NVIDIA DOCA Telemetry Service

Guide

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Chapter 1. Introduction

DOCA Telemetry Service (DTS) collects data from built-in providers and from external telemetry applications. The following 3 providers are available:

- sysfs
- ethtool
- tc (traffic controll)

Note: Sysfs provider is enabled by default.

DTS stores collected data into binary files under the `/opt/mellanox/doca/services/telemetry/data` directory. Data write is disabled by default due to BlueField storage restrictions.

DTS can export the data via Prometheus Endpoint (pull) or Fluent Bit (push).

DTS allows exporting NetFlow packets when data is collected from the DOCA Telemetry NetFlow API client application. NetFlow exporter is enabled from `dts_config.ini` by setting NetFlow collector IP/address and port.

Chapter 2. Service Deployment

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

2.1. DOCA Service on NGC

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.

2.2. Default Deployment – BlueField OS

DTS service starts automatically on BlueField boot according to the `.yaml` file located at `/etc/kubelet.d/doca_telemetry_standalone.yaml`. Removing the `.yaml` file from this path stops the automatic DTS boot.

DTS files can be found under the directory `/opt/mellanox/doca/services/telemetry/`.

- Container folder mounts:
  - `config`
  - `data`
  - `ipc_sockets`
- Backup files:
  - `doca_telemetry_service_${version}_arm64.tar.gz` – DTS image
  - `doca_telemetry_standalone.yaml` – copy of the default boot `.yaml` file

Chapter 3. Configuration

The configuration of DTS is placed under `/opt/mellanox/doca/services/telemetry/config` by DTS during initialization. The user can interact with the `dts_config.ini` file and `fluent_bit_configs` folder. `dts_config.ini` contains the main configuration for the service and must be used to enable/disable providers, exporters, data writing. More details are provided in the corresponding sections. For every update in this file, DST must be restarted. Interaction with `fluent_bit_configs` folder is described in section Fluent Bit.

3.1. Init Scripts

The `InitContainers` section of the `.yaml` file has 2 scripts for config initialization:

- `/usr/bin/telemetry-init.sh` – generates the default configuration files if, and only if, the `/opt/mellanox/doca/services/telemetry/config` folder is empty.
- `/usr/bin/enable-fluent-forward.sh` – configures the destination host and port for Fluent Bit forwarding. The script requires that both the host and port are present, and only in this case it would start. The script overwrites the `/opt/mellanox/doca/services/telemetry/config/fluent_bit_configs` folder and configures the `forward.exp` file. It inputs 3 arguments: `host`, `port`, and `data_set`. The `data_set` argument must be set to `all_data` which signifies no data filtering.

> **Note:** Not setting `data_set` argument filters out all data from the exporter.

3.2. Enabling Fluent Bit Forwarding

If enabling Fluent Bit forwarding is desired, add the destination host and port to the command line found in the `initContainers` section of the `.yaml` file:

```
command: ["/bin/bash/", "-c", /usr/bin/telemetry-init.sh && /usr/bin/enable-fluent-forward.sh 127.0.0.1 24224 0 all_data"]
```

> **Note:** The host and port shown above are just an example and `all_data` must be set as a 4th argument to allow data streaming. The 3rd parameter must be set to zero. See section Fluent Bit to learn about manual configuration.

3.3. Generating Configuration

The configuration folder `/opt/mellanox/doca/services/telemetry/config` starts empty by default. Once the service starts, the initial scripts run as a part of the initial container and create configuration as described in section Enabling Fluent Bit Forwarding.

3.4. Resetting Configuration

Resetting the configuration can be done by deleting the content found in the configuration folder and restarting the service to generate the default configuration.

3.5. Disabling Providers

Disabling a provider can be done using the `dts_config.ini` configuration file. Uncomment the `disable-provider=$provider-name` line to disable data collection for this provider. For example, uncommenting the following line disables the `ethtool` provider:

```
#disable-provider=ethtool
```

Note: More information about telemetry providers can be found under the Providers section.

