DPDK

Flow Bifurcation on Intel® Ethernet Controller X710/XL710

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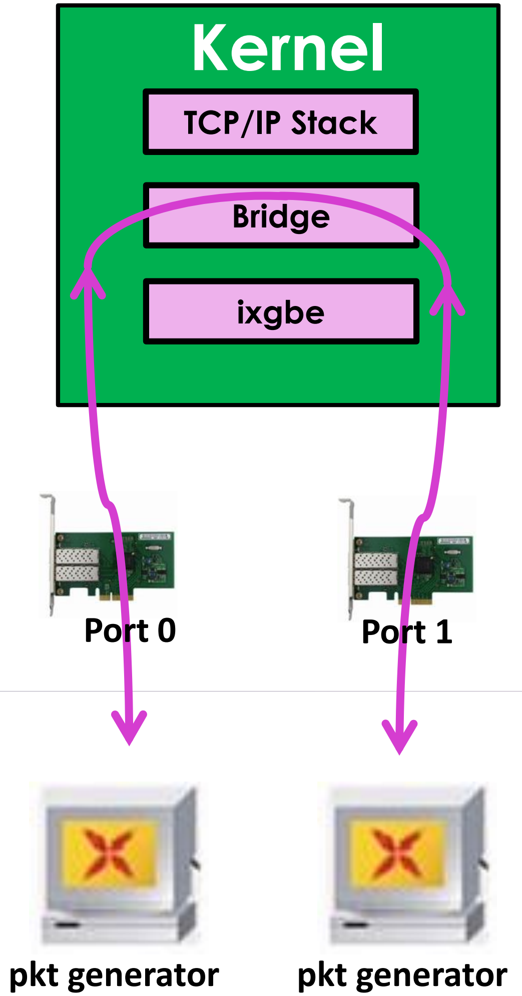
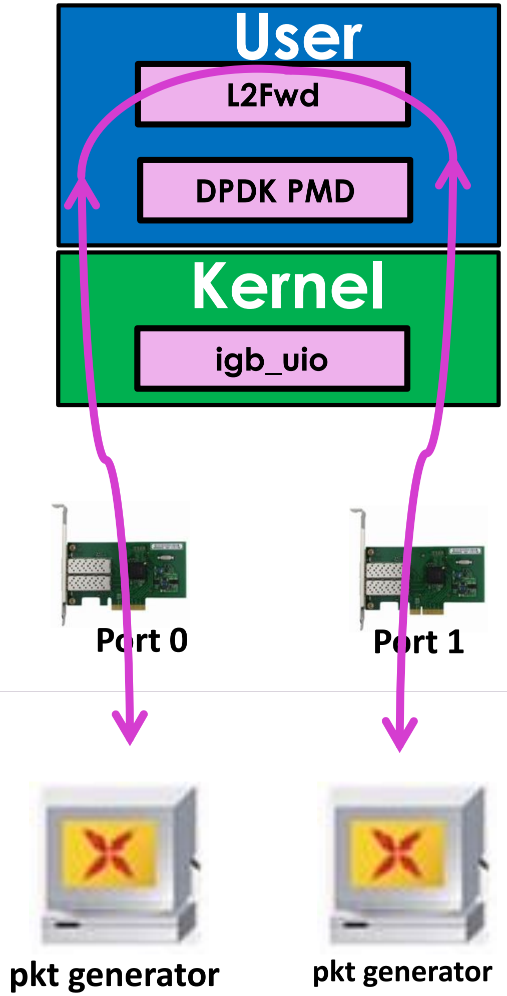
Agenda

