernet to InfiniBand

Make sure that you have started the Mellanox Software Tools (MST) as explain in the section Starting the Mellanox Software Tools, and have identified the correct ports to change.

1. Change the configuration for the network cluster ports to InfiniBand by setting LINK_TYPE_P1=1 for each port.

   The following example configures all 8 network cluster ports.

   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf0 set LINK_TYPE_P1=1
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf1 set LINK_TYPE_P1=1
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf2 set LINK_TYPE_P1=1
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf3 set LINK_TYPE_P1=1
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf4 set LINK_TYPE_P1=1
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf5 set LINK_TYPE_P1=1
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf6 set LINK_TYPE_P1=1
   ~$ sudo mlxconfig -y -d /dev/mst/mt4119_pciconf7 set LINK_TYPE_P1=1

2. Verify the configuration changes have been applied.

   $ sudo mlxconfig query | egrep -e Device\|LINK_TYPE

   Device #1:
   Device type: ConnectX4
   Device: 0000:bd:00.0
   LINK_TYPE_P1 IB(1)
   Device #2:
   Device type: ConnectX4
   Device: 0000:b8:00.0
   LINK_TYPE_P1 IB(1)
   Device #3:
   Device type: ConnectX4
   Device: 0000:3a:00.0
   LINK_TYPE_P1 IB(1)
   Device #4:
   Device type: ConnectX4
   Device: 0000:e1:00.0
   LINK_TYPE_P1 IB(1)
<table>
<thead>
<tr>
<th>Device #5:</th>
<th>Device type: ConnectX4</th>
<th>Device: 0000:35:00.0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LINK_TYPE_P1 IB(1)</td>
<td></td>
</tr>
<tr>
<td>Device #6:</td>
<td>Device type: ConnectX4</td>
<td>Device: 0000:5d:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1 IB(1)</td>
<td></td>
</tr>
<tr>
<td>Device #7:</td>
<td>Device type: ConnectX4</td>
<td>Device: 0000:e6:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1 IB(1)</td>
<td></td>
</tr>
<tr>
<td>Device #8:</td>
<td>Device type: ConnectX4</td>
<td>Device: 0000:58:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1 IB(1)</td>
<td></td>
</tr>
<tr>
<td>Device #9:</td>
<td>Device type: ConnectX5</td>
<td>Device: 0000:86:00.0</td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P1 ETH(2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LINK_TYPE_P2 ETH(2)</td>
<td></td>
</tr>
</tbody>
</table>
Chapter 6.
CONFIGURING STORAGE - NFS MOUNT AND CACHE

By default, the DGX-2 System includes eight SSDs in a RAID 0 configuration. These SSDs are intended for application caching, so you must set up your own NFS storage for long term data storage. The following instructions describe how to mount the NFS onto the DGX-2 System, and how to cache the NFS using the DGX-2 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-2 System, and that there is network access between the DGX-2 System and the NFS server.

1. Configure an NFS mount for the DGX-2 System.
   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.
   
   ```
   ping <nfs_server>
   ```
Use the server IP address or the server name provided by your network administrator.

3. **Mount the NFS export.**
   
   ```
   sudo mount /mnt
   
   /mnt is an example mount point.
   ```

4. **Verify caching is enabled.**
   
   ```
   cat /proc/fs/nfsfs/volumes
   
   Look for the text FSC=yes in the output.
   ```

   The NFS will be mounted and cached on the DGX-2 System automatically upon subsequent reboot cycles.
If the DGX-2 software image becomes corrupted (or both OS NVMe drives are replaced), restore the DGX-2 software image to its original factory condition from a pristine copy of the image.

The process for restoring the DGX-2 software image is as follows:

1. Obtain an ISO file that contains the image from NVIDIA Enterprise Support as explained in Obtaining the DGX-2 Software ISO Image and Checksum File.
2. Restore the DGX-2 software image from this file either remotely through the BMC or locally from a bootable USB flash drive.
   - If you are restoring the image remotely, follow the instructions in Re-Imaging the System Remotely.
   - If you are restoring the image locally, prepare a bootable USB flash drive and restore the image from the USB flash drive as explained in the following topics:
     - Creating a Bootable Installation Medium
     - Re-Imaging the System From a USB Flash Drive

Note: The DGX OS Server software is restored on one of the two NMVe M.2 drives. When the system is booted after restoring the image, software RAID begins the process rebuilding the RAID 1 array - creating a mirror of (or resynchronizing) the drive containing the software. System performance may be affected during the RAID 1 rebuild process, which can take an hour to complete.
7.1 Obtaining the DGX-2 Software ISO Image and Checksum File

To ensure that you restore the latest available version of the DGX-2 software image, obtain the current ISO image file from NVIDIA Enterprise Support. A checksum file is provided for the image to enable you to verify the bootable installation medium that you create from the image file.

1. Log on to the NVIDIA Enterprise Support site.
2. Click the Announcements tab to locate the download links for the DGX-2 software image.
3. Download the ISO image and its checksum file and save them to your local disk.
   The ISO image is also available in an archive file. If you download the archive file, be sure to extract the ISO image before proceeding.

7.2 Re-Imaging the System Remotely

These instructions describe how to re-image the system remotely through the BMC. For information about how to restore the system locally, see Re-Imaging the System from a USB Flash Drive.

Before re-imaging the system remotely, ensure that the correct DGX-2 software image is saved to your local disk. For more information, see Obtaining the DGX-2 Software ISO Image and Checksum File.

1. Log in to the BMC.
2. Click Remote Control and then click Launch KVM.
3. Set up the ISO image as virtual media.
   a) From the top bar, click Browse File and then locate the re-image ISO file and click Open.
   b) Click Start Media.
4. Reboot, install the image, and complete the DGX-2 System setup.
   a) From the top menu, click Power and then select Hard Reset, then click Perform Action.
   b) Click Yes and then OK at the Power Control dialogs, then wait for the system to power down and then come back online.
   c) At the boot selection screen, select Install DGX Server.
      If you are an advanced user who is not using the RAID disks as cache and want to keep data on the RAID disks, then select Install DGX Server without formatting.
**RAID.** See the section [Retaining the RAID Partition While Installing the OS](#) for more information.

d) Press **Enter**.

The DGX-2 System will reboot from ISO image and proceed to install the image. This can take approximately 15 minutes.

*Note:* The Mellanox InfiniBand driver installation may take up to 10 minutes.

After the installation is completed, the system ejects the virtual CD and then reboots into the OS.

Refer to [Setting Up the DGX-2 System](#) for the steps to take when booting up the DGX-2 System for the first time after a fresh installation.

### 7.3 CREATING A BOOTABLE INSTALLATION MEDIUM

After obtaining an ISO file that contains the software image from NVIDIA Enterprise Support, create a bootable installation medium, such as a USB flash drive or DVD-ROM, that contains the image.

*Note:* If you are restoring the software image remotely through the BMC, you do not need a bootable installation medium and you can omit this task.

- If you are creating a bootable USB flash drive, follow the instructions for the platform that you are using:
  - On a text-only Linux distribution, see [Creating a Bootable USB Flash Drive by Using the `dd` Command](#).
  - On Windows, see [Creating a Bootable USB Flash Drive by Using Akeo Rufus](#).
- If you are creating a bootable DVD-ROM, you can use any of the methods described in [Burning the ISO on to a DVD](#) on the Ubuntu Community Help Wiki.
7.3.1 Creating a Bootable USB Flash Drive by Using the \texttt{dd} Command

On a Linux system, you can use the \texttt{dd} command to create a bootable USB flash drive that contains the DGX-2 software image.

\begin{itemize}
  \item \textbf{Note:} To ensure that the resulting flash drive is bootable, use the \texttt{dd} command to perform a device bit copy of the image. If you use other commands to perform a simple file copy of the image, the resulting flash drive may not be bootable.
\end{itemize}

Ensure that the following prerequisites are met:

\begin{itemize}
  \item The correct DGX-2 software image is saved to your local disk. For more information, see \texttt{Obtaining the DGX-2 Software ISO Image and Checksum File}.
  \item The USB flash drive capacity is at least 4 GB.
  \item Plug the USB flash drive into one of the USB ports of your Linux system.
  \item Obtain the device name of the USB flash drive by running the \texttt{fdisk} command.
    \begin{verbatim}
    sudo fdisk -l
    \end{verbatim}
    You can identify the USB flash drive from its size, which is much smaller than the size of the SSDs in the DGX-2 System.
  \item Create a mount point.
    Example:
    \begin{verbatim}
    sudo mkdir /media/usb
    \end{verbatim}
  \item Mount the USB flash drive.
    \begin{verbatim}
    sudo mount -t vfat /dev/sdb1 /media/usb -o uid=1000,gid=100,utf8,dmask=027,fmask=137
    \end{verbatim}
  \item As root, convert and copy the image to the USB flash drive.
    \begin{verbatim}
    sudo dd if=path-to-software-image bs=2048 of=usb-drive-device-name
    \end{verbatim}
\end{itemize}

\begin{itemize}
  \item \textbf{CAUTION:} The \texttt{dd} command erases all data on the device that you specify in the \texttt{of} option of the command. To avoid losing data, ensure that you specify the correct path to the USB flash drive.
\end{itemize}
7.3.2 Creating a Bootable USB Flash Drive by Using Akeo Rufus

On a Windows system, you can use the Akeo Reliable USB Formatting Utility (Rufus) to create a bootable USB flash drive that contains the DGX-2 software image.

Ensure that the following prerequisites are met:

- The correct DGX-2 software image is saved to your local disk. For more information, see Obtaining the DGX-2 Software ISO Image and Checksum File.
- The USB flash drive has a capacity of at least 4 GB.

