# NVIDIA DOCA Switch

## Application Guide

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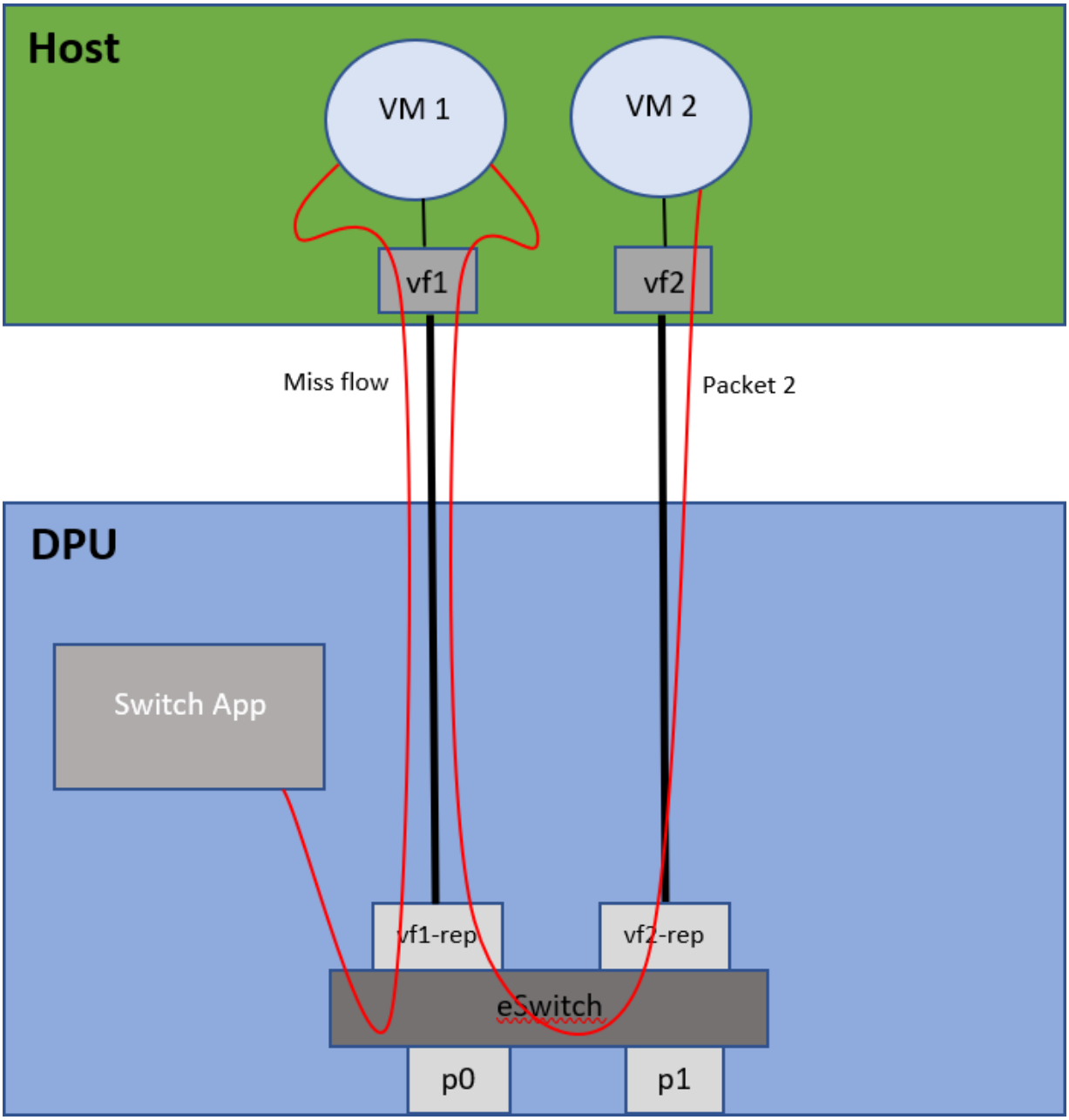
# Chapter 1. Introduction

