NVIDIA DOCA

Installation Guide for Linux
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Chapter 1. Introduction

There are two ways to install the NVIDIA BlueField DPU software:

- Using the SDK Manager which provides a GUI/CLI for full DPU software installation
- Manual installation with a step-by-step procedure

1.1. Supported Platforms

<table>
<thead>
<tr>
<th>NVIDIA SKU</th>
<th>Legacy OPN</th>
<th>PSID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1004/699210040230</td>
<td>N/A</td>
<td>NVD0000000015</td>
<td>BlueField-2 A30X, P1004 SKU 205, Generic, GA100, 24GB HBM2e, PCIe passive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dual Slot 230W GEN4, DPU Crypto ON W/ Bkt, 1 Dongle, Black, HF, VCPD</td>
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| 900-9D219-0086-ST1 | MBF2M516A-CECOT | MT_0000000375 | BlueField-2 E-Series DPU 100GbE Dual-Port QSFP56; PCIe Gen4 x16; Crypto and Secure Boot Enabled; 16GB on-board DDR; 1GbE OOB management; FHHL |

| 900-9D219-0086-ST0 | MBF2M516A-ECCOT | MT_0000000376 | BlueField-2 E-Series DPU 100GbE/EDR/ HDR100 VPI Dual-Port QSFP56; PCIe Gen4 x16; Crypto and Secure Boot Enabled; 16GB on-board DDR; 1GbE OOB management; FHHL |

<p>| 900-9D219-0056-ST1 | MBF2M516A-EENOT | MT_0000000377 | BlueField-2 E-Series DPU 100GbE/EDR/ HDR100 VPI Dual-Port QSFP56; PCIe Gen4 x16; Crypto Disabled; 16GB on-board DDR; 1GbE OOB management; FHHL |</p>
<table>
<thead>
<tr>
<th>NVIDIA SKU</th>
<th>Legacy OPN</th>
<th>PSID</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>900-9D206-0053-SQ0</td>
<td>MBF2H332A-AENOT</td>
<td>MT_0000000539</td>
<td>OOB management; FHHL BlueField-2 P-Series DPU 25GbE Dual-Port SFP56; PCIe Gen4 x8; Crypto Disabled; 16GB on-board DDR; 1GbE OOB management; HHHL</td>
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<td>900-9D206-0063-ST2</td>
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<td>NVIDIA SKU</td>
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<td>PSID</td>
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<td>900-9D219-0056-ST2</td>
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<td>900-9D218-0073-ST1</td>
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<td>MT_0000000723</td>
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| 900-9D218-0083-ST2 | MBF2H512C-AECOT | MT_0000000724     | BlueField-2 P-Series DPU 25GbE Dual-Port SFP56; integrated BMC;...
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<tr>
<td>900-9D208-0076-ST5</td>
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<td>NVIDIA SKU</td>
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<td>PSID</td>
<td>Description</td>
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<td>MT_0000000737</td>
<td>OOB management; Tall Bracket; FHHL BlueField-2 P-Series DPU 100GbE/EDR/ HDR100 VPI Dual-Port QSFP56; integrated BMC; PCIe Gen4 x16; Secure Boot Enabled; Crypto Disabled; 16GB on-board DDR; 1GbE OOB management; Tall Bracket; FHHL</td>
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<td>MT_0000000738</td>
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<td>900-9D218-0083-ST4</td>
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<td>OOB management; Tall Bracket; FHHL BlueField-2 P-Series DPU 25GbE Dual-Port SFP56; integrated BMC; PCIe Gen4 x8; Secure Boot Enabled; Crypto Enabled; 32GB on-board DDR; 1GbE OOB management; FHHL</td>
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<td>900-9D208-0086-ST2</td>
<td>MBF2H536C-CECOT</td>
<td>MT_0000000768</td>
<td>OOB management; Tall Bracket; FHHL BlueField-2 P-Series DPU 100GbE Dual-Port QSFP56; integrated BMC; PCIe Gen4 x16; Secure Boot Enabled; Crypto Disabled; 32GB on-board DDR; 1GbE OOB management; FHHL</td>
</tr>
<tr>
<td>NVIDIA SKU</td>
<td>Legacy OPN</td>
<td>PSID</td>
<td>Description</td>
</tr>
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<tr>
<td>900-9D250-0048-ST0</td>
<td>MBF2M355A-VECOT</td>
<td>MT_0000000786</td>
<td>BlueField-2 E-Series DPU; 200GbE single-port QSFP56; PCIe Gen4 x16; Secure Boot Enabled; Crypto Enabled; 32GB on-board DDR; 1GbE OOB management</td>
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<td>900-9D208-0076-STA</td>
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<td>MT_0000000973</td>
<td>BlueField-2 P-Series DPU 100GbE Dual-Port QSFP56; integrated BMC; PCIe Gen4 x16; Secure Boot Enabled with UEFI disabled; Crypto Disabled; 16GB on-board DDR; 1GbE OOB management</td>
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</table>
1.2. Hardware Prerequisites