1. Plug the USB flash drive into one of the USB ports of your Windows system.
2. Download and launch the Akeo Reliable USB Formatting Utility (Rufus).

3. Under Boot selection, click SELECT and then locate and select the ISO image.
4. Under Partition scheme, select GPT.
5. Under File system, select FAT32.
6. Click Start. Because the image is a hybrid ISO file, you are prompted to select whether to write the image in ISO Image (file copy) mode or DD Image (disk image)
Restoring the DGX-2 Software Image

7. Select **Write in ISO Image mode** and click **OK**.

7.4 RE-IMAGING THE SYSTEM FROM A USB FLASH DRIVE

These instructions describe how to re-image the system from a USB flash drive. For information about how to restore the system remotely, see Re-Imaging the System Remotely.

Before re-imaging the system from a USB flash drive, ensure that you have a bootable USB flash drive that contains the current DGX-2 software image.

1. Plug the USB flash drive containing the OS image into the DGX-2 System.
2. Connect a monitor and keyboard directly to the DGX-2 System.
3. Boot the system and press **F11** when the NVIDIA logo appears to get to the boot menu.
4. Select the USB volume name that corresponds to the inserted USB flash drive, and boot the system from it.
5. When the system boots up, select **Install DGX Server** on the startup screen.
   If you are an advanced user who is not using the RAID disks as cache and want to keep data on the RAID disks, then select **Install DGX Server without formatting RAID**. See the section Retaining the RAID Partition While Installing the OS for more information.
6. Press **Enter**.
   The DGX-2 System will reboot and proceed to install the image. This can take more than 15 minutes.

**Note:** The Mellanox InfiniBand driver installation may take up to 10 minutes.
After the installation is completed, the system then reboots into the OS.

Refer to Setting Up the DGX-2 System for the steps to take when booting up the DGX-2 System for the first time after a fresh installation.

7.5 RETAINING THE RAID PARTITION WHILE INSTALLING THE OS

The re-imaging process creates a fresh installation of the DGX OS. During the OS installation or re-image process, you are presented with a boot menu when booting the installer image. The default selection is Install DGX Software. The installation process then repartitions all the SSDs, including the OS SSD as well as the RAID SSDs, and the RAID array is mounted as /raid. This overwrites any data or file systems that may exist on the OS disk as well as the RAID disks.

Since the RAID array on the DGX-2 System is intended to be used as a cache and not for long-term data storage, this should not be disruptive. However, if you are an advanced user and have set up the disks for a non-cache purpose and want to keep the data on those drives, then select the Install DGX Server without formatting RAID option at the boot menu during the boot installation. This option retains data on the RAID disks and performs the following:

- Installs the cache daemon but leaves it disabled by commenting out the RUN=yes line in /etc/default/cachefilesd.
- Creates a /raid directory, leaves it out of the file system table by commenting out the entry containing “/raid” in /etc/fstab.
- Does not format the RAID disks.

When the installation is completed, you can repeat any configurations steps that you had performed to use the RAID disks as other than cache disks.

You can always choose to use the RAID disks as cache disks at a later time by enabling cachefilesd and adding /raid to the file system table as follows:

1. Uncomment the #RUN=yes line in /etc/default/cachefilesd.
2. Uncomment the /raid line in etc/fstab.
3. Run the following:
   a) Mount /raid.

   ```bash
   sudo mount /raid
   ```

   b) Start the cache daemon.
systemctl start cachefilesd

These changes are preserved across system reboots.
Chapter 8.
UPDATING THE DGX OS SOFTWARE

You must register your DGX-2 System in order to receive email notification whenever a new software update is available.

These instructions explain how to update the DGX-2 software through an internet connection to the NVIDIA public repository. The process updates a DGX-2 System image to the latest QA'd versions of the entire DGX-2 software stack, including the drivers.

8.1 CONNECTIVITY REQUIREMENTS FOR SOFTWARE UPDATES

Before attempting to perform the update, verify that the DGX-2 System network connection can access the public repositories and that the connection is not blocked by a firewall or proxy.

Enter the following on the DGX-2 System.

```
$ wget -O f1-changelogs http://changelogs.ubuntu.com/meta-release-lts
$ wget -O f2-archive
$ wget -O f3-usarchive
    http://us.archive.ubuntu.com/ubuntu/dists/bionic/Release
$ wget -O f4-security
    http://security.ubuntu.com/ubuntu/dists/bionic/Release
$ wget -O f5-download
    http://download.docker.com/linux/ubuntu/dists/bionic/Release
$ wget -O f6-international
```
All the `wget` commands should be successful and there should be six files in the directory with non-zero content.

## 8.2 UPDATE INSTRUCTIONS

![CAUTION: These instructions update all software for which updates are available from your configured software sources, including applications that you installed yourself. If you want to prevent an application from being updated, you can instruct the Ubuntu package manager to keep the current version. For more information, see Introduction to Holding Packages on the Ubuntu Community Help Wiki.]

Perform the updates using commands on the DGX-2 console.

1. Run the package manager.

   ```bash
   $ sudo apt update
   ```

2. Check to see which software will get updated.

   ```bash
   $ sudo apt full-upgrade -s
   ```

   To prevent an application from being updated, instruct the Ubuntu package manager to keep the current version. See Introduction to Holding Packages.

3. Upgrade to the latest version.

   ```bash
   $ sudo apt full-upgrade
   ```

   Answer any questions that appear.

   Most questions require a Yes or No response. If asked to select the grub configuration to use, select the current one on the system.

   Other questions will depend on what other packages were installed before the update and how those packages interact with the update. Typically, you can accept the default option when prompted.

4. Reboot the system.
Chapter 9.
UPDATING FIRMWARE

This section provides instructions for updating firmware for the NVIDIA® DGX server BIOS and BMC using a Docker container.

9.1 GENERAL FIRMWARE UPDATE GUIDELINES

- Before updating the firmware, do the following to prevent corrupting the firmware due to a system crash or disruption to the update process.
  - Ensure the system is healthy
  - Stop system activities
- Do not terminate the firmware update console while updating the firmware. Component firmware corruption may occur if the update process is interrupted.
- Certain components, such as the system BIOS, require a system reboot for the new firmware to take effect.
  Reboot the system if prompted.
- When updating the BMC firmware, system management services are shut down first to allow the update to occur. Consequently, system management is not available during the BMC update.
- In the event of a firmware update failure, run `nvsm dump health` and then send the resulting archive containing the output to NVIDIA Enterprise Support (https://nvid.nvidia.com/dashboard/) for failure analysis.
  Do not attempt any further firmware updates until the issue is resolved or cleared by NVIDIA Enterprise Support.
9.2 OBTAINING THE FIRMWARE UPDATE CONTAINER

1. Obtain the container tarball from the NVIDIA Enterprise Support portal and transfer it to the DGX-2 System. The container is provided in the tarball `<image-name>.tar.gz`.

2. From the directory where you copied the tarball file, enter the following command.
   
   ```
   $ sudo docker load -i `<image-name>.tar.gz`
   ```

3. To verify that the container image is loaded, enter the following.
   
   ```
   $ sudo docker images
   ```

Example output after loading `nvfw-dgx2_18.09.3.tar.gz`.

<table>
<thead>
<tr>
<th>REPOSITORY</th>
<th>TAG</th>
<th>IMAGE ID</th>
<th>CREATED</th>
<th>SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>nvfw-dgx2_18.09.3</td>
<td>latest</td>
<td>aa681a4ae600</td>
<td>1 hours ago</td>
<td>278MB</td>
</tr>
</tbody>
</table>

9.3 QUERYING THE FIRMWARE MANIFEST

The manifest displays a listing of firmware components embedded in the containers that are qualified by NVIDIA.

To query the firmware manifest, enter the following:

```
# sudo docker run --rm --privileged -v /:/hostfs `<image-name>`
show_fw_manifest
```

9.4 QUERYING THE CURRENTLY INSTALLED FIRMWARE VERSIONS

Display the onboard firmware version level of each component supported by the container. The output will show which component firmware is up to date, or whether it needs to be updated to the firmware level listed in the manifest.

To query the version information, enter the following.
# Updating Firmware

The output shows the onboard version, the version in the manifest, and whether the firmware is up-to-date.

## 9.5 UPDATING THE FIRMWARE

You can either update all the down-level firmware components at one time, or update just one or more components.

### 9.5.1 Command Syntax

```
# sudo docker run --privileged -v /:/hostfs <image-name> show_version
```

The command will scan the specified firmware components and update any that are down-level.

See the section [Additional Options](#) for an explanation of the `-e auto=1` and `-f` options.
9.5.2 Updating All Firmware components

The following instructions are an example of attempting to update all the firmware components using the container `nvfw-dgx2_18.09.3`. In this example, the SBIOS and BMC require an update.

1. Enter the following.
   
   ```bash
   $ sudo docker run --rm --privileged -ti -v /:/hostfs nvfw-dgx2_18.09.3 update_fw all
   
   The container will scan the components and then prompt for confirmation before starting the update.
   
   Following components will be updated with new firmware version:
   SBIOS
   BMC
   IMPORTANT: Firmware update is disruptive and may require system reboot.
   Stop system activities before performing the update.
   Ok to proceed with firmware update? <Y/N>
   
   2. Press Y to proceed.
   
   The firmware update progress is displayed for each component.

   ```
   Note: While the progress output shows the current and manifest firmware versions, the versions may be truncated due to space limitations. You can confirm the updated version after the update is completed using the show_version option.
   ```

   When the update completes successfully, the following message is displayed.
   
   ```
   Firmware update completed Component: SBIOS, update status: success, reboot required: yes
   Component: BMC, update status: success, new version: 3.20.30
   ```

   3. If directed by the update message, reboot the system.

9.5.3 Updating Specific Firmware Components

The following is an example of updating the SBIOS firmware using the container `nvfw-dgx2_18.09.3`.

1. Enter the following.
   ```bash
   $ sudo docker run --rm --privileged -ti -v /:/hostfs nvfw-dgx2_18.09.3 update_fw SBIOS
   
   The container will scan the components and then prompt for confirmation before starting the update.
   
