NVIDIA DOCA Flow Inspector Service

Guide

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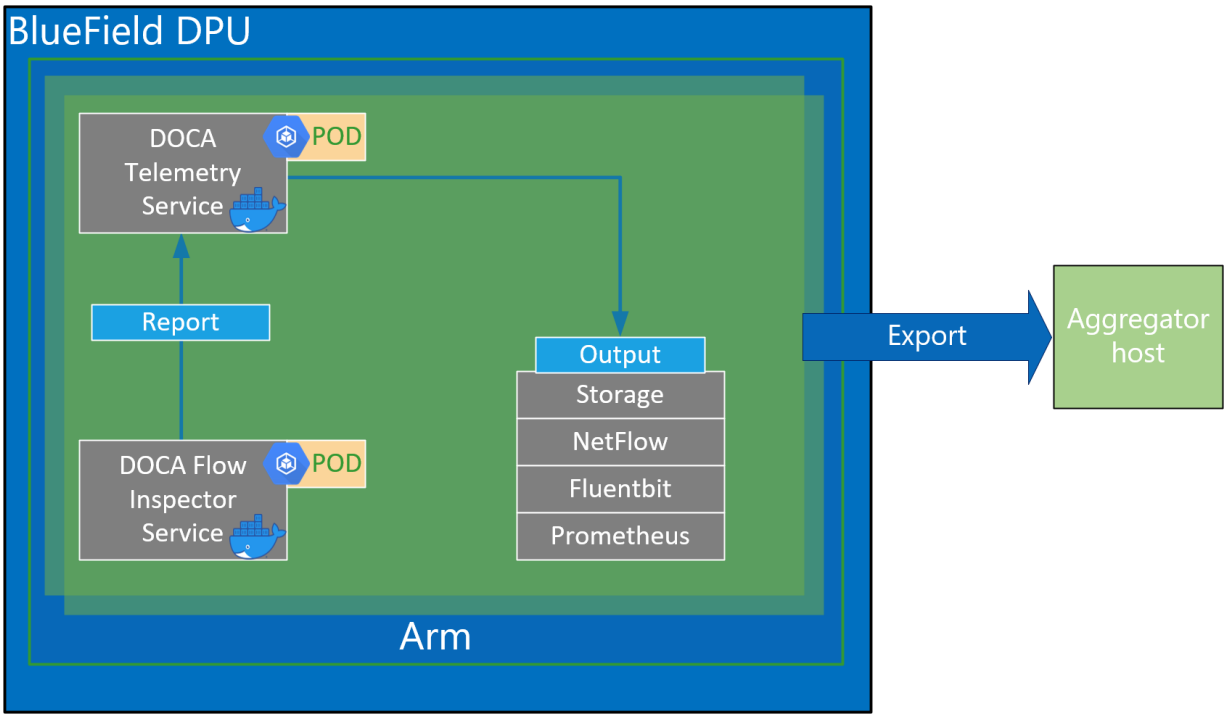
Chapter 1. Introduction

DOCA Flow Inspector service allows monitoring real-time data and extraction of telemetry components which can be utilized by various services for security, big data, and other purposes.

DOCA Flow Inspector service is linked to DOCA Telemetry Service (DTS). DOCA Flow Inspector receives mirrored packets from the user and parses and forwards the data to the DTS which gathers predefined statistics forwarded by various providers/sources. DOCA Flow Inspector uses the DOCA Telemetry API to communicate with the DTS while the DPDK infrastructure allows acquiring packets at a user-space layer.

DOCA Flow Inspector runs inside of its own Kubernetes pod on BlueField and is intended to receive mirrored packets for analysis. The packets received are parsed and sent, in a predefined struct, to a telemetry collector which manages the rest of the telemetry aspects.



