NVIDIA DOCA Security Gateway

Application Guide

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Chapter 1. Introduction

DOCA Security Gateway leverages the DPU's hardware capability for secure network communication. The application demonstrates how to insert rules related to IPsec encryption and decryption based on the DOCA Flow and IPsec libraries.

The application gets a list of rules for IPsec encryption and decryption as an input which are then translated to the respective IPsec tunnel mode and ESP header definitions.

The application supports the following modes:

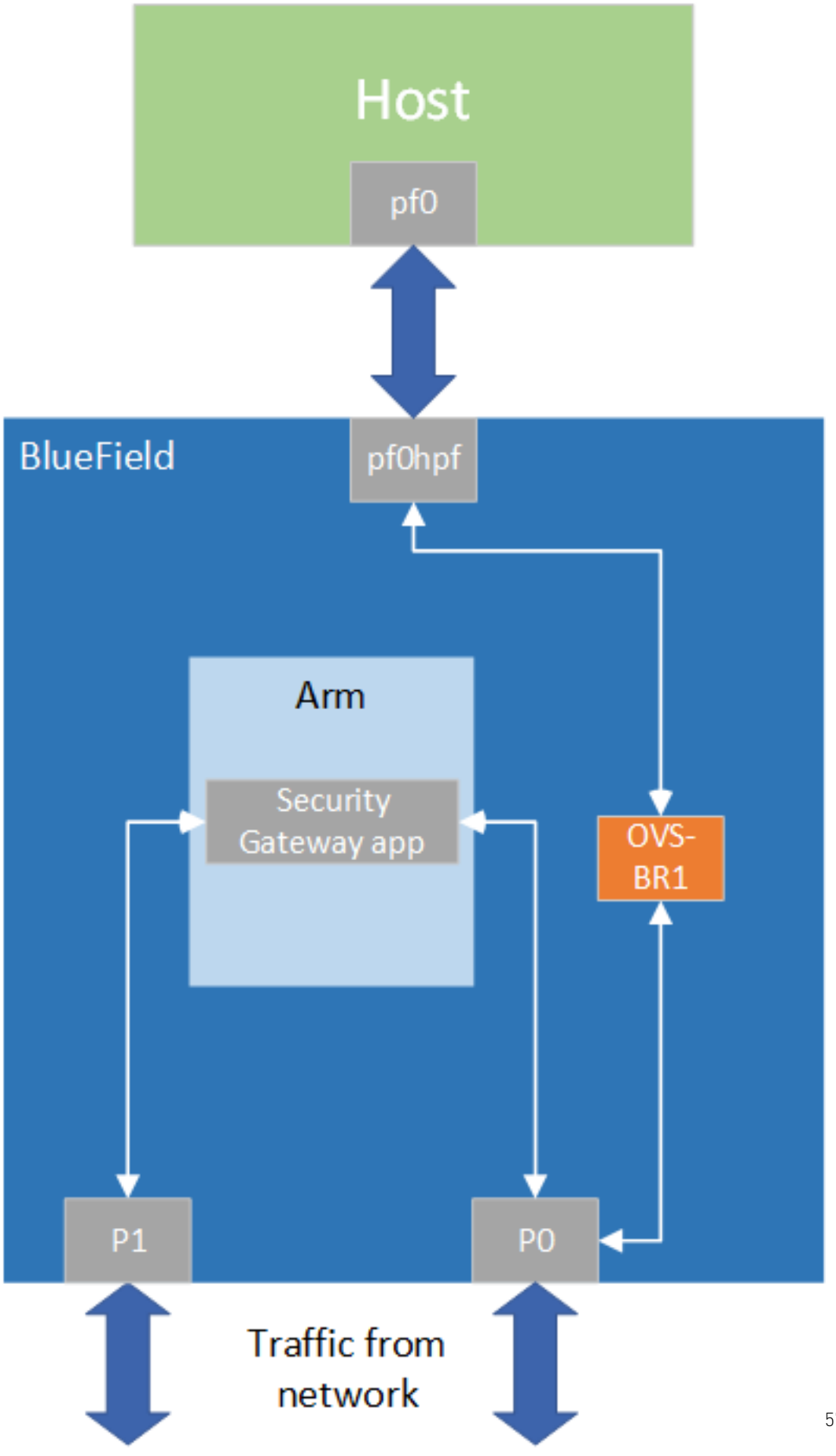
- Full offload – packets are processed in hardware and hairpinned to the next port
- Partial offload – packets are processed in hardware and passed onwards to the application before they are forwarded to the next port

Note: When creating the SA object, the application uses a fixed IPsec key to serve as an example. Make sure to replace it with your own implementation when using the application for more than testing.

