vSwitch Acceleration with Hardware Offloading

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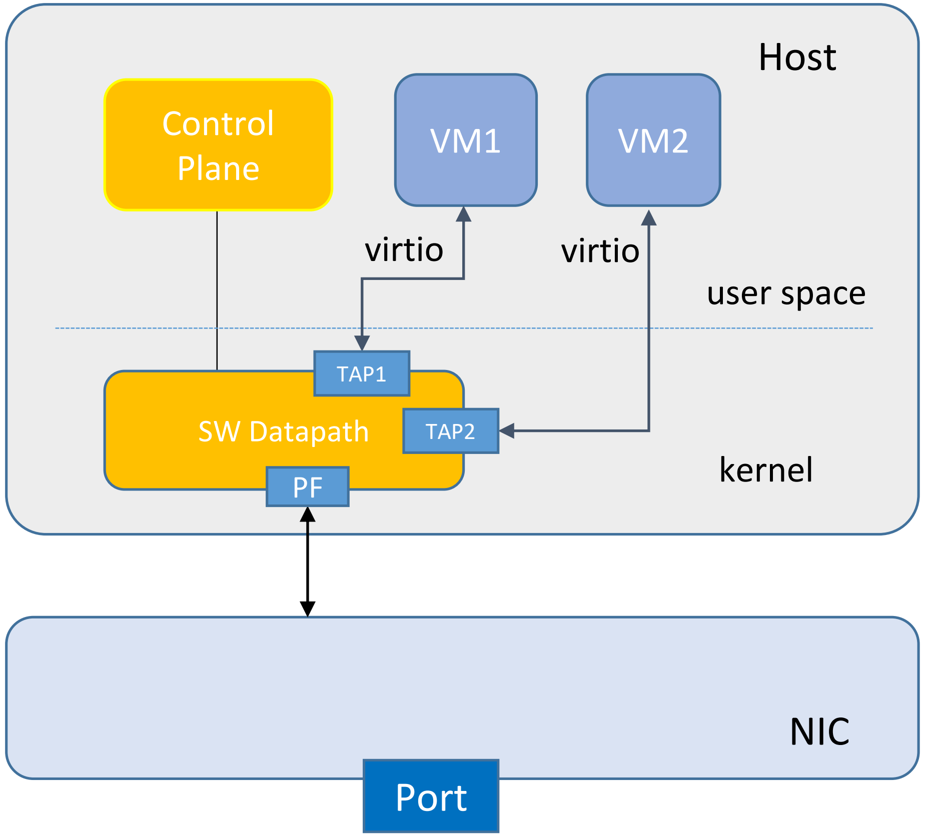
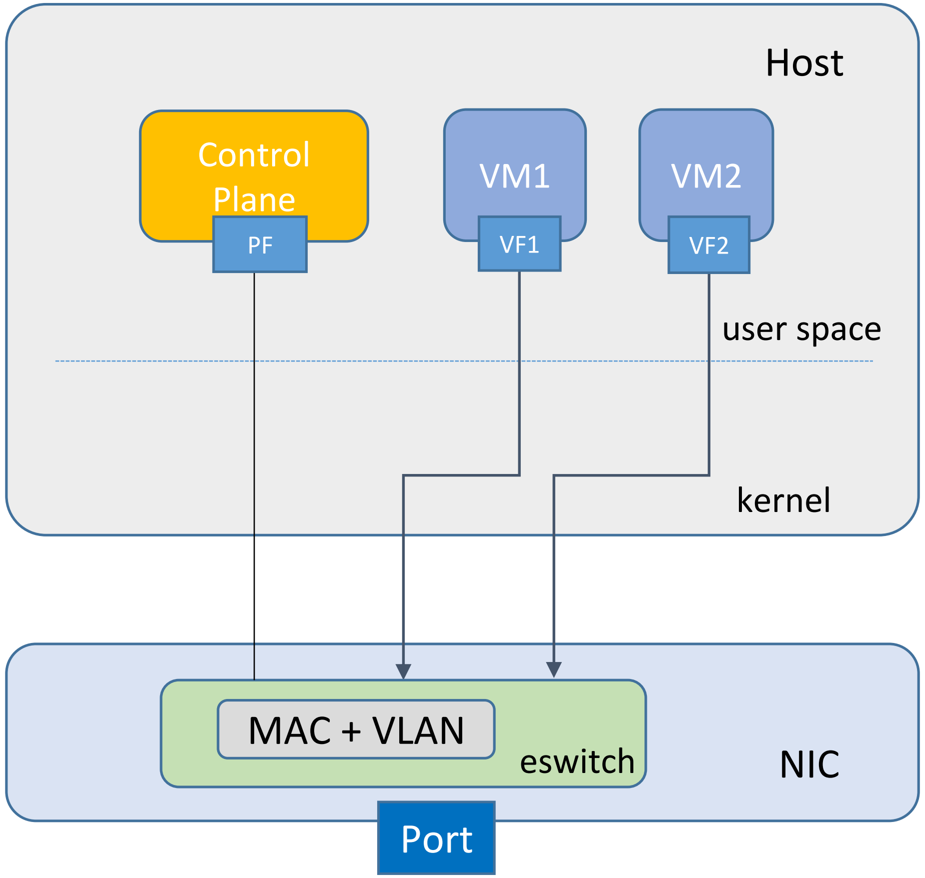
JUNE 2018