   Following components will be updated with new firmware version:
   IMPORTANT: Firmware update is disruptive and may require system reboot.
   Stop system activities before performing the update.
   ```
Ok to proceed with firmware update? <Y/N>

2. Press **Y** to proceed. When the update completes successfully, the following message is displayed.

```
Firmware update completed
Component: SBIOS, update status: success, reboot required: yes
```

You can also update a subset of all the components. For example, to update both the BMC firmware and the system BIOS, enter the following:

```
$ sudo docker run --rm --privileged -ti -v /:/hostfs nvfw-dgx2_18.09.3 update_fw BMC SBIOS
```

### 9.5.4 Updating Firmware for Individual NVMe or PSU units

To update firmware for an individual PSU or NMVe unit, use the `-s` option along with the component ID, where the PSU component ID is 1 – 6, and the NVMe component ID is the nvme device name.

Example of updating the firmware for PSU 5:

```
$ sudo docker run --rm --privileged -ti -v /:/hostfs nvfw-dgx2_18.10.2 update_fw PSU -s 5
```

Example of updating the firmware for nvme0n1:

```
$ sudo docker run --rm --privileged -ti -v /:/hostfs nvfw-dgx2_18.10.2 update_fw SSD -s nvme0n1
```

### 9.6 ADDITIONAL OPTIONS

#### 9.6.1 Forcing the Firmware Update

To update the firmware regardless of whether it is down-level, use the `-f` option as follows.

```
$ sudo docker run --rm --privileged -ti -v /:/hostfs <image-name> update_fw -f <target>
```

The container will not check the onboard versions against the manifest.
9.6.2 Updating the Firmware Non-interactively

The standard way to run the container is interactively (-ti option). The container will prompt you to confirm before initiating the update.

To update the firmware without encountering the prompt, omit the -ti option and instead use the -e auto=1 and -t options as follows.

```bash
$ sudo docker run -e auto=1 --rm --privileged -t -v /:/hostfs <image-name> update_fw <target>
```

9.7 COMMAND SUMMARY

- Show the manifest.
  ```bash
  $ sudo docker run --rm --privileged -v /:/hostfs <image-name>
  show_fw_manifest
  ```

- Show version information.
  ```bash
  $ sudo docker run --rm --privileged -v /:/hostfs <image-name>
  show_version
  ```

- Check the onboard firmware against the manifest and update any down-level firmware.
  ```bash
  $ sudo docker run --rm --privileged -ti -v /:/hostfs <image-name>
  update_fw <target>
  ```

- Bypass the version check and update the firmware.
  ```bash
  $ sudo docker run --rm --privileged -ti -v /:/hostfs <image-name>
  update_fw -f <target>
  ```

- Update the firmware in non-interactive mode.
  ```bash
  $ sudo docker run --rm -e auto=1 --privileged -t -v /:/hostfs <image-name>
  update_fw <target>
  ```

- Update the firmware for an individual PSU or NVme.
  ```bash
  $ sudo docker run --rm -e auto=1 --privileged -t -v /:/hostfs <image-name>
  update_fw <PSU | SSD> -s <component-id>
  ```

9.8 REMOVING THE CONTAINER

Remove the container and image from the DGX server when it is no longer needed. To remove the container and image, enter the following:

```bash
$ sudo docker rmi -f <image-name>
```

In this case, specify only the container repository and not the tag.
Chapter 10. USING THE BMC

The NVIDIA DGX-2 System comes with a baseboard management controller (BMC) for monitoring and controlling various hardware devices on the system. It monitors system sensors and other parameters.

10.1 CONNECTING TO THE BMC

1. Make sure you have connected the BMC port on the DGX-2 System to your LAN.
2. Open a browser within your LAN and go to:
   
   https://<ipmi-ip-address>/

   Make sure popups are allowed for the BMC address.
3. Log in.

10.2 OVERVIEW OF BMC CONTROLS

The left-side navigation menu on the BMC dashboard contains the primary controls.
10.2.1 QuickLinks ...

Provides quick access to several tasks.

Note: Depending on the BMC firmware version, the following quick links may appear:
- Maintenance->Firmware Update
- Settings->NbMeManagement->NvMe P3700Vpd Info

Do not access these tasks using the Quick Links dropdown menu, as the resulting pages are not fully functional.

10.2.2 Sensor

Provides status and readings for system sensors, such as SSD, PSUs, voltages, CPU temperatures, DIMM temperatures, and fan speeds.

10.2.3 FRU Information

Provides, chassis, board, and product information for each FRU device.

10.2.4 Logs & Reports

Lets you view, and if applicable, download and erase, the IPMI even log, and system, audit, video and POST Code logs.

10.2.5 Settings

Configure the following settings
10.2.6  Remote Control

Opens the KVM Launch page for accessing the DGX-2 console remotely.

10.2.7  Power Control

Perform various power actions

![Power Actions]

- **Power Off**
- **Power On**
- **Power Cycle**
- **Hard Reset**
- **ACPI Shutdown**

10.2.8  Maintenance

![Maintenance]

**Note:** While you can update the BMC firmware from this page, NVIDIA recommends using the NVIDIA Firmware Update Container instead (see section Updating Firmware for instructions). If you need to update from this page, click Dual Firmware Update and then select the Both Images from the Images to be Updated menu.

The Both images option ensures that the primary image (Image1) and the backup image (Image2) are updated. Image2 is used if there is a problem with Image1.
11.1 OVERVIEW

11.1.1 About NVIDIA KVM

The NVIDIA Kernel-based Virtual Machine (KVM) is a virtualization solution based on the Linux Kernel Virtual Machine (https://www.linux-kvm.org) and enhanced to enable GPU multi-tenancy. Since the KVM Hypervisor is part of the Linux kernel on the DGX-2 System, it contains the system-level components necessary to support multi-tenancy on the DGX-2 System, such as a memory manager, process scheduler, input/output (I/O) stack, device drivers, security manager, and a network stack.

The following diagram depicts an overview of the NVIDIA KVM architecture, showing the hardware layer, the DGX Server KVM OS, and the virtual machines.
Using NVIDIA KVM, the DGX-2 System can be converted to include a bare metal hypervisor to provide GPU multi-tenant virtualization. This is referred to as the DGX-2 KVM host. It allows different users to run concurrent deep learning jobs using multiple virtual machines (guest GPU VMs) within a single DGX-2 System. Just like the bare-metal DGX-2 System, each GPU-enabled VM contains a DGX OS software image which includes NVIDIA drivers, CUDA, the NVIDIA Container Runtime for Docker, and other software components for running deep learning containers.

Note: Unlike the bare metal DGX-2 system or the KVM host OS, the guest VM OS is configured for English-only, and cannot be configured for other languages.

Running NVIDIA containers on the VM is just like running containers on a DGX-2 bare metal system with DGX OS software installed.

While NVIDIA KVM turns your DGX system into a hypervisor supporting multiple guest GPU VMs, it does not currently provide support for the following:

- oVirt,virt-manager
  The DGX-2 OS incorporates Ubuntu server, which does not include a graphics manager required by oVirt and virt-manager.
- Orchestration/resource manager
  Created GPU VMs are static and cannot be altered once created.
NVMe drives as pass-through devices
To preserve the existing RAID configuration on the DGX-2 System and simplify the process of reusing this resource if the server were ever to be reverted from KVM, NVMe drives cannot be used as pass-through devices.

The DGX-2 KVM host cannot be used to run deep learning containers with GPUs.

NVIDIA GPUDirect™ is not supported on multi-GPU guest VMs over InfiniBand.

11.1.2 About the Guest GPU VM (Features and Limitations)

- Guest GPU VMs are based on an installed KVM image.
- Guest GPU VM size and resources are based on the number of GPUs assigned
- Once a GPU VM is created and resources assigned, reconfiguring the VM (adding or removing GPUs, modifying other resource allocations) is not supported.
- Access to the hardware is restricted from within the guest GPU VM such that
  - GPUs cannot be reset
  - GPU VBIOS cannot be updated
  - System firmware (including Mellanox IB) upgrade is not supported
  - There is no guest UEFI BIOS support

11.1.3 About nvidia-vm

Guest GPU VMs can be managed using the virsh (see https://linux.die.net/man/1/virsh) program or using libvirt-based XML templates. For the NVIDIA KVM, NVIDIA has taken the most common virsh options and configuration steps and incorporated them into the tool nvidia-vm, provided with the DGX KVM package. nvidia-vm simplifies the process of creating guest GPU VMs and allocating resources. In addition, you can use nvidia-vm to modify default options to suit your needs for the VM and manage VM images installed on the system.

To view the top-level help, enter the following.

nvidia-vm --help

You can view the man pages by entering the following from the DGX-2 KVM host.

man nvidia-vm

Details of basic commands are provided in the following sections.
11.2 PRELIMINARY SETUP - CONVERTING THE DGX-2 SYSTEM TO A DGX-2 KVM HOST

To operate VMs from the DGX-2 System, you must first convert the DGX-2 System to a DGX-2 KVM host. Do this by installing the DGX KVM Software package and the DGX KVM image.

Perform the following steps on the command line of the DGX-2 System.

1. Update the package list.
   ```
   sudo apt-get update
   ```

2. Check available DGX KVM images.
   ```
   sudo apt-cache policy dgx-kvm-image*
   ```
   This returns a list of images in the repository.

3. Install the `dgx-kvm-sw` package as well as one of the images listed in the previous step.
   ```
   sudo apt-get install dgx-kvm-sw <dgx-kvm-image-x-y-z>
   ```
   Example of selecting image `dgx-kvm-image-4-0-1`:
   ```
   sudo apt-get install dgx-kvm-sw dgx-kvm-image-4-0-1
   ```

4. Reboot the system.
   Rebooting the system is needed to finalize the KVM preparation of the DGX-2 System. It updates the GRUB menu options so the Linux kernel is made KVM-ready, and binds the virtualization drivers to the NVIDIA devices
   ```
   sudo reboot.
   ```
   Your DGX-2 System is now ready for you to create VMs.

Restoring to Bare Metal

After setting up the DGX-2 System as a KVM host, you can restore the server to a bare metal system.

`CAUTION:` Reverting the server back to a bare metal system destroys all guest GPU VMs that were created as well as any data. Be sure to save your data before removing the KVM software.

To restore the DGX-2 System to a bare metal system, do the following

1. Remove all the installed dgx-kvm-image packages.
   Refer to the section Uninstalling Images for instructions.
2. Remove the meta package and all its dependencies.
   
   ```
   sudo apt-get purge --auto-remove dgx-kvm-sw
   ```

3. Reboot the system.
   
   ```
   sudo reboot
   ```

**11.3 LAUNCHING A GUEST GPU VM INSTANCE**

To create and delete guest GPU VMs, use the NVIDIA utility nvidia-vm which simplifies the complex process of these tasks. For other VM management tasks, use `virsh` where indicated in these instructions.

**11.3.1 Determining the Guest GPU VMs on the DGX-2 System**

GPUs cannot be assigned to more than one VM. Therefore, before you can create a VM that uses one or more GPUs, you must determine the number and position of the GPUs that are already allocated to VMs.

Run the following command.