3.6. Enabling Data Write

Uncomment the following line in `dts_config.ini`:

```
#output=/data
```

Note: Changes in `dts_config.ini` force the main DTS process to restart in 60 seconds to apply the new settings.

Chapter 4. Description

4.1. Providers

DTS supports on-board data collection from sysf, ethtool, and tc providers.

4.1.1. Sysfs Counters List

The sysfs provider has several components: ib_port, hw_port, mr_cache, and eth. By default, all the components are enabled when the provider is enabled:

```
#disable-provider=sysfs
```

The components can be disabled separately. For instance, to disable eth:

```
enable-provider=sysfs
disable-provider=sysfs.eth
```

Note: `ib_port` and `ib_hvw` are state counters which are collected per port. These counters are only collected for ports whose state is active.

- `ib_port` counters:

```
{hca_name}:{port_num}:ib_port_state
{hca_name}:{port_num}:VL15_dropped
{hca_name}:{port_num}:excessive_buffer_overrun_errors
{hca_name}:{port_num}:link_downed
{hca_name}:{port_num}:link_error_recovery
{hca_name}:{port_num}:local_link_integrity_errors
{hca_name}:{port_num}:multicast_rcv_packets
{hca_name}:{port_num}:multicast_xmit_packets
{hca_name}:{port_num}:port_rcv_constraint_errors
{hca_name}:{port_num}:port_rcv_data
{hca_name}:{port_num}:port_rcv_errors
{hca_name}:{port_num}:port_rcv_packets
{hca_name}:{port_num}:port_rcv_remote_physical_errors
{hca_name}:{port_num}:port_rcv_switch_relay_errors
{hca_name}:{port_num}:port_xmit_constraint_errors
{hca_name}:{port_num}:port_xmit_data
{hca_name}:{port_num}:port_xmit_discards
{hca_name}:{port_num}:port_xmit_packets
{hca_name}:{port_num}:port_xmit_wait
{hca_name}:{port_num}:symbol_error
{hca_name}:{port_num}:unicast_rcv_packets
{hca_name}:{port_num}:unicast_xmit_packets
```

- `ib_hw` counters:

```
{hca_name}:{port_num}:hw_state
```

```
{hca_name}:{port_num}:hw_duplicate_request
{hca_name}:{port_num}:hw_implied_nak_seq_err
{hca_name}:{port_num}:hw_lifespan
{hca_name}:{port_num}:hw_local_ack_timeout_err
{hca_name}:{port_num}:hw_out_of_buffer
{hca_name}:{port_num}:hw_out_of_sequence
{hca_name}:{port_num}:hw_packet_seq_err
{hca_name}:{port_num}:hw_req_cqe_error
{hca_name}:{port_num}:hw_req_cqe_flush_error
{hca_name}:{port_num}:hw_req_remote_access_errors
{hca_name}:{port_num}:hw_req_remote_invalid_request
{hca_name}:{port_num}:hw_resp_cqe_error
{hca_name}:{port_num}:hw_resp_cqe_flush_error
{hca_name}:{port_num}:hw_resp_local_length_error
{hca_name}:{port_num}:hw_resp_remote_access_errors
{hca_name}:{port_num}:hw_rnr_nak_retry_err
{hca_name}:{port_num}:hw_rx_atomic_requests
{hca_name}:{port_num}:hw_rx_dct_connect
{hca_name}:{port_num}:hw_rx_icrc_encapsulated
{hca_name}:{port_num}:hw_rx_read_requests
{hca_name}:{port_num}:hw_rx_write_requests
```

- `ib_mr_cache` counters:

  Note: `n` ranges from 0 to 24.

```
{hca_name}:mr_cache:size_{n}:cur
{hca_name}:mr_cache:size_{n}:limit
{hca_name}:mr_cache:size_{n}:miss
mlx5_0:mr_cache:size_{n}:size
```