This quick start guide assumes that an NVIDIA® BlueField® DPU has been installed in a server according to the instructions detailed in your DPU’s hardware user guide.

1.3. DOCA Packages

<table>
<thead>
<tr>
<th>Device</th>
<th>Component</th>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host</td>
<td>DOCA SDK</td>
<td>1.5.1</td>
<td>Software development kit package for developing host software</td>
</tr>
<tr>
<td>Host</td>
<td>DOCA Runtime</td>
<td>1.5.1</td>
<td>Runtime libraries required to run DOCA-based software applications on host</td>
</tr>
<tr>
<td>Host</td>
<td>DOCA Tools</td>
<td>1.5.1</td>
<td>Tools for developers and administrators on host</td>
</tr>
<tr>
<td>Host</td>
<td>Arm emulated [QEMU] development container</td>
<td>3.9.3.1</td>
<td>Linux-based BlueField Arm emulated container for developers</td>
</tr>
<tr>
<td>Target BlueField-2 DPU [Arm]</td>
<td>BlueField BSP</td>
<td>3.9.3.1</td>
<td>BlueField image and firmware</td>
</tr>
<tr>
<td>Target BlueField-2 DPU [Arm]</td>
<td>DOCA SDK</td>
<td>1.5.1</td>
<td>Software development kit packages for developing Arm software</td>
</tr>
<tr>
<td>Target BlueField-2 DPU [Arm]</td>
<td>DOCA Runtime</td>
<td>1.5.1</td>
<td>Runtime libraries required to run DOCA-based software applications on Arm</td>
</tr>
<tr>
<td>Target BlueField-2 DPU [Arm]</td>
<td>DOCA Tools</td>
<td>1.5.1</td>
<td>Tools for developers and administrators for Arm target</td>
</tr>
</tbody>
</table>

1.4. Supported Operating System

The operating system supported on the BlueField DPU is Ubuntu 20.04.
The following operating systems are supported on the host machine:

- Ubuntu 18.04/20.04/22.04
1.5. Supported Kernel Versions

Note: Only the following generic kernel versions are supported for DOCA local repo package for host installation (whether by SDKM or manually).

<table>
<thead>
<tr>
<th>Host Operation System</th>
<th>Kernel Support</th>
<th>Arch Support</th>
</tr>
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<td>4.14.0-115.el7.aarch64</td>
<td>aarch64</td>
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<td>3.10.0-957.el7.x86_64</td>
<td>x86</td>
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<tr>
<td>CentOS 8.0</td>
<td>4.18.0-80.el8.x86_64</td>
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<tr>
<td>CentOS 8.2</td>
<td>4.18.0-193.el8.x86_64</td>
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<tr>
<td>RHEL 7.6</td>
<td>3.10.0-957.el7.x86_64</td>
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<td>RHEL 8.2</td>
<td>4.18.0-193.el8.x86_64</td>
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<tr>
<td>Rocky 8.6</td>
<td>4.18.0-372.9.1.el8.x86_64</td>
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<tr>
<td>Ubuntu 18.04</td>
<td>4.15.0-20-generic</td>
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<td>Ubuntu 20.04</td>
<td>5.4.0-26-generic</td>
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<td>Ubuntu 22.04</td>
<td>5.15.0-52-generic</td>
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<tr>
<td>Debian 10.8</td>
<td>4.19.0-14-amd64</td>
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</tbody>
</table>
Chapter 2. SDK Manager

**NVIDIA SDK Manager** supports DOCA installation, including software packages on the host and the BlueField-2 target.

- To use the SDK Manager GUI, please refer to [NVIDIA SDK Manager GUI installation guide for DOCA](#) for detailed instructions.
- To use the SDK Manager CLI, please refer to [NVIDIA SDK Manager CLI installation guide for DOCA](#) for detailed instructions.