```virsh list```

The domain of each guest GPU VM is either based on the username of the VM creator appended with a timestamp, or is specified by the VM creator. The domain is then appended with a suffix to indicate the number of GPUs and their indices using the format

```<number-of-gpus>g<starting-index>-<ending index>```

Examples:

- `my-lab-vm1-8g0-7` : This VM is assigned 8 GPUs from index 0 through 7
- `my-lab-vm2-1g0` : This VM is assigned 1 GPU from index 0
- `my-lab-vm3-4g8-11` : This VM is assigned 4 GPUs from index 8 through 11

Inspect the list to determine the GPU indices that are available to you.
11.3.2 Creating a VM Using Available GPUs

Use `nvidia-vm` as explained in About `nvidia-vm`.

Syntax

```
nvidia-vm create --gpucount N --gpu-index X [--image] [options]
```

where

<table>
<thead>
<tr>
<th>--gpucount</th>
<th>The allowed number of GPUs to assign to the VM, depending on availability. Acceptable values: 1, 2, 4, 8, 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>--gpu-index</td>
<td>For the purposes of the KVM, GPUs on the DGX-2 System are distinguished by a zero-based, sequential index. <code>gpu_index</code> specifies the starting index value for the group of sequentially indexed GPUs to be assigned to the VM. Allowed values for <code>gpu_index</code> depend on the number of GPUs assigned to the VM, as shown in the following table.</td>
</tr>
<tr>
<td>Number of GPUs</td>
<td>Allowed values for <code>gpu_index</code></td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15</td>
</tr>
<tr>
<td>2</td>
<td>0,2,4,6,8,10,12,14</td>
</tr>
<tr>
<td>4</td>
<td>0,4,8,12</td>
</tr>
<tr>
<td>8</td>
<td>0,8</td>
</tr>
<tr>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td>--image</td>
<td>(Optional) Specifies the KVM image to use as the basis for the VM. If not specified, the latest version that is installed will be used. See the section Managing the Images for instructions on how to install images and also how to view which images are installed.</td>
</tr>
<tr>
<td>[options]</td>
<td>Optional parameters, including options to customize the default resource allocation (vCPUs, memory, OS disk size): See the man pages or the Help for a detailed list of options.</td>
</tr>
</tbody>
</table>

Command Help:

```
nvidia-vm create --help
```

Command Examples:

- Basic command
Using DGX-2 System in KVM Mode

nvidia-vm create --gpu-count 4 --gpu-index 12

This command creates a guest GPU VM with 4 GPUs, starting with index 12. Since no domain was specified, the software generates a domain which incorporates the username, day, hour, and minute. For example, jsmithTue1308-4g12-15.

Specifying a domain

nvidia-vm create --gpu-count 2 --gpu-index 8 --domain mydgx2vm2

This command creates a VM with 2 GPUs, starting with index 8, named mydgx2vm-2g8-9.

Specifying an image

nvidia-vm create --gpu-count 2 --gpu-index 2 --image dgx-kvm-image-4-0-1

This command creates a VM with 2 GPUs, starting with index 2, named jsmithTue1308-2g2-3, and based on the image dgx-kvm-image-4-0-1.

11.4 STOPPING, RESTARTING, AND DELETING A GUEST GPU VM

Once a guest GPU is created, it can be stopped if you want to temporarily free resources while keeping your data. You can then restart the stopped guest GPU VM. You can also permanently delete a guest GPU VM, which frees resources and deletes associated data.

11.4.1 Stopping a VM

You can stop a VM, which does the following:

- Releases the CPUs, memory, GPUs, and NVLink
- Retains allocation of the OS and data disks

Note: Since allocation of the OS and data disks are retained, the creation of other VMs is still impacted by the stopped VM

To stop a VM, enter the following.

\texttt{virsh shutdown <vm-domain>}

If `virsh shutdown` fails to stop the VM, for example, if the VM OS is unresponsive, you can force a VM shutdown as follows.

```bash
virsh destroy <vm-domain>
```

Like `virsh shutdown`, `virsh destroy` does not remove files or clear the OS disk allocation, so the options for creating other VMs may still be impacted depending on available disk space.

**CAUTION:** Only use `virsh destroy` as a last resort, since the command initiates an ungraceful shutdown and may result in a corrupt VM file system.

### 11.4.2 Restarting a VM

To restart a VM that has been stopped (not deleted), run the following.

```bash
virsh start <vm-domain>
```

You can also connect to the console automatically upon restarting the VM using the following command.

```bash
virsh start --console <vm-domain>
```

### 11.4.3 Deleting a VM

Like the process of creating a guest GPU VM, deleting a VM involves several `virsh` commands. For this reason, NVIDIA provides a simple way to delete a VM using `nvidia-vm`. Deleting a VM using `nvidia-vm` does the following:

- Stops the VM if it is running
- Erases data on disks that the VM is using and releases the disks
- Deletes any temporary support files

You should delete your VM instead of merely stopping it in order to release all resources and to remove unused files.

**CAUTION:** VMs that are deleted cannot be recovered. Be sure to save any data before deleting any VMs.
Use `nvidia-vm` as explained in About nvidia-vm.

**Syntax**

```
nvidia-vm delete --domain <vm-domain>
```

**Command Help**

```
nvidia-vm delete --help
```

**Command Examples**

- Deleting an individual VM
  
  ```
  nvidia-vm delete --domain dgx2vm-labTue1308-4g12-15
  ```

- Deleting all the VMs on the system
  
  ```
  nvidia-vm delete --domain ALL
  ```

## 11.5 CONNECTING TO YOUR GUEST GPU VM

### 11.5.1 Determining IP Addresses

If you are using the default network configuration, you can determine the IP address of your VM by entering the following.

```
virsh net-dhcp-leases default
```

**NOTE:** “`virsh net-dhcp-leases default`” may show a stale VM name for a newly created VM, in which case the IP address for the new VM is not shown.

To work around, connect to the incorrectly named VM.

```
$ virsh console <vm-name>
Connected to domain <vm-name>
```

Then use the “`ifconfig`” command to find the IP address for the VM.

### 11.5.2 Connecting to the Guest GPU VM

You can connect to your VM in the following ways.

- Option 1 (connecting to the VM from the Host OS)
Using DGX-2 System in KVM Mode

virsh console <vm-domain>

NOTE: This command will not work right away for a non-GPU guest VM.
To resolve, reset the guest VM using either

$ virsh reboot

or

$ virsh reset

Option 2 (connecting to the VM using SSH)

ssh <username>@IP ADDRESS

The default credentials for logging into the VM are -

Login: nvidia

Password: nvidia

These can be changed. See the section Changing Login Credentials for instructions.

11.5.3 Making Your VM More Secure

There are a couple of things you can do to make your VM more secure.

- Change the Login Credentials
- Add SSH Keys

11.5.4 Changing Login Credentials

When the guest GPU VM is created, the default login credentials are nvidia/nvidia. As a security practice, use the standard Ubuntu methods to create a new user account and then delete the nvidia user account from the GPU VM. The basic commands are provided below for convenience. Consult the Ubuntu/Linux documentation for additional options.

- Creating a new user account

  sudo useradd -m <new-username> -p <new-password>

- Deleting the nvidia user account

  deluser -r nvidia

To run virsh commands, the new user must then be added to the libvirt group.
11.5.5 Adding SSH Keys

You can incorporate SSH keys to increase security over password authentication.

Refer to the following websites for instructions.

- How to set up SSH so you aren’t asked for a password
- How to disable password authentication

11.6 MANAGING IMAGES

Guest GPU VMs are based on an installed KVM image. You can manage these images as explained in this section.

Use `nvidia-vm` as explained in About nvidia-vm.

Syntax

```
 nvidia-vm image [options]
```

This section describes common command options.

Command Help

```
 nvidia-vm image --help
```

11.6.1 Installing Images

The KVM image is typically installed at the time the KVM package is installed. Since updated KVM images may be available from the repository, you can install any of these images for use in creating a guest GPU VM.

To check available DGX KVM images, enter the following.