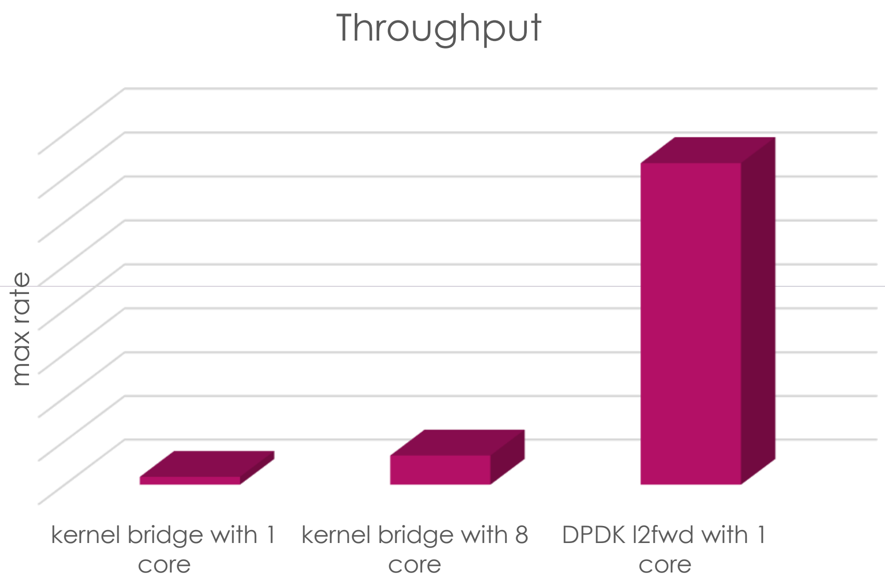
- Background -- DPDK co-work with Kernel stack
- Flow bifurcation on Intel® Ethernet Controller X710/XL710
- Summary

Kernel Bridging vs. L2Fwd





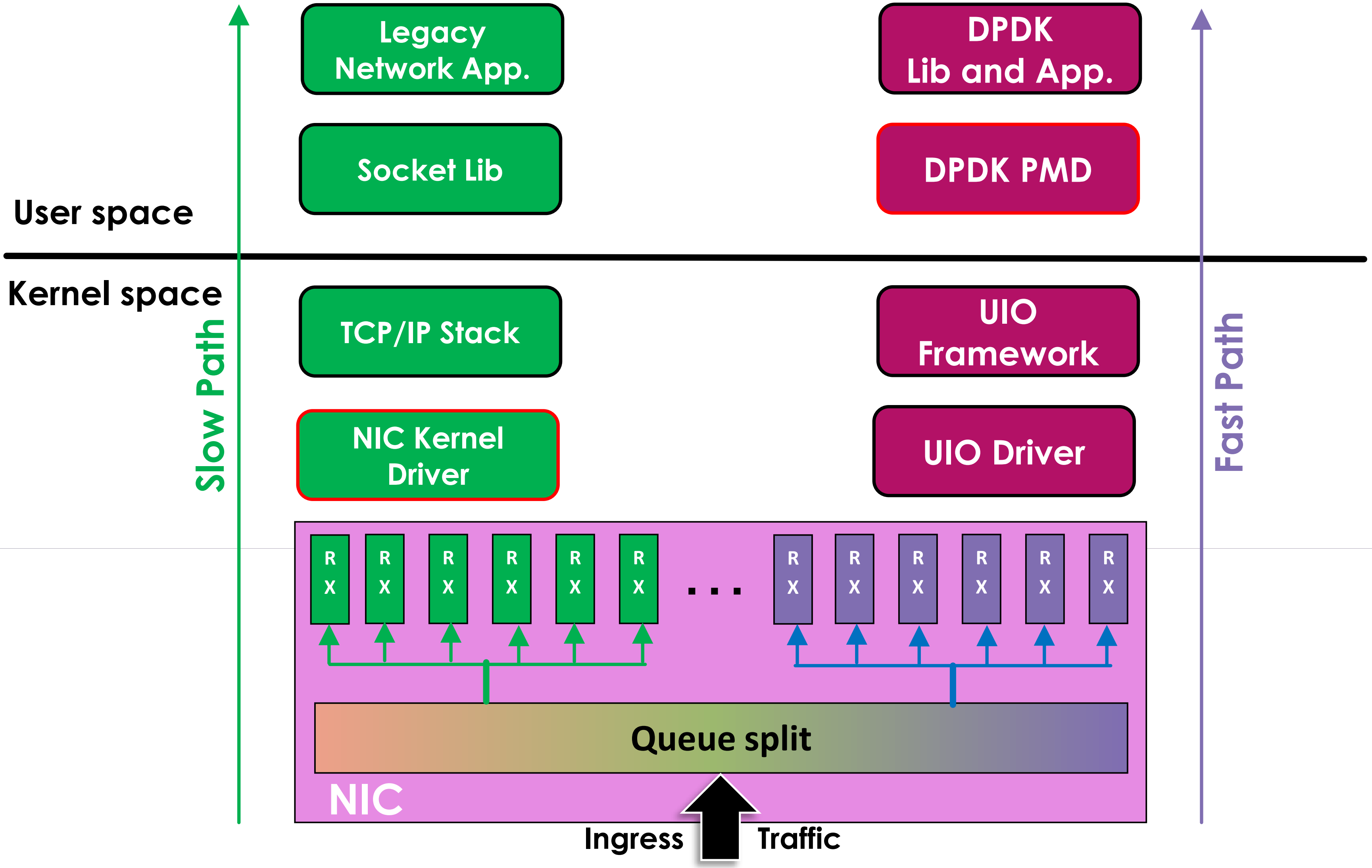
kernel bridge throughput is much worse than DPDK L2fwd when processing small packets even the stack doesn't scale.



