



# NVIDIA DOCA IPS

## Reference Application Guide

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# Chapter 1. Introduction

Intrusion prevention system (IPS) is an application that monitors a network for malicious activity or policy violations.

IPS uses the deep packet inspection (DPI) engine to scan network flow for malicious content based on predefined Suricata signatures. Packets that are deemed malicious are dropped and a corresponding message is printed.

IPS supports NetFlow protocol for sending data from the DPU to remote NetFlow collector for further analysis.

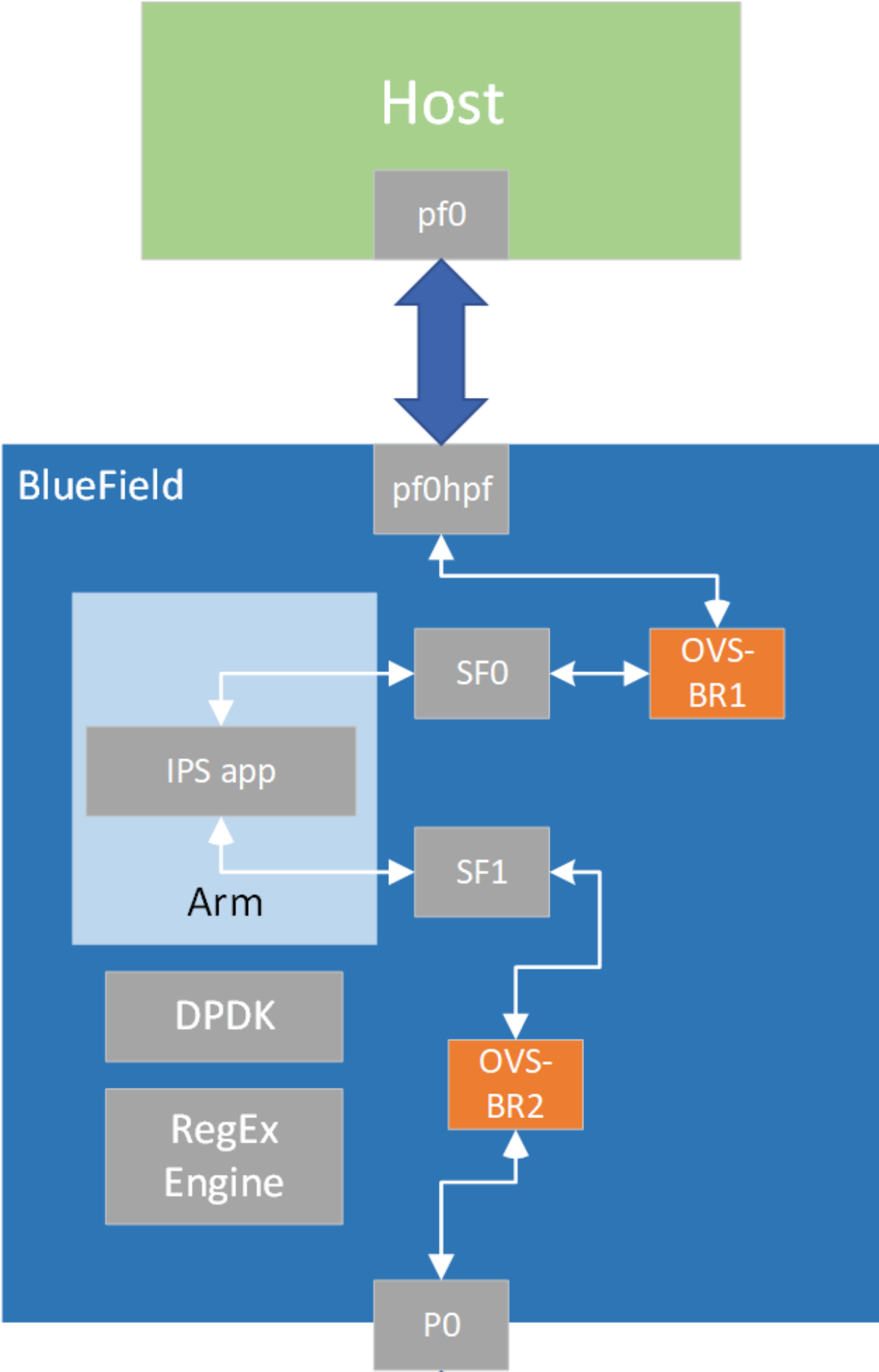
Connection tracking is also supported for tracking all network connections or flows which helps the identification of all the packets that make up a flow for better handling of the network traffic.