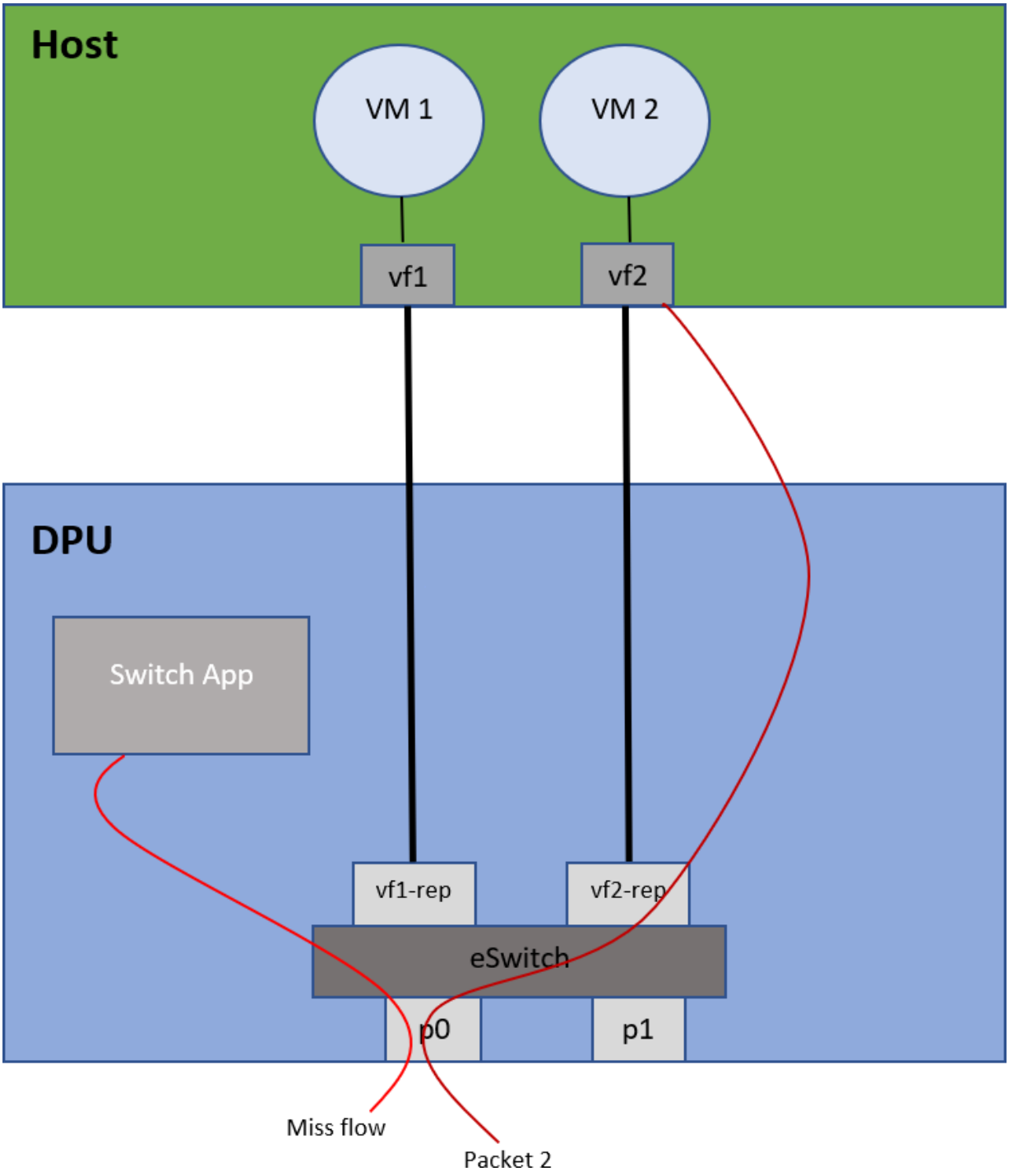
DOCA Switch is a network application that leverages the DPU's hardware capability for internal switching between representor ports on the DPU.

DOCA Switch is based on the DOCA Flow library. As such, it exposes a command line interface which receives DOCA Flow like commands to allow adding rules in real time.

# Chapter 2. System Design

DOCA Switch is designed to run on the DPU as a standalone application (all network traffic goes directly through it).

