NVIDIA DOCA URL Filter

Reference App

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Chapter 1. Introduction

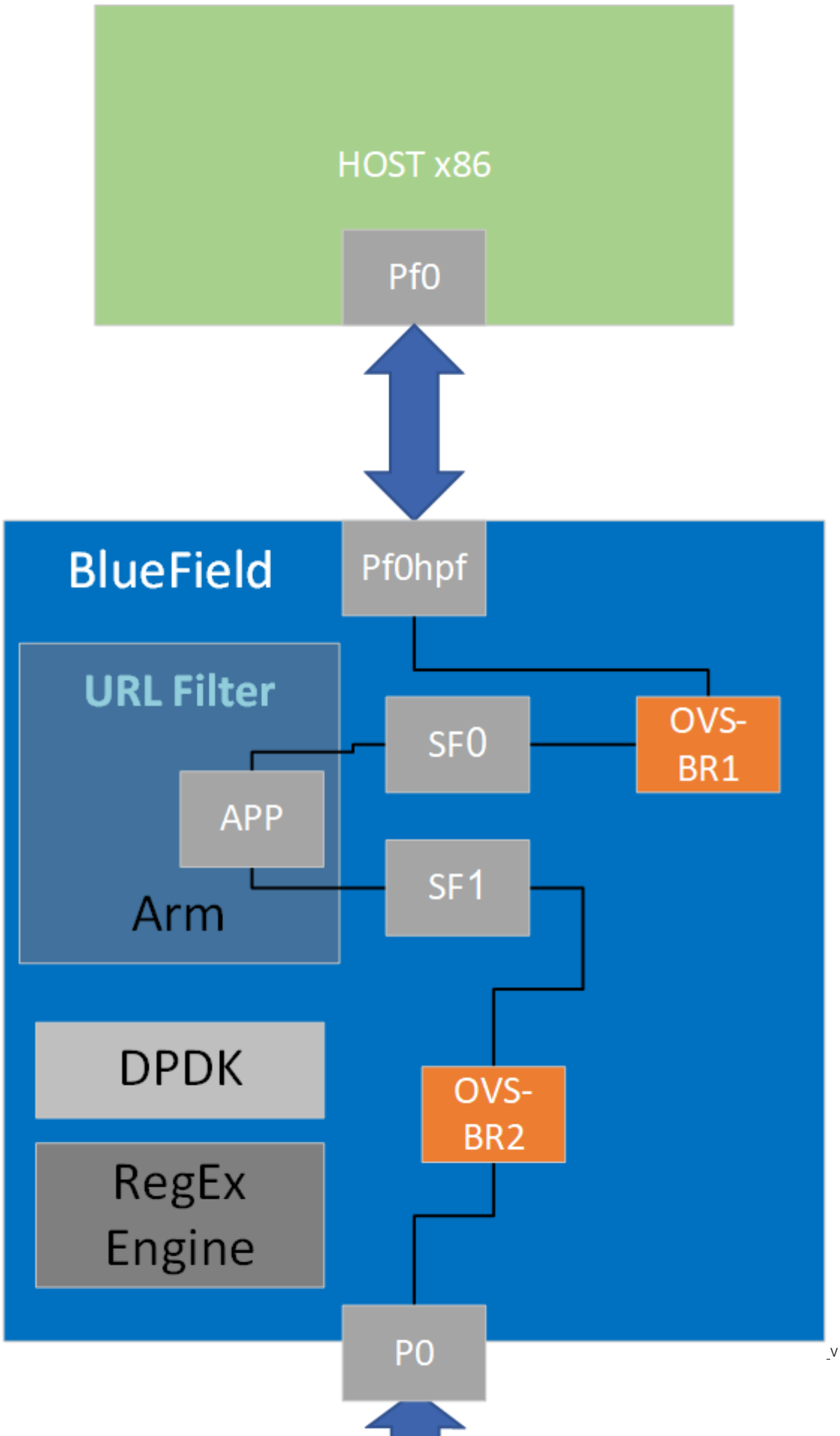
URL filtering limits access by comparing web traffic against a database to prevent user from different threats, malware and accessing harmful sites such as phishing pages.

