NVIDIA DOCA

Development Guide

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Chapter 1. Introduction

This guide is intended for software developers aiming to modify existing NVIDIA® DOCA applications or develop their own DOCA-based software.

For steps to install DOCA on NVIDIA® BlueField® DPU, refer to the DOCA Installation Guide.

This guide focuses on the recommended flow for developing DOCA-based software, and will target two main environments:

- BlueField DPU is accessible and can be used during the development and testing process
- BlueField DPU is inaccessible, and the development happens on the host/a different server

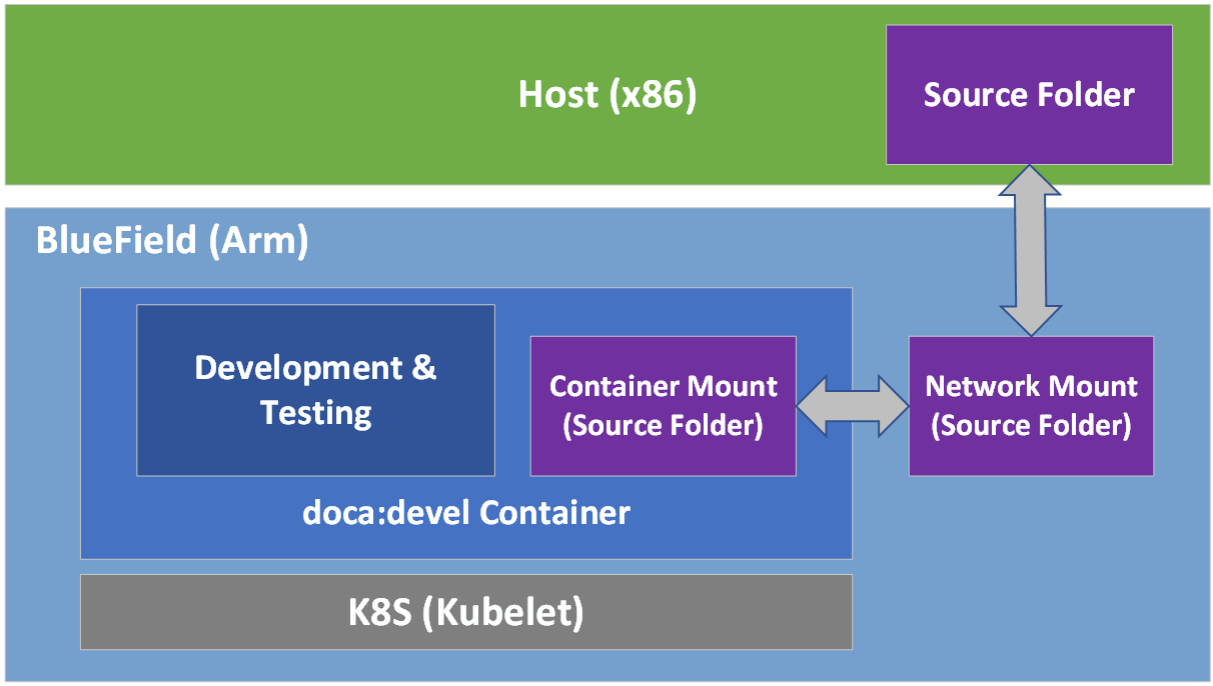
It is recommended to follow the former case, leveraging the DPU during the development and testing process.

Chapter 2. Developing Using BlueField DPU

2.1. Setup

A DOCA development container is created as part of the DOCA base image containers. It is recommended that it is deployed on top of the DPU. The `doca:devel` container may be found on NGC, and the full instructions for deploying the DOCA container on the DPU can be found on the DOCA Container User Guide page.

The development container allows developers to develop and test their DOCA-based software in a developer-friendly environment that comes pre-shipped with a set of handy development tools. In contrast to the BlueField OS that is meant to be an efficient runtime environment for DOCA products, the development container is focused on improving the development experience and is designed for that purpose.



2.2. Development

It is recommended not to do the development within the `doca:devel` container.

That said, some developers prefer different integrated development environments (IDEs) or development tools, and sometimes will prefer working using a graphical IDE, at least until it is time to compile the code. As such, the recommendation is to mount a network share to the DPU (refer to "Useful CLI Commands" for more information) and configure it in the container's `.yaml` file. This way the code is used by the graphical IDE and is directly accessible inside the development container.