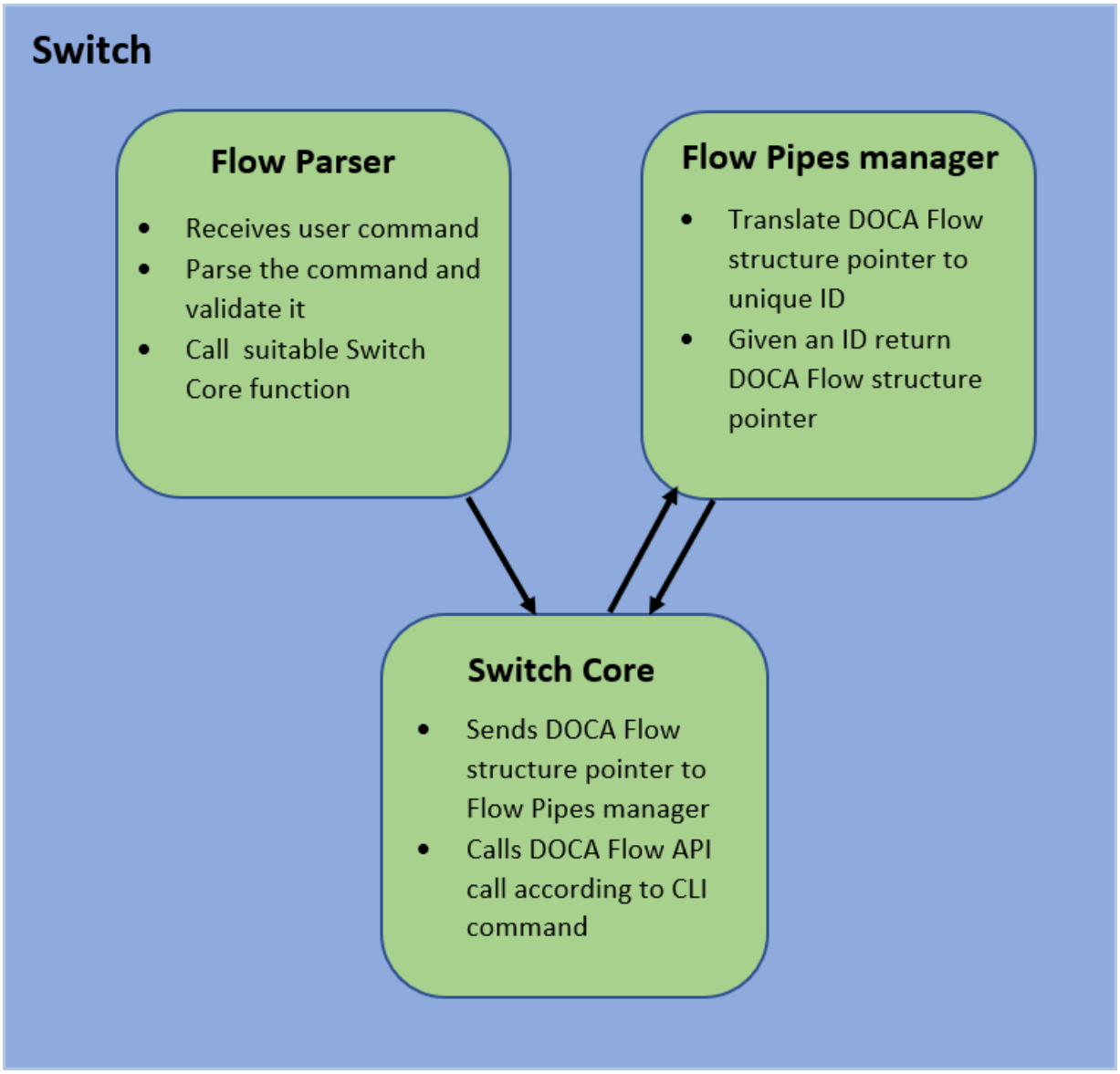

Host
VM 1
VM 2
vf1
vf2
Miss flow
Packet 2
DPU
Switch App
vf1-rep
vf2-rep
eSwitch
p0
p1


Host
VM 1
VM 2
vf1
vf2
DPU
Switch App
vf1-rep
vf2-rep
eSwitch
p0
p1
Miss flow
Packet 2

# Chapter 3. Application Architecture

DOCA Switch is based on 3 modules:

- Command line interface – receives pre-defined DOCA Flow-like commands and parses them
- Flow pipes manger – generates a unique identification number for each DOCA Flow structure created
- Switch core – combines all modules together and calls necessary DOCA Flow API




Port initialization cannot be made dynamically. All ports must be defined when running the application with standard DPDK flags.

