NVIDIA DOCA Simple Forward VNF

Application
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Chapter 1.  Introduction

Simple forward is a forwarding application that takes either VXLAN, GRE, or GTP traffic from a single RX port and transmits it on a single TX port.

For every packet received on an RX queue on a given port, DOCA Simple Forward checks the packet’s key, which consists of a 5-tuple. If it finds that the packet matches an existing flow, then it does not create a new one. Otherwise, a new flow is created with a FORWARDING component. Finally, the packet is forwarded to the TX queue of the egress port. Refer to Arg Parser DOCA Flags if “rx-only” mode is not set.

The FORWARDING component type depends on the flags delivered when running the application. For example, if the hairpin flag is provided, then the FORWARDING component would be hairpin. Otherwise, it would be RSS’d to software, and hence every VXLAN, GTP, or GRE packet would be received on RX queues.

Simple forward should be run with dual ports. By using a traffic generator, the RX port receives the VXLAN, GRE, or GTP packets and forwarding forwards them back to the traffic generator.
Chapter 2. System Design

The following diagram illustrates simple forward’s packet flows. It receives traffic coming from the wire and passes it to the other port.
Chapter 3. Application Architecture

Simple forward first initializes DPDK, after which the application handles the incoming packets.

The following diagram illustrates the initialization process.

1. Init_DPDK – EAL init, parse argument from command line and register signal.
2. Start port – mbuf_create, dev_configure, rx/tx/hairpin queue setup and start the port.
3. Simple_fwd INIT – create flow tables, build default forward pipes.

The following diagram illustrates how to process the packet.

1. Based on the packet’s info, find the key values (e.g. src/dst IP, src/dst port, etc).
2. Traverse the inner flow tables, check if the keys exist or not.
   ▶ If yes, update inner counter
   ▶ If no, a new flow table is added and new pipes are configured on the DPU
3. Forward the packet to the other port.
Chapter 4. DOCA Libraries

This application leverages the DOCA Flow Library.
Chapter 5. Configuration Flow

1. Parse application argument.
   doca_argp_init();
   a). Initialize arg parser resources.
   b). Register DOCA general flags.
      register_simple_fwd_params();
   c). Register application flags.
      doca_argp_start();
   d). Parse DPDK flags and invoke handler for calling the rte_eal_init() function.
   e). Parse app flags.

2. DPDK initialization.
   dpdk_init();
   Calls rte_eal_init() to initialize EAL resources with the provided EAL flags.

3. DPDK port initialization and start.
   dpdk_queues_and_ports_init();
   a). Initialize DPDK ports.
   b). Create mbuf pool using rte_pktmbuf_pool_create
   c). Driver initialization – use rte_eth_dev_configure to configure the number of queues
   d). Rx/Tx queue initialization – use rte_eth_rx_queue_setup and
      rte_eth_tx_queue_setup to initialize the queues
   e). Rx hairpin queue initialization – use rte_eth_rx_hairpin_queue_setup to initialize
      the queues
   f). Start the port using rte_eth_dev_start

4. Simple forward initialization.
   simple_fwd_init();
   a). simple_fwd_create_ins - create flow tables using simple_fwd_ft_create
   b). simple_fwd_init_ports_and_pipes - initialize DOCA port using
      simple_fwd_init_doca_port and build default pipes for each port.

5. Main loop.
   simple_fwd_process_pkts();
   a). Receive packets using rte_eth_rx_burst in a loop
   b). Process packets using simple_fwd_process_offload
Configuration Flow

NVIDIA DOCA Simple Forward VNF

   ```c
   simple_fwd_process_offload();
   ```
   a). Parse the packet’s `rte_mbuf` using `simple_fwd_pkt_info`.
   b). Handle the packet using `simple_fwd_handle_packet`. If the packet’s key does not match the existed the flow entry, create a new flow entry and PIPE using `simple_fwd_handle_new_flow`. Otherwise, increase the total packet’s counter.

7. Simple forward destroy.
   ```c
   simple_fwd_destroy();
   ```
   Simple forward closes port and cleans the flow resources.

8. DPDK ports and queues destruction.
   ```c
   dpdk_queues_and_ports_fini();
   ```

9. DPDK finish.
   ```c
   dpdk_fini();
   ```
   Calls `rte_eal_destroy()` to destroy initialized EAL resources.

10. Arg parser destroy.
    ```c
    doca_argp_destroy();
    ```
    ▶ Free DPDK resources by call `rte_eal_cleanup()` function.
Chapter 6. Running Application

1. Refer to the following documents:
   - NVIDIA DOCA Installation Guide 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.

2. The simple forward binary is located under /opt/mellanox/doca/applications/simple_fwd_vnf/bin/doeca_simple_fwd_vnf. To build all the applications together, run:
   ```bash
   cd /opt/mellanox/doca/applications/
   meson build
   ninja -C build
   ```

3. To build the simple forward sample only:
   a). Edit the following flags in /opt/mellanox/doca/applications/meson_option.txt:
      - Set enable_all_applications to false
      - Set enable_simple_fwd_vnf to true
   b). Run the commands in step 2.