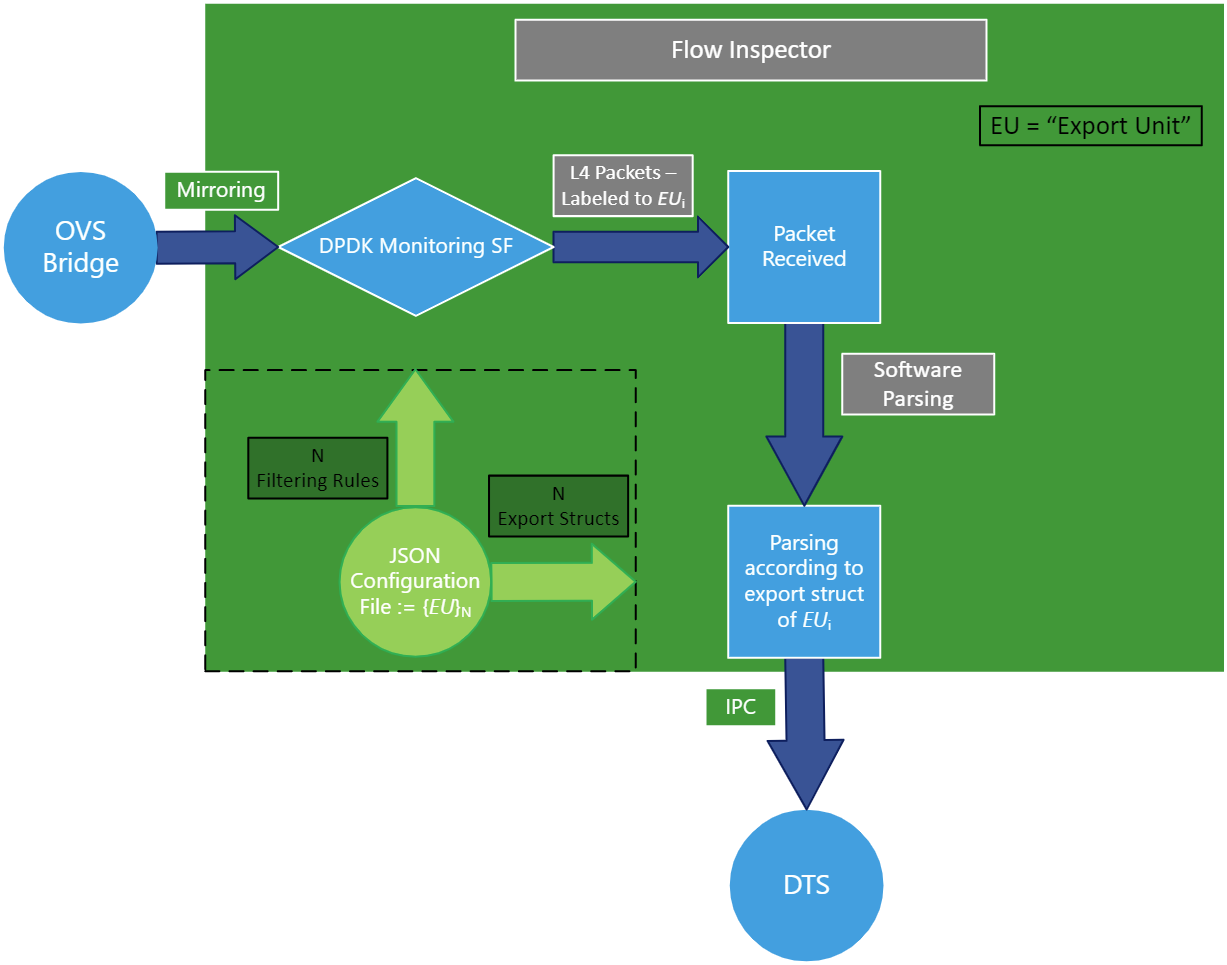
1.1. Service Flow

DOCA Flow Inspector receives a configuration file in a JSON format indicating which of the mirrored packets should be filtered out based on the L4 network header.

The configuration file can include several "export units". Each one is comprised of a "filter" and an "export". Each packet that matches one filter (based on the protocol and ports in the L4 header) is then parsed to the corresponding requested struct defined in the export. That information only is sent for inspection. A packet that does not match any filter is dropped. See JSON format and example in the Configuration section.

In addition, the service watches for changes in the JSON configuration file in runtime and for any change that reconfigures the service.

The DOCA Flow Inspector runs on top of DPDK to acquire L4. The packets are then filtered and HW-marked with their export unit index. The packets are then parsed according to their export unit and export struct, and then forwarded to the telemetry collector using IPC.



Configuration phase:

1. A JSON file is used as input to configure the export units (i.e., filters and corresponding export structs).
2. The filters are translated to HW rules on the SF (scalable function port) using the DOCA Flow library.
3. The connection to the telemetry collector is initialized and all export structures are registered to DTS.

Inspection phase:

1. Traffic is mirrored to the relevant SF.
2. Ingress traffic is received through the configured SF.
3. Non-L4 traffic and packets that do not match any filter are dropped using hardware rules.
4. Packets matching a filter are marked with the export unit index they match and are passed to the software layer in the Arm cores.
5. Packets are parsed to the desired struct by the index of export unit.
6. The telemetry information is forwarded to the telemetry agent using IPC.
7. Mirrored packets are freed.
8. If the JSON file is changed, run the configuration phase with the updated file.