**Note:** SDK manager installation requires internet connection through out-of-band (OOB) port.
Chapter 3. Manual BlueField Image Installation

This guide provides the minimal first-step instructions for setting up DOCA on a standard system.

3.1. Installation Files

<table>
<thead>
<tr>
<th>Device</th>
<th>Component</th>
<th>Arch and OS</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host</td>
<td>These files contain the following components suitable for their respective OS version.</td>
<td>CentOS/RHEL 7.6 on aarch64</td>
<td>doca-host-repo-rhel76-1.5.1-0.1.8.1.5.1007.1.el7a.5.8.1.1.2.1.aarch64.rpm</td>
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<td></td>
<td>CentOS/RHEL 7.6 on x86</td>
<td>doca-host-repo-rhel76-1.5.1-0.1.8.1.5.1007.1.el7.5.8.1.1.2.1.x86_64.rpm</td>
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<td></td>
<td>CentOS/RHEL 8.0 on x86</td>
<td>doca-host-repo-rhel80-1.5.1-0.1.8.1.5.1007.1.el8.5.8.1.1.2.1.x86_64.rpm</td>
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<td>CentOS/RHEL 8.2 on x86</td>
<td>doca-host-repo-rhel82-1.5.1-0.1.8.1.5.1007.1.el8.5.8.1.1.2.1.x86_64.rpm</td>
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<td>Rocky/RHEL 8.6 on x86</td>
<td>doca-host-repo-rhel86-1.5.1-0.1.8.1.5.1007.1.el8.5.8.1.1.2.1.x86_64.rpm</td>
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<td>Ubuntu 18.04 on x86</td>
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<td>Ubuntu 20.04 on x86</td>
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<td>Ubuntu 22.04 on x86</td>
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<td>Debian 10.8 on x86</td>
<td>doca-host-repo-debian108-1.5.1-0.1.8.1.5.1007.1.5.8.1.1.x86_64.deb</td>
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<td>Arm Emulated Development Container</td>
<td>Arm container v3.9.3.1 on aarch64</td>
<td>doca_develUbuntu_20.04-inbox-5.5.tar</td>
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<td>BlueField Software v3.9.3.1</td>
<td>Ubuntu 20.04 on aarch64</td>
<td>DOCA_1.5.1_BSP_3.9.3_Ubuntu_20.04-4.2.LTS.signed.blb</td>
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<td>DOCA SDK v1.5.1</td>
<td></td>
<td>doca-dpu-repo-ubuntu2004-local_1.5.0055-1.5.8.1.0.1.1.blf3.9.3.12383.tar</td>
</tr>
</tbody>
</table>
3.2. Uninstalling Software from Host

If an older DOCA software version is installed on your host, make sure to uninstall it before proceeding with the installation of the new version:

- For Ubuntu/Debian:

  ```bash
  $ for f in $( dpkg --list | grep doca | awk '{print $2}' ); do echo $f ; apt remove --purge $f -y ; done
  $ sudo apt-get autoremove
  ```

- For CentOS/RHEL/Rocky:

  ```bash
  $ for f in $(rpm -qa |grep -i doca ) ; do yum -y remove $f; done
  $ yum autoremove
  $ yum makecache
  ```

3.3. Installing Prerequisites on Host for Target DPU

Install `doca-tools` to manage and flash the BlueField DPU.

- For Ubuntu/Debian

  1. Download the DOCA Tools package from Installation Files section for the host.
  2. Unpack the deb repo. Run:
     ```bash
     host# sudo dpkg -i doca-host-repo-ubuntu<version>_amd64.deb
     ```
  3. Perform apt update. Run:
     ```bash
     host# sudo apt-get update
     ```
  4. Run `apt install` for DOCA Tools.
     ```bash
     * For DPU:
       host# sudo apt install doca-tools
     * For ConnectX on Ubuntu 20.04:
       host# sudo apt install doca-cx-tools
     ```

- For CentOS/RHEL 8.x or Rocky 8.6

  1. Download the DOCA Tools package from Installation Files section for the x86 host.
  2. Unpack the RPM repo. Run:
     ```bash
     host# sudo rpm -Uvh doca-host-repo-rhel<version>.x86_64.rpm
     ```
  3. Enable new dnf repos. Run:
     ```bash
     host# sudo dnf makecache
     ```
  4. Run `dnf install` to install DOCA Tools.
     ```bash
     * For DPU:
       host# sudo dnf install doca-tools
     * For ConnectX:
       host# sudo dnf install doca-cx-tools
     ```