   Note: doca_simple_fwd_vnf is created under ./build/simple_fwd_vnf/src/

Application usage:
Usage: doca_simple_forward_vnf [DPDK Flags] -- [DOCA Flags] [Program Flags]
DOCA Flags:
- -h, --help
- -v, --version
- -l, --log-level
  - Set the log level for the app <CRITICAL=0, DEBUG=4>
Program Flags:
- -t, --stats-timer <time>
  - Set interval to dump stats information
- -q, --nr-queues <num>
  - Set queues number
- -r, --rx-only
  - Set rx only
- -o, --hw-offload
  - Set hw offload
- -hq, --hairping
  - Set forwarding to hairpin queue
4. Running the application on BlueField:

- Pre-run setup:

  The simple forward example is based on DPDK libraries. Therefore, the user is required to provide DPDK flags, and allocate huge pages.

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

- CLI example for running the app:

  ```bash
  /opt/mellanox/doca/applications/simple_fwd_vnf/bin/doca_simple_fwd_vnf -a auxiliary:mlx5_core.sf.4 -a auxiliary:mlx5_core.sf.5 -- -l 4
  ```

  **Note:** The flag `-a auxiliary:mlx5_core.sf.4 -a auxiliary:mlx5_core.sf.5` is mandatory for proper usage of the application. Modifying this flag results unexpected behavior as only 2 ports are supported. The SF number is arbitrary and configurable.

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

  Before creating SFs on a specific physical port, it is important to verify the encap mode on the respective PF FDB. The default mode is basic. To check the encap mode, run:

  ```bash
  cat /sys/class/net/p0/compat/devlink/encap
  ```

  In this case, disable encap on the PF FDB before creating the SFs by running:

  ```bash
  /opt/mellanox/iproute2/sbin/devlink dev eswitch set pci/0000:03:00.0 mode legacy
  /opt/mellanox/iproute2/sbin/devlink dev eswitch set pci/0000:03:00.1 mode legacy
  echo none > /sys/class/net/p0/compat/devlink/encap
  echo none > /sys/class/net/p1/compat/devlink/encap
  /opt/mellanox/iproute2/sbin/devlink dev eswitch set pci/0000:03:00.0 mode switchdev
  /opt/mellanox/iproute2/sbin/devlink dev eswitch set pci/0000:03:00.1 mode switchdev
  ```

  **Note:** If the encap mode is set to `basic` then the application fails upon initialization.

5. Running the application on the host, CLI example:

  ```bash
  /opt/mellanox/doca/applications/simple_fwd_vnf/bin/doca_simple_fwd_vnf -a 04:00.3 -a 04:00.4 -- -l 4
  ```

  **Note:** Refer to section “Running DOCA Application on Host” in [NVIDIA DOCA Virtual Functions User Guide](#).

6. To run `doca_simple_fwd_vnf` using a JSON file:

   ```bash
   doca_simple_fwd_vnf --json [json_file]
   ```

   For example:

   ```bash
   cd /opt/mellanox/doca/applications/simple_fwd_vnf/bin
   ```
./doca_simple_fwd_vnf --json simple_fwd_params.json
Chapter 7. Arg Parser DOCA Flags

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

<table>
<thead>
<tr>
<th>Flag Type</th>
<th>Short Flag</th>
<th>Long Flag/JSON Key</th>
<th>Description</th>
<th>JSON Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPDK Flags</td>
<td>a</td>
<td>devices</td>
<td>Add a PCIe device into the list of devices to probe.</td>
<td>&quot;devices&quot;: [</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>{&quot;device&quot;: &quot;sf&quot;, &quot;id&quot;: &quot;4&quot;, &quot;sft&quot;: true},</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>{&quot;device&quot;: &quot;sf&quot;, &quot;id&quot;: &quot;5&quot;, &quot;sft&quot;: true},</td>
</tr>
<tr>
<td>General Flags</td>
<td>l</td>
<td>log-level</td>
<td>Set the log level for the application:</td>
<td>&quot;log-level&quot;: 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>► CRITICAL=0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>► ERROR=1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>► WARNING=2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>► INFO=3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>► DEBUG=4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>v</td>
<td>version</td>
<td>Print program version information.</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>h</td>
<td>help</td>
<td>Print a help synopsis.</td>
<td>N/A</td>
</tr>
<tr>
<td>Program Flags</td>
<td>t</td>
<td>stats-timer</td>
<td>Set interval to dump stats information.</td>
<td>&quot;stats-timer&quot;: 2</td>
</tr>
<tr>
<td></td>
<td>q</td>
<td>nr-queues</td>
<td>Set queues number.</td>
<td>&quot;nr-queues&quot;: 4</td>
</tr>
<tr>
<td></td>
<td>r</td>
<td>rx-only</td>
<td>Set RX only. When set, the packets</td>
<td>&quot;rx-only&quot;: false</td>
</tr>
<tr>
<td>Flag Type</td>
<td>Short Flag</td>
<td>Long Flag/JSON Key</td>
<td>Description</td>
<td>JSON Content</td>
</tr>
<tr>
<td>-----------</td>
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<td>-------------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>will not be sent to the TX queues.</td>
<td></td>
</tr>
<tr>
<td>o</td>
<td>hw-offload</td>
<td></td>
<td>Set HW offload of the RXP engine to use.</td>
<td>&quot;hw-offload&quot;: false</td>
</tr>
<tr>
<td>hq</td>
<td>hairping</td>
<td></td>
<td>Set forwarding to hairpin queue.</td>
<td>&quot;hairping&quot;: false</td>
</tr>
<tr>
<td>a</td>
<td>age-thread</td>
<td></td>
<td>Start a dedicated thread that handles the aged flows.</td>
<td>&quot;age-thread&quot;: false</td>
</tr>
</tbody>
</table>
Chapter 8. References

- /opt/mellanox/doca/applications/simple_fwd_vnf/src/simple_fwd_vnf.c
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