Chapter 2. Requirements

DOCA Flow Inspector service must be used with DTS of the same DOCA version.

Before deploying the flow inspector container, ensure that the following prerequisites are satisfied:

1. Create the needed files and directories.

   Folders should be created automatically. Make sure the `.json` file resides inside the folder:

   ```
   $ touch /opt/mellanox/doca/services/flow_inspector/bin/flow_inspector_cfg.json
   ```

   Validate that DTS's configuration folders exist. They should be created automatically when DTS is deployed.

   ```
   $ sudo mkdir -p /opt/mellanox/doca/services/telemetry/config
   $ sudo mkdir -p /opt/mellanox/doca/services/telemetry/ipc_sockets
   $ sudo mkdir -p /opt/mellanox/doca/services/telemetry/data
   ```

2. Allocate hugepages.

   Allocated huge pages as needed by DPDK. This requires root privileges.

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

   Or alternatively:

   ```
   $ sudo echo '2048' | sudo tee -a /sys/kernel/mm/hugepages/hugepages-2048kB/
   nr_hugepages
   $ sudo mkdir /mnt/huge
   $ sudo mount -t hugetlbfs nodev /mnt/huge
   ```

   Deploy a scalable function according to Scalable Function Setup Guide and mirror packets accordingly using the Open vSwitch command.

   For example:

   a). Mirror packets from `p0` to `sf0`:

   ```
   $ ovs-vsctl add-br ovsbr1
   $ ovs-vsctl add-port ovsbr1 p0
   $ ovs-vsctl add-port ovsbr1 en3f0pf0sf0
   $ ovs-vsctl -- --id=@p1 get port en3f0pf0sf0 \
               -- --id=@p2 get port p0 \
               -- --id=@m create mirror name=m0 select-dst-port=@p2 select-src-
   port=@p2 output-port=@p1 \
               -- set bridge ovsbr1 mirrors=@m
   ```

   b). Mirror packets from `pf0hpf` to `sf0`:

   ```
   $ ovs-vsctl add-br ovsbr1
   $ ovs-vsctl add-port ovsbr1 pf0hpf
   $ ovs-vsctl add-port ovsbr1 en3f0pf0sf0
   $ ovs-vsctl -- --id=@p1 get port en3f0pf0sf0 \
               -- --id=@p2 get port pf0hpf \
   ```

```
            -- --id=@m create mirror name=m0 select-dst-port=@p2 select-src-
port=@p2 output-port=@p1 \
            -- set bridge ovsbr1 mirrors=@m
```

The output of last command should be in the following format:

```
exp: 0d248ca8-66af-427c-b600-af1e286056e1
```

Note: The designated SF must be created as a trusted function. Additional details can be found in the Scalable Function Setup Guide.

Chapter 3. Service Deployment

For information about the deployment of DOCA containers on top of the BlueField DPU, refer to NVIDIA DOCA Container Deployment Guide.

DTS is available on NGC, NVIDIA's container catalog. Service-specific configuration steps and deployment instructions can be found under the service's container page.

Chapter 4. Configuration

4.1. JSON Input

The flow inspector configuration file should be placed under `/opt/mellanox/doca/services/flow_inspector/bin/<json_file_name>.json` and be built in the following format:

```
[
    {
    # Export Unit:
        "filter":
        {
            "protocols": [<L4 protocols separated by comma>], # What L4 protocols
 are allowed
            "ports":                                          # What L4 port ranges
 are allowed [src,dst]
                [
                    [<source port>, <destination port>],
                    [<source ports range>, <destination ports range>],
                    <... more pairs of source, dest ports>
                ]
        },
        "export":
        {
            "fields": [<fields to be part of export struct, separated by comma>] #
 the Telemetry event will contain these fields.
        }
    },

    <... More Export Units>
]
```

Allowed protocols:

- `TCP`
- `UDP`

Port range:

- It is possible to insert a range of ports for both source and destination
- Range should include borders `[start_port-end_port]`

Allowed ports:

- All ports in range `0-65535` as a string

- Or * to indicate any port

Allowed fields in export struct:

timestamp
Timestamp indicating when it was received by the service.

host_ip
The IP of the host running the service

src_mac
Source MAC address

dst_mac
Destination MAC address

src_ip
Source IP

dst_ip
Destination IP

protocol
L4 protocol

src_port
Source port

dst_port
Destination port

flags
Additional flags (relevant to TCP only)

data_len
Data payload length

data_short
Short version of data (payload sliced to first 64 bytes)

data_medium
Medium version of data (payload sliced to first 1500 bytes)

data_long
Long version of data (payload sliced to first 9*1024 bytes)