Before	Shared folder is commented out.
	…
	`  # Shared host <-> container folder (uncomment to share a directory with the hosting DPU)`
	`  #- mountPath: /doca_devel`
	`  #  name: input-output`
	`  resources:`
	`  …`
	`  # Shared host <-> container folder (see comment above)`
	`  #- name: input-output`
	`  #  hostPath:`
	`  #    path: /tmp/doca_devel`
	`  #    type: Directory`

After	Shared folder is active.
	…
	`  # Shared host <-> container folder (uncomment to share a directory with the hosting DPU)`
	`  - mountPath: /doca_devel`
	`    name: input-output`
	`  resources:`
	`  …`
	`  # Shared host <-> container folder (see comment above)`
	`  - name: input-output`
	`    hostPath:`
	`      path: /tmp/doca_devel`
	`      type: Directory`

Note: The container's .yaml file is sensitive to indentations. Please make sure to use only spaces (' '), and to keep each indentation level at a width of 2 space characters.

Note: Having the same code folder accessible from the IDE and the container helps prevent edge cases where the compilation fails due to a typo in the code, but the typo is only fixed locally within the container and not propagated to the main source folder.

2.3. Testing

The container is marked as "privileged", hence it can directly access the HW capabilities of the BlueField DPU. This means that once the tested program compiles successfully, it can be

directly tested from within the container without the need to copy it to the DPU and running it there.

2.4. Publishing

Once the program passes the testing phase, it should be prepared for deployment. While some proof-of-concept (POC) programs are just copied "as-is" in their binary form, most deployments will probably be in the form of a package (`.deb`/`.rpm`) or a container.

Construction of the binary package can be done as-is inside the current `doca:devel` container, or as part of a CI pipeline that will leverage the same development container as part of it.

For the construction of a container to ship the developed software, it is recommended to use a multi-staged build that ships the software on top of the runtime-oriented DOCA base images:

- doca:base-rt – slim DOCA runtime environment
- doca:full-rt – full DOCA runtime environment similar to BlueField OS

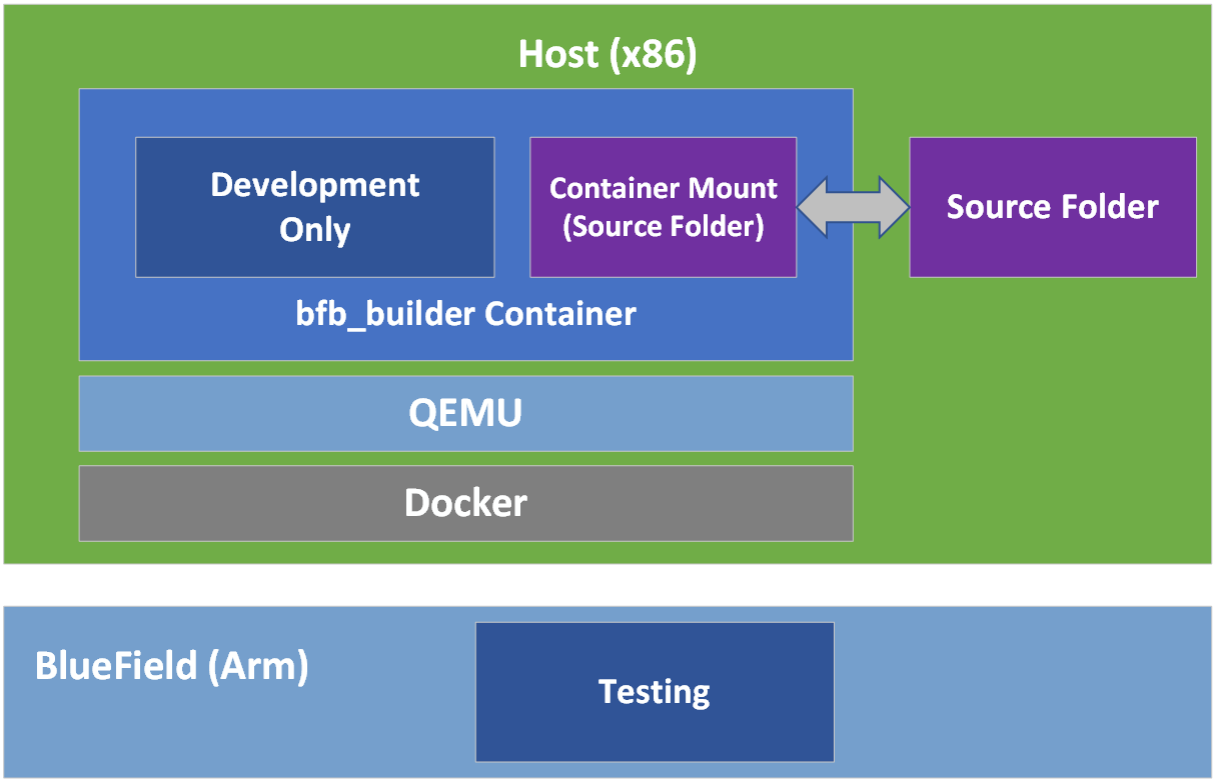
The runtime DOCA base images, alongside more details about their structure, can be found under the same NGC page that hosts the `doca:devel` image.

