NVIDIA DOCA

Installation Guide
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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>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBF2H322A-AEEOT</td>
<td>NVIDIA® BlueField®-2 P-Series DPU 25GbE Dual-Port SFP56, PCIe Gen4 x8, Crypto Enabled, 8GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHL</td>
</tr>
<tr>
<td>MBF2H322A-AENOT</td>
<td>NVIDIA BlueField-2 P-Series DPU 25GbE Dual-Port SFP56, PCIe Gen4 x8, Crypto Disabled, 8GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHL</td>
</tr>
<tr>
<td>MBF2H332A-AEEOT</td>
<td>NVIDIA BlueField-2 P-Series DPU 25GbE Dual-Port SFP56, PCIe Gen3/4 x8, Crypto Enabled, 16GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHL</td>
</tr>
<tr>
<td>MBF2H332A-AENOT</td>
<td>NVIDIA BlueField-2 P-Series DPU 25GbE Dual-Port SFP56, PCIe Gen3/4 x8, Crypto Disabled, 16GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHL</td>
</tr>
<tr>
<td>MBF2H516A-CEEOT</td>
<td>NVIDIA BlueField-2 P-Series DPU 100GbE Dual-Port QSFP56, PCIe Gen4 x16, Crypto Enabled, 16GB on-board DDR, 1GbE OOB management, Tall Bracket, FHHL</td>
</tr>
<tr>
<td>MBF2H516A-CENOT</td>
<td>NVIDIA BlueField-2 P-Series DPU 100GbE Dual-Port QSFP56, PCIe Gen4 x16, Crypto Disabled, 16GB on-board DDR, 1GbE OOB management, Tall Bracket, FHHL</td>
</tr>
<tr>
<td>MBF2H516A-EEEOT</td>
<td>NVIDIA BlueField-2 P-Series DPU 100GbE/EDR HDR100 VPI Dual-Port QSFP56, PCIe Gen4 x16, Crypto Enabled, 16GB on-board DDR, 1GbE OOB management, Tall Bracket, FHHL</td>
</tr>
<tr>
<td>MBF2H516A-EENOT</td>
<td>NVIDIA BlueField-2 P-Series DPU 100GbE/EDR VPI Dual-Port QSFP56, PCIe Gen4 x16; Crypto Disabled; 16GB on-board DDR; 1GbE OOB management; FHHL</td>
</tr>
<tr>
<td>MBF2H516B-CENOT</td>
<td>NVIDIA BlueField-2 P-Series BF2500 DPU Controller, 100GbE Dual-Port QSFP56, PCIe Gen4 x16, Crypto Disabled, 16GB on-board DDR, 1GbE OOB Management, Tall Bracket, FHHL</td>
</tr>
</tbody>
</table>

