



NVIDIA DOCA Firewall

Application Guide

Table of Contents

Chapter 1. Introduction.....	1
Chapter 2. System Design.....	2
Chapter 3. Application Architecture.....	4
3.1. Static Mode.....	4
3.2. Interactive Mode.....	5
Chapter 4. DOCA Libraries.....	7
Chapter 5. Configuration Flow.....	8
Chapter 6. Running the Application.....	9
Chapter 7. Arg Parser DOCA Flags.....	11
Chapter 8. References.....	12

Chapter 1. Introduction

A firewall application is a network security application that leverages the DPU's hardware capability to monitor incoming and outgoing network traffic and allow or block packets based on a set of preconfigured rules.

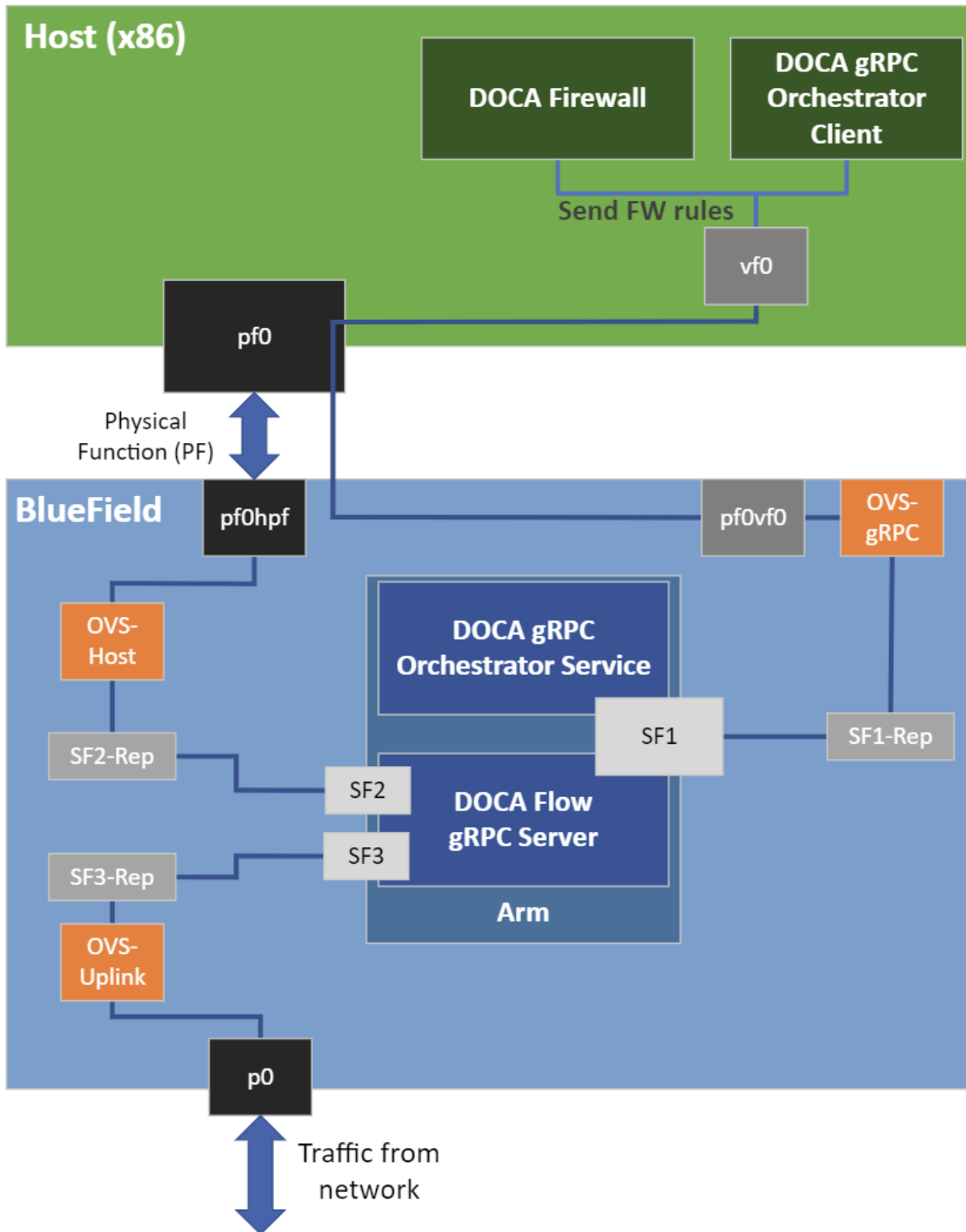
The firewall application is based on DOCA Flow gRPC, used for remote programming of the DPU's hardware.