Current Network Solution for Virtualization

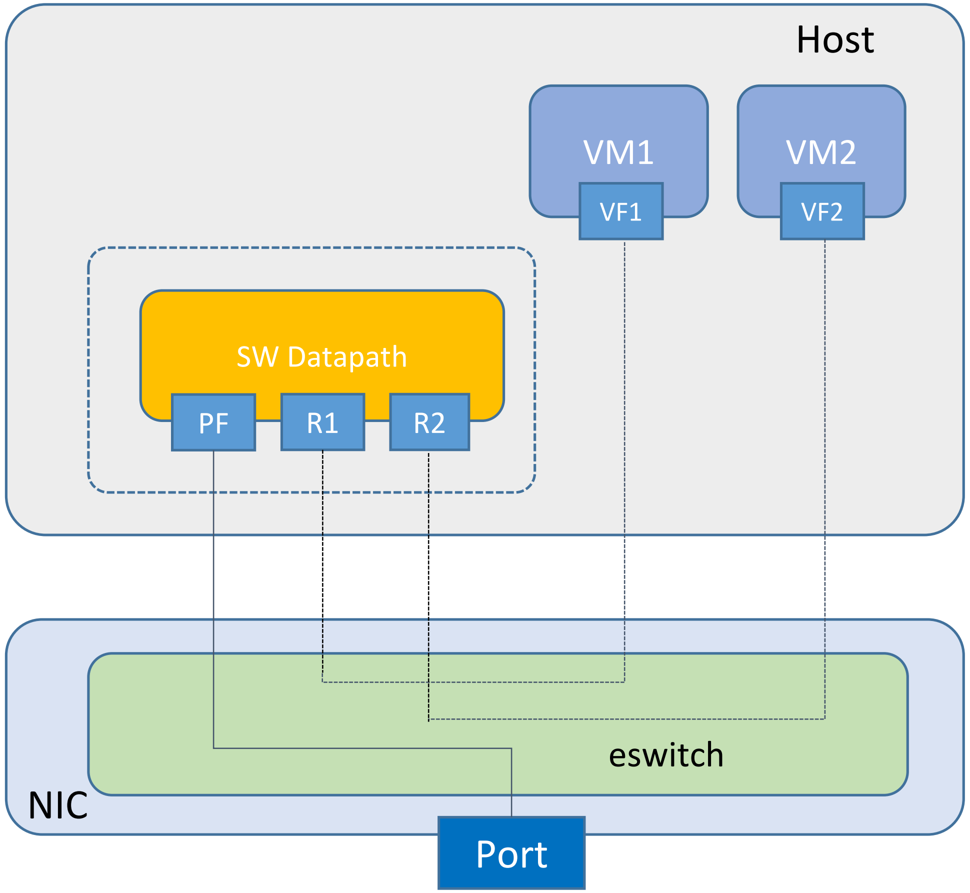


Software Solution



SRIOV Solution

VF Representor for Virtualization



- VF Representor
  - Net Device modeling of eswitch port and exposed through PF driver.
  - VF and its representor works like Linux veth pair
  - Flow configuration (add/remove)
  - Works under switchdev mode
- Access from both kernel and DPDK
  - Multi Queue (RSS/TSO/CSUM)
  - Attach/Detach in DPDK
  - Multiple DPDK instances over VF representor