This document describes how to build and run the IPS application both on the host and on the DPU.

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## Chapter 2. System Design

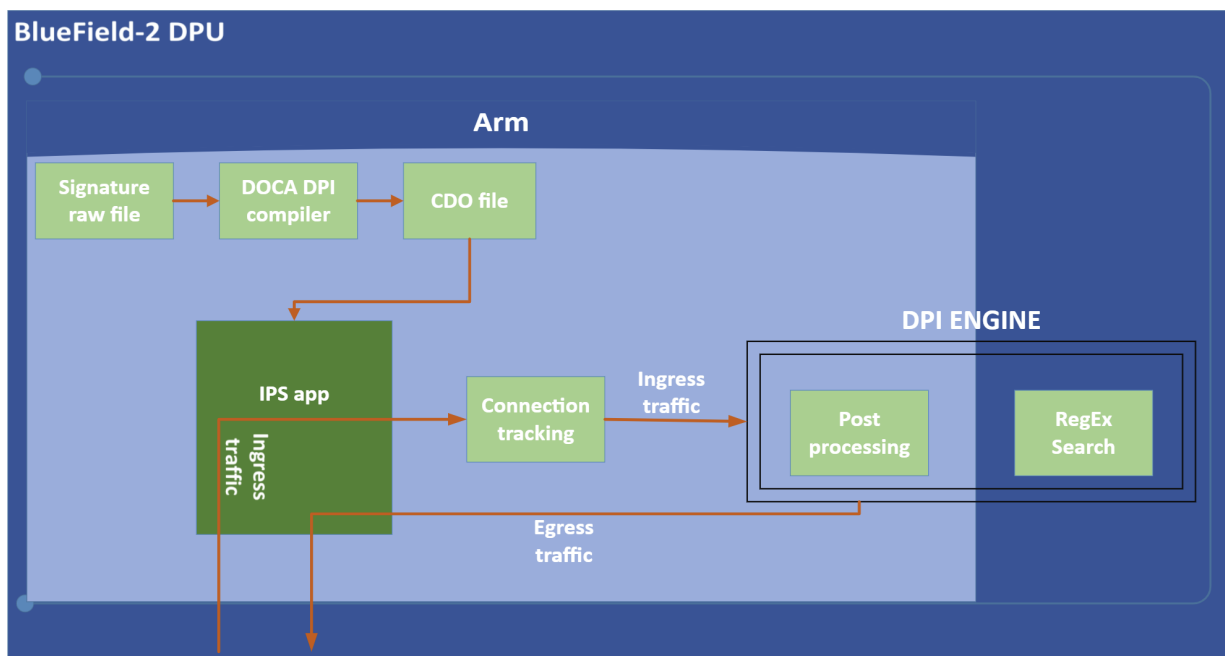
The IPS application is designed to run as "bump-on-the-wire" on the BlueField instance, it intercepts the traffic coming from the wire, and passes it to peer port.





# Chapter 3. Application Architecture

IPS runs on top of DPDK-based stateful flow tracking (SFT) to identify the flow that each packet belongs to, then uses DPI to process L7 classification.



1. Signatures are compiled by DPI compiler and then loaded to DPI engine. See [DOCA DPI Compiler](#) for more information.
2. Ingress traffic is identified using the stateful table module which utilizes the connection tracking hardware offloads.
3. Traffic is scanned against DPI-engine-compiled signature DB.
4. Post-processing is performed for match decision.
5. Matched flows are identified and drop actions can be offloaded to the hardware to increase performance as no further inspection is needed.
6. Flow termination is done by a configurable aging timer set in the SFT to 60 seconds. When a flow is offloaded, it cannot be tracked and destroyed.