NVIDIA DOCA
<table>
<thead>
<tr>
<th>Model Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBF2H516B-EENOT</td>
<td>NVIDIA BlueField-2 P-Series BF2500 DPU Controller, 100GbE/EDR/HDR100 VPI</td>
</tr>
<tr>
<td></td>
<td>Dual-Port QSFP56, PCIe Gen4 x16, Crypto Disabled, 16GB on-board DDR, 1GbE</td>
</tr>
<tr>
<td></td>
<td>OOB management, Tall Bracket, FHHL</td>
</tr>
<tr>
<td>MBF2M322A-AEEOET</td>
<td>NVIDIA BlueField-2 E-Series DPU 25GbE Dual-Port SFP56, PCIe Gen3/4 x8,</td>
</tr>
<tr>
<td></td>
<td>Crypto, 8GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHH</td>
</tr>
<tr>
<td>MBF2M322A-AENOT</td>
<td>NVIDIA BlueField-2 E-Series DPU 25GbE Dual-Port SFP56, PCIe Gen3/4 x8,</td>
</tr>
<tr>
<td></td>
<td>Crypto Disabled, 8GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHH</td>
</tr>
<tr>
<td>MBF2M332A-AEEOT</td>
<td>NVIDIA BlueField-2 E-Series DPU 25GbE Dual-Port SFP56, PCIe Gen4 x8, Crypto,</td>
</tr>
<tr>
<td></td>
<td>16GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHH</td>
</tr>
<tr>
<td>MBF2M332A-AENOT</td>
<td>NVIDIA BlueField-2 E-Series DPU 25GbE Dual-Port SFP56, PCIe Gen4 x8, Crypto,</td>
</tr>
<tr>
<td></td>
<td>Disabled, 16GB on-board DDR, 1GbE OOB management, Tall Bracket, HHHH</td>
</tr>
<tr>
<td>MBF2M516A-CCEOT</td>
<td>NVIDIA BlueField-2 E-Series DPU 100GbE Dual-Port QSFP56; PCIe Gen4 x16;</td>
</tr>
<tr>
<td></td>
<td>Crypto Enabled, 16GB on-board DDR; 1GbE OOB management; FHHL</td>
</tr>
<tr>
<td>MBF2M516A-CENOT</td>
<td>NVIDIA BlueField-2 E-Series DPU 100GbE Dual-Port QSFP56, PCIe Gen4 x16,</td>
</tr>
<tr>
<td></td>
<td>Crypto Disabled, 16GB on-board DDR, 1GbE OOB management, Tall Bracket, FHHL</td>
</tr>
<tr>
<td>MBF2M516A-EEEOT</td>
<td>NVIDIA BlueField-2 E-Series DPU 100GbE/EDR/HDR100 VPI Dual-Port QSFP56,</td>
</tr>
<tr>
<td></td>
<td>PCIe Gen4 x16, Crypto Enabled, 16GB on-board DDR, 1GbE OOB management, Tall</td>
</tr>
<tr>
<td></td>
<td>Bracket, FHHL</td>
</tr>
<tr>
<td>MBF2M516A-EENOT</td>
<td>NVIDIA BlueField-2 E-Series DPU 100GbE/EDR/HDR100 VPI Dual-Port QSFP56;</td>
</tr>
<tr>
<td></td>
<td>PCIe Gen4 x16; Crypto Disabled; 16GB on-board DDR; 1GbE OOB management; FHHL</td>
</tr>
<tr>
<td>900-21004-0030-000</td>
<td>NVIDIA BlueField-2 A30X, P1004 SKU 205, Generic, GA100, 24GB HBM2e, PCIe</td>
</tr>
<tr>
<td></td>
<td>Passive Dual Slot 230W Gen 4.0, DPU Crypto ON W/ Bkt, 1 Dongle, Black, HF,</td>
</tr>
<tr>
<td></td>
<td>VCPD</td>
</tr>
<tr>
<td>900-21004-0010-000</td>
<td>NVIDIA BlueField-2 A100X, P1004 SKU 230, Generic, GA100, 80GB HBM2e, PCIe</td>
</tr>
<tr>
<td></td>
<td>Passive Dual Slot 300W Gen 4.0, DPU Crypto ON W/ Bkt, 1 Dongle, Black, HF,</td>
</tr>
<tr>
<td></td>
<td>VCPD</td>
</tr>
</tbody>
</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>0.5.0</td>
<td>Software development kit package for developing host software</td>
</tr>
<tr>
<td>Device</td>
<td>Component</td>
<td>Version</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>DOCA Runtime</td>
<td>1.4.0</td>
<td>Runtime libraries required to run DOCA-based software applications on host</td>
<td></td>
</tr>
<tr>
<td>DOCA Tools</td>
<td>1.4.0</td>
<td>Tools for developers and administrators on host</td>
<td></td>
</tr>
<tr>
<td>Arm emulated (Qemu) development container</td>
<td>3.9.2</td>
<td>Linux-based BlueField Arm emulated container for developers</td>
<td></td>
</tr>
<tr>
<td>Target BlueField-2 DPU (Arm)</td>
<td>BlueField OS</td>
<td>3.9.2</td>
<td>BlueField OS image and firmware</td>
</tr>
<tr>
<td>DOCA SDK</td>
<td>0.5.0</td>
<td>Software development kit packages for developing Arm software</td>
<td></td>
</tr>
<tr>
<td>DOCA Runtime</td>
<td>1.4.0</td>
<td>Runtime libraries required to run DOCA-based software applications on Arm</td>
<td></td>
</tr>
<tr>
<td>DOCA Tools</td>
<td>1.4.0</td>
<td>Tools for developers and administrators for Arm target</td>
<td></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
- CentOS/RHEL 7.6/8.0/8.2
- Debian 10.8