DPDK co-work with Kernel stack

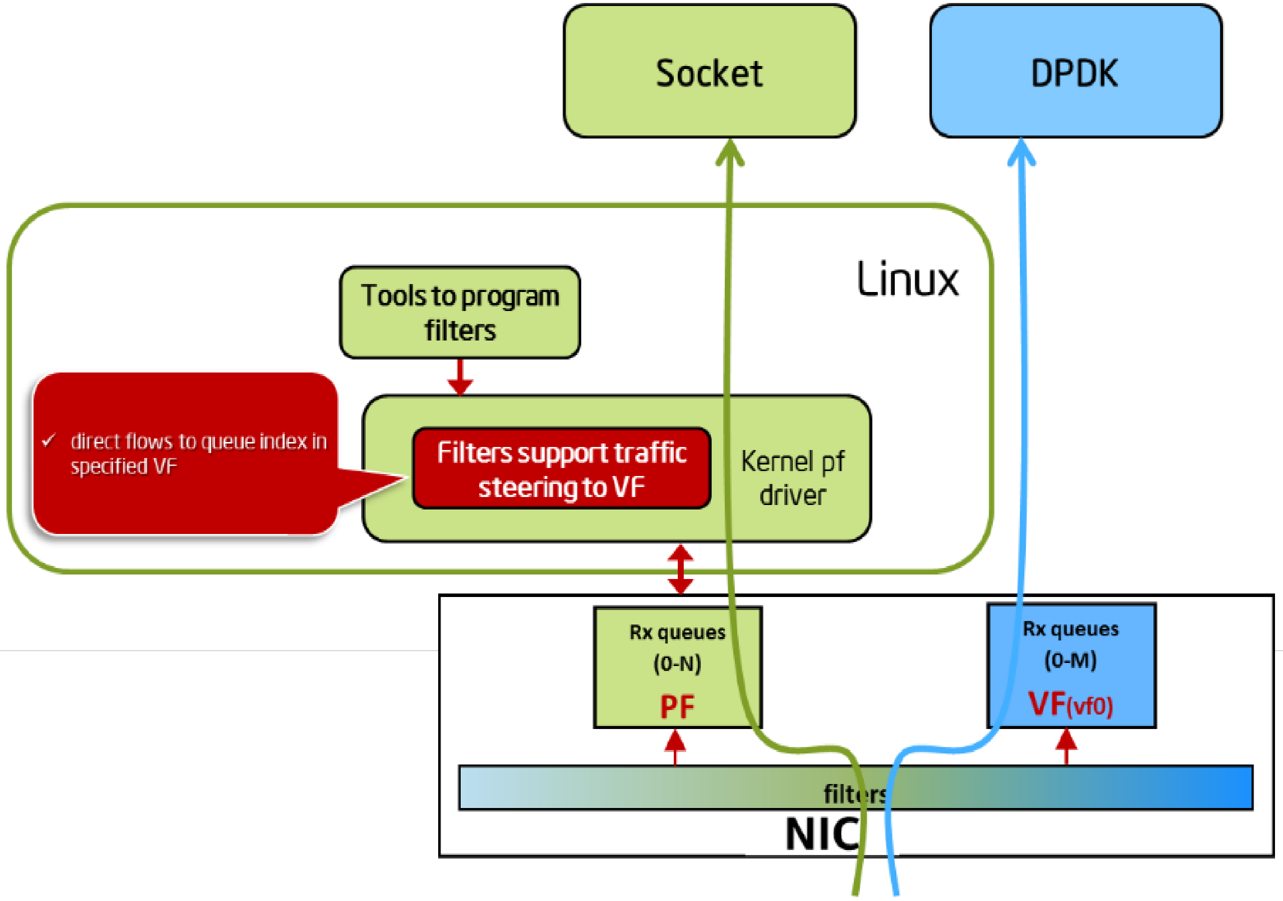
- DPDK is known to build the high performing data plane workload.
- A real world packet processing workload often relies heavily on the Linux kernel and its large stack for the control plane design and implementation. As a known limit, Linux performance is not sufficient for high speed data plane workloads.
- DPDK PMD or kernel driver take over the whole network card, not allowing any traffic on that NIC to reach each other.
- In order to combine the advantages of both, few key technical components are used to achieve the interworking between DPDK and Linux.
  - Exception path: TAP, KNI, AF_Packet
  - A high speed data traffic direction into Linux Kernel and DPDK -- Flow Bifurcation.