- For CentOS/RHEL 7.x
1. Download the DOCA Tools package from Installation Files section for the x86 host.
2. Unpack the RPM repo. Run:
   ```
   host# sudo rpm -Uvh doca-host-repo-rhel<version>.x86_64.rpm
   ```
3. Enable new yum repos. Run:
   ```
   host# sudo yum makecache
   ```
4. Run `yum install` to install DOCA Tools.
   - For DPU:
     ```
     host# sudo yum install doca-tools
     ```
   - For ConnectX:
     ```
     host# sudo yum install doca-cx-tools
     ```

### 3.4. Installing Software on Host

1. Make sure to follow the instructions under Installing Prerequisites on Host for Target DPU.
2. Install DOCA local repo package for host:
   - **For Ubuntu/Debian Host**
     a). Run `apt install` for DOCA runtime, tools, and SDK.
     ```
     host# sudo apt install -y doca-runtime doca-sdk
doca-cx-runtime doca-cx-sdk
     ```
     b). Extra package:
     ```
     host# sudo dnf install -y doca-extra
     ```
     `doca-extra`, located under `/opt/mellanox/doca/tools/`, contains:
     - `doca-info` – displays details of all installed dependencies in DOCA
     - `doca-kernel-support` – running it adds support on existing kernel to support DOCA
   - **For CentOS Host**
     a). Install the following software dependencies. Run:
     ```
     host# sudo yum install -y epel-release
     ```
     b). For CentOS 8.2 only, also run:
     ```
     host# yum config-manager --set-enabled PowerTools
     ```
     c). Enable new yum repos. Run:
     ```
     host# sudo yum makecache
     ```
     d). Run `yum install` for DOCA runtime, tools, and SDK.
     ```
     host# sudo yum install -y doca-runtime doca-sdk
     ```
     e). Extra package:
     ```
     host# sudo dnf install -y doca-extra
     ```
     `doca-extra`, located under `/opt/mellanox/doca/tools/`, contains:
     - `doca-info` – displays details of all installed dependencies in DOCA
doca-kernel-support – running it adds support on existing kernel to support DOCA

For Rocky 8.6 Host

a). Install the following software dependencies. Run:

```bash
host# sudo dnf install -y yum-utils
host# sudo yum-config-manager --enable PowerTools
```

b). Clean cache. Run:

```bash
host# sudo dnf clean dcache
```

c). Run `dnf install` for DOCA SDK, DOCA runtime, DOCA tools.

```bash
host# sudo dnf install -y doca-runtime doca-sdk doca-tools
```

d). Extra package:

```bash
host# sudo dnf install -y doca-extra
```

doca-extra, located under `/opt/mellanox/doca/tools/`, contains:

- doca-info – displays details of all installed dependencies in DOCA
- doca-kernel-support – running it adds support on existing kernel to support DOCA

For RHEL Host

Note: For RHEL 7.6, only perform step d. from the following procedure.

a). Open a RedHat account.

i. Log into RedHat website via the developers tab.

ii. Create a developer user.

b). Run:

```bash
host# subscription-manager register --username=<username> --password=PASSWORD
```

to extract pool ID:

```bash
host# subscription-manager list --available --all
```

<table>
<thead>
<tr>
<th>Subscription Name</th>
<th>Provides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Hat Developer Subscription for Individuals</td>
<td>Red Hat Developer Tools (for RHEL Server for ARM)</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>Red Hat CodeReady Linux Builder for x86_64</td>
</tr>
</tbody>
</table>

And use the pool ID for the Subscription Name and Provides that include Red Hat CodeReady Linux Builder for x86_64.

c). Run:

```bash
host# subscription-manager attach --pool=<pool-id>
host# subscription-manager repos --enable codeready-builder-for-rhel-8-x86_64-rpms
host# sudo yum makecache
```

d). Install the DOCA local repo package for host, enable new yum repos, and install DOCA runtime and SDK. Run:

```bash
host# sudo yum makecache
host# sudo yum install -y doca-runtime doca-sdk
```
e). Sign out from your RHEL account. Run:

```
host# subscription-manager remove --all
dhost# subscription-manager unregister
```

f). Extra package:

```
host# sudo dnf install -y doca-extra
doca-extra, located under /opt/mellanox/doca/tools/, contains:

➤ doca-info – displays details of all installed dependencies in DOCA
➤ doca-kernel-support – running it adds support on existing kernel to support DOCA
```