### 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>
</thead>
<tbody>
<tr>
<td>CentOS 7.6</td>
<td>4.14.0-115.el7a.aarch64</td>
<td>aarch64</td>
</tr>
<tr>
<td></td>
<td>3.10.0-957.el7.x86_64</td>
<td>x86</td>
</tr>
<tr>
<td>Host Operation System</td>
<td>Kernel Support</td>
<td>Arch Support</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>CentOS 8.0</td>
<td>4.18.0-80.el8.x86_64</td>
<td></td>
</tr>
<tr>
<td>CentOS 8.2</td>
<td>4.18.0-193.el8.x86_64</td>
<td></td>
</tr>
<tr>
<td>RHEL 7.6</td>
<td>3.10.0-957.el7.x86_64</td>
<td></td>
</tr>
<tr>
<td>RHEL 8.0</td>
<td>4.18.0-80.el8.x86_64</td>
<td></td>
</tr>
<tr>
<td>RHEL 8.2</td>
<td>4.18.0-193.el8.x86_64</td>
<td></td>
</tr>
<tr>
<td>Ubuntu 18.04</td>
<td>4.15.0-20-generic</td>
<td></td>
</tr>
<tr>
<td>Ubuntu 20.04</td>
<td>5.4.0-26-generic</td>
<td></td>
</tr>
<tr>
<td>Debian 10.8</td>
<td>4.19.0-14-amd64</td>
<td></td>
</tr>
</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 7.6 on aarch64</td>
<td>doca-host-repo-rhel76-1.4.0-0.1.9.1.4.0079.1.el7a.5.7.1.0.2.0.aarch64.rpm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CentOS/RHEL 7.6 on x86</td>
<td>doca-host-repo-rhel76-1.4.0-0.1.9.1.4.0079.1.el7.5.7.1.0.2.0.x86_64.rpm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CentOS/RHEL 8.0 on x86</td>
<td>doca-host-repo-rhel80-1.4.0-0.1.9.1.4.0079.1.el8.5.7.1.0.2.0.x86_64.rpm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CentOS/RHEL 8.2 on x86</td>
<td>doca-host-repo-rhel82-1.4.0-0.1.9.1.4.0079.1.el8.5.7.1.0.2.0.x86_64.rpm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ubuntu 18.04 on x86</td>
<td>doca-host-repo-ubuntu1804_1.4.0-0.1.9.1.4.0079.1.5.7.1.0.2.0_amd64.deb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ubuntu 20.04 on x86</td>
<td>doca-host-repo-ubuntu2004_1.4.0-0.1.9.1.4.0079.1.5.7.1.0.2.0_amd64.deb</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Debian 10.8 on x86</td>
<td>doca-host-repo-debian108_1.4.0-0.1.9.1.4.0079.1.5.7.1.0.2.0_amd64.deb</td>
</tr>
<tr>
<td>Arm Emulated</td>
<td>Arm container</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Development Container</td>
<td>v3.9.2 on aarch64</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target BlueField-2 DPU</td>
<td>BlueField OS image v3.9.2</td>
<td>Ubuntu 20.04 on aarch64</td>
<td>doca 1.4.0 bsp 3.9.2 ubuntu 20.04-4.sign</td>
</tr>
<tr>
<td>(Arm)</td>
<td>DOCA SDK v0.5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DOCA Runtime v1.4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DOCA Tools v1.4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

These files are designed for different operating systems as follows:

- **Host**
  - CentOS 7.6 on aarch64
  - CentOS/RHEL 7.6 on x86
  - CentOS/RHEL 8.0 on x86
  - CentOS/RHEL 8.2 on x86
  - Ubuntu 18.04 on x86
  - Ubuntu 20.04 on x86
  - Debian 10.8 on x86

- **Target BlueField-2 DPU (Arm)**
  - BlueField OS image v3.9.2
  - DOCA SDK v0.5.0
  - DOCA Runtime v1.4.0
  - DOCA Tools v1.4.0

- **Arm Emulated Development Container**
  - Arm container v3.9.2 on aarch64
3.2. Installing Software on Host

1. Installation of MFT and RShim for managing and flashing the BlueField DPU.

   **For Ubuntu/Debian**
   
   a). Download the DOCA Tools package from Installation Files section for the host.
   
   b). Unpack the deb repo. Run:
   ```
   host# sudo dpkg -i doca-host-repo-ubuntu<version>_amd64.deb
   ```
   
   c). Perform apt update. Run:
   ```
   host# sudo apt-get update
   ```
   
   d). Run `apt install` for DOCA Tools.
   ```
   host# sudo apt install doca-tools
   ```
   
   For DPU
   ```
   host# sudo apt install doca-tools
   ```
   
   For ConnectX on Ubuntu 20.04
   ```
   host# sudo apt install doca-cx-tools
   ```

   **For CentOS/RHEL**
   
   a). Download the DOCA Tools package from Installation Files section for the x86 host.
   
   b). Unpack the RPM repo. Run:
   ```
   host# sudo rpm -Uvh doca-host-repo-rhel<version>.x86_64.rpm
   ```
   
   c). Run `yum install` to install DOCA Tools.
   ```
   host# sudo yum install doca-tools
   ```

   **Note:** Skip the following step to proceed without the DOCA local repo package for host.

2. Alternatively, to continue with the DOCA local repo package for host installation:

   **Installing DOCA Local Repo Package on Ubuntu Host**
   
   a). Download the DOCA SDK and DOCA Runtime packages from Installation Files section for the host.
   
   b). Unpack the deb repo. Run:
   ```
   host# sudo dpkg -i doca-host-repo-ubuntu<version>_amd64.deb
   ```
   
   c). Perform apt update. Run:
   ```
   host# sudo apt-get update
   ```
   
   d). Run `apt install` for DOCA runtime, tools, and SDK.
   ```
   host# sudo apt install -y doca-runtime doca-sdk
   ```
   
   For DPU
   ```
   host# sudo apt install -y doca-runtime doca-sdk
   ```
   
   For ConnectX on Ubuntu 20.04
   ```
   host# sudo apt install -y doca-cx-runtime doca-cx-sdk
   ```

   **Installing DOCA Local Repo Package on CentOS Host**
   
   a). Download the DOCA SDK and DOCA Runtime packages from Installation Files section for the x86 host.
   
   b). Install the following software dependencies. Run:
host# sudo yum install -y epel-release
c. For CentOS 8.2 only, also run:
  host# yum config-manager --set-enabled PowerTools
d. Unpack the RPM repo. Run:
  host# sudo rpm -Uhv doca-host-repo-rhel<version>.x86_64.rpm
e. Run `yum install` for DOCA runtime, tools, and SDK.
  host# sudo yum install -y doca-runtime doca-sdk

Installing DOCA Local Repo Package on 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:
  host# subscription-manager register --username=<username> --password=PASSWORD

To extract pool ID:
  host# subscription-manager list --available --all
...
Subscription Name:   Red Hat Developer Subscription for Individuals
Provides:            Red Hat Developer Tools (for RHEL Server for ARM)
...                   Red Hat CodeReady Linux Builder for x86_64
...                   <pool-id>

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

c. Run:
  host# subscription-manager attach --pool=<pool-id>
  host# subscription-manager repos --enable codeready-builder-for-rhel-8-x86_64-rpms
  host# yum makecache
d. Install the DOCA local repo package for host. Run:
  host# rpm -Uhv doca-host-repo-rhel<version>.x86_64.rpm
  host# sudo yum install -y doca-runtime doca-sdk
e. Sign out from your RHEL account. Run:
  host# subscription-manager remove --all
  host# subscription-manager unregister