Chapter 2. System Design

DOCA Security Gateway is designed to run with 2 ports, secured and unsecured:

- Secured port – the application receives encrypted packets and, after decryption, they are sent through the unsecured port
- Unsecured port – the application receives regular (plain text) packets and, after encryption, they are sent through the secured port


Host
pf0
BlueField
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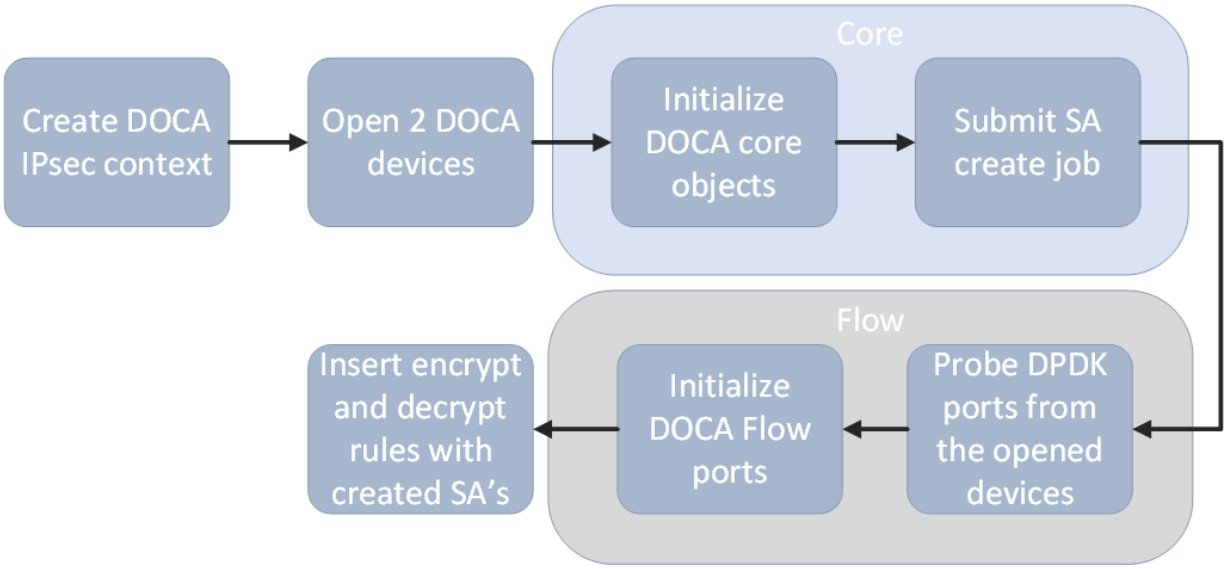
Arm
Security Gateway app
OVS-BR1
P1
P0
Traffic from network