- `eth` counters:

```
{hca_name}:{device_name}:eth_collisions
{hca_name}:{device_name}:eth_multicast
{hca_name}:{device_name}:eth_rx_bytes
{hca_name}:{device_name}:eth_rx_compressed
{hca_name}:{device_name}:eth_rx_crc_errors
{hca_name}:{device_name}:eth_rx_dropped
{hca_name}:{device_name}:eth_rx_errors
{hca_name}:{device_name}:eth_rx_fifo_errors
{hca_name}:{device_name}:eth_rx_frame_errors
{hca_name}:{device_name}:eth_rx_length_errors
{hca_name}:{device_name}:eth_rx_missed_errors
{hca_name}:{device_name}:eth_rx_nohandler
{hca_name}:{device_name}:eth_rx_over_errors
{hca_name}:{device_name}:eth_rx_packets
{hca_name}:{device_name}:eth_tx_aborted_errors
{hca_name}:{device_name}:eth_tx_bytes
{hca_name}:{device_name}:eth_tx_carrier_errors
{hca_name}:{device_name}:eth_tx_compressed
{hca_name}:{device_name}:eth_tx_dropped
{hca_name}:{device_name}:eth_tx_errors
{hca_name}:{device_name}:eth_tx_fifo_errors
{hca_name}:{device_name}:eth_tx_heartbeat_errors
{hca_name}:{device_name}:eth_tx_packets
{hca_name}:{device_name}:eth_tx_window_errors
```

4.1.2. Ethtool Counters

Ethtool counters is the generated list of counters which corresponds to Ethtool utility. Counters are generated on a per-device basis. See this community post for more information on mlx5 ethtool counters.

4.1.3. Traffic Control Info

The following TC objects are supported and reported regarding the ingress filters:

- Filters
  - flower
- Actions
  - mirred
  - tunnel_key

The info is provided as one of the following events:

- Basic filter event
- flower/ipv4 filter event
- flower/ipv6 filter event
- Basic action event
- mirred action event
- tunnel_key/ipv4 action event
- tunnel_key/ipv6 action event

General notes:

- Actions always belong to a filter, so action events share the filter event's ID via the `event_id` data member
- Basic filter event only contains textual *kind* (so users can see which real life objects' support they are lacking)
- Basic action event only contains textual *kind* and some basic common statistics if available

4.2. Data Outputs

DTS can send the collected data to the following outputs:

- Data writer (saves binary data to disk)
- Fluent Bit (push-model streaming)
- Prometheus endpoint (keeps the most recent data to be pulled).

4.2.1. Data Writer

The data writer is disabled by default to save space on BlueField. Steps for activating data write during debug can be found under section Enabling Data Write.

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 (`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 appears when the service starts or when binary file age/size restriction is reached. If no schema or no data folders are present, refer to the Troubleshooting section.

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
```

Note: The path to the data file must be an absolute path.

Example output:

```
{
    "timestamp": 1634815738799728,
    "event_number": 0,
    "iter_num": 0,
    "string_number": 0,
    "example_string": "example_str_1"
}
{
    "timestamp": 1634815738799768,
    "event_number": 1,
    "iter_num": 0,
    "string_number": 1,
    "example_string": "example_str_2"
}
…
```

4.2.2. Prometheus

The Prometheus endpoint keeps the most recent data to be pulled by the Prometheus server and is enabled by default.

To check that data is available, run the following command on BlueField:

```
curl -s http://0.0.0.0:9100/metrics
```

The command dumps every counter in the following format:

```
counter_name {list of label fields} counter_value timestamp
```

Note: The default port for Prometheus can be changed in `dts_config.ini`.

4.2.3. Configuration Details

Prometheus is configured as a part of `dts_config.ini`.

By default, the Prometheus HTTP endpoint is set to port 9100. Comment this line out to disable Prometheus export.

```
prometheus=http://0.0.0.0:9100
```

Prometheus can use the data field as an index to keep several data records with different index values. Index fields are added to Prometheus labels.

```
# Comma-separated counter set description for Prometheus indexing:
#prometheus-indexes=idx1,idx2

# Comma-separated fieldset description for prometheus indexing
#prometheus-fset-indexes=idx1,idx2
```

The default fset index is `device_name`. It allows Prometheus to keep ethtool data up for both the `p0` and `p1` devices.