This kind of content filtering can increase network security and enforce policies on different network resources.

Chapter 2. System Design

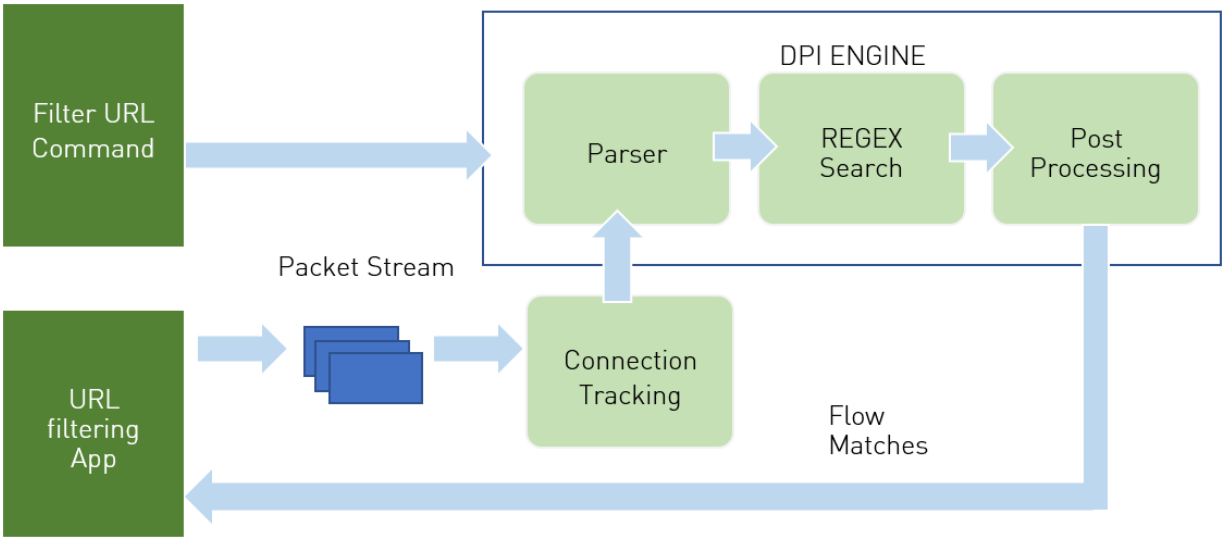
URL filtering is designed to run as "bump-on-the-wire" on the BlueField-2 instance. It intercepts traffic coming from the wire and passes it to the physical function (PF) representor connected to the host.

URL filter utilizes the SFT and RegEx engines which are HW accelerators on BlueField.


HOST x86
Pf0
BlueField
Pf0hpf
URL Filter
SF0
OVS-
BR1
APP
SF1
Arm
DPDK
OVS-
BR2
RegEx
Engine
P0

Chapter 3. Application Architecture

- User adds a URL using the URL command from the CLI. Available commands:
  - Create database – create DB of URLs to be filtered (also removes old signatures)
  - Filter http [MSG] [RegEx] – add specific URL/URL RegEx pattern to be filtered
    - MSG – user information for the URL filter
    - RegEx – can hold URL or RegEx pattern
  - Commit database [PATH] – compile and load signature database
- Ingress traffic is identified using the connection tracking module
- Traffic is scanned against compiled signature DB
- Post-processing is performed for match decision
- Matched flows are filtered and traffic is blocked



1. Signatures are compiled by the DPI compiler and are then loaded to the DPI engine.
2. Ingress traffic is identified and classified using the stateful table module in the DPDK libs which utilizes the connection tracking hardware offloads. This allows flow classifications

to be done at the hardware level and forwarded to a hairpin queue without being processed by the software, which increases performance dramatically.

3. Traffic is scanned against the DPI engine compiled signature DB.
4. Post-processing is performed for match decision.
5. Matched flows are identified and can be offloaded to the hardware to increase performance as not further inspection is needed.
6. Flow termination is done by the aging timer (set in the SFT to 60 seconds). When a flow is offloaded it cannot be tracked and destroyed.
7. Is it important to note that only sites that support non-encrypted HTTP traffic can be matched against signatures created by the URL filtering as it specifically targets the URI field in the HTTP request.