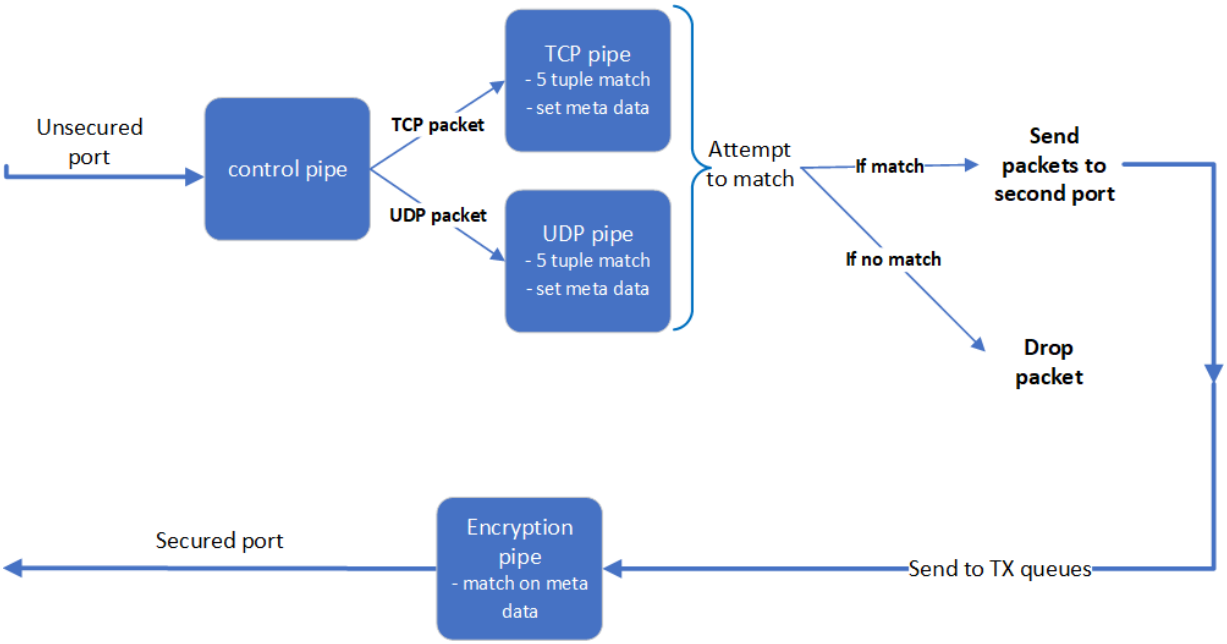
Chapter 3. Application Architecture



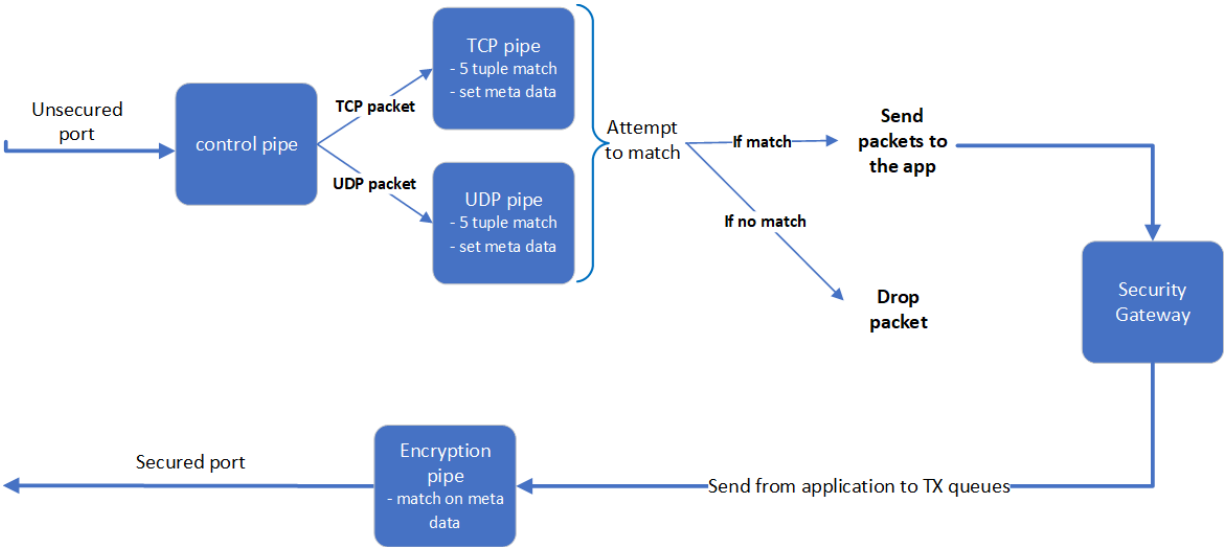
1. Crete IPsec library context.
2. Open two DOCA devices, one for the secured port and another for the unsecured port.
3. Initialize the DOCA work queue.
4. Submit "Create SA" jobs, one job for encryption and another for decryption.
5. With the open DOCA devices, the application probes DPDK ports and initializes DOCA Flow and DOCA Flow ports accordingly.
6. On the created ports, you build and insert DOCA Flow pipes and entries according to the input JSON rules and the created SA objects.

3.1. Encryption

Full offload flow:

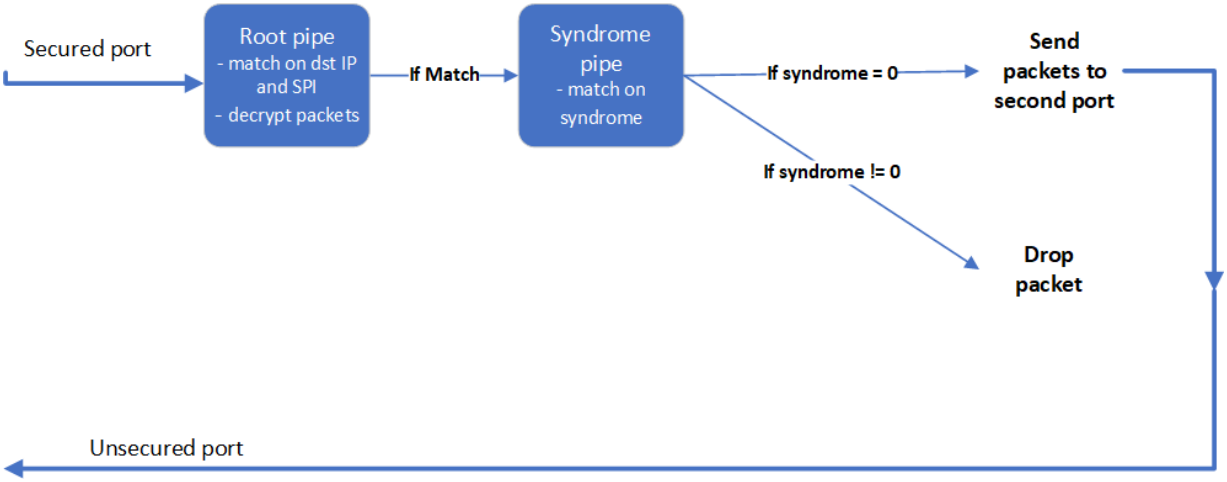


Partial offload flow:

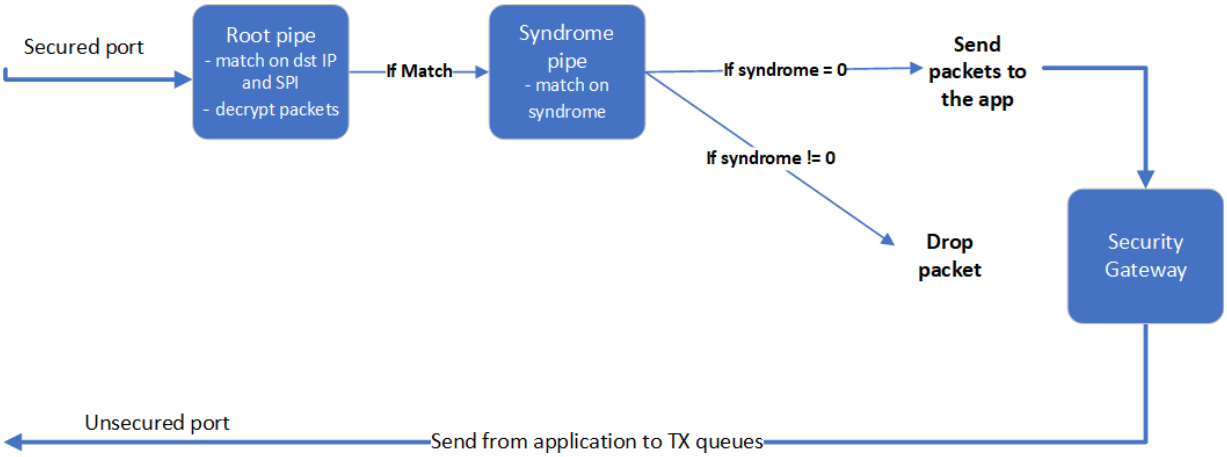


3.2. Decryption

Full offload flow:



Partial offload flow:



Chapter 4. DOCA Libraries

This application leverages the following DOCA libraries:

- DOCA Flow library
- DOCA IPsec library

Chapter 5. Configuration Flow

1. Parse application argument.
   a). Initialize the arg parser resources and register DOCA general parameters.
   ```
   doca_argp_init();
   ```
   b). Register application parameters.
   ```
   register_security_gateway_params();
   ```
   c). Parse application flags.
   ```
   doca_argp_start();
   ```
      i. Parse app parameters.
2. Parse rules file.
   ```
   security_gateway_parse_rules();
   ```
3. DPDK initialization.
   ```
   rte_eal_init();
   ```
   Call `rte_eal_init()` to initialize EAL resources with the provided EAL flags for not probing the ports.
4. Initialize devices and ports.
   ```
   security_gateway_init_devices();
   ```
   a). Open DOCA devices with input PCIe addresses.
   b). Probe DPDK port from each opened device.
5. Initialize and start DPDK ports.
   ```
   dpdk_queues_and_ports_init();
   ```
   a). Initialize DPDK ports, including mempool allocation.
   b). Initialize hairpin queues if needed.
   c). Binds hairpin queues of each port to its peer port.
6. Create SA object for encryption and decryption.
   ```
   security_gateway_create_ipsec_sa();
   ```
   a). Create IPsec library context.
   b). Create DOCA Work queue.
   c). Submit create SA job.
7. Initialize DOCA Flow.
   ```
   security_gateway_init_doca_flow();
   ```
   a). Initialize DOCA Flow library.

b). Find the indices of the DPDK-probed ports and start DOCA Flow ports with them.