- With VF representor, vSwitch can work with SRIOV together and reduce CPU% consumed by virtio.
- Disadvantages:
  - 3x PCIe access for traffic from VM to wire and vice versa, PCIe can become a bottleneck for throughput.
  - Need vendor specific driver in VM.

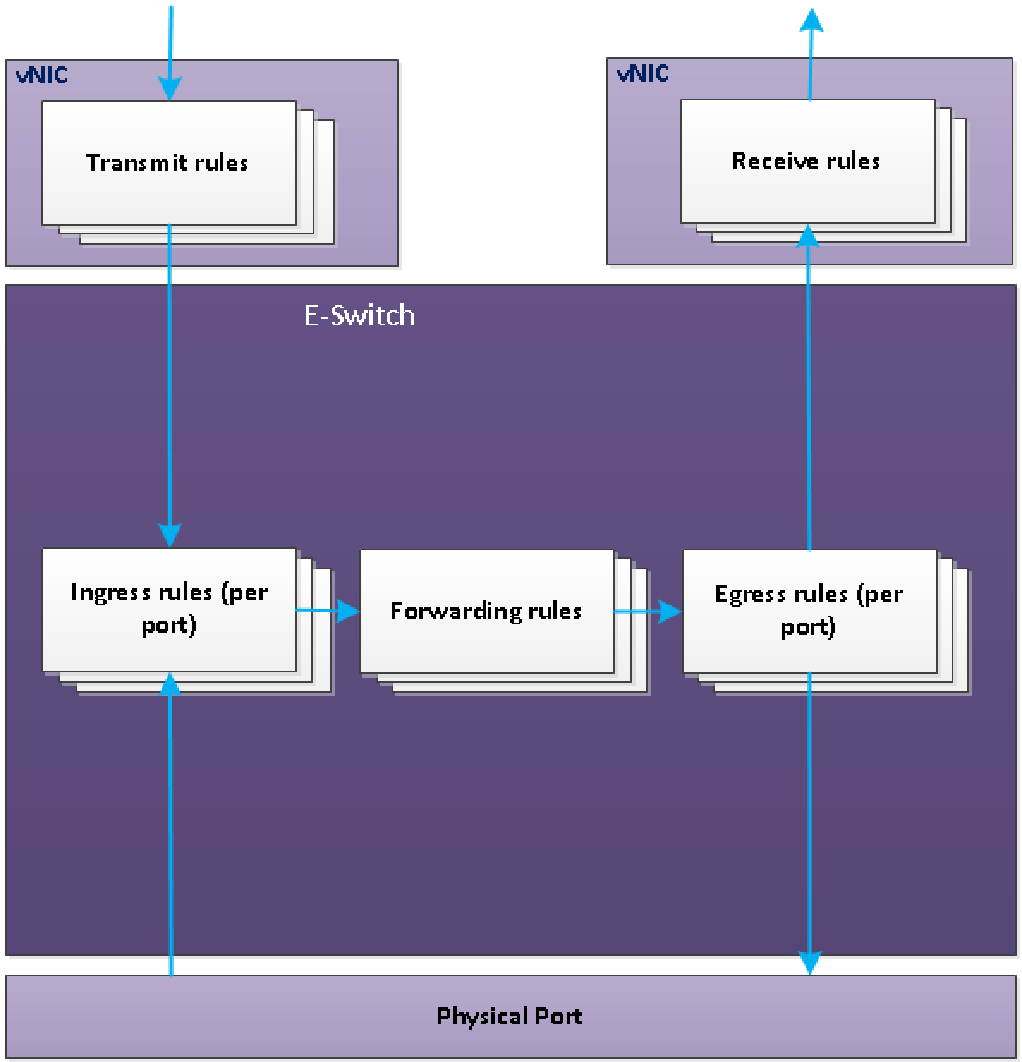
Flow Table with Mellanox Adapter

- Key match fields
  - Ethernet
  - IP(v4 /v6)
  - TCP/UDP
  - Inner packet for Overlay
  - VNI
- Flexible fields extraction by “Flexparse”