The firewall can operate in two modes:

- ▶ Static mode – the firewall application gets 5-tuple traffic from the user with a JSON file for packets to be dropped. The packets that do not match any of the 5-tuple are forwarded by a hairpin pipe.
- ▶ Interactive mode – the user can add rules from the command line in real time to execute different firewall rules

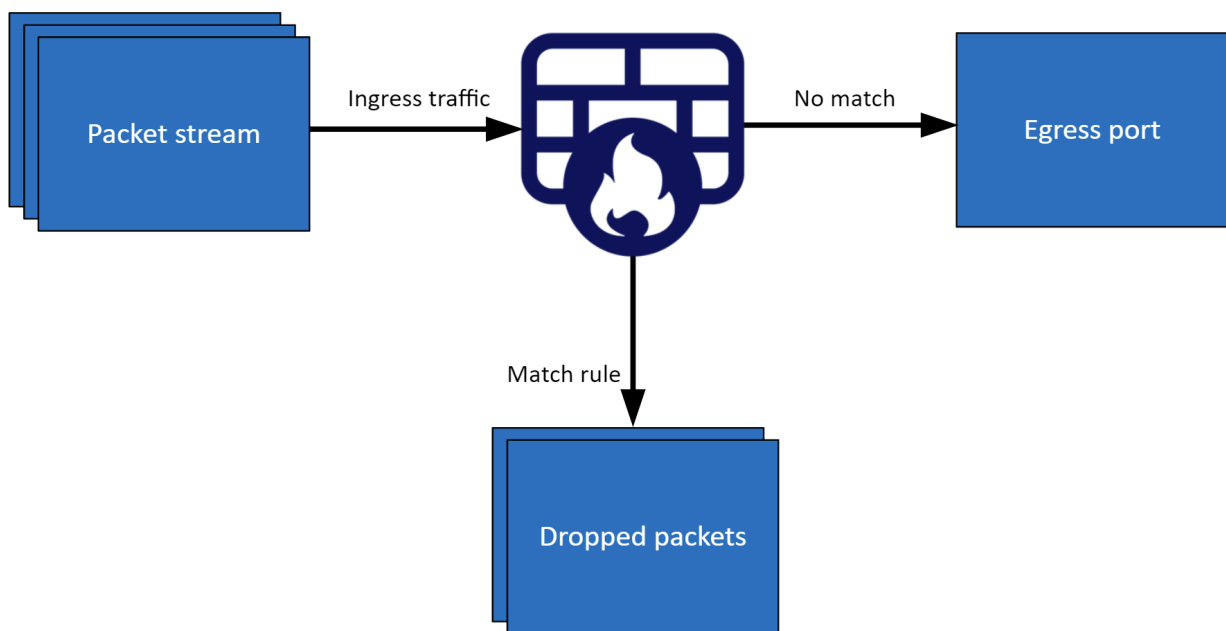
Chapter 2. System Design

The firewall application is designed to run on the host and to use DOCA Flow gRPC client to send instructions to a server that runs on the BlueField DPU instance. The DPU intercepts ingress traffic from the wire and either drops it or forwards it to the egress port using a hairpin. The decision is made using traffic classification.