```
 apt-cache policy dgx-kvm-image
```

This returns a list of images in the repository.

To install a KVM image from the list, use the `nvidia-vm image install` command.

Syntax

```
 nvidia-vm image install <vm-image>
```
Example

`nvidia-vm image install dgx-kvm-image-4-0-1`

11.6.2 Viewing a List of Installed Images

To view a list of all the VM images that are installed in the guest OS image directory, enter the following.

`nvidia-vm image show`

11.6.3 Viewing Image Usage

To view a list of created VMs and the images they are using, enter the following.

`nvidia-vm image vmshow`

11.6.4 Uninstalling Images

If you convert the DGX-2 System from a KVM OS back to the bare metal system, you need to uninstall all the dgx-kvm images that were installed.

Perform the following for each installed image.

`nvidia-vm image uninstall dgx-kvm-image-x-y-z`

`Ok to remove image package "dgx-kvm-image-4-0-1"? (y/N) :`

where `x-y-z` is the version for each installed image.

11.7 USING THE GUEST OS DRIVES AND DATA DRIVES

The figure below depicts how NVIDIA KVM generates the Guest OS Drive and Data Drive from the physical drives on the DGX-2 System.
11.7.1 Guest OS Drive

DGX-2 KVM Host software uses the existing RAID-1 volume as the OS drive of each Guest (/dev/vda1) which by default is 50 GB. Since the OS drive resides on the RAID-1 array of the KVM Host, its data shall always be persistent.

Using the nvidia-vm tool, a system administrator can change the default OS drive size.

11.7.2 Data Drives

The DGX-2 KVM host software assigns a virtual disk to each guest GPU VM, referred to here as the Data Drive. It is based on filesystem directory-based volumes and can be used either as scratch space or as a cache drive.

DGX-2 software sets up a storage pool on top of the existing RAID-0 volume on the KVM Host for Data Drives on the Guests. The Data drive is automatically carved, by nvidia-vm tool, out of the Storage Pool and allocated to each GPU VM as a Data Drive (/dev/vdb1) which is automatically mounted on /raid. The Data Drive size is pre-configured according to the size of the GPU VM. For example, a 16-GPU VM gets a very large Data Drive (See the Resource Allocation section for size details).
Since the Data Drive is created on the Host RAID-0 array, data is not intended to be persistent. Therefore, when the GPU VM is destroyed, the Data Drive is automatically deleted and data is not preserved.

Using the `nvidia-vm` tool, a system administrator can change the default Data Drive size.

**11.7.3 Storage Pool Demonstration**

This section shows how to view the storage pool, and how disk space is assigned to a VM from the storage pool.

**Show storage pool**

Enter the following to verify the storage pool is active.

```bash
$ virsh pool-list
Name                 State      Autostart
-------------------------------------------
dgx-kvm-pool          active     yes
```

**Create a VM:**

```bash
$ nvidia-vm create --gpu-count 1 --gpu-index 0
dgx2vm-labTue1209-1g0: create  start vnc: 0.0.0.0:0  mac: 52:54:00:16:b9:ff  ip: 192.168.122.126
```

**Viewing the Volume from the DGX-2 KVM Host**

To see the volumes that are created for each VM, enter the following.

```bash
$ virsh vol-list dgx-kvm-pool --details
Name                    Path                        Type   Capacity  Allocation
-----------------------------------------------------------------------------------------
vol-dgx2vm-labTue1209-1g0 /raid/vol-dgx2vm-labTue1209-1g0 file  54.85 GiB  1.11 GiB
```

**Viewing the Data Volume from the Guest VM**
1. Connect to the guest GPU VM.

```
$ virsh console dgx2vm-labTue1209-1g0
Connected to domain dgx2vm-labTue1209-1g0
```

2. List the virtual storage on the guest GPU VM.

```
nvidia@dgx2vm-labTue1209-1g0:~$ lsblk
NAME   MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
vda    252:0    0   50G  0 disk
└─vda1 252:1 0   50G  0 part /
vdal   252:1 0  54.9G  0 disk
└─vdal1 252:17 0  54.9G  0 part /raid
nvidia@dgx2vm-labTue1209-1g0:~$
```

11.8 UPDATING THE SOFTWARE

11.8.1 Uploading the Host OS

You can update the DGX OS software for the host using standard Ubuntu `apt` process with an internet connection.

Since the reboot step will stop any running guest VMs, they should be stopped first to avoid an uncontrolled or unexpected interruption.

Perform the following from the host OS.

1. Update the list of available packages and their versions.

```
$ sudo apt update
```

2. Review the packages that will be updated.

```
$ sudo apt full-upgrade -s
```

To prevent an application from being updated, instruct the Ubuntu package manager to keep the current version. See Introduction to Holding Packages.

3. Upgrade to the latest version.

```
$ sudo apt full-upgrade
```

  - Answer any questions that appear.
Most questions require a Yes or No response. When asked to select the grub configuration to use, select the current one on the system.

Other questions will depend on what other packages were installed before the update and how those packages interact with the update.

If a message appears indicating that nvidia-docker.service failed to start, you can disregard it and continue with the next step. The service will start normally at that time.

4. Reboot the system.

11.8.2 Updating the Guest VM OS

You can update the DGX OS software for the guest VM using standard Ubuntu apt process with an internet connection. This is the same process that is used when updating the DGX OS software on the bare metal system.

Perform the following from the guest VM.

1. Update the list of available packages and their versions.

   
   ```bash
   sudo apt update
   ```

2. Review the packages that will be updated.

   ```bash
   sudo apt full-upgrade -s
   ```

   To prevent an application from being updated, instruct the Ubuntu package manager to keep the current version. See Introduction to Holding Packages.

3. Upgrade to the latest version.

   ```bash
   sudo apt full-upgrade
   ```

   Answer any questions that appear.

   – Most questions require a Yes or No response. When asked to select the grub configuration to use, select the current one on the system.

   – Other questions will depend on what other packages were installed before the update and how those packages interact with the update.

   If a message appears indicating that nvidia-docker.service failed to start, you can disregard it and continue with the next step. The service will start normally at that time.

4. Reboot the guest VM.

   ```bash
   sudo reboot
   ```
11.9 SUPPLEMENTAL INFORMATION

11.9.1 Resource Allocations

By default, the KVM software assigns the following resources in approximate proportion to the number of assigned GPUs:

<table>
<thead>
<tr>
<th>GPU</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>vCPU/HT</td>
<td>5</td>
<td>11</td>
<td>23</td>
<td>46</td>
<td>92</td>
</tr>
<tr>
<td>Memory (GB)</td>
<td>92</td>
<td>185</td>
<td>372</td>
<td>739</td>
<td>1478</td>
</tr>
<tr>
<td>InfiniBand</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>OS Drive (GB)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Data Drive (TB)</td>
<td>1.92</td>
<td>3.84</td>
<td>7.68</td>
<td>15.36</td>
<td>31.72</td>
</tr>
<tr>
<td>NVLink</td>
<td>N/A</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

- Data drive values indicate the maximum space that will be used. The actual space is allocated as needed.
- You can use command options to customize memory allocation, OS disk size, and number of vCPUs to assign.

11.9.2 Resource Management

NVIDIA KVM optimizes resources to maximize the performance of the VM.

- vCPU
  vCPUs are pinned to each VM to be NUMA-aware and to provide better VM performance.

- InfiniBand
  IB ports are set up as passthrough devices to maximize performance.

- GPU
  GPUs are set up as passthrough devices to maximize performance.

- Data Drive
  Data drives are intended to be used as scratch space cache.
Using DGX-2 System in KVM Mode

- **NVSwitch**
  NVSwitch assignments are optimized for NVLink peer-to-peer performance.

- **NVLink**
  An NVLink connection is the connection between each GPU and the NVSwitch fabric. Each NVLink connection allows up to 25 GB/s uni-directional performance.

### 11.9.3 NVIDIA KVM Security Considerations

Consult the security policies of your organization to determine firewall needs and settings.

### 11.9.4 Launching VMs in Degraded Mode

On DGX-2 KVM systems, degraded mode is a mechanism that allows one or more GPUs to fail without affecting the operation or creation of other VMs on the server. This allows the DGX-2 System to run GPU VMs with fewer than 16 GPUs present. System administrators can then keep a subset of GPU VMs available for use while waiting to replace GPUs that may have failed.

#### 11.9.4.1 When the DGX-2 is Put in Degraded Mode

The following are the type of GPU errors that will put the system in degraded mode:

- GPU double-bit ECC errors
- GPU failure to enumerate on the PCIe bus
- GPU side NVLink training error
- GPU side unexpected XID error

To identify failed GPUs, the KVM host automatically polls the state of all GPUs in the system at various times:

- When the DGX-2 System boots, to capture the initial state of the GPUs
- On a nightly basis
- Upon launching a VM

When a failed GPU is identified by the software, the DGX-2 System is marked as ‘degraded’ and operates in degraded mode until all bad GPUs are replaced.

#### 11.9.4.2 Creating VMs with the DGX-2 System in Degraded Mode

You can still create guest GPU VMs on a DGX-2 System in degraded mode as long as you do not try to assign a failed GPU. If you attempt to create a VM with a failed GPU
after its state has been marked as ‘bad’ by the system, the VM will fail to start and an appropriate error message is returned. Restarting an existing VM after a GPU fails will result in the same failure and error message.

The following is an example of launching a VM when GPU 12 and 13 have been marked as degraded or in a failed state.