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! -1- 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:

```bash
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>Boot</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>IB(1)</td>
<td></td>
<td></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:

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

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

```
host# ifconfig tmfifo_net0 192.168.100.1 netmask 255.255.255.252 up
```

7. 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:

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

### 3.3. 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.

#### 3.3.1. 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.
### 3.3.1.1. Option 1 - No Pre-defined Password

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

BFB installation is executed as follows:

```bash
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:

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

### 3.3.1.2. Option 2 - Set Pre-defined Password

Ubuntu users can provide a unique password that will be applied at the end of the BlueField OS 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:

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

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

   ```bash
   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:

```bash
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).

```bash
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...
```
3.3.2. 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# ./bfb-multi-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/RH 7.6 – the script creates a configuration file `/etc/sysconfig/network-scripts/ifcfg-br_tmfifo`
- For CentOS/RH 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.

3.3.3. Installing DOCA Local Repo Package on DPU

**Note:** DOCA repo files are already installed by default as part of the BlueField OS image.

To upgrade DOCA packages on the DPU, use the Debian package manager to upgrade the new packages:

1. Download the DOCA repo file `doca-repo-aarch64-<version>.deb` for the target DPU from section Installation Files.
2. Copy the DOCA repo file into the BlueField DPU.
3. Unpack and install the DOCA repo file. Run:
   ```
dpu# sudo dpkg -i doca-repo-aarch64-<version>.deb
   ```
4. Check for any DOCA package content upgrade. Run:
   ```
dpu# sudo apt-get update
dpu# sudo apt-get upgrade
   ```

3.4. 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:
   ```
   host# ssh ubuntu@192.168.100.2 Password: <configured-password>
   ```

2. Upgrade firmware in BlueField DPU. Run:
   ```
   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:
   ```
   dpu# sudo mst start
   ```
   b). Query the available reset flows:
   ```
   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, 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 following operation can only be used after upgrading to DOCA 1.4.0. It is not supported from previous versions and may cause unexpected behavior if used.
   ```
   dpu# sudo mlxfwreset -d /dev/mst/mt41686_pciconf0 --sync 1 -y reset
   ```
   Note: The entire DPU will experience reset.
3.5. 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 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.
Chapter 5. Setting Up Build Environment for Developers

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:

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

Standard mode output:

```
Device #1:
[...]
Configurations:               Next Boot
PCI_DOWNSTREAM_PORT_OWNER[4]  DEVICE_DEFAULT(0)
```

BlueField-X mode output:

```
Device #1:
[...]
Configurations:               Next Boot
PCI_DOWNSTREAM_PORT_OWNER[4]  EMBEDDED_CPU(15)
```
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
```

---

**Note:** Firmware reset or power cycle is required for configuration to take effect.

- For firmware reset, run the following command on the BlueField DPU and immediately afterwards on the host. **Do not wait for the command to complete on the BlueField DPU before issuing the command on the host.**

```
dpu+host# sudo mlxfwreset -d /dev/mst/mt41686_pciconf0 -l 3 -y reset
```

- For 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://developer.nvidia.com/cuda-downloads) 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. | MIG M. |
|                               |                      |               MIG 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. Install Download CUDA samples repo. Run:
      ```
git clone https://github.com/NVIDIA/cuda-samples.git
```

   b. Build and run `vectorAdd` CUDA sample. Run:
      ```
cd cuda-samples/Samples/0_Introduction/vectorAdd
```
make
./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:
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:
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:
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.
   $ sudo yum install dkms check check-devel subunit subunit-devel
   ▶ For Debian:
   $ sudo apt install check libsubunit0 libsubunit-dev
3. Build the library and install the driver. Run:
cd gdrcopy
make
# Launch gdrdrv kernel module on the system
./insmod.sh
4. Setup GDRCopy path. Run:
export GDRCOPY_PATH_L=/path/to/libgdrapi

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