- When adding a pipe or an entry, the user must run commands to create the relevant structs beforehand
- Optional parameters must be specified by the user in the command line; otherwise, `NULL` is used
- After a pipe or an entry is created successfully, the relevant ID is printed for future use

Available commands:

- `create pipe port_id=[port_id][,<optional_parameters>]`

  Available optional parameters:

- `name=<pipe-name>`
- `root_enable=[1|0]`
- `monitor=[1|0]`
- `match_mask=[1|0]`
- `fwd=[1|0]`
- `fwd_miss=[1|0]`
- `type=[basic|control]`

- `add entry pipe_id=<pipe_id>,pipe_queue=<pipe_queue>[,<optional_parameters>]`

  Available optional parameters:

  - `monitor=[1|0]`
  - `fwd=[1|0]`

- `add control_pipe entry priority=<priority>,pipe_id=<pipe_id>,pipe_queue=<pipe_queue>[,<optional_parameters>]`

  Available optional parameters:

  - `match_mask=[1|0]`
  - `fwd=[1|0]`

- `destroy pipe port_id=[port_id],pipe_id=<pipe_id>`
- `rm entry pipe_queue=<pipe_queue>,entry_id=[entry_id]`
- `port pipes flush port_id=[port_id]`
- `port pipes dump port_id=[port_id],file=[file_name]`
- `query entry_id=[entry_id]`
- `create [struct] [field=value,…]`
  - Struct options: `pipe_match`, `entry_match`, `match_mask`, `actions`, `monitor`, `fwd`, `fwd_miss`
    - Match struct fields:

| Fields | Field Options |
|---|---|
| `flags` | |
| `port_meta` (source port) | According to the number of physical ports |
| `out_src_mac` | |
| `out_dst_mac` | |
| `out_eth_type` | |
| `out_vlan_id` | |
| `out_src_ip_type` | `ipv4`, `ipv6` |
| `out_src_ip_addr` | |

| Fields | Field Options |
|---|---|
| out_dst_ip_type | ipv4, ipv6 |
| out_dst_ip_addr | |
| out_l4_type | tcp, udp, gre |
| out_tcp_flags | FIN, SYN, RST, PSH, ACK, URG, ECE, CWR |
| out_src_port | |
| out_dst_port | |
| tun_type | |
| vxlan-tun_id | |
| gre_key | |
| gtp_teid | |
| in_src_mac | |
| in_dst_mac | |
| in_eth_type | |
| in_vlan_id | |
| in_src_ip_type | ipv4, ipv6 |
| in_src_ip_addr | |
| in_dst_ip_type | ipv4, ipv6 |
| in_dst_ip_addr | |
| in_l4_type | tcp, udp |
| in_tcp_flags | FIN, SYN, RST, PSH, ACK, URG, ECE, CWR |
| in_src_port | |
| in_dst_port | |

- Actions struct fields:

| Fields | Field Options |
|---|---|
| decap | true, false |
| mod_src_mac | |
| mod_dst_mac | |
| mod_src_ip_type | ipv4, ipv6 |
| mod_src_ip_addr | |
| mod_dst_ip_type | ipv4, ipv6 |
| mod_dst_ip_addr | |
| mod_src_port | |
| mod_dst_port | |
| dec_ttl | true, false |
| has_encap | true, false |
| encap_src_mac | |
| encap_dst_mac | |

| Fields | Field Options |
|---|---|
| encap_src_ip_type | ipv4, ipv6 |
| encap_src_ip_addr | |
| encap_dst_ip_type | ipv4, ipv6 |
| encap_dst_ip_addr | |
| encap_tup_type | vxlan, gtpu, gre |
| encap_vxlan-tun_id | |
| encap_gre_key | |
| encap_gtp_teid | |