---

# Chapter 4. Configuration Flow

1. Parse application argument.

```
arg_parser_init();
```

- a). Initialize Arg Parser resources.
- b). Register DOCA general flags.  

```
register_ips_params();
```
- c). Register IPS application flags.  

```
arg_parser_start();
```
- d). Parsing DPDK flags and calling `rte_eal_init()` function.
- e). Parsing APP flags.

2. Initialize DPDK.

```
dpdk_init();
```

- a). Initialize SFT.
- b). Initialize DPDK ports, including mempool allocation.

3. Initialize IPS application resources including DPI engine and NetFlow.

```
ips_init();
```

4. Configure DPI packet processing.

```
ips_worker_lcores_run();
```

- a). Configure DPI enqueue packets.
- b). Send jobs to RegEx engine.
- c). Configure DPI dequeue packets.

5. IPS destroy.

```
ips_destroy();
```

- a). Stop and free DPI resources.
- b). Destroy netflow resources.
- c). Stop SFT.
- d). Free IPS resources.



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# Chapter 5. Running Application on BlueField

1. Refer to [DOCA Installation Guide](#) for details on how to install BlueField related software.
2. The IPS application binary is located under `/opt/mellanox/doca/examples/ips/bin/doca_ips`.
3. To rebuild the application:

a). Run:

```
cd /opt/mellanox/doca/examples/ips/src
meson /tmp/build
ninja -C /tmp/build
```

`doca_ips` is created under `/tmp/build`.

b). The build process depends on the `PKG_CONFIG_PATH` environment variable to locate the DPDK libraries. If the variable accidentally gets corrupted and the build fails, run the following command:

► For Ubuntu:

```
export PKG_CONFIG_PATH=$PKG_CONFIG_PATH:/opt/mellanox/dpdk/lib/aarch64-linux-gnu/pkgconfig
```

► For CentOS:

```
export PKG_CONFIG_PATH=$PKG_CONFIG_PATH:/opt/mellanox/dpdk/lib64/pkgconfig
```

4. Pre-run setup

a). The IPS example is based on DPDK libraries. Therefore, the user is required to provide DPDK flags and allocate huge pages. Run:

```
echo 2048 > /sys/kernel/mm/hugepages/hugepages-2048kB/nr_hugepages
```

b). Make sure the RegEx engine is active:

```
systemctl status mlx-regex
```

If the status is inactive (Active: failed), run:

```
systemctl start mlx-regex
```

5. To run the application:

```
Usage: doca_ips [DPDK Flags] -- [DOCA Flags] [Program Flags]
```

DOCA Flags:

<code>-h, --help</code>	Print a help synopsis
<code>-l, --log-level</code>	Set the log level for the app <CRITICAL=0, DEBUG=4>

Program Flags:

<code>-p, --print-match</code>	Prints FID when matched in DPI engine
--------------------------------	---------------------------------------

```
-n, --netflow          Collect netflow statistics and send according to
conf file
-o, --output-csv <path> Path to the output of the CSV file
-c, --cdo <path>      Path to CDO file compiled from a valid PDD
```

For example:

```
/opt/mellanox/doca/examples/ips/bin/doca_ips -a 0000:03:00.0,class=regex -a
auxiliary:mlx5_core.sf.4,sft_en=1 -a auxiliary:mlx5_core.sf.5,sft_en=1 -- --
cdo /root/ips.cdo -p -n
```



**Note:** The SFT supports a maximum of 64 queues. Therefore, the application cannot be run with more than 64 cores. To limit the number of cores, run:

```
/opt/mellanox/doca/examples/ips/bin/doca_ips -a 0000:03:00.0,class=regex -
a auxiliary:mlx5_core.sf.4,sft_en=1 -a auxiliary:mlx5_core.sf.5,sft_en=1 -
l 0-64 -- --cdo /root/ips.cdo -p -n
```

This limits the application to use 65 cores (core-0 to core-64). That is 1 core for the main thread and 64 cores to serve as workers.