- Action
  - Forwarding
  - Drop
  - Counter
  - Encap/Decap
  - Flow ID
  - Header rewrite
  - ……

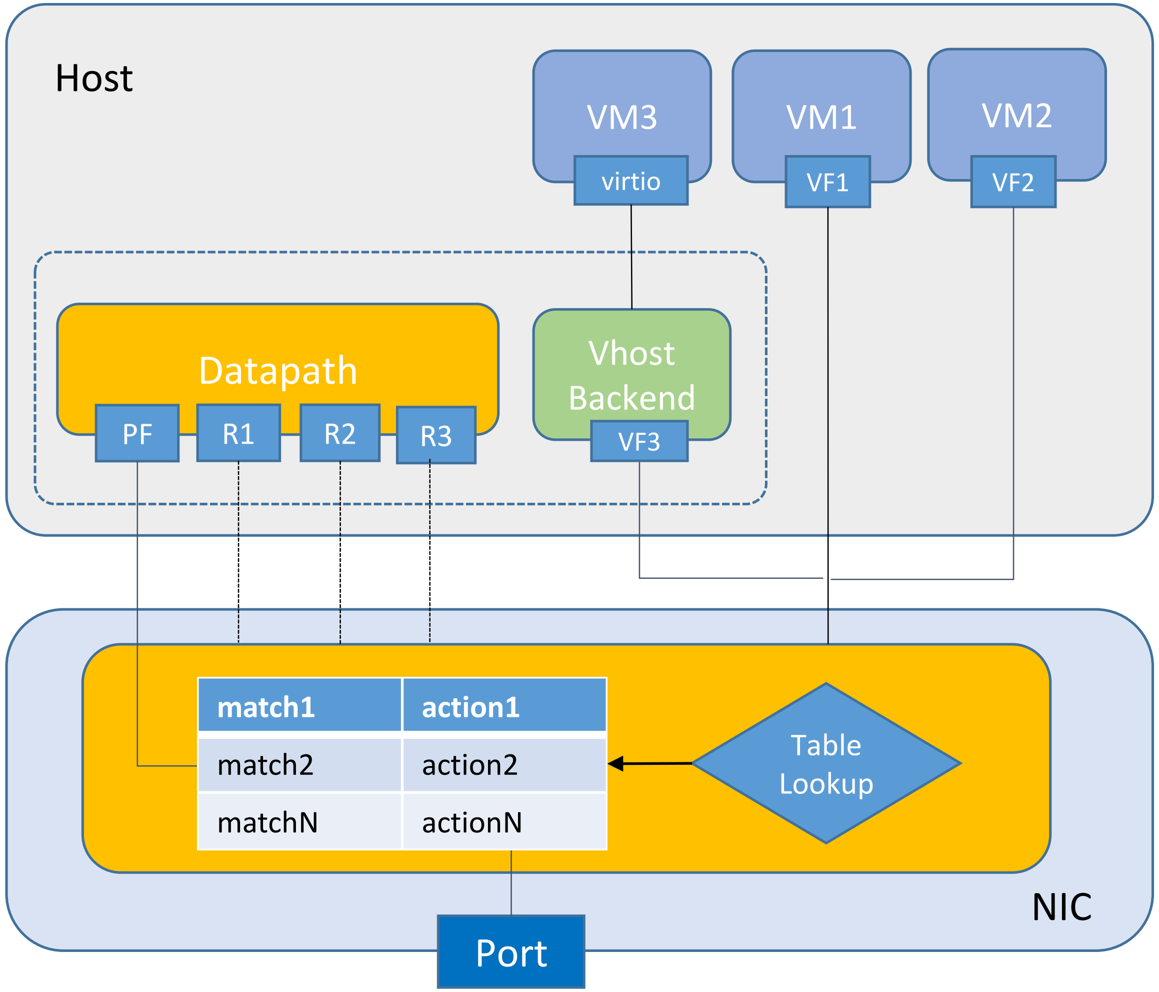
Classification					Action
SRC MAC =	Dest MAC =	SRC IP =	Dest IP =	Protocol =	Counter
SRC MAC =	Dest MAC =	SRC IP =	Dest IP =	Protocol =	Another rule