```
prometheus-fset-indexes=device_name
```

If the fset index is not set, the data from `p1` overwrites `p0`'s data.

For quick name filtering, the Prometheus exporter supports being provided with a comma-separated list of counter names to be ignored:

```
#prometheus-ignore-names=counter_name1,counter_name_2
```

For quick filtering of data by tag, the Prometheus exporter supports being provided with a comma-separated list of data source tags to be ignored.

Users should add tags for all streaming data since the Prometheus exporter cannot be used for streaming. By default, `FI_metrics` are disabled.

```
prometheus-ignore-tags=FI_metrics
```

4.2.4. Fluent Bit

Fluent Bit allows streaming to multiple destinations. Destinations are configured in `.exp` files that are documented in-place and can be found under:

```
/opt/mellanox/doca/services/telemetry/config/fluent_bit_configs
```

Fluent Bit allows exporting data via "Forward" protocol which connects to the Fluent Bit/ FluentD instance on customer side.

Export can be enabled manually:

1. Uncomment the line with `fluent_bit_configs=` in `dts_config.ini`.
2. Set `enable=1` in required `.exp` files for the desired plugins.
3. Additional configurations can be set according to instructions in the `.exp` file if needed.
4. Restart the DTS.
5. Set up receiving instance of Fluent Bit/FluentD if needed.
6. See the data on the receiving side.

Export file destinations are set by configuring `.exp` files or creating new ones. It is recommended to start by going over documented example files. Documented examples exist for the following supported plugins:

- forward
- file
- stdout

Note: All `.exp` files are disabled by default if not configured by `initContainer` entry point through `.yaml` file.

Note: To forward the data to several destinations, create several `forward_{num}.exp` files. Each of these files must have their own destination host and port.

4.2.4.1. Export File Configuration Details

Each export destination has the following fields:

- `name` – configuration name
- `plugin_name` – Fluent Bit plugin name
- `enable` – 1 or 0 values to enable/disable this destination
- `host` – the host for Fluent Bit plugin
- `port` – port for Fluent Bit plugin
- `msgpack_data_layout` – the msgpacked data format. Default is `flb_std`. The other option is `custom`. See section Msgpack Data Layout for details.
- `plugin_key=val` – key-value pairs of Fluent Bit plugin parameter (optional)
- `counterset/fieldset` – file paths (optional). See details in section Cset/Fset Filtering.
- `source_tag=source_tag1,source_tag2` – comma separated list of data page source tags for filtering. The rest tags will be filtered out during export.

Note: Use `#` to comment a configuration line.

4.2.4.2. Msgpack Data Layout

Data layout can be configured using `.exp` files by setting `msgpack_data_layout=layout`. There are two available layouts: Standard and Custom.

The standard `flb_std` data layout is an array of 2 fields:

- timestamp double value
- a plain dictionary (key-value pairs)

The standard layout is appropriate for all Fluent Bit plugins. For example:

```
[timestamp_val, {"timestamp"->ts_val, type=>"counters/
events", "source"=>"source_val", "key_1"=>val_1, "key_2"=>val_2,...}]
```

The custom data layout is a dictionary of meta-fields and counter fields. Values are placed into a separate plain dictionary. Custom data format can be dumped with `stdout_raw` output plugin of Fluent-Bit installed, or can be forwarded with `forward` output plugin.

Counters example:

```
{"timestamp"=>timestamp_val, "type"=>"counters", "source"=>"source_val", "values"=>
 {"key_1"=>val_1, "key_2"=>val_2,...}}
```

Events example