For a multi-staged build, it is recommended to compile the software inside the `doca:devel` container, and later copy it to one of the runtime container images. All relevant images must be pulled directly from NGC (using `docker pull`) to the container registry of the DPU.

Chapter 3. Developing Without BlueField DPU

3.1. Setup

If the development process needs to be done without access to a BlueField DPU, the recommendation is to use a QEMU-based deployment of a container on top of a regular x86 server. The development container for the host will be a "bfb_builder" development container which comes as part of the SDK Manager during installation of DOCA on the host.



1. Make sure Docker is installed on your host. Run:

```
docker version
```

If it is not installed, visit the official Install Docker Engine webpage for installation instructions.

2. Install QEMU on the host.

   Note: This step is for x86 hosts only. If you are working on an aarch64 host, move to the next step.

   - For an Ubuntu host, run:
     ```
     sudo apt-get install qemu binfmt-support qemu-user-static
     sudo docker run --rm --privileged multiarch/qemu-user-static --reset -p yes
     ```
   - For a CentOS/RHEL 7.x host, run:
     ```
     sudo yum install epel-release
     sudo yum install qemu-system-arm
     ```
   - For a CentOS 8.0/8.2 host, run:
     ```
     sudo yum install epel-release
     sudo yum install qemu-kvm
     ```
   - For a Fedora host, run:
     ```
     sudo yum install qemu-system-aarch64
     ```
3. If you are using CentOS or Fedora on the host, verify if `qemu-aarch64.conf` exists. Run:
   ```
   $ cat /etc/binfmt.d/qemu-aarch64.conf
   ```
   If it is missing, run:
   ```
   echo ":qemu-aarch64:M::\x7fELF
   \x02\x01\x01\x00\x00\x00\x00\x00\x00\x00\x00\x00\x02\x00\xb7:\xff\xff\xff\xff\xff
   \xff\xff\xfc\xff\xff\xff\xff\xff\xff\xff\xff\xfe\xff\xff:/usr/bin/qemu-aarch64-
   static:" > /etc/binfmt.d/qemu-aarch64.conf
   ```
4. If you are using CentOS or Fedora on the host, restart system binfmt. Run:
   ```
   $ sudo systemctl restart systemd-binfmt
   ```
5. Load the docker image.

   - Make sure the docker service is started. Run:
     ```
     systemctl daemon-reload
     systemctl start docker
     ```
   - Go to the location the tar file is saved at and run the following command from the host:
     ```
     sudo docker load -i <filename>
     ```
     For example:
     ```
     sudo docker load -i bfb_builder_ubuntu20.04-5.3-1.0.0.0-3.6.0.11699-1.tar
     ```

     Note: The loading process may take a while. After the image is loaded, you may find its ID using the command `docker images`.
6. Run the docker image:
   ```
   sudo docker run -v <source-code-folder>:<dest-folder-on-docker> --privileged -it
    -e container=docker <image-name/ID>
   ```
   For example, if the source code folder is `/<...>/buildEnv`, the destination folder on the docker is `/app`, and the image is the one downloaded in the previous step, the command will look like this:
   ```
   sudo docker run -v /<...>/buildEnv:/app --privileged -it -e container=docker
    doca_v1.11_bluefield_os_ubuntu_20.04-mlnx-5.4
   ```
   Or, if you use a loaded image with the ID 185c50ecb31d, the command will be:

```
sudo docker run -v /<...>/buildEnv:/app --privileged -it -e container=docker
 185c50ecb31d
```

After running this command, you get a shell inside the container where you can build your project using the regular build commands.

Note: Make sure you map a folder that everyone has Write privileges to. Otherwise, the docker will not be able to write the output file to it.

Note: The folder will be mapped to the destination folder. In this example the folder `/app` inside the docker will be mapped to `/<...>/buildEnv`.

3.2. Development

Much like the development phase when using a BlueField DPU explained above, it is recommended to develop within the container running on top of QEMU.

3.3. Testing

While the compilation can be performed on top of the container, testing the compiled software must be done on top of a BlueField-2 DPU. This is because the QEMU environment emulates an aarch64 architecture, but it does not emulate the hardware devices present on the BlueField DPU. Therefore, the tested program will not be able to access the devices needed for its successful execution, thus mandating that the testing is done on top of a physical DPU.

3.4. Publishing

The publishing process is similar to the publishing process when using a BlueField DPU, the only difference being the containers being deployed on top of QEMU for emulating the aarch64 architecture.

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