Classification					Action
VLAN tag =	Tunneling type	Inner packet SRC IP =	Inner packet Dest IP =	Inner packet Protocol =	Header re-write
VLAN tag =	Tunneling type	Inner packet SRC IP =	Inner packet Dest IP =	Inner packet Protocol =	Meta Data
VLAN tag =	Tunneling type	Inner packet SRC IP =	Inner packet Dest IP =	Inner packet Protocol =	Flow-ID Tag



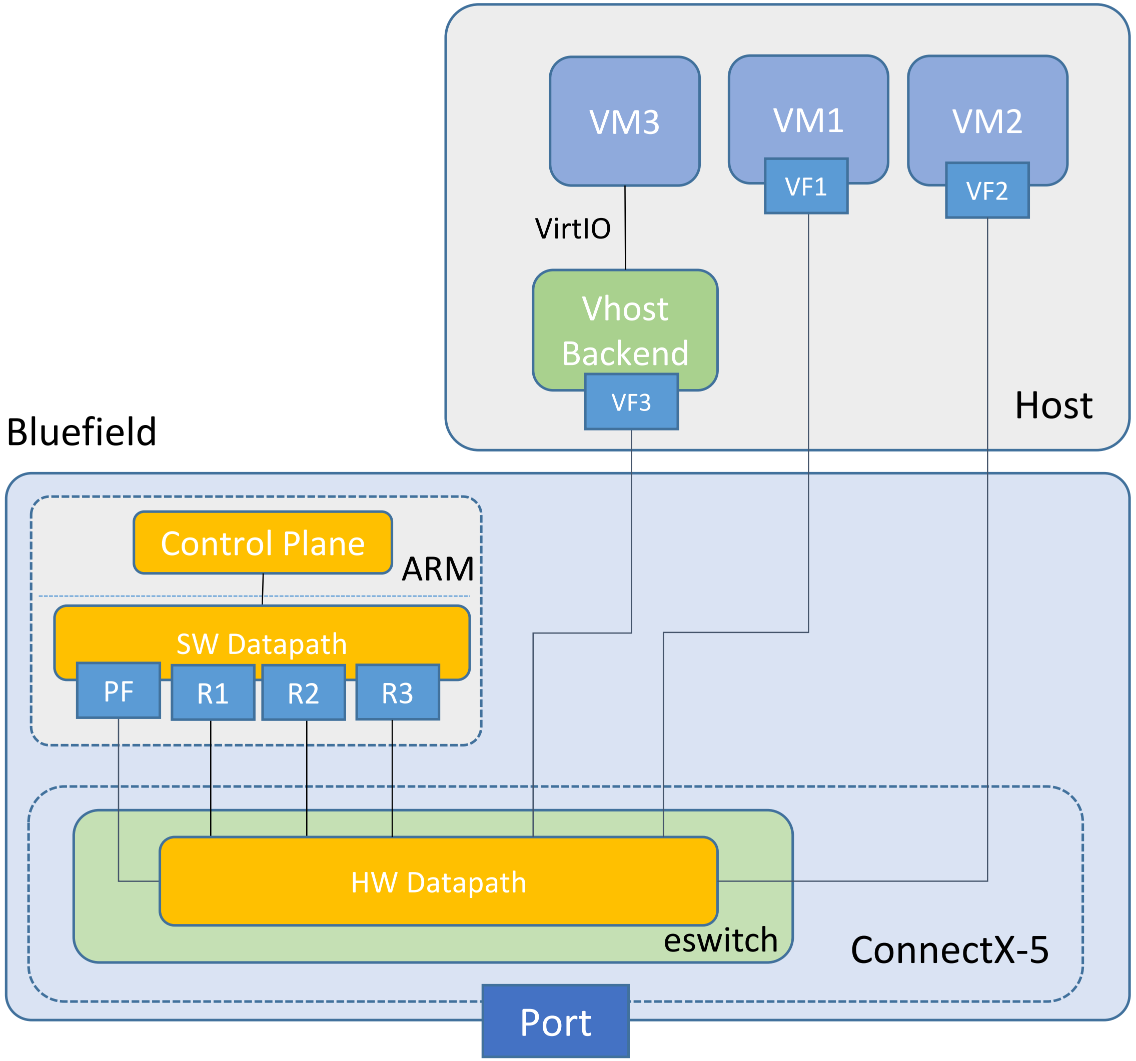
vSwitch Design with Hardware Offloading

- HW datapath on eswitch through configuring flow table.
    - TC Flower
    - DPDK RTE_FLOW
- Software datapath handle ‘the first packet’ and unsupported flows through VF representor.
- Support both SRIOV and VirtIO
    - Direct path to VM for SRIOV
    - Optimized vhost backend for virtio acceleration