```
nvidia-vm create --gpu-count 8 --gpu-index 8
ERROR: GPU 12 is in unexpected state "missing", can't use it -
BDF:e0:00.0 SXMID:13 UUID:GPU-b7187786-d894-2266-d11d-21124dc61dd3
ERROR: GPU 13 is in unexpected state "missing", can't use it -
BDF:e2:00.0 SXMID:16 UUID:GPU-9a6a6a52-c6b6-79c3-086b-fcf2d5b1c87e
ERROR: 2 GPU's are unavailable, unable to start this VM "dgx2vm-
labMon1559-8g8-15"
```

**Note:** If you attempt to launch a VM with a failed GPU before the system has identified its failed state, the VM will fail to launch but without an error message. If this happens, keep trying to launch the VM until the message appears.

### 11.9.4.3 Restarting a VM After the System or VM Crashes

Some GPU errors may cause the VM or the system to crash.

- If the system crashes, you can attempt to restart the VM.
- If the VM crashes (but not the system), you can attempt to restart the VM.

Your VM should restart successfully if none of the associated GPUs failed. However, if one or more of the GPUs associated with your VM failed, then the response depends on whether the system has had a chance to identify the GPU as unavailable.

- Failed GPU identified as unavailable
  - The system will return an error indicating that the GPU is missing or unavailable and that the VM is unable to start.
- Failed GPU not yet identified as unavailable
  - The VM crashes upon being restarted.

### 11.9.4.4 Restoring a System from Degraded Mode

All GPUs need to be replaced to restore the DGX-2 from degraded mode.
The server must be powered off when performing the replacement. After GPU replacement and upon powering on the server, the KVM software runs a health scan to add any new GPUs to the health database.
For security purposes, some installations require that systems be isolated from the internet or outside networks. Since most DGX-2 software updates are accomplished through an over-the-network process with NVIDIA servers, this section explains how updates can be made when using an over-the-network method is not an option. It includes a process for installing Docker containers as well.

### A.1. Installing NVIDIA DGX-2 Software

One method for updating DGX-2 software on an air-gapped DGX-2 System is to download the ISO image, copy it to removable media and then re-image the DGX-2 System from the media. This method is available only for software versions that are available as ISO images for download.

Alternately, you can update the DGX-2 software by performing a network update from a local repository. This method is available only for software versions that are available for over-the-network updates.
A.2. Re-Imaging the System

**CAUTION:** This process destroys all data and software customizations that you have made on the DGX-2 System. Be sure to back up any data that you want to preserve, and push any Docker images that you want to keep to a trusted registry.

1. Obtain the ISO image from the Enterprise Support site.
   a) Log on to the NVIDIA Enterprise Support site and click the Announcements tab to locate the DGX OS Server image ISO file.
   b) Download the image ISO file.
2. Refer to the instructions in the Restoring the DGX-2 Software Image section for additional instructions.

A.3. Creating a Local Mirror of the NVIDIA and Canonical Repositories

Instructions for setting up a private repository or mirroring the NVIDIA and Canonical repositories are beyond the scope of this document. It is expected that users are knowledgeable about those processes.

1. Create a private repository that mirrors the NVIDIA as well as the Canonical repositories.
   Consult `/etc/apt/sources.list` and the contents of `/etc/apt/sources.list.d` on your running DGX-2 for the repository locations.

2. Modify `/etc/apt/sources.list` and appropriate contents of `/etc/apt/sources.list.d` to point to your private repository.

3. Perform the update from the private repository, starting with Get the new package list step (`sudo apt-get update`) of the instructions found in the DGX-2 Software Release Notes and Upgrade Guide, which you can obtain from the Enterprise Support site.
A.4. Installing Docker Containers

This method applies to Docker containers hosted on the NVIDIA NGC Container Registry, and requires that you have an active NGC account.

1. On a system with internet access, log in to the NGC Container Registry by entering the following command and credentials.

   $ docker login nvcr.io
   Username: $oauthtoken
   Password: apikey

   Type “$oauthtoken” exactly as shown for the Username. This is a special username that enables API key authentication. In place of apikey, paste in the API Key text that you obtained from the NGC website.

2. Enter the docker pull command, specifying the image registry, image repository, and tag:

   $ docker pull nvcr.io/nvidia/repository:tag

3. Verify the image is on your system using docker images.

   $ docker images

4. Save the Docker image as an archive.

   $ docker save nvcr.io/nvidia/repository:tag > framework.tar

5. Transfer the image to the air-gapped system using removable media such as a USB flash drive.

6. Load the NVIDIA Docker image.

   $ docker load -i framework.tar

7. Verify the image is on your system.

   $ docker images
APPENDIX B. SAFETY

B.1. Safety Information

To reduce the risk of bodily injury, electrical shock, fire, and equipment damage, read this document and observe all warnings and precautions in this guide before installing or maintaining your server product.

In the event of a conflict between the information in this document and information provided with the product or on the website for a particular product, the product documentation takes precedence.

Your server should be integrated and serviced only by technically qualified persons.

You must adhere to the guidelines in this guide and the assembly instructions in your server manuals to ensure and maintain compliance with existing product certifications and approvals. Use only the described, regulated components specified in this guide. Use of other products or components will void the UL Listing and other regulatory approvals of the product, and may result in noncompliance with product regulations in the region(s) in which the product is sold.
B.2. Safety Warnings and Cautions

To avoid personal injury or property damage, before you begin installing the product, read, observe, and adhere to all of the following safety instructions and information. The following safety symbols may be used throughout the documentation and may be marked on the product and/or the product packaging.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAUTION</td>
<td>Indicates the presence of a hazard that may cause minor personal injury or property damage if the CAUTION is ignored.</td>
</tr>
<tr>
<td>WARNING</td>
<td>Indicates the presence of a hazard that may result in serious personal injury if the WARNING is ignored.</td>
</tr>
<tr>
<td>✓</td>
<td>Indicates potential hazard if indicated information is ignored.</td>
</tr>
<tr>
<td>⚡</td>
<td>Indicates shock hazards that result in serious injury or death if safety instructions are not followed.</td>
</tr>
<tr>
<td>🔥</td>
<td>Indicates hot components or surfaces.</td>
</tr>
<tr>
<td>🚨</td>
<td>Indicates do not touch fan blades, may result in injury.</td>
</tr>
<tr>
<td>⚠️</td>
<td>Shock hazard - Product might be equipped with multiple power cords. To remove all hazardous voltages, disconnect all power cords.</td>
</tr>
<tr>
<td>📣</td>
<td>High leakage current ground(earth) connection to the Power Supply is essential before connecting the supply.</td>
</tr>
<tr>
<td>🚮</td>
<td>Recycle the battery.</td>
</tr>
<tr>
<td>🚸</td>
<td>The rail racks are designed to carry only the weight of the server system. Do not use rail-mounted equipment as a workspace. Do not place additional load onto any rail-mounted equipment.</td>
</tr>
</tbody>
</table>
B.3. Intended Application Uses

This product was evaluated as Information Technology Equipment (ITE), which may be installed in offices, schools, computer rooms, and similar commercial type locations. The suitability of this product for other product categories and environments (such as medical, industrial, residential, alarm systems, and test equipment), other than an ITE application, may require further evaluation.

B.4. Site Selection

Choose a site that is:

- Clean, dry, and free of airborne particles (other than normal room dust).
- Well-ventilated and away from sources of heat including direct sunlight and radiators.
- Away from sources of vibration or physical shock.
- In regions that are susceptible to electrical storms, we recommend you plug your system into a surge suppressor and disconnect telecommunication lines to your modem during an electrical storm.
- Provided with a properly grounded wall outlet.
- Provided with sufficient space to access the power supply cord(s), because they serve as the product’s main power disconnect.

B.5. Equipment Handling Practices

Reduce the risk of personal injury or equipment damage:

- Conform to local occupational health and safety requirements when moving and lifting equipment.
- Use mechanical assistance or other suitable assistance when moving and lifting equipment.
B.6. Electrical Precautions

Power and Electrical Warnings

Caution: The power button, indicated by the stand-by power marking, DOES NOT completely turn off the system AC power; standby power is active whenever the system is plugged in. To remove power from system, you must unplug the AC power cord from the wall outlet. Make sure all AC power cords are unplugged before you open the chassis, or add or remove any non hot-plug components.

Do not attempt to modify or use an AC power cord if it is not the exact type required. A separate AC cord is required for each system power supply.

