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Chapter 1.
INTRODUCTION

NVIDIA® GPU Cloud (NGC) containers leverage the power of GPUs based on the NVIDIA Pascal™, Volta™, and Turing architectures. NGC containers can run in virtual machines (VMs) configured with NVIDIA virtual GPU (vGPU) software in NVIDIA vGPU and GPU pass-through deployments.

The document describes how to set up a VM configured with NVIDIA virtual GPU software to run NGC containers. Open the command line in the VM and paste the code blocks into the command line.

**Prerequisites**

These instructions assume that the following prerequisites are met:

- A guest VM running a supported Linux release is configured with an NVIDIA vGPU or a pass-through GPU.
- The NVIDIA virtual GPU software graphics driver is installed in the guest VM.

Ensure that the driver that is installed is the graphics driver bundled with the NVIDIA virtual GPU software.

- Any NVIDIA virtual GPU software products that you are using have been licensed with NVIDIA Quadro® Virtual Data Center Workstation (Quadro vDWS).

For instructions, visit https://docs/nvidia.com/grid.

**Supported Software and Hardware**

NVIDIA virtual GPU software release 7.0 to 9.0 is supported.

In NVIDIA vGPU deployments, the following vGPU types are supported only on NVIDIA GPU architectures after the Maxwell architecture:

- All Q-series vGPU types
- All C-series vGPU types
In GPU pass-through deployments, all GPUs based on NVIDIA GPU architectures after the NVIDIA Maxwell™ architecture that support NVIDIA vGPU software are supported.

Supported guest operating system: Ubuntu 16.04 LTS, Ubuntu 18.04 LTS

The following hypervisor software releases are supported.

- Citrix Hypervisor 7.0, 7.1, 7.5, and 7.6
- Microsoft Windows Server with Hyper-V role 2016 1709 and 2016 1607
- Nutanix AHV 5.5, 5.6, and 5.11
- Red Hat Enterprise Linux with Kernel Virtual Machine (KVM) 7.0-7.6
- Red Hat Virtualization (RHV) 4.3
- VMware vSphere 6.7, 6.5, and 6.0
Chapter 2.
INSTALLING DOCKER AND THE NVIDIA CONTAINER RUNTIME FOR DOCKER

The Docker runtime is required to run NGC containers. In addition, the NVIDIA Container Runtime for Docker (nvidia-docker2) ensures that the high performance power of the GPU is leveraged when running NVIDIA-optimized Docker containers.

2.1. Installing the Docker Repository

The following code block

1. Installs apt-transport-https.
2. Installs curl.
3. Installs the Docker prerequisites.
4. Adds the Docker official GPG key.
5. Adds the official stable Docker repository.

Refer to https://docs.docker.com/engine/installation/linux/docker-ce/ubuntu/#install-docker-ce for more information.

```
sudo apt-get install -y apt-transport-https
curl ca-certificates
software-properties-common
curl -fsSL https://download.docker.com/linux/ubuntu/gpg | sudo apt-key add -
sudo add-apt-repository \
"deb [arch=amd64] https://download.docker.com/linux/ubuntu $(lsb_release -cs) stable"
```

2.2. Installing the NVIDIA Container Runtime for Docker
1. Issue the following commands to install the NVIDIA Container Runtime for Docker (nvidia-docker2) repository, install nvidia-docker2, and then set up permissions to use Docker without sudo each time (where $USER refers to the user name).

```bash
curl -s -L https://nvidia.github.io/nvidia-docker/gpgkey | \
  sudo apt-key add -
curl -s -L https://nvidia.github.io/nvidia-docker/ubuntu16.04/amd64/nvidia-
docker.list | \
  sudo tee /etc/apt/sources.list.d/nvidia-docker.list
sudo apt update
sudo apt install -y nvidia-docker2
sudo usermod -aG docker $USER
```

For more information, see https://github.com/NVIDIA/nvidia-docker.