JSON example:

```
[
    /* Export Unit 0 */
    {          "filter":
        {              "protocols": ["udp"],             # What L4 protocols are
 allowed
               "ports":                                  # What L4 port ranges are
 allowed
                 [
                     ["*","433-460"],                    # In this case, "*" stands
 for all source ports and dst port in range of [433-460]
                     ["20480","28341"]                   # src port 20480, dst port
 28341
                 ]
        },          "export":
        {             "fields": ["timestamp", "src_mac", "dst_mac", "protocol",
 "data_len", "data_long"]
        }
    },

    /* Export Unit 1 */
    {          "filter":
        {              "protocols": ["tcp"],
               "ports":
```

```
                [
                    ["5-10","422"]
                ]
        },          "export":
        {              "fields": ["timestamp", "host_ip", "src_ip", "dst_ip",
 "data_len", "data_short"]
        }
    }
]
```

Note: If a packet contains L4 ports which are not specified in the file, it is filtered out.

Note: The JSON file can be changed during runtime. The new configuration is applied in less than 60 seconds. This time period can be changed using the `-t` flag (see section Yaml File).

4.2. Yaml File

The `.yaml` file downloaded from NGC can be easily edited according to your needs.

```
env:
  # Set according to the local setup
  - name: SF_NUM_1
    value: "2"
  # Additional EAL flags, if needed
  - name: EAL_FLAGS
    value: ""
  # Service-Specific command line arguments
  - name: SERVICE_ARGS
    value: "--policy /flow_inspector/flow_inspector_cfg.json -l 60"
```

- The `SF_NUM_1` value can be changed according to the SF used in the OVS configuration and can be found using the command in Scalable Function Setup Guide.
- The `EAL_FLAGS` value must be changed according to the DPDK flags required when running the container.
- The `SERVICE_ARGS` are the runtime arguments received by the service:
  - `-l, --log-level <value>` – sets the log level (CRITICAL=20, ERROR=30, WARNING=40, INFO=50, DEBUG=60)
  - `-p, --policy <json_path>` – sets the JSON path inside the container
  - `-t, --time <seconds>` – time period to check for changes in JSON config file (default is 60 seconds)

4.3. Verifying Output

Enabling write to data in the DTS allows debugging the validity of DOCA Flow Inspector.

Uncomment the following line in `/opt/mellanox/doca/services/telemetry/config/dts_config.ini`:

```
#output=/data
```

Note: Any changes in `dts_config.ini` necessitate restarting the pod for the new settings to apply.

The schema folder contains JSON-formatted metadata files which allow reading the binary files containing the actual data. The binary files are written according to the naming convention shown in the following example:

Note: Requires installing the `tree` runtime utility (`apt install tree`).

```
$ tree /opt/mellanox/doca/services/telemetry/data/
/opt/mellanox/doca/services/telemetry/data/
├── {year}
│   └── {mmdd}
│       └── {hash}
│           ├── {source_id}
│           │   └── {source_tag}{timestamp}.bin
│           └── {another_source_id}
│               └── {another_source_tag}{timestamp}.bin
└── schema
    └── schema_{MD5_digest}.json
```

New binary files appear when:

- The service starts
- When the binary file's max age/size restriction is reached
- When JSON file is changed and new schemas of telemetry are created
- An hour passes

If no schema or no data folders are present, refer to the Troubleshooting section in the NVIDIA DOCA Telemetry Service Guide.

Note: `source_id` is usually set to the machine hostname. `source_tag` is a line describing the collected counters, and it is often set as the provider's name or name of user-counters.

Reading the binary data can be done from within the DTS container using the following command:

```
crictl exec -it <Container ID> /opt/mellanox/collectx/bin/clx_read -s /data/schema /data/path/to/datafile.bin
```

The data written locally should be shown in the following format assuming a packet matching Export Unit 1 from the example has arrived:

```
{
    "timestamp": 1656427771076130,
    "host_ip": "10.237.69.238",
    "src_ip": "11.7.62.4",
    "dst_ip": "11.7.62.5",
    "data_len": 1152,
    "data_short": "Hello World"
}
```

Chapter 5. Troubleshooting

Refer to the Troubleshootings section in NVIDIA DOCA Container Deployment Guide and NVIDIA DOCA Telemetry Service Guide.

Additional notes:

- Make sure hugepages are allocated (step 2 under Requirements)
- Validate the JSON file and port config
- When running both containers, you must first run DOCA Telemetry Service, wait a few seconds, and then run DOCA Flow Inspector.

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