8. Insert rules.

   a). Insert encryption rules.
   ```
   security_gateway_insert_encrypt_rules();
   ```
   b). Insert decryption rules.
   ```
   security_gateway_insert_decrypt_rules();
   ```

9. Wait for traffic.
   ```
   security_gateway_wait_for_traffic();
   ```
   a). In full offload mode, wait in a loop until the user terminates the program.

   b). In partial offload, receive packets on all cores and send the received packets to second port.

10. Security gateway cleanup:

    a). DOCA Flow cleanup; destroy initialized ports.
    ```
    doca_flow_cleanup();
    ```
    b). Destroy DPDK ports and queues.
    ```
    dpdk_queues_and_ports_fini();
    ```
    c). DPDK finish.
    ```
    dpdk_fini();
    ```
    Calls `rte_eal_destroy()` to destroy initialized EAL resources.

    d). 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 for the DOCA applications.
2. DOCA Security Gateway binary is located under `/opt/mellanox/doca/applications/security_gateway/bin/doca_security_gateway`. To build all the applications together, run:

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

3. To build only the security gateway application:

   a). Edit the following flags in `/opt/mellanox/doca/applications/meson_option.txt`:
   - Set `enable_all_applications` to `false`
   - Set `enable_security_gateway` to `true`

   b). Run the commands in step 2.

> **Note:** `doca_security_gateway` will be created under `./build/switch/src/`.

Application usage:

```
Usage: doca_security_gateway [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>
 Program Flags:
  -s, --secured                     secured port pci-address
  -u, --unsecured                   unsecured port pci-address
  -r, --rules                       Path to the JSON file with 5-tuple rules
  -o, --offload                     offload mode - {partial/full}
```

> **Note:** For additional information on the app, use `-h`:
>
> ```
> /opt/mellanox/doca/applications/<application name>/bin/doca_<application
>  name> -h
> ```

4. Running the application on BlueField:
   - Pre-run setup:
     a). The security gateway example is based on DPDK libraries. Therefore, the user is required to allocate huge pages.
     ```
     echo 2048 > /sys/kernel/mm/hugepages/hugepages-2048kB/nr_hugepages
     ```
     b). The security gateway example requires disabling some of the hardware tables which can be done using the following commands:
     ```
     echo none > /sys/class/net/p0/compat/devlink/encap
     echo none > /sys/class/net/p1/compat/devlink/encap
     ```
   - CLI example for running the application:
     ```
     /opt/mellanox/doca/applications/security_gateway/bin/doca_security_gateway
      -s 03:00.0 -u 03:00.1 -r applications/security_gateway/
     security_gateway_rules.json -o full
     ```
5. Running the application on the host, CLI example:
   ```
   /opt/mellanox/doca/applications/security_gateway/bin/doca_security_gateway -s
    08:00.0 -u 08:00.1 -r applications/security_gateway/security_gateway_rules.json
    -o full
   ```

   Note: Refer to section "Running DOCA Application on Host" in NVIDIA DOCA Virtual Functions User Guide.

6. To run `doca_security_gateway` using a JSON file:
   ```
   doca_security_gateway --json [json_file]
   ```
   For example:
   ```
   cd /opt/mellanox/doca/applications/security_gateway/bin
   ./doca_security_gateway --json ./security_gateway_params.json
   ```

Chapter 7. Arg Parser DOCA Flags

Refer to NVIDIA DOCA Arg Parser User Guide for more information.

Flag Type	Short Flag	Long Flag/JSON Key	Description	JSON Content
General flags	`l`	`log-level`	Sets the log level for the application: ▶ CRITICAL=20 ▶ ERROR=30 ▶ WARNING=40 ▶ INFO=50 ▶ DEBUG=60	`"log-level": 60`
	`v`	`version`	Print program version information	N/A
	`h`	`help`	Print a help synopsis	N/A
Program flags	`r`	`rules`	Path to JSON file with rules for encrypt and decrypt	`"rules": security_gateway_rules.json`
	`u`	`unsecured`	PCIe address for the unsecured port	`"unsecured": 03:00.1`
	`s`	`secured`	PCIe address for the secured port	`"secured": 03:00.0`
	`o`	`offload`	Offload mode	`"offload": "full"`

Chapter 8. References

- `/opt/mellanox/doca/applications/security_gateway/src/security_gateway.c`

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