Using a JSON file:

```
doca_ips --json [json_file]
```

For example:

```
/opt/mellanox/doca/examples/ips/bin/doca_ips --json /root/ips_params.json
```



**Note:** Sub-functions must be enabled according to [Scalable Function Setup Guide](#).



**Note:** The flags `-a 0000:03:00.0,class=regex -a auxiliary:mlx5_core.sf.4,sft_en=1 -a auxiliary:mlx5_core.sf.5,sft_en=1` are necessary for proper usage of the application. Modifying these flags results in unexpected behavior as only 2 ports are supported. The SF numbers are arbitrary and configurable. The RegEx device, however, is not and must be initiated on port 0.

For additional information on available flags for DPDK, use `-h` before the `--separator`:

```
/opt/mellanox/doca/examples/ips/bin/doca_ips -h
```

For additional information on the app, use `-h` after the `-- separator`:

```
/opt/mellanox/doca/examples/ips/bin/doca_ips -- -h
```

# Chapter 6. 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
DPDK Flags	a	devices	Adds a PCIe device into the list of devices to probe	<pre>"devices": [   {"device": "regex", "id": "00"},   {"device": "sf", "id": "4", "s true},   {"device": "sf", "id": "5", "s true}, ]</pre>
	l	core-list	Lists cores to run on	<pre>"core- list": "0-4"</pre>
General Flags	l	log-level	Sets the log level for the application: <ul style="list-style-type: none"> <li>▶ CRITICAL=0</li> <li>▶ ERROR=1</li> <li>▶ WARNING=2</li> <li>▶ INFO=3</li> <li>▶ DEBUG=4</li> </ul>	<pre>"log-level": 4</pre>
	h	help	Prints a help synopsis	N/A
Program Flags	p	print-match	Prints FID when matched in DPI engine	<pre>"print-match": true</pre>
	n	netflow	Collects netflow statistics and	<pre>"netflow": false</pre>

Flag Type	Short Flag	Long Flag/JSON Key	Description	JSON Content
			sends according to .conf file	
	o	output-csv	Path to the output of the CSV file	<code>"output-csv": "/tmp/ips_stats.csv"</code>
	c	cdo	Path to CDO file compiled from a valid PDD	<code>"cdo": "/tmp/ips.cdo"</code>

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# Chapter 7. Running Application on Host