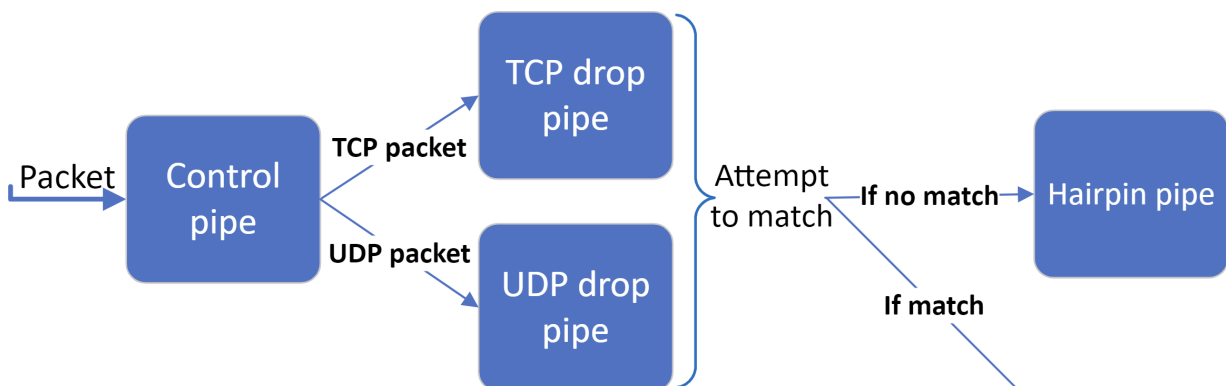


Chapter 3. Application Architecture

The firewall runs on top of DOCA Flow gRPC to classify packets.



3.1. Static Mode



1. The firewall application builds 4 pipes for each port: One control pipe, two drop pipes, and a hairpin pipe.
2. The drop pipes match only 5-tuple traffic with specific source and destination IPs and source and destination ports.
 - ▶ One of the drop pipes matches TCP traffic and the other matches UDP
 - ▶ The hairpin pipe matches every packet (no misses)
 - ▶ The control pipe serves as a root pipe and has two entries: The first entry forwards the TCP traffic to the TCP drop pipe, and the second entry forwards UDP traffic to the UDP drop pipe
 - ▶ The hairpin pipe serves as a forwarding miss component to the drop pipes. Therefore, every received packet is checked first against the drop pipes. If there is a match, then it is dropped, otherwise, it is forwarded to the hairpin pipe and is then matched.

3.2. Interactive Mode

Running in interactive mode initializes 2 ports, creates the same pipes as in "Static Mode", and the user then adds or removes entries.

- ▶ When adding an entry, the user must run commands to create a 5-tuple match beforehand
- ▶ After an entry is created successfully, the relevant ID is printed for future use

Available commands:

- ▶ `add entry port_id=<port_id>`
- ▶ `rm entry port_id=<port_id>,entry_id=[entry_id]`
- ▶ `port pipes flush port_id=[port_id]`
- ▶ `port pipes dump port_id=[port_id],file=[file_name]`
- ▶ `create entry_match [field=value,...]`

5-tuple match struct fields:

Fields	Field Options
<code>outer.src_ip_addr</code>	
<code>outer.dst_ip_addr</code>	
<code>outer.l4_type_ext</code>	<code>tcp, udp</code>
<code>outer.tcp_src_port</code>	
<code>outer.tcp_dst_port</code>	
<code>outer.udp_src_port</code>	
<code>outer.udp_dst_port</code>	

The following is an example for creating a pipe and adding an entry:

```
create entry_match
  outer.src_ip_addr=192.168.105.2,outer.dst_ip_addr=192.168.105.3,outer.l4_type_ext=tcp,outer.tcp_s
add entry port_id=0,pipe_queue=0
```

Chapter 4. DOCA Libraries

This application leverages the [DOCA Flow library](#).

Chapter 5. Configuration Flow

1. Parse application argument.

a). Initialize the arg parser resources.

```
doca_argp_init();
```

b). Register application parameters.

```
register_firewall_params();
```

c). Parse application parameters.

```
doca_argp_start();
```

2. Firewall initialization.

```
firewall_ports_init();
```

a). Create a new gRPC channel and initialize a stub.

b). Initialize DOCA Flow and DOCA Flow ports.

3. Create control, TCP, UDP, and hairpin pipes for both ports.

```
firewall_pipes_init();
```

4. Configure firewall rules.

Mode	Procedure
Static	<p>a). Initialize drop packets array from the input JSON file: <code>init_drop_packets();</code></p> <p>b). Add firewall drop rules parsed from JSON file: <code>firewall_add_drop_rules();</code></p>
Interactive	<p>a). Initialize the firewall's interactive command line: <code>interactive_cmdline();</code></p> <p>b). Free allocated resources: <code>interactive_mode_cleanup();</code></p>

5. Firewall cleanup.

```
firewall_ports_destroy();
```

a). Destroy all DOCA Flow resources.