Data traffic direction – queue split



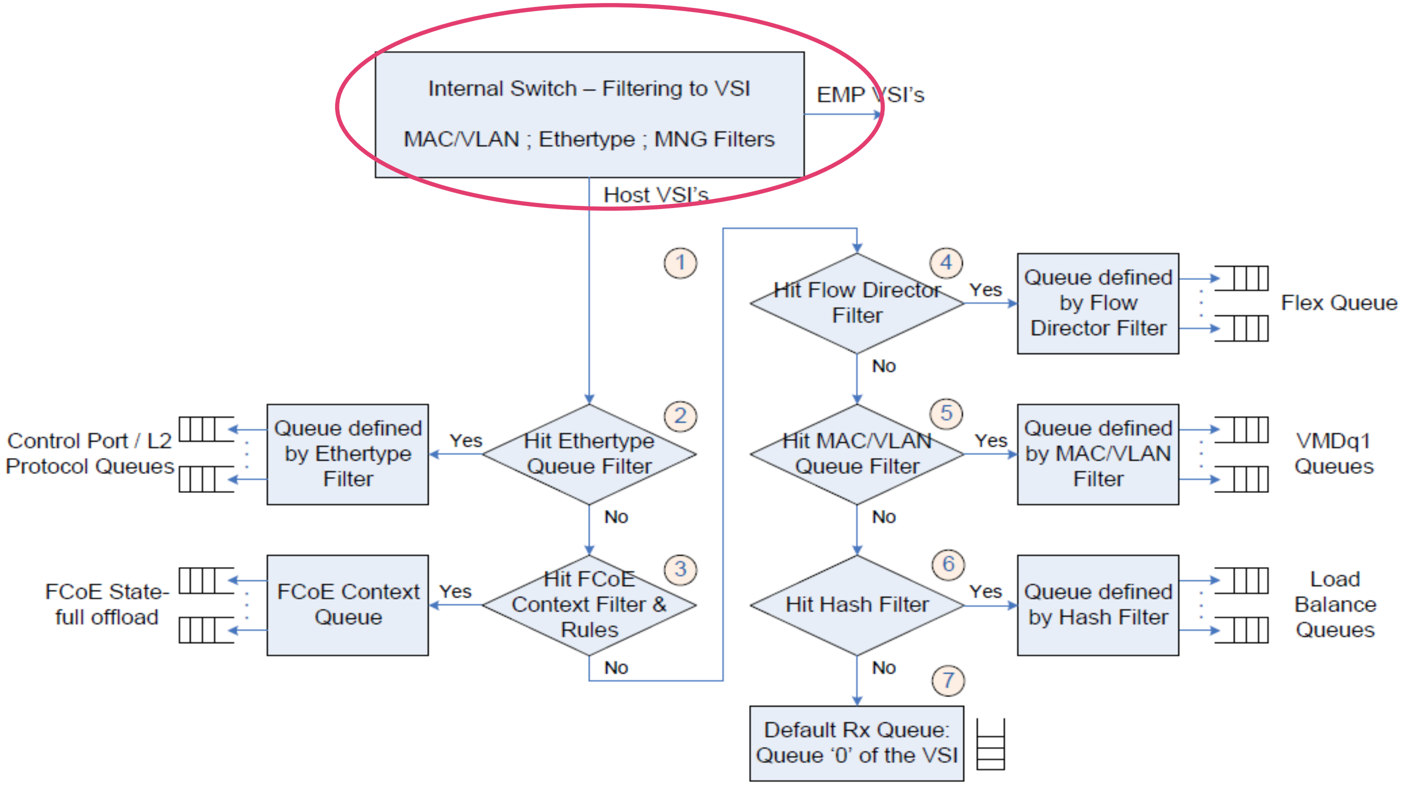
Flow Bifurcation

- SRIOV Based
- Queue split
- Hardware's Packet classification filtering capability
- kernel driver + DPDK
- Flow director in Intel 82599
- Cloud filter in Intel® X710/XL710



Packet classification filtering on X710/XL710

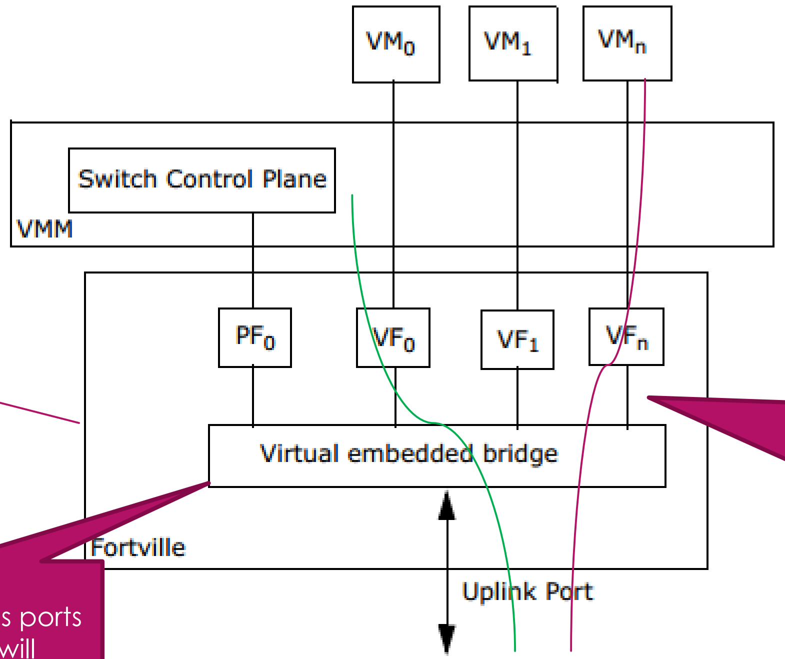
- To VSI
  - Internal switch filters
- To Queue
  - Ethertype Queue filter
  - Flow director filter
  - MAC/VLAN Queue filter
  - Hash(RSS) filter



Internal Switch – Filtering to VSI
MAC/VLAN ; Ethertype ; MNG Filters
EMP VSI's
Host VSI's
1
2
Hit Ethertype Queue Filter
Yes
Queue defined by Ethertype Filter
Control Port / L2 Protocol Queues
No
3
Hit FCoE Context Filter & Rules
Yes
FCoE Context Queue
FCoE State-full offload
No
4
Hit Flow Director Filter
Yes
Queue defined by Flow Director Filter
Flex Queue
No
5
Hit MAC/VLAN Queue Filter
Yes
Queue defined by MAC/VLAN Filter
VMDq1 Queues
No
6
Hit Hash Filter
Yes
Queue defined by Hash Filter
Load Balance Queues
No
7
Default Rx Queue: Queue '0' of the VSI

Internal Switch - VEB on X710/XL710

- Virtual Ethernet Bridge with Cloud Support (Cloud VEB)
- Cloud VEB Switching Rules
  - Priority 1 filters
  - Priority 2 filters
  - Priority 3 filters



Disallow LOOPBACK: this port won't be allowed to send packets to other virtual ports

define which egress ports (VSIs and LAN) will receive a packet received by the VEB.