Chapter 4. Configuration Flow

1. DPDK initialization.
   ```
   dpdk_init(&argc, &argv, &nb_queues);
   ```
2. DPDK port initialization.
   ```
   dpdk_ports_init(nb_queues, nb_ports);
   ```
   a). Mempool allocation
   b). Port initialization
3. Stateful Flow Table (SFT).
   ```
   dpdk_sft_init(ar_config.ct, nb_queues, nb_ports);
   ```
   a). SFT initialization with the configurable parameters (CT on/off)
   b). Configure RTE flow to forward non-L4 traffic to hairpin queue and L4 traffic to SFT
   c). Configure RTE flow to forward matched traffic to hairpin queue
4. DPI initialization.
   ```
   doca_dpi_init(&doca_dpi_config);
   ```
   a). Configure RegEx engine
   b). Configure DPI queues
5. Configure DPI packet processing.
   ```
   dpi_worker_lcores_run(nb_queues, CLIENT_ID, url_filter_worker_attr);
   ```
   a). Configure DPI enqueue packets
   b). Send jobs to RegEx engine
   c). Configure DPI dequeue packets
6. Add URL shell command.
   a). Create database
   b). Filter http
   c). Commit database
7. DPI destroy
   ```
   doca_dpi_destroy(dpi_ctx);
   ```
   - Free DPI resources

Chapter 5. Running Application on BlueField

1. Please refer to the DOCA Installation Guide for details on how to install BlueField related software.
2. To build the application

   a). The URL filtering example is installed as part of the `doca-dpi-lib` package. The binary is located under `/opt/mellanox/doca/examples/url_filter/bin/doca_url_filter`. To re-build the URL filter sample, run the following command:

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

   `doca_url_filter` will be created under `tmp/build`.

   b). The build process depends on the PKG_CONFIG_PATH environment variable to locate the DPDK libraries. If the variable was accidently 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
     ```

   c). The URL filter 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
   sudo mkdir /mnt/huge
   sudo mount -t hugetlbfs nodev /mnt/huge
   systemctl start mlx-regex
   ```

3. To run the application:

   ```
   doca_url_filter [dpdk flags] -- --print_match
   ```

   Sub-functions need to be enabled according to the Scalable Function Setup Guide.

   For example:

   ```
   /opt/mellanox/doca/examples/url_filter/bin/doca_url_filter -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 -c3 -- -p
   ```

   Note: The flag `-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`

is necessary for proper usage of the application. Modifying this flag will result in unexpected behavior as only 2 ports are supported. The subfunction number is arbitrary and configurable. The RegEx device, however, is not and must be initiated on port 0.

Note: URL filter will only work when using a single worker thread on Ubuntu systems.

To print the output when DPI engine finds a match, use `--print_match` or `-p` flag.

For additional information on available flags for DPDK, use `-h` before the `--` separator and for the app, use `-h` after `--`.

Application flags:

- `-t` or `--connection_tracking` – enable SFT connection tracking (may decrease performance)
- `-l` or `--log_level` – set the log level for the app (ERR=0, DEBUG=3)

If the `print_match` flag is used, a print will be posted to the screen whenever a match is found.

The URL filter is based on user interaction with shell commands. Using the TAB key allows autocompletion while the `quit` command terminates the application. Other available commands are as follows:

- `create database` – removes and creates a new signature database at `/tmp/signature.txt` so it can be used in the filter command
- `filter http [msg] [regex]` – a signature containing the regular expression written is created in the database. When a match is found, a message is printed.
- `commit database [path]` – compiles and loads the signatures created by the filter command from the file path provided. The default database is `/tmp/signature.txt`.

Note: To load a signatures file that was created beforehand, simply run commit database with the desired path to load the file.

Note: For instructions on running the application on the host, please refer to Running Reference Applications Over Host Guide.

Chapter 6. Running Application on Host

Please refer to Running Reference Applications Over Host Guide.

Chapter 7. References

- `/opt/mellanox/doca/examples/url_filter/src/url_filter.c`

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