```
{"timestamp"=>timestamp_val, "type"=>"events", "type_name"=>"type_name_val", "source"=>"
 source_val", "values"=>{"key_1"=>val_1, "key_2"=>val_2,...}}
```

4.2.4.3. Cset/Fset Filtering

Each export file can optionally use one cset and one fset file to filter UFM telemetry counters and events data.

- Cset file contains tokens per line to filter data with `"type"="counters"`.
- Fset contains several blocks started with the header line `[event_type_name]` and tokens under that header. An Fset file is used to filter data with `"type"="events"`.

> **Note:** Event type names could be prefixed to apply the same tokens to all fitting types. For example, to filter all ethtool events, use `[ethtool_event_*]`.

If several tokens must be matched simultaneously, use `<tok1>+<tok2>+<tok3>`. Exclusive tokens are available as well. For example, the line `<tok1>+<tok2>-<tok3>-<tok4>` filters names that match both tok1 and tok2 and do not match tok3 or tok4.

The following are the details of writing cset files:

```
# Put tokens on separate lines
# Tokens are the actual name 'fragments' to be matched
# port$ # match names ending with token "port"
# ^port # match names starting with token "port"
# ^port$ # include name that is exact token "port
# port+xmit # match names that contain both tokens "port" and "xmit"
# port-support # match names that contain the token "port" and do not match the "-"
 token "support"
#
# Tip: To disable counter export put a single token line that fits nothing
```

The following are the details of writing fset files:

```
# Put your events here
# Usage:
#
# [type_name_1]
# tokens
# [type_name_2]
# tokens
# [type_name_3]
# tokens
# ...
# Tokens are the actual name 'fragments' to be matched
# port$ # match names ending with token "port"
# ^port # match names starting with token "port"
# ^port$ # include name that is exact token "port
# port+xmit # match names that contain both tokens "port" and "xmit"
# port-support # match names that contain the token "port" and do not match the "-"
 token "support"

# The next example will export all the "tc" events and all events with type prefix
 "ethtool_" "ethtool" are filtered with token "port":
# [tc]
#
# [ethtool_*]
```

```
# packet

# To know which event type names are available check export and find field
 "type_name"=>"ethtool_event_p0"
# ...
# Corner cases:
# 1. Empty fset file will export all events.
# 2. Tokens written above/without [event_type] will be ignored.
# 3. If cannot open fset file, warning will be printed, all event types will be
 exported.
```

4.2.5. NetFlow Exporter

NetFlow exporter must be used when data is collected as NetFlow packets from the telemetry client applications. In this case, DOCA Telemetry NetFlow API sends NetFlow data packages to DTS via IPC. DTS uses NetFlow exporter to send data to the NetFlow collector (3rd party service).

To enable NetFlow exporter, set `netflow-collector-ip` and `netflow-collector-port` in `dts_config.ini`. `netflow-collector-ip` could be set either to IP or an address.

For additional information, refer to the `dts_config.ini` file.

Chapter 5. Troubleshooting

On top of the troubleshooting section found in the NVIDIA DOCA Container Deployment Guide, here are additional troubleshooting tips for DTS:

- For general troubleshooting, refer to the NVIDIA DOCA Troubleshooting Guide
- If the pod's state fails to be marked as "`Ready`", refer to the log `/var/log/syslog`.
- Check if the service is configured to write data to the disk, as this may cause the system to run out of disk space.
- If `/opt/mellanox/doca/services/telemetry/data folder` contains no schema or data folder, refer to the `clx.log` file:

  ```
  crictl exec -it <Container ID> cat /var/log/clx.log
  ```

  If the error `Failed to allocate data page od size 16384...` appears in the log, it signifies that the buffer size is not big enough to fit the data.

  ```
  [2021-07-22 12:42:26.675] [error][data_page] Failed to allocate data page of size
   16384 which is less then header size 720 + block size 30112
  [2021-07-22 12:42:26.675] [error] Data page allocation failed
  ```

  Increase the buffer size by modifying the buffer size line in the file:

  ```
  # vi /opt/mellanox/doca/services/telemetry/config/dts_config.ini
  ```

  Refresh the `.yaml` file and check the data using the tree command as shown earlier.
- If a PIC bus error occurs, configure the following files inside the container:

  ```
  crictl exec -it <Container ID> /bin/bash
  # Add to /config/clx.env the following line:
  "
  export UCX_TLS=tcp
  "
  ```

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