3. Initialize MST. Run:

```
host# sudo mst start
```

4. Reset the nvconfig params to their default values:

```
host# sudo mlxconfig -d /dev/mst/mt41686_pciconf0 -y reset
```

Reset configuration for device /dev/mst/mt41686_pciconf0? (y/n) [n] : y
Applying... Done!
-I- Please reboot machine to load new configurations.

5. Skip this step if your BlueField DPU is Ethernet only. Please refer to Supported Platforms to learn your DPU type.

If you have a VPI DPU, the default link type of the ports will be configured to IB. To verify your link type, run:

```
host# sudo mst start
host# sudo mlxconfig -d /dev/mst/mt41686_pciconf0 -e q | grep -i link_type
```

<table>
<thead>
<tr>
<th>Configurations:</th>
<th>Default</th>
<th>Current</th>
<th>Next</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Boot</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* LINK_TYPE_P1</td>
<td>IB(1)</td>
<td>ETH(2)</td>
<td></td>
</tr>
<tr>
<td>* LINK_TYPE_P2</td>
<td>IB(1)</td>
<td>ETH(2)</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** If your DPU is Ethernet capable only, then the `sudo mlxconfig -d <device>` command will not provide an output.

If the current link type is set to IB, run the following command to change it to Ethernet:

```
host# sudo mlxconfig -d /dev/mst/mt41686_pciconf0 s LINK_TYPE_P1=2 LINK_TYPE_P2=2
```

6. Verify that RShim is active.

```
host# sudo systemctl status rshim
```

This command is expected to display active (running). If RShim service does not launch automatically, run:

```
host# sudo systemctl enable rshim
host# sudo systemctl start rshim
```

7. Assign a dynamic IP to `tmfifo_net0` interface (RShim host interface).

**Note:** Skip this step if you are installing the DOCA image on multiple DPUs.

```
host# ifconfig tmfifo_net0 192.168.100.1 netmask 255.255.255.252 up
```
3.5. Installing Software on DPU

Users have two options for installing DOCA on the DPU:

- Upgrading the full DOCA image on the DPU (recommended) - this option overwrites the entire boot partition.
- Upgrading DOCA local repo package on the DPU – this option upgrades DOCA components without overwriting the boot partition. Use this option to preserve configurations or files on the DPU itself.

3.5.1. Installing Full DOCA Image on DPU

**Note:** This installation sets up the OVS bridge.

**Note:** If you are installing DOCA on multiple DPUs, skip to section Installing Full DOCA Image on Multiple DPUs.

**Note:** This step overwrites the entire boot partition.

3.5.1.1. Option 1 - No Pre-defined Password

**Note:** To set the password in advance, proceed to Option 2.

BFB installation is executed as follows:

```
host# sudo bfb-install --rshim <rshimN> --bfb <image_path.bfb>
```

Where `rshimN` is `rshim0` if you only have one DPU. You may run the following command to verify:

```
host# ls -la /dev/ | grep rshim
```

3.5.1.2. Option 2 - Set Pre-defined Password

Ubuntu users can provide a unique password that will be applied at the end of the BlueField software image installation. This password needs to be defined in a `bf.cfg` configuration file.

To set the password for the "ubuntu" user:

1. Create password hash. Run:

   ```
   host# openssl passwd -1
   Password:
   Verifying - Password:
   $1$3B0RIrfX$TlHry93NFUJzg3Nya00rE1
   ```

2. Add the password hash in quotes to the `bf.cfg` file:

   ```
   host# sudo vim bf.cfg
   ubuntu_PASSWORD='$1$3B0RIrfX$TlHry93NFUJzg3Nya00rE1'
   ```
When running the installation command, use the `--config` flag to provide the file containing the password:

```
host# sudo bfb-install --rshim <rshimN> --bfb <image_path.bfb> --config bf.cfg
```

**Note:** If `--config` is not used, then upon first login to the BlueField device, users will be asked to update their password.