Some power supplies in servers use Neutral Pole Fusing. To avoid risk of shock use caution when working with power supplies that use Neutral Pole Fusing.

The power supply in this product contains no user-serviceable parts. Do not open the power supply. Hazardous voltage, current and energy levels are present inside the power supply. Return to manufacturer for servicing.

When replacing a hot-plug power supply, unplug the power cord to the power supply being replaced before removing it from the server.

To avoid risk of electric shock, turn off the server and disconnect the power cords, telecommunications systems, networks, and modems attached to the server before opening it.

Power Cord Warnings

Use certified AC power cords to connect to the server system installed in your rack.

Caution: To avoid electrical shock or fire, check the power cord(s) that will be used with the product as follows:

- Do not attempt to modify or use the AC power cord(s) if they are not the exact type required to fit into the grounded electrical outlets.
- The power cord(s) must meet the following criteria:
  - The power cord must have an electrical rating that is greater than that of the electrical current rating marked on the product.
  - The power cord must have safety ground pin or contact that is suitable for the electrical outlet.
  - The power supply cord(s) is/are the main disconnect device to AC power. The socket outlet(s) must be near the equipment and readily accessible for disconnection.
  - The power supply cord(s) must be plugged into socket-outlet(s) that is/are provided with a suitable earth ground.
B.7. System Access Warnings

**Caution:** To avoid personal injury or property damage, the following safety instructions apply whenever accessing the inside of the product:

- Turn off all peripheral devices connected to this product.
- Turn off the system by pressing the power button to off.
- Disconnect the AC power by unplugging all AC power cords from the system or wall outlet.
- Disconnect all cables and telecommunication lines that are connected to the system.
- Retain all screws or other fasteners when removing access cover(s). Upon completion of accessing inside the product, refasten access cover with original screws or fasteners.
- Do not access the inside of the power supply. There are no serviceable parts in the power supply.
- Return to manufacturer for servicing.
- Power down the server and disconnect all power cords before adding or replacing any non hot-plug component.
- When replacing a hot-plug power supply, unplug the power cord to the power supply being replaced before removing the power supply from the server.

**Caution:** If the server has been running, any installed processor(s) and heat sink(s) may be hot.

Unless you are adding or removing a hot-plug component, allow the system to cool before opening the covers. To avoid the possibility of coming into contact with hot component(s) during a hot-plug installation, be careful when removing or installing the hot-plug component(s).

**Caution:** To avoid injury do not contact moving fan blades. Your system is supplied with a guard over the fan, do not operate the system without the fan guard in place.
B.8. Rack Mount Warnings

**Note:** *The following installation guidelines are required by UL for maintaining safety compliance when installing your system into a rack.*

The equipment rack must be anchored to an unmovable support to prevent it from tipping when a server or piece of equipment is extended from it. The equipment rack must be installed according to the rack manufacturer's instructions.

Install equipment in the rack from the bottom up with the heaviest equipment at the bottom of the rack.

Extend only one piece of equipment from the rack at a time.

You are responsible for installing a main power disconnect for the entire rack unit. This main disconnect must be readily accessible, and it must be labeled as controlling power to the entire unit, not just to the server(s).

To avoid risk of potential electric shock, a proper safety ground must be implemented for the rack and each piece of equipment installed in it.

Elevated Operating Ambient- If installed in a closed or multi-unit rack assembly, the operating ambient temperature of the rack environment may be greater than room ambient. Therefore, consideration should be given to installing the equipment in an environment compatible with the maximum ambient temperature (T<sub>ma</sub>) specified by the manufacturer.

Reduced Air Flow - Installation of the equipment in a rack should be such that the amount of air flow required for safe operation of the equipment is not compromised.

Mechanical Loading- Mounting of the equipment in the rack should be such that a hazardous condition is not achieved due to uneven mechanical loading.

Circuit Overloading- Consideration should be given to the connection of the equipment to the supply circuit and the effect that overloading of the circuits might have on overcurrent protection and supply wiring. Appropriate consideration of equipment nameplate ratings should be used when addressing this concern.

Reliable Earthing- Reliable earthing of rack-mounted equipment should be maintained.

Particular attention should be given to supply connections other than direct connections to the branch circuit (e.g. use of power strips).
B.9. Electrostatic Discharge (ESD)

**Caution:** ESD can damage drives, boards, and other parts. We recommend that you perform all procedures at an ESD workstation. If one is not available, provide some ESD protection by wearing an antistatic wrist strap attached to chassis ground -- any unpainted metal surface -- on your server when handling parts.

Always handle boards carefully. They can be extremely sensitive to ESD. Hold boards only by their edges. After removing a board from its protective wrapper or from the server, place the board component side up on a grounded, static free surface. Use a conductive foam pad if available but not the board wrapper. Do not slide board over any surface.

B.10. Other Hazards

**CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL:**

Perchlorate Material – special handling may apply. See [www.dtsc.ca.gov/hazardouswaste/perchlorate](http://www.dtsc.ca.gov/hazardouswaste/perchlorate).

Perchlorate Material: Lithium battery (CR2032) contains perchlorate. Please follow instructions for disposal.

**NICKEL**

![NICKEL](N.png)

**NVIDIA Bezel.** The bezel’s decorative metal foam contains some nickel. The metal foam is not intended for direct and prolonged skin contact. Please use the handles to remove, attach or carry the bezel. While nickel exposure is unlikely to be a problem, you should be aware of the possibility in case you’re susceptible to nickel-related reactions.

**Battery Replacement**

**Caution:** There is the danger of explosion if the battery is incorrectly replaced. When replacing the battery, use only the battery recommended by the equipment manufacturer.
Dispose of batteries according to local ordinances and regulations. Do not attempt to recharge a battery.

Do not attempt to disassemble, puncture, or otherwise damage a battery.

警告

警告
如果更換不正確之電池型式會有爆炸的風險，
請依製造商說明書處理用過之電池。

Cooling and Airflow

Caution: Carefully route cables as directed to minimize airflow blockage and cooling problems. For proper cooling and airflow, operate the system only with the chassis covers installed. Operating the system without the covers in place can damage system parts. To install the covers:

- Check first to make sure you have not left loose tools or parts inside the system.
- Check that cables, add-in cards, and other components are properly installed.
- Attach the covers to the chassis according to the product instructions.
APPENDIX C. COMPLIANCE

The NVIDIA DGX-2 is compliant with the regulations listed in this section.

C.1. United States

Federal Communications Commission (FCC)

FCC Marking (Class A)

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including any interference that may cause undesired operation of the device.

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

California Department of Toxic Substances Control: Perchlorate Material - special handling may apply. See www.dtsc.ca.gov/hazardouswaste/perchlorate.
C.2. United States / Canada

cULus Listing Mark

C.3. Canada

Innovation, Science and Economic Development Canada (ISED)

CAN ICES-3(A)/NMB-3(A)

The Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulation.

Cet appareil numérique de la class A respecte toutes les exigences du Reglement sur le materiel brouilleur du Canada.

C.4. CE

European Conformity; Conformité Européenne (CE)

This is a Class A product. In a domestic environment this product may cause radio frequency interference in which case the user may be required to take adequate measures.
This device bears the CE mark in accordance with Directive 2014/53/EU.

This device complies with the following Directives:


› Low Voltage Directive for electrical safety.

› RoHS Directive for hazardous substances.

› Energy-related Products Directive (ErP).

The full text of EU declaration of conformity is available at the following internet address: [www.nvidia.com/support](http://www.nvidia.com/support)

A copy of the Declaration of Conformity to the essential requirements may be obtained directly from NVIDIA GmbH (Floessergasse 2, 81369 Munich, Germany).

C.5. Japan

Voluntary Control Council for Interference (VCCI)

This is a Class A product.

In a domestic environment this product may cause radio interference, in which case the user may be required to take corrective actions. VCCI-A