        - **TX**: Forward packet to HW with meta data.
        - **RX**: Receive packet from VF with Flow ID which can identify destination VM.
- Rules management
    - Add/delete/Query
    - Aging
    - Batch operations



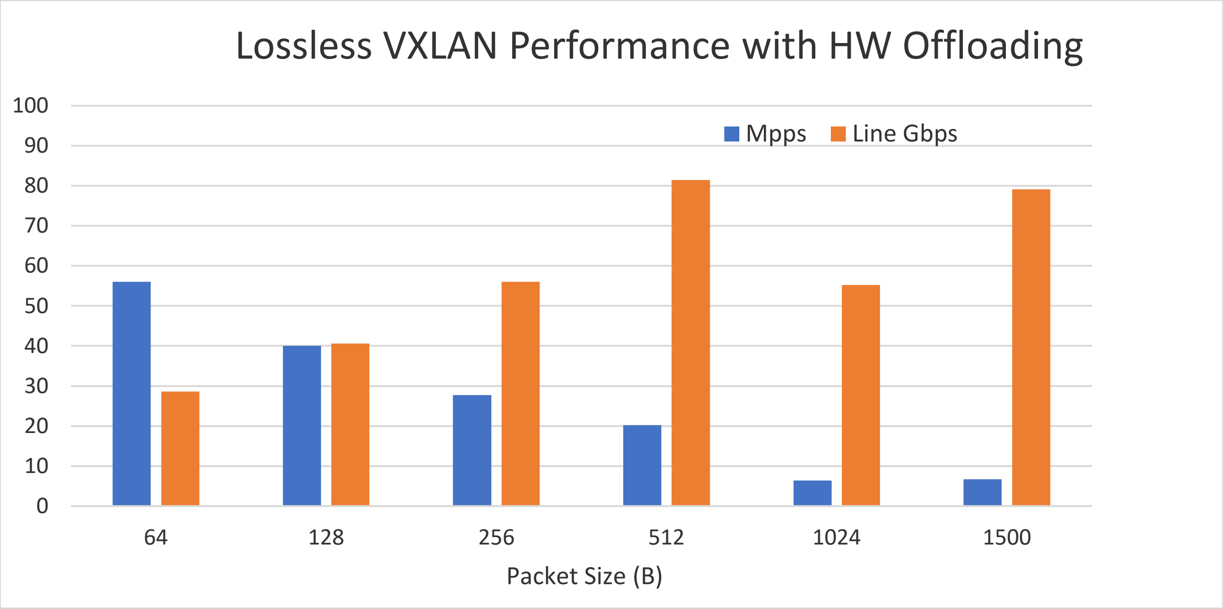
match1	action1
match2	action2
matchN	actionN

vSwitch with Hardware Offloading for SmartNIC



- Control plane and SW Datapath on ARM
- HW Datapath on NIC
- Both SRIOV and VIRTIO interface to VM
- Advantages
  - Support bare-metal cloud
  - Separation of computing domain and networking domain, all host resources (core and memory) can be used for VMs.
  - Efficient
- Disadvantages
  - Higher cost and power
  - Two management domain.