The following is an example of Ubuntu installation assuming the "pv" Linux tool has been installed (to view the installation progress).

```
host# sudo bfb-install --rshim rshim0 --bfb DOCA_<version>-aarch64.bfb --config bf.cfg
Pushing bfb
1.08GiB 0:00:57 [19.5MiB/s] [    <=>   ]
Collecting BlueField booting status. Press Ctrl+C to stop…
INFO[BL2]: start
INFO[BL2]: DDR POST passed
INFO[BL2]: UEFI loaded
INFO[BL31]: start
INFO[BL31]: runtime
INFO[UEFI]: eMMC init
INFO[UEFI]: eMMC probed
INFO[UEFI]: PCIe enum start
INFO[UEFI]: PCIe enum end
INFO[MISC]: Ubuntu installation started
INFO[MISC]: Installation finished
INFO[MISC]: Rebooting...
```

### 3.5.2. Installing Full DOCA Image on Multiple DPUs

On a host with multiple DPUs, the BFB image can be installed on all of them using the `multi-bfb-install` script.

```
host# ./multi-bfb-install --bfb <bfb-file> --password <password>
```

This script detects the number of RShim devices and configures them statically.

- For Ubuntu – the script creates a configuration file `*/etc/netplan/20-tmfifo.yaml`
- For CentOS/RHEL 7.6 – the script creates a configuration file `*/etc/sysconfig/network-scripts/ifcfg-br_tmfifo`
- For CentOS/RHEL 8.0 and 8.2 – the script installs bridge-utils package to use the command `brctl`, creates bridge `tm-br` and connects all RShim interfaces to it

After the installation is complete, the configuration of the bridge and each RShim interface can be observed using `ifconfig`. The expected result is to see the IP on the bridge `tm-br` configured to `192.168.100.1` with subnet `255.255.255.0`.

**Note:** To log into BlueField with `rshim0`, run:

```
ssh ubuntu@192.168.100.2
```

For each RShim after that, add 1 to the fourth octet of the IP address [e.g.,

```
ubuntu@192.168.100.3 for rshim1, ubuntu@192.168.100.4 for rshim2, etc.
```

The script burns a new MAC address to each DPU and configures a new IP, 192.168.100.x, as described earlier.
3.5.3. Installing DOCA Local Repo Package on DPU

**Note:** If you have already installed BlueField image, be aware that the DOCA SDK, Runtime, and Tools are already contained in the BFB, and this installation is not mandatory. If you have not installed the BlueField image and wish to update DOCA Local Repo package, proceed with the following procedure.

**Note:** Before installing DOCA on the target DPU, make sure the out-of-band interface (mgmt) is connected to the Internet.

1. Download the DOCA SDK, DOCA Runtime, and DOCA Tools package from section *Installation Files*.
2. Copy deb repo package into BlueField. Run:
   ```
   host# sudo scp -r doca-repo-aarch64-ubuntu2004-local_<version>_arm64.deb ubuntu@192.168.100.2:/tmp/
   ```
3. Unpack the deb repo. Run:
   ```
   dpu# sudo dpkg -i doca-repo-aarch64-ubuntu2004-local_<version>_arm64.deb
   ```
4. Run apt update:
   ```
   dpu# sudo apt-get update
   ```
5. Check for any DOCA package content upgrade. Run:
   ```
   dpu# sudo apt install doca-runtime
dpu# sudo apt install doca-tools
dpu# sudo apt install doca-sdk
   ```

3.5.4. Updating DOCA Local Repo Package on DPU

**Note:** Do not perform the following if you have already performed the steps under *Installing DOCA Local Repo Package on DPU*.

To upgrade the DPU software to DOCA_1.5.1_BSP_3.9.3_Ubuntu_20.04-4.2211-LTS version from DOCA_1.5.0_BSP_3.9.3_Ubuntu_20.04-11:

1. Run the following:
   ```
   $ wget -qO - https://linux.mellanox.com/public/repo/doca/lts/latest/ubuntu20.04/aarch64/GPG-KEY-Mellanox.pub | sudo apt-key add -
   $ sudo apt update
   $ sudo apt-mark hold linux-tools-bluefield linux-image-bluefield linux-bluefield linux-headers-bluefield linux-libc-dev linux-tools-common
   $ sudo apt upgrade
   ```
2. Download and install the mlxbf-bootimages DEB file which includes the DPU's UEFI/ATF and set the right image type ("dev" vs "prod"):
   ```
   $ IMAGE_TYPE=dev
   $ dpkg -i /tmp/mlxbf-bootimages_*_arm64.deb
   ```
3. Upgrade UEFI/ATF (included in mlxbf-bootimages DEB package) on the boot partition, run:
   ```
   $ bfrec --bootctl --policy dual
   ```
3.6. Upgrading Firmware

Note: If multiple DPUs are installed, the following steps must be performed on all of them after BFB installation.