2008年、日本における製品含有表示方法、JIS C 0950が公示されました。製造事業者は、2006年7月1日以降に販売される電気・電子機器の特定化学物質の含有に付きまして情報提供を義務付けられました。製品の部材表示に付きましては、

A Japanese regulatory requirement, defined by specification JIS C 0950, 2008, mandates that manufacturers provide Material Content Declarations for certain categories of electronic products offered for sale after July 1, 2006.

To view the JIS C 0950 material declaration for this product, visit www.nvidia.com Japan RoHS Material Content Declaration

<table>
<thead>
<tr>
<th>主な分類</th>
<th>特定化学物質記号</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pb</td>
</tr>
<tr>
<td>壳体</td>
<td>除外項目</td>
</tr>
<tr>
<td>プリント基板</td>
<td>除外項目</td>
</tr>
<tr>
<td>プロセッサー</td>
<td>除外項目</td>
</tr>
<tr>
<td>マザーボード</td>
<td>除外項目</td>
</tr>
<tr>
<td>電源</td>
<td>除外項目</td>
</tr>
<tr>
<td>システムメモリ</td>
<td>除外項目</td>
</tr>
<tr>
<td>ハードディスクドライブ</td>
<td>除外項目</td>
</tr>
<tr>
<td>機械部品（ファン、ヒートシンク、ベゼルなど）</td>
<td>除外項目</td>
</tr>
<tr>
<td>ケーブル/コネクター</td>
<td>除外項目</td>
</tr>
<tr>
<td>はんだ付け材料</td>
<td>除外項目</td>
</tr>
<tr>
<td>フラックス・クリームほんだ、ラベル、その他の消耗品</td>
<td>除外項目</td>
</tr>
</tbody>
</table>

注：
1. 「0」は、特定化学物質の含有率が日本工業規格JIS C 0950:2008に記載されている含有率基準値より低いことを示します。
2. 「除外項目」は、特定化学物質が含有マークの除外項目に該当するため、特定化学物質について、日本工業規格JIS C 0950:2008に基づく含有マークの表示が不要であることを示します。
3. 「0.1wt%超」または「0.01wt%超」は、特定化学物質の含有率が日本工業規格JIS C 0950:2008に記載されている含有率基準値を超えることを示します。

Product Model Number: DGX-2

<table>
<thead>
<tr>
<th>Major Classification</th>
<th>Symbols of Specified Chemical Substance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pb</td>
</tr>
<tr>
<td>Chassis</td>
<td>Exempt</td>
</tr>
<tr>
<td>PCA</td>
<td>Exempt</td>
</tr>
<tr>
<td>Processor</td>
<td>Exempt</td>
</tr>
<tr>
<td>Motherboard</td>
<td>Exempt</td>
</tr>
<tr>
<td>Power supply</td>
<td>Exempt</td>
</tr>
<tr>
<td>System memory</td>
<td>Exempt</td>
</tr>
<tr>
<td>Hard drive</td>
<td>Exempt</td>
</tr>
<tr>
<td>Mechanical parts (fan, heat sink, bezel…)</td>
<td>Exempt</td>
</tr>
<tr>
<td>Cables/Connectors</td>
<td>Exempt</td>
</tr>
<tr>
<td>Soldering material</td>
<td>0</td>
</tr>
<tr>
<td>Flux, Solder Paste, label and other consumable materials</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes:
1. "0" indicates that the level of the specified chemical substance is less than the threshold level specified in the standard, JIS C 0950: 2008.
2. "Exempt" indicates that the specified chemical substance is exempt from marking and it is not required to display the marking for that specified chemical substance per the standard, JIS C 0950: 2008.
3. "Exceeding 0.1wt%" or "Exceeding 0.01wt%" is entered in the table if the level of the specified chemical substance exceeds the threshold level specified in the standard, JIS C 0950: 2008.

C.6. Australia and New Zealand

Australian Communications and Media Authority

This product meets the applicable EMC requirements for Class A, I.T.E equipment
### C.7. China

#### China RoHS Material Content Declaration

<table>
<thead>
<tr>
<th>部件名称</th>
<th>Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>机箱</td>
<td>Chassis</td>
</tr>
<tr>
<td>印刷电路部件</td>
<td>PCA</td>
</tr>
<tr>
<td>处理器</td>
<td>Processor</td>
</tr>
<tr>
<td>主板</td>
<td>Motherboard</td>
</tr>
<tr>
<td>电源设备</td>
<td>Power supply</td>
</tr>
<tr>
<td>存储设备</td>
<td>System memory</td>
</tr>
<tr>
<td>硬盘驱动器</td>
<td>Hard drive</td>
</tr>
<tr>
<td>机械部件 (风扇、散热器、面板等)</td>
<td>Mechanical parts (fan, heat sink, bezel...)</td>
</tr>
<tr>
<td>线材/连接器</td>
<td>Cables/Connectors</td>
</tr>
<tr>
<td>焊接金属</td>
<td>Soldering material</td>
</tr>
<tr>
<td>助焊剂，锡膏，标签及其他耗材</td>
<td>Flux, Solder Paste, label and other consumable materials</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>有害物质</th>
<th>Hazardous Substances</th>
</tr>
</thead>
<tbody>
<tr>
<td>铅 (Pb)</td>
<td>X</td>
</tr>
<tr>
<td>汞 (Hg)</td>
<td>0</td>
</tr>
<tr>
<td>镉 (Cd)</td>
<td>0</td>
</tr>
<tr>
<td>六价铬 (Cr(VI))</td>
<td>0</td>
</tr>
<tr>
<td>多溴联苯 (PBB)</td>
<td>0</td>
</tr>
<tr>
<td>多溴联苯醚 (PBDE)</td>
<td>0</td>
</tr>
</tbody>
</table>

本表格依据 SJ/T 11364-2014 的规定编制

The table according to SJ/T 11364-2014

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572-2011 标准规定的限量要求以下。</td>
</tr>
<tr>
<td>O</td>
<td>Indicates that this hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in GB/T 26572-2011.</td>
</tr>
<tr>
<td>X</td>
<td>表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572-2011 标准规定的限量要求。</td>
</tr>
<tr>
<td>X</td>
<td>Indicates that this hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in GB/T 26572-2011.</td>
</tr>
</tbody>
</table>

此表中所有名称中含 “X” 的部件均符合欧盟 RoHS 立法。

All parts named in this table with an “X” are in compliance with the European Union’s RoHS Legislation.

注：环保使用期限的参考标识取决于产品正常工作的温度和湿度等条件

Note: The referenced Environmental Protection Use Period Marking was determined according to normal operating use conditions of the product such as temperature and humidity.
C.8. Israel

SII

C.9. Russia/Kazakhstan/Belarus

EurAsian Customs Union

This device complies with the technical regulations of the Customs Union (CU TR)

C.10. Vietnam

ICT

Phù hợp quy chuẩn kỹ thuật, tiêu chuẩn: TCVN 7189:2009 - Thiết bị công nghệ thông tin
– Đặc tính nhiều tần số vô tuyến – Giới hạn và phương pháp đo
C.11. South Korea

Korean Agency for Technology and Standards (KATS)

Class A Equipment (Industrial Broadcasting & Communication Equipment). This equipment Industrial (Class A) electromagnetic wave suitability equipment and seller or user should take notice of it, and this equipment is to be used in the places except for home.

Korea RoHS Material Content Declaration

<table>
<thead>
<tr>
<th>확인 및 평가 양식은 제품에 포함 된 유해 물질의 허용 기준의 준수에 관한</th>
</tr>
</thead>
<tbody>
<tr>
<td>문</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

제품 내용

<p>| 제품의 종류 | 해당없음 | 제품명(규격) | 해당없음 |</p>
<table>
<thead>
<tr>
<th>세부모델명(번호):</th>
<th>해당없음</th>
<th>제품출시일</th>
<th>해당없음</th>
</tr>
</thead>
<tbody>
<tr>
<td>제품의 중량</td>
<td>해당없음</td>
<td>제조, 수입업자</td>
<td>앤비디아</td>
</tr>
</tbody>
</table>

엔비디아의 그래픽 카드 제품은 전기 전자제품 및 자동차의 자원순환에 관한 법률 시행령 제 11조 제 1항에 의거한 법 시행규칙 제 3조에 따른 유해물질함유 기준을 확인 및 평가한 결과, 이를 준수하였음을 공표합니다.

구비서류: 없음

작성방법

① 제품의 종류는 "전기·전자제품 및 자동차의 자원순환에 관한 법률 시행령" 제 8조 제 1항 및 제 2항에 따른 품목별로 구분하여 기재합니다.

② 전기 전자 제품의 경우 모델명 (번호), 자동차의 경우, 제원관리번호를 기재합니다.

③ 해당제품의 제조업자 또는 수입업자를 기재합니다.

---

**Confirmation and Evaluation Form Concerning the Adherence to Acceptable Standards of Hazardous Materials Contained in Products**

<table>
<thead>
<tr>
<th>Statement Prepared by</th>
<th>Company Name:</th>
<th>Corporate Identification Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nvidia HongKong Holding Ltd.Korea branch</td>
<td>110181-0036373</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Name of Company Representative:</th>
<th>Business Registration Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karen Theresa Burns</td>
<td>120-84-06711</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>2788 San Tomas Expressway, Santa Clara, CA 95051</td>
</tr>
<tr>
<td>Product Information</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Product Category:</td>
</tr>
<tr>
<td><strong>Detailed Product</strong></td>
</tr>
<tr>
<td>Model Name (Number):</td>
</tr>
<tr>
<td>Weight of Product:</td>
</tr>
</tbody>
</table>

This form is publicly certify that NVIDIA Company has undergone the confirmation and evaluation procedures for the acceptable amounts of hazardous materials contained in graphic card according to the regulations stipulated in Article 3 of the ‘Status on the Recycling of Electrical and Electronic Products, and Automobiles’ and that company has graphic card adhered to the Enforcement Regulations of Article 11, Item 1 of the statute.

Attachment: None

* Preparing the Form

① Please indicate the product category according to the categories listed in Article 8, Items 1 and 2 of the ‘Enforcement Ordinance of the Statute on the Recycling of Electrical, Electronic and Automobile Materials’

② For electrical and electronic products, please indicate the Model Name (and number). For automobiles, please indicate the Vehicle Identification Number.

③ Please indicate the name of manufacturer and/or importer of the product.
C.12. Taiwan

Bureau of Standards, Metrology & Inspection (BSMI)

Taiwan RoHS Material Content Declaration
## Declaration of the presence condition of the Restricted Substances Marking

### Equipment Name: DGX-2

<table>
<thead>
<tr>
<th>單元/Parts</th>
<th>限制物質及其化學符號/Restricted substances and its chemical symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>鉛 (Pb)</td>
</tr>
<tr>
<td>機箱 Chassis</td>
<td></td>
</tr>
<tr>
<td>印刷電路部件 PCA</td>
<td></td>
</tr>
<tr>
<td>處理器 Processor</td>
<td></td>
</tr>
<tr>
<td>主板 Motherboard</td>
<td></td>
</tr>
<tr>
<td>電源設備 Power supply</td>
<td></td>
</tr>
<tr>
<td>存儲設備 System memory</td>
<td></td>
</tr>
<tr>
<td>硬盤驅動器 Hard drive</td>
<td></td>
</tr>
<tr>
<td>機械部件 (風扇、散熱器、面板等) Mechanical parts (fan, heat sink, bezel...)</td>
<td></td>
</tr>
<tr>
<td>線材/連接器 Cables/Connectors</td>
<td></td>
</tr>
<tr>
<td>焊接金屬 Soldering material</td>
<td>0 0 0 0 0</td>
</tr>
<tr>
<td>助焊劑、鍍屌、標籤及其他耗材 Flux, Solder Paste, label and other consumable materials</td>
<td>0 0 0 0 0</td>
</tr>
</tbody>
</table>

備考1：O：系指該限制物質未超出百分比含量基準值
Note 1：O indicates that the percentage content of the restricted substance does not exceed the percentage of reference value of presence.

備考2：-：系指該項限制物質為排外項目。
Note 2：- indicates that the restricted substance corresponds to the exemption.

此表中所有名稱中含"-"的部件均符合歐盟RoHS立法。
All parts named in this table with an "-" are in compliance with the European Union's RoHS Legislation.

注：環保使用期限的參考標籤取決於產品正常工作的溫度和濕度等條件
Note: The referenced Environmental Protection Use Period Marking was determined according to normal operating use conditions of the product such as temperature and humidity.
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