6. Arg parser destroy.

```
doca_argp_destroy();
```

Chapter 6. Running the Application

1. Refer to the following documents:

- ▶ [NVIDIA DOCA Installation Guide for Linux](#) for details on how to install BlueField-related software.
- ▶ [NVIDIA DOCA Troubleshooting Guide](#) for any issue you may encounter with the installation, compilation, or execution of DOCA applications.
- ▶ [NVIDIA DOCA Applications Overview](#) for additional compilation instructions and development tips regarding the DOCA applications.

2. The firewall example binary is located under `/opt/mellanox/doca/applications/firewall/bin/doca_firewall`.



Note: Before building the application, make sure that gRPC support is enabled. Set the `enable_grpc_support` flag in `/opt/mellanox/doca/applications/meson_options.txt` to `true`.

To build all the applications together, run:

```
cd /opt/mellanox/doca/applications/  
meson build  
ninja -C build
```

3. To build only the firewall application:

a). Edit the following flags in `/opt/mellanox/doca/applications/meson_options.txt`:

- ▶ Set `enable_all_applications` to `false`
- ▶ Set `enable_firewall` to `true`

b). Run the commands in step 2.



Note: `doca_firewall` will be created under `./build/firewall/src/`.

Application usage:

```
Usage: doca_firewall [DOCA Flags] [Program Flags]  
DOCA Flags:  
-h, --help                Print a help synopsis  
-v, --version             Print program version information  
-l, --log-level           Set the log level for the program  
<CRITICAL=20, ERROR=30, WARNING=40, INFO=50, DEBUG=60>  
--grpc-address ip_address[:port] Set the IP address for the grpc server  
Program Flags:
```

```
-m, --mode                Set running mode {static, interactive}
-r, --firewall-rules <path> Path to the JSON file with 5-tuple rules when
running with static mode
```



Note: For additional information on the app use `-h`:

```
/opt/mellanox/doca/applications/firewall/bin/doca_firewall -h
```

4. Running the application on the host:

- ▶ For instructions on running the DOCA Flow gRPC server on the BlueField, refer to [NVIDIA DOCA gRPC Infrastructure User Guide](#).

- ▶ CLI example for running the app in interactive mode:

```
/opt/mellanox/doca/applications/firewall/bin/doca_firewall --grpc-address
192.168.101.2 -l 50 -m interactive
```

- ▶ CLI example for running the app in static mode:

```
/opt/mellanox/doca/applications/firewall/bin/doca_firewall --grpc-address
192.168.101.2 -l 50 -m static -d firewall_rules.json
```

5. To run `doca_firewall` using a JSON file:


```
doca_firewall --json [json_file]
```

For example:

```
cd /opt/mellanox/doca/applications/firewall/bin
./doca_firewall --json firewall_params.json
```

Chapter 7. Arg Parser DOCA Flags

Refer to [NVIDIA DOCA Arg Parser Programming Guide](#) for more information.

Flag Type	Short Flag	Long Flag/ JSON Key	Description	JSON Content
General Flags	l	log-level	Set the log level for the application: <ul style="list-style-type: none"> ▶ CRITICAL=20 ▶ ERROR=30 ▶ WARNING=40 ▶ INFO=50 ▶ DEBUG=60 	<code>"log-level": 60</code>
	v	version	Print program version information	N/A
	h	help	Print a help synopsis	N/A
	g	grpc-address	Set the IP address for the gRPC server	<code>"grpc-address": "0.0.0.0"</code>
Program Flags	m	mode	Set running mode {static or interactive} <div style="border: 1px solid gray; padding: 5px; margin-top: 10px;">  Note: This flag is mandatory. </div>	<code>"mode": "interactive"</code>
	r	firewall-rules	Path to JSON rules file	<code>"firewall-rules": "firewall_rules.json"</code>

Chapter 8. References

- ▶ `/opt/mellanox/doca/applications/firewall/src`

Notice

This document is provided for information purposes only and shall not be regarded as a warranty of a certain functionality, condition, or quality of a product. NVIDIA Corporation nor any of its direct or indirect subsidiaries and affiliates (collectively: "NVIDIA") make no representations or warranties, expressed or implied, as to the accuracy or completeness of the information contained in this document and assume no responsibility for any errors contained herein. NVIDIA shall have no liability for the consequences or use of such information or for any infringement of patents or other rights of third parties that may result from its use. This document is not a commitment to develop, release, or deliver any Material (defined below), code, or functionality.