VEB

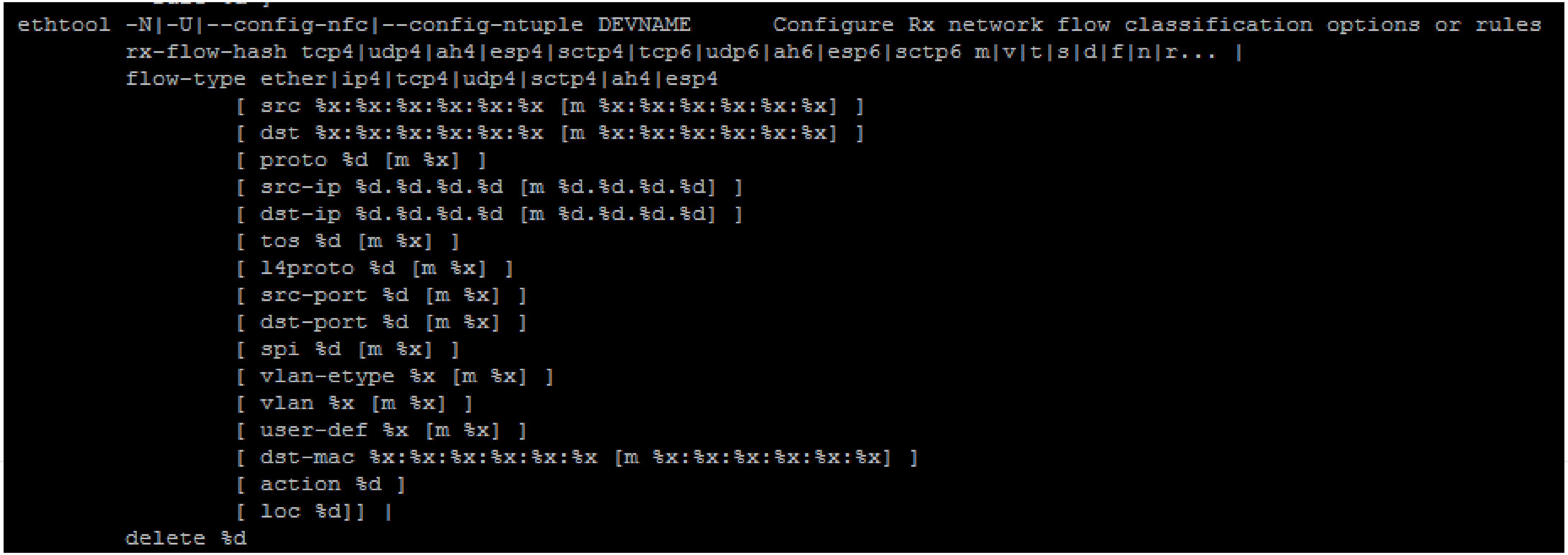
- Priority 1 filters ():
  - {Ethertype}
  - {MAC, Ethertype}
- Priority 2 filters (Cloud Filters):
  - {Inner MAC, Inner VLAN}
  - {Inner MAC, Inner VLAN, Tenant ID}
  - {Inner MAC, Tenant ID}
  - {Inner MAC}
  - {Outer MAC, Tenant ID, Inner MAC}
  - {Inner IP}
  - {Inner Source IP, inner destination MAC}
- Priority 3 filters:
  - {MAC, VLAN}
  - {MAC}
  - {VLAN}