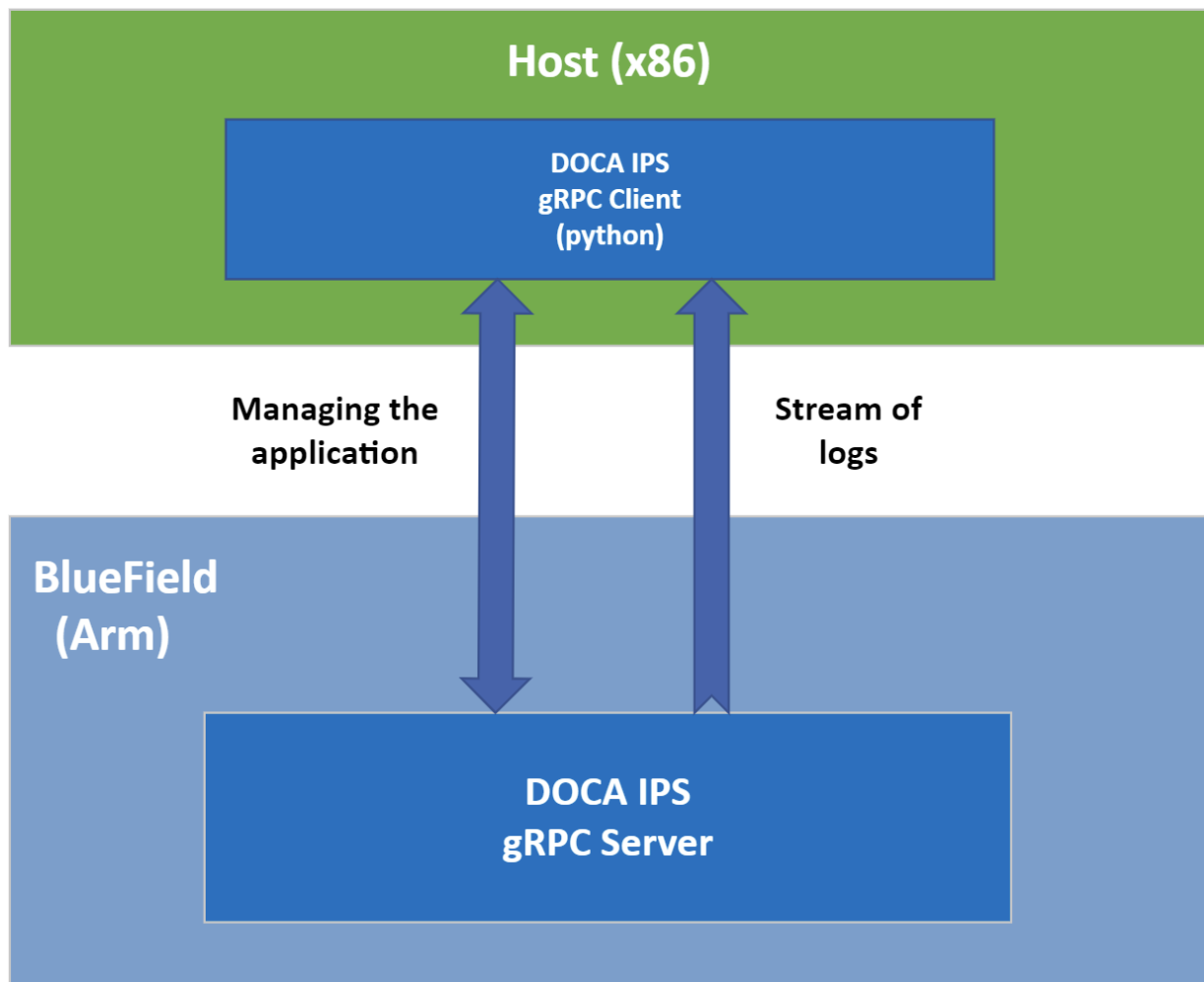
Host execution example:

```
cd /opt/mellanox/doca/examples/ips/  
./doca_ips#-a 0000:21:00.0,class=regex -a 0000:21:00.3 -a 0000:21:00.4 -- --cdo ~/ips.cdo
```

Refer to section "Running DOCA Application on Host" in [NVIDIA DOCA Virtual Functions User Guide](#).

# Chapter 8. Managing gRPC-Enabled Application from Host

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



To run the Python client of the gRPC-enabled application:

```
./doca_ips_gRPC_client.py -d/--debug <server address[:server port]>
```

For example:

```
/opt/mellanox/doca/examples/ips/bin/grpc/client/doca_ips_gRPC_client.py  
192.168.104.2
```



**Note:** Refer to known issue 2872829 in [NVIDIA DOCA Release Notes](#) regarding the deployment of the gRPC enabled application using the DOCA gRPC orchestrator.



**Note:** Please refer to known issue 2872883 in [NVIDIA DOCA Release Notes](#) regarding the execution of the gRPC python client.

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# Chapter 9. Deploying Containerized Application

The IPS example supports a container-based deployment. Refer to the [NVIDIA DOCA Container Deployment Guide](#) for more information.

Application-specific configuration steps may be found on NGC under the application's [container page](#).



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## Chapter 10. References

- ▶ `/opt/mellanox/doca/examples/ips/src/ips.c`
- ▶ `/opt/mellanox/doca/examples/ips/src/grpc/ips.proto`
- ▶ `/opt/mellanox/doca/examples/ips/bin/ips_suricata_rules_example`

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