2. Reboot the system.

```bash
sudo reboot
```

3. Upon reboot, test nvidia-smi with the latest official CUDA image.

```bash
docker run --runtime=nvidia --rm nvcr.io/nvidia/cuda:latest 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

2.3. Enabling GPU Support for NGC Containers

To obtain the best performance when running NGC containers, three methods of providing GPU support for Docker containers have been developed:

- Native GPU support (included with Docker-ce 19.03 or later)
- NVIDIA Container Runtime for Docker (nvidia-docker2 package)
- Docker Engine Utility for NVIDIA GPUs (nvidia-docker package)

The method implemented in your system depends on the DGX OS version installed (for DGX systems), the specific NGC Cloud Image provided by a Cloud Service Provider, or the software that you have installed in preparation for running NGC containers on TITAN PCs, Quadro PCs, or vGPUs.

Refer to the following table to assist in determining which method is implemented in your system.

<table>
<thead>
<tr>
<th>GPU Support Method</th>
<th>When Used</th>
<th>How to Determine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native GPU Support</td>
<td>Included with Docker-ce 19.03 or later</td>
<td>Run docker version to determine the installed Docker version.</td>
</tr>
<tr>
<td>NVIDIA Container Runtime for Docker</td>
<td>If the nvidia-docker2 package is installed</td>
<td>Run nvidia-docker version and check for NVIDIA Docker version 2.0 or later</td>
</tr>
<tr>
<td>Docker Engine Utility for NVIDIA GPUs</td>
<td>If the nvidia-docker package is installed</td>
<td>Run nvidia-docker version and check for NVIDIA Docker version 1.x</td>
</tr>
</tbody>
</table>
Each method is invoked by using specific Docker commands, described as follows.

### Using Native GPU support

If Docker is updated to 19.03 on a system which already has nvidia-docker or nvidia-docker2 installed, then the corresponding methods can still be used.

- To use the native support on a new installation of Docker, first enable the new GPU support in Docker.
  ```bash
  sudo apt-get install -y docker nvidia-container-toolkit
  ```
  This step is not needed if you have updated Docker to 19.03 on a system with nvidia-docker2 installed. The native support will be enabled automatically.

- Use `docker run --gpus` to run GPU-enabled containers.
  - Example using all GPUs
    ```bash
    docker run --gpus all ...
    ```
  - Example using two GPUs
    ```bash
    docker run --gpus 2 ...
    ```
  - Examples using specific GPUs
    ```bash
    docker run --gpus "device=1,2" ...
    docker run --gpus "device=UUID-ABCDEF,1" ...
    ```

### Using the NVIDIA Container Runtime for Docker

With the NVIDIA Container Runtime for Docker installed (nvidia-docker2), you can run GPU-accelerated containers in one of the following ways.

- Use `docker run` and specify `runtime=nvidia`.
  ```bash
  docker run --runtime=nvidia ...
  ```

- Use `nvidia-docker run`.
  ```bash
  nvidia-docker run ...
  ```
  The new package provides backward compatibility, so you can still run GPU-accelerated containers by using this command, and the new runtime will be used.

- Use `docker run` with `nvidia` as the default runtime.

You can set `nvidia` as the default runtime, for example, by adding the following line to the `/etc/docker/daemon.json` configuration file as the first entry.

```
"default-runtime": "nvidia",
```

The following is an example of how the added line appears in the JSON file. Do not remove any pre-existing content when making this change.

```
{
  "default-runtime": "nvidia",
  "runtimes": {
    "nvidia": {
      "path": "/usr/bin/nvidia-container-runtime",
      "runtimeArgs": []
    }
  }
}
```
You can then use `docker run` to run GPU-accelerated containers.

```bash
$ docker run ...
```

**Caution** If you build Docker images while `nvidia` is set as the default runtime, make sure the build scripts executed by the Dockerfile specify the GPU architectures that the container will need. Failure to do so may result in the container being optimized only for the GPU architecture on which it was built. Instructions for specifying the GPU architecture depend on the application and are beyond the scope of this document. Consult the specific application build process for guidance.

**Using the Docker Engine Utility for NVIDIA GPUs**

With the Docker Engine Utility for NVIDIA GPUs installed (`nvidia-docker`), run GPU-enabled containers as follows.

```bash
$ nvidia-docker run ...
```
Chapter 3.
USING NGC CONTAINERS

Make sure you have performed the following steps from the NGC website (see the NGC Getting Started Guide)

- Signed up for an NGC account at https://ngc.nvidia.com/signup.
- Created an NGC API key for access to the NGC container registry.
- Browsed the NGC website and identified an available NGC container and tag to run.

See the following documents for detailed instructions on using NGC Containers.

- NGC Container User Guide
- Using Deep Learning Containers
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