Control filters: filtering control Frame

Cloud filters: used for flow Bifurcation, can be programmed through ethtool

L2 filters: traditional filtering by mac address and VLAN, programmed when mac address or VLAN assigned to device

Classification configure -- Ethtool



```
ethtool -N|-U|--config-nfc|--config-ntuple DEVNAME      Configure Rx network flow classification options or rules
        rx-flow-hash tcp4|udp4|ah4|esp4|sctp4|tcp6|udp6|ah6|esp6|sctp6 m|v|t|s|d|f|n|r... |
        flow-type ether|ip4|tcp4|udp4|sctp4|ah4|esp4
                [ src %x:%x:%x:%x:%x:%x [m %x:%x:%x:%x:%x:%x] ]
                [ dst %x:%x:%x:%x:%x:%x [m %x:%x:%x:%x:%x:%x] ]
                [ proto %d [m %x] ]
                [ src-ip %d.%d.%d.%d [m %d.%d.%d.%d] ]
                [ dst-ip %d.%d.%d.%d [m %d.%d.%d.%d] ]
                [ tos %d [m %x] ]
                [ l4proto %d [m %x] ]
                [ src-port %d [m %x] ]
                [ dst-port %d [m %x] ]
                [ spi %d [m %x] ]
                [ vlan-etype %x [m %x] ]
                [ vlan %x [m %x] ]
                [ user-def %x [m %x] ]
                [ dst-mac %x:%x:%x:%x:%x:%x [m %x:%x:%x:%x:%x:%x] ]
                [ action %d ]
                [ loc %d]] |
        delete %d
```

- I40e driver programs classification rule configured by Flow Director typically. But Flow director in i40e filters packets in scope of VSI.

Adapt to Ethtool classification

- If the upper 32 bits of ‘user-def’ are 0xffffffff, then the filter can be used for programming an L3 VEB filter, otherwise the upper 32 bits of ‘user-def’ can carry the tenant ID/VNI if specified/required.
- Cloud filters can be defined with inner mac, outer mac, inner ip, inner vlan and VNI as part of the cloud tuple. It is always the destination (not source) mac/ip that these filters use. For all these examples dst and src mac address fields are overloaded dst == outer, src == inner.
- The filter will direct a packet matching the rule to a vf specified in the lower 32 bits of user-def to the queue specified by ‘action’.
- If the vf id specified by the lower 32 bits of user-def is greater than or equal to max_vfs, then the filter is for the PF queues.

Procedure

# Create Virtual Functions:

```
echo 2 > /sys/bus/pci/devices/0000:01:00.0/sriov_numvfs
```

# Add udp port offload to the NIC if using cloud filter:

```
ip li add vxlan0 type vxlan id 1 group 239.1.1.1 local 127.0.0.1 dev <name>
ifconfig vxlan0 up
```

# Enable and setup rules

- Route whose destination IP is 192.168.50.108 to VF 0’s queue 0:

```
ethtool -N <dev_name> flow-type ip4 dst-ip 192.168.50.108 user-def 0xffffffff00000000 action 0 loc 0
```

- Route whose inner destination mac is 0:0:0:0:9:0 and VNI is 8 to PF’s queue 1:

```
ethtool -N <dev_name> flow-type ether dst 00:00:00:00:00:00 m ff:ff:ff:ff:ff:ff \
src 00:00:00:00:09:00 m 00:00:00:00:00:00  user-def 0x800000003 action 1 loc 1
```

- ……

# start DPDK application without interrupt net device

```
testpmd -c 0xff -n 4 -- -i -w 01:10.0 -w 01:10.1 --forward-mode=mac
```