NVIDIA reserves the right to make corrections, modifications, enhancements, improvements, and any other changes to this document, at any time without notice.

Customer should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

NVIDIA products are sold subject to the NVIDIA standard terms and conditions of sale supplied at the time of order acknowledgement, unless otherwise agreed in an individual sales agreement signed by authorized representatives of NVIDIA and customer ("Terms of Sale"). NVIDIA hereby expressly objects to applying any customer general terms and conditions with regards to the purchase of the NVIDIA product referenced in this document. No contractual obligations are formed either directly or indirectly by this document.

NVIDIA products are not designed, authorized, or warranted to be suitable for use in medical, military, aircraft, space, or life support equipment, nor in applications where failure or malfunction of the NVIDIA product can reasonably be expected to result in personal injury, death, or property or environmental damage. NVIDIA accepts no liability for inclusion and/or use of NVIDIA products in such equipment or applications and therefore such inclusion and/or use is at customer's own risk.

NVIDIA makes no representation or warranty that products based on this document will be suitable for any specified use. Testing of all parameters of each product is not necessarily performed by NVIDIA. It is customer's sole responsibility to evaluate and determine the applicability of any information contained in this document, ensure the product is suitable and fit for the application planned by customer, and perform the necessary testing for the application in order to avoid a default of the application or the product. Weaknesses in customer's product designs may affect the quality and reliability of the NVIDIA product and may result in additional or different conditions and/or requirements beyond those contained in this document. NVIDIA accepts no liability related to any default, damage, costs, or problem which may be based on or attributable to: (i) the use of the NVIDIA product in any manner that is contrary to this document or (ii) customer product designs.

No license, either expressed or implied, is granted under any NVIDIA patent right, copyright, or other NVIDIA intellectual property right under this document. Information published by NVIDIA regarding third-party products or services does not constitute a license from NVIDIA to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property rights of the third party, or a license from NVIDIA under the patents or other intellectual property rights of NVIDIA.

Reproduction of information in this document is permissible only if approved in advance by NVIDIA in writing, reproduced without alteration and in full compliance with all applicable export laws and regulations, and accompanied by all associated conditions, limitations, and notices.

THIS DOCUMENT AND ALL NVIDIA DESIGN SPECIFICATIONS, REFERENCE BOARDS, FILES, DRAWINGS, DIAGNOSTICS, LISTS, AND OTHER DOCUMENTS (TOGETHER AND SEPARATELY, "MATERIALS") ARE BEING PROVIDED "AS IS." NVIDIA MAKES NO WARRANTIES, EXPRESSED, IMPLIED, STATUTORY, OR OTHERWISE WITH RESPECT TO THE MATERIALS, AND EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. TO THE EXTENT NOT PROHIBITED BY LAW, IN NO EVENT WILL NVIDIA BE LIABLE FOR ANY DAMAGES, INCLUDING WITHOUT LIMITATION ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES, HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY, ARISING OUT OF ANY USE OF THIS DOCUMENT, EVEN IF NVIDIA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Notwithstanding any damages that customer might incur for any reason whatsoever, NVIDIA's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms of Sale for the product.

Trademarks

NVIDIA, the NVIDIA logo, and Mellanox are trademarks and/or registered trademarks of Mellanox Technologies Ltd. and/or NVIDIA Corporation in the U.S. and in other countries. The registered trademark Linux® is used pursuant to a sublicense from the Linux Foundation, the exclusive licensee of Linus Torvalds, owner of the mark on a world-wide basis. Other company and product names may be trademarks of the respective companies with which they are associated.

Copyright

© 2023 NVIDIA Corporation & affiliates. All rights reserved.