- FWD struct fields:

| Fields | Field Options |
|---|---|
| type | rss, port, pipe, drop |
| rss_flags | |
| rss_queues | |
| num_of_queues | |
| rss_mark | |
| port_id | |
| next_pipe_id | |

- Monitor struct fields:
  - flags
  - id
  - cir
  - cbs
  - aging

Consider that the physical port number (only one physical port is supported) will always be 0 and all representor ports are numbered from 1 to N where N is the number of representors being used. For example:

- Physical port ID: 0
- VF0 representor port ID: 1
- VF1 representor port ID: 2
- VF2 representor port ID: 3

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

- The first entry matches UDP packets with destination port 54223 and forwards it to VF1 representor (port ID 2)
- The second entry matches UDP packets with destination port 54222 and forwards it to VF0 representor (port ID 1)

In the final stage, both entries are deleted, each according to the unique random ID it was given:

```
create pipe_match
 out_l4_type=udp,out_src_ip_type=ipv4,out_dst_port=0xffff,port_meta=0xffffffff
create fwd type=port,port_id=0xffff
create pipe port_id=0,name=vf0_to_vf1,root_enable=1,fwd=1
create entry_match port_meta=1,out_dst_port=54223
create fwd type=port,port_id=2
add entry pipe_queue=0,fwd=1,pipe_id=1012
create entry_match port_meta=2,out_dst_port=54222
create fwd type=port,port_id=1
add entry pipe_queue=0,fwd=1,pipe_id=1012
rm entry pipe_queue=0,entry_id=345
rm entry pipe_queue=0,entry_id=447
```

# 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 and register DOCA general parameters.
   ```
   doca_argp_init();
   ```
   b). Register application parameters.
   ```
   register_switch_params();
   ```
   c). Parse application flags.
   ```
   doca_argp_start();
   ```
2. Count total number of ports.
   ```
   switch_ports_count();
   ```
   a). Check how many ports are entered when running the application.
3. Initialize DPDK ports and queues.
   ```
   dpdk_queues_and_ports_init();
   ```
4. Initialize DOCA Switch.
   ```
   switch_init();
   ```
   a). Initialize DOCA Flow.
   b). Create port pairs.
   c). Create Flow Pipes Manger module
   d). Register an action for each relevant CLI command.
5. Initialize Flow Parser.
   ```
   flow_parser_init();
   ```
   a). Reset all internal Flow Parser structures.
   b). Start the command line interface.
   c). Receive user commands, parse them, and call the required DOCA Flow API command.
   d). Close the interactive shell once a "quit" command is entered.
6. Clean Flow Parser resources.
   ```
   flow_parser_cleanup();
   ```
7. Destroy DOCA Switch resources.
   ```
   switch_destroy();
   ```
   a). Destroy Flow Pipes Manager resources.
8. Destroy DOCA Flow.
   ```
   switch_destroy();
   ```

9. Destroy DPDK ports and queues.
   ```
   dpdk_queues_and_ports_fini();
   ```
10. DPDK finish.
    ```
    dpdk_fini();
    ```
    a). Call `rte_eal_destroy()` to destroy initialized EAL resources.
11. 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. The DOCA Switch example binary is located under `/opt/mellanox/doca/applications/switch/bin/doca_switch`. To build all the applications together, run:

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

3. To build only the Switch application:

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

   b). Run the commands in step 2.

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

Application usage:

```
Usage: doca_switch [DOCA 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>
```

> **Note:** For additional information on the app, use `-h`:
>
> `/opt/mellanox/doca/applications/switch/bin/doca_switch -h`

4. CLI example for running the app on BlueField with 3 VF representors:

```
/opt/mellanox/doca/applications/switch/bin/doca_switch -a
 03:00.0,representor=[0-2] -- -l 30
```

# 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:<br>▶ CRITICAL=20<br>▶ ERROR=30<br>▶ WARNING=40<br>▶ INFO=50<br>▶ DEBUG=60 | `"log-level": 60` |
| | `v` | `version` | Print program version information | N/A |
| | `h` | `help` | Print a help synopsis | N/A |

# Chapter 8. References

- /opt/mellanox/doca/applications/switch/src/switch.c
- /opt/mellanox/doca/applications/switch/src/switch_core.c
- /opt/mellanox/doca/applications/switch/src/switch_core.h

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