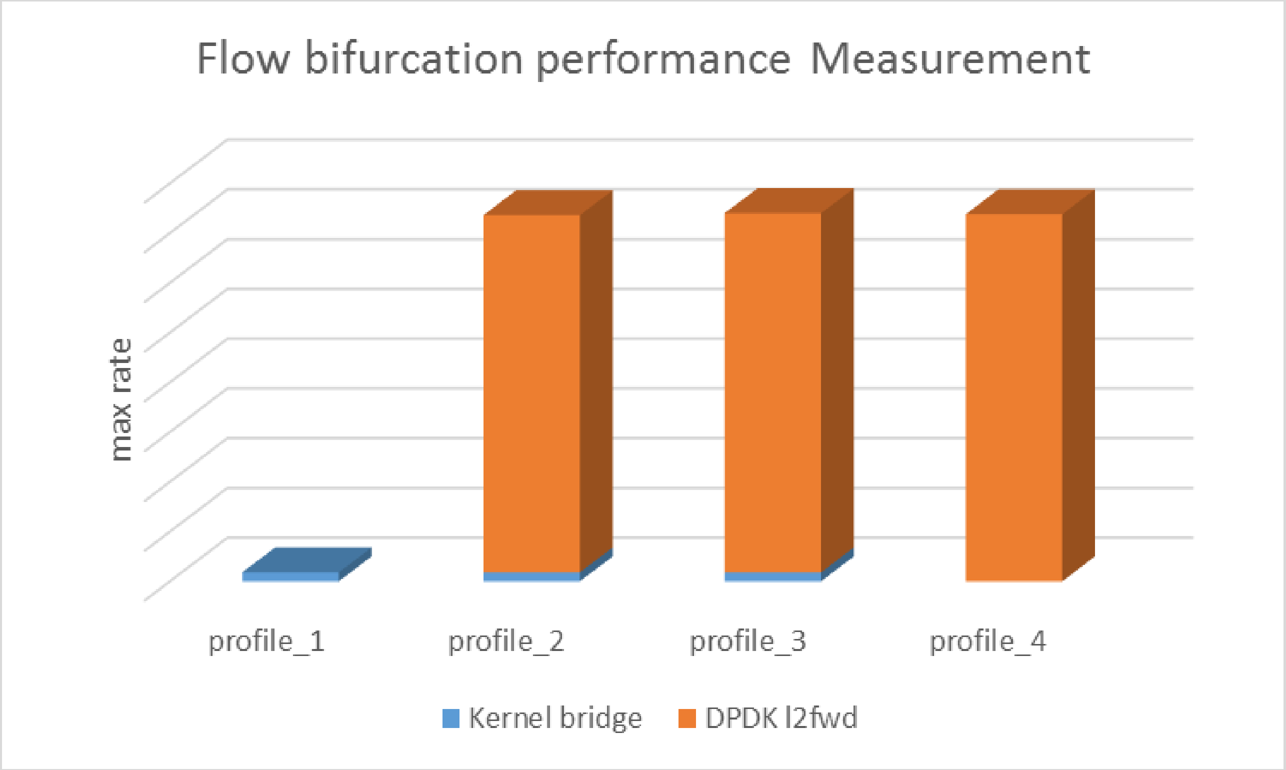
Performance Measurement

DPDK

- Platform
  - Kernel version:4.5.5-300.fc24.x86_64
  - I40e driver: 1.5.23
  - Firmware-version: 5.04
  - DPDK： 16.07
  - Intel(R) Xeon(R) CPU E5-2699 v3 @ 2.30GHz
  - Intel® Ethernet Controller XL710 for 40GbE QSFP+ (PCIe Gen 3 x 8)
- Mixed traffic flows
  - flow_1: IP packets with destination IP address is 192.168.50.109 → kernel bridge
  - flow_2: IP packets with destination IP address is 192.168.50.108 → DPDK l2fwd

Performance Measurement

Mixed traffic	Flow1 vs flow 2
Profile_1	100% vs 0
Profile_2	10% vs 90%
Profile_3	2% vs 98%
Profile_4	0 vs 100%



Summary

- Advantages
  - Support control interface, such as ethtool on PF.
  - Flows are split on HW. Without overload, DPDK application's performance can keep stable.
  - Only need kernel driver to enable filters, no DPDK changes are required, and no out-of-tree module is required.
  - Security protected by SRIOV and IOMMU.
- Disadvantages
  - Depends on Hardware's Packet classification filtering capability. Different NIC has limited filtering capability. Not flexible as SW filtering.
  - Is not absolute queue split, depends on PF driver's supporting.

Questions?

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