To upgrade firmware:

1. SSH to your BlueField device via 192.168.100.2 (preconfigured).

Note: If multiple DPUs are installed, the tmfifo IP interface does not have to be 192.168.100.2. The last octate changes and depends on the RShim number.

The default credentials for Ubuntu are as follows:

- Username: ubuntu
- Password: ubuntu or a unique password that you set in bf.cfg

For example:

```bash
guest# ssh ubuntu@192.168.100.2 Password: <configured-password>
```

2. Upgrade firmware in BlueField DPU. Run:

```bash
dpu# sudo /opt/mellanox/mlnx-fw-updater/mlnx_fw_updater.pl --force-fw-update
```

Example output:

```
Device #1:
----------
Device Type:      BlueField-2

[...]

 Versions:         Current        Available
 FW             <Old_FW>       <New_FW>
```

3. For the firmware upgrade to take effect:

a). Run the following command on the BlueField DPU and host:

```bash
dpu# sudo mst start
```

b). Query the available reset flows:

```bash
dpu# sudo mlxfwreset -d /dev/mst/mt41686_pciconf0 q
```

Example output:

```
Reset-levels:
...

Reset-types (relevant only for reset-levels 3,4):
...

Reset-sync (relevant only for reset-level 3):
0: Tool is the owner       -Supported (default)
1: Driver is the owner     -Supported
```
c). **If reset-sync 1 is not supported or if mlxfwreset failed, perform host power cycle.** Otherwise, trigger reset by running the following:

dpu# sudo mlxfwreset -d /dev/mst/mt41686_pciconf0 --sync 1 -y reset

*Note: The entire DPU will experience reset.*

### 3.7. Post-installation Procedure

1. **Restart the driver. Run:**

   ```
   host# sudo /etc/init.d/openibd restart
   Unloading HCA driver:                                      [ OK ]
   Loading HCA driver and Access Layer:                       [ OK ]
   ```

2. **Configure the physical function (PF) interfaces.**

   ```
   host# sudo ifconfig <interface-1> <network-1/mask> up
   host# sudo ifconfig <interface-2> <network-2/mask> up
   ```

   **For example:**

   ```
   host# sudo ifconfig p2p1 192.168.200.32/24 up
   host# sudo ifconfig p2p2 192.168.201.32/24 up
   ```

   Pings between the source and destination should now be operational.
Chapter 4. Building Your Own BFB Installation Image

Users wishing to build their own customized BlueField OS image can use the BFB build environment. Please refer to the bfb-build project in this GitHub webpage for more information.

Note: For a customized BlueField OS image to boot on the UEFI secure-boot-enabled DPU (default DPU secure boot setting), the OS must be either signed with an existing key in the UEFI DB (e.g., the Microsoft key), or UEFI secure boot must be disabled. Please refer to the Secure Boot section and its subpages of the NVIDIA BlueField DPU Platform Operating System Documentation for more details.
For full instructions about setting up a development environment, refer to the NVIDIA DOCA Developer Guide.
Chapter 6. Installing CUDA on NVIDIA Converged Accelerator

NVIDIA® CUDA® is a parallel computing platform and programming model developed by NVIDIA for general computing GPUs.

This section details the necessary steps to set up CUDA on your environment. This section assumes that a BFB image has already been installed on your environment.

To install CUDA on your converged accelerator:

1. Download and install the latest NVIDIA Data Center GPU driver.
2. Download and install CUDA.

**Note:** Downloading CUDA includes the latest NVIDIA Data Center GPU driver and CUDA toolkit. For more information about CUDA and driver compatibility please refer to [NVIDIA CUDA Toolkit Release Notes](#).