Hardware Offloading Performance with SRIOV



System Configuration:

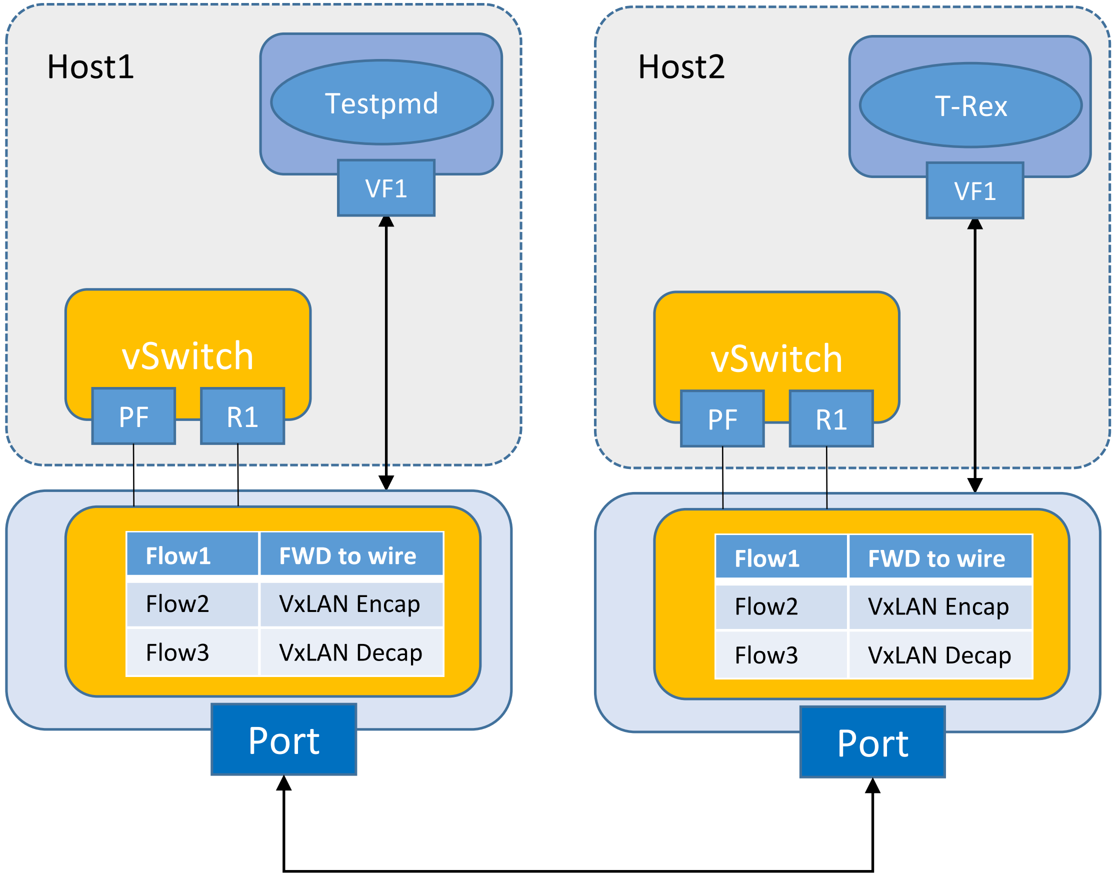
(1) E5-2667 V3 @ 3.20GHz

(2) Mellanox 100G ConnectX-5 NIC

(3) RHEL7.5 Host and Guest

(4) Vxlan Encap/Decap on NIC

(5) T-Rex and Testpmd run in VMs



Flow1	FWD to wire
Flow2	VxLAN Encap
Flow3	VxLAN Decap

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Hardware Offloading Performance with VirtIO

Test Case\Cores	1	2	4
VM->HV->wire	9.98	18.3	36.4
VM->HW->VxLAN Encap-wire	9.95	18.3	36.2
Wire->HV->VM	13.4	23.3	46.3
Wire->VxLAN Decap->HW>VM	13.5	25.0	45.8