### 6.1. Configuring Operation Mode

There are two modes that the NVIDIA Converged Accelerator may operate in:

- Standard mode (default) – the BlueField DPU and the GPU operate separately
- BlueField-X mode – the GPU is exposed to the DPU and is no longer visible on the host

To verify which mode the system is operating in, run:

```bash
host# sudo mst start
host# sudo mlxconfig -d /dev/mst/mt41686_pciconf0 q PCI_DOWNSTREAM_PORT_OWNER[4]
```

**Standard mode output:**

<table>
<thead>
<tr>
<th>Device #1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[..]</td>
</tr>
<tr>
<td>Configurations:</td>
</tr>
<tr>
<td>PCI_DOWNSTREAM_PORT_OWNER[4]</td>
</tr>
<tr>
<td>DEVICE_DEFAULT(0)</td>
</tr>
</tbody>
</table>

**BlueField-X mode output:**

<table>
<thead>
<tr>
<th>Device #1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[..]</td>
</tr>
<tr>
<td>Configurations:</td>
</tr>
<tr>
<td>PCI_DOWNSTREAM_PORT_OWNER[4]</td>
</tr>
<tr>
<td>EMBEDDED_CPU(15)</td>
</tr>
</tbody>
</table>
To configure BlueField-X mode, run:
```
host# mlxconfig -d /dev/mst/mt41686_pciconf0 s PCI_DOWNSTREAM_PORT_OWNER[4]=0xF
```

To configure standard mode, run:
```
host# mlxconfig -d /dev/mst/mt41686_pciconf0 s PCI_DOWNSTREAM_PORT_OWNER[4]=0x0
```

Power cycle is required for configuration to take effect. To power cycle the host run:
```
host# ipmitool power cycle
```

### 6.2. Downloading and Installing CUDA Toolkit and Driver

This section details the necessary steps to set up CUDA on your environment. It assumes that a BFB image has already been installed on your environment.

1. Install CUDA by visiting the [CUDA Toolkit 11.6.2 Downloads](https://nvdocs.nvidia.com/cuda-released/downloads.html) webpage.

   **Note:** Select the Linux distribution and version relevant for your environment.

2. Test that the driver installation completed successfully. Run:
```
nvidia-smi
```

```
Tue Apr  5 13:37:59 2022
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 510.47.03    Driver Version: 510.47.03    CUDA Version: 11.6     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap| Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  NVIDIA BF A10       Off  | 00000000:06:00.0 Off |                    0 |
|  0%   43C    P0    N/A / 225W |      0MiB / 23028MiB |      0%      Default |
|                               |                      |                  N/A |
+-------------------------------+----------------------+----------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory | |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                   |
| +-----------------------------------------------------------------------------+
```

3. Verify that the installation completed successfully.

   a). Download CUDA samples repo. Run:
```
dpu# git clone https://github.com/NVIDIA/cuda-samples.git
```

   b). Build and run `vectorAdd` CUDA sample. Run:
```
dpu# cd cuda-samples/Samples/0_Introduction/vectorAdd

dpu# make
```
dpu# ./vectorAdd

**Note:** If the `vectorAdd` sample works as expected, it should output “Test Passed”.

**Note:** If it seems that the GPU is slow or stuck, stop execution and run:
```
dpu# sudo setpci -v -d ::0302 800.L=201 # CPL_VC0 = 32
```

### 6.3. GPUDirect RDMA

To enable GPUDirect RDMA with a network card on NVIDIA Converged Accelerator, you need an additional kernel module. Run:
```
dpu# sudo modprobe nvidia-peermem
```

### 6.4. DPDK GPUDEV

To enable CPU map GPU memory feature in DPDK’s gpudev library, you need the GDRCopy library and driver to be installed on your system.

1. Install GDRCopy library. Run:
   ```
dpu# git clone https://github.com/NVIDIA/gdrcopy.git
```
2. Install dependencies.
   - For RHEL:
     ```
     # DKMs can be installed from epel-release. See https://fedoraproject.org/wiki/EPEL.
     dpu# $ sudo yum install dkms check check-devel subunit subunit-devel
     ```
   - For Debian:
     ```
     dpu# $ sudo apt install check libsubunit0 libsubunit-dev
     ```
3. Build the library and install the driver. Run:
   ```
dpu# cd gdrcopy
dpu# make
# Launch gdrdrv kernel module on the system
dpu# ./insmod.sh
```
4. Setup GDRCopy path. Run:
   ```
dpu# export GDRCOPY_PATH_L=/path/to/libgdrapi
```

**Note:** In general, the path to libgdrapi is `/path/to/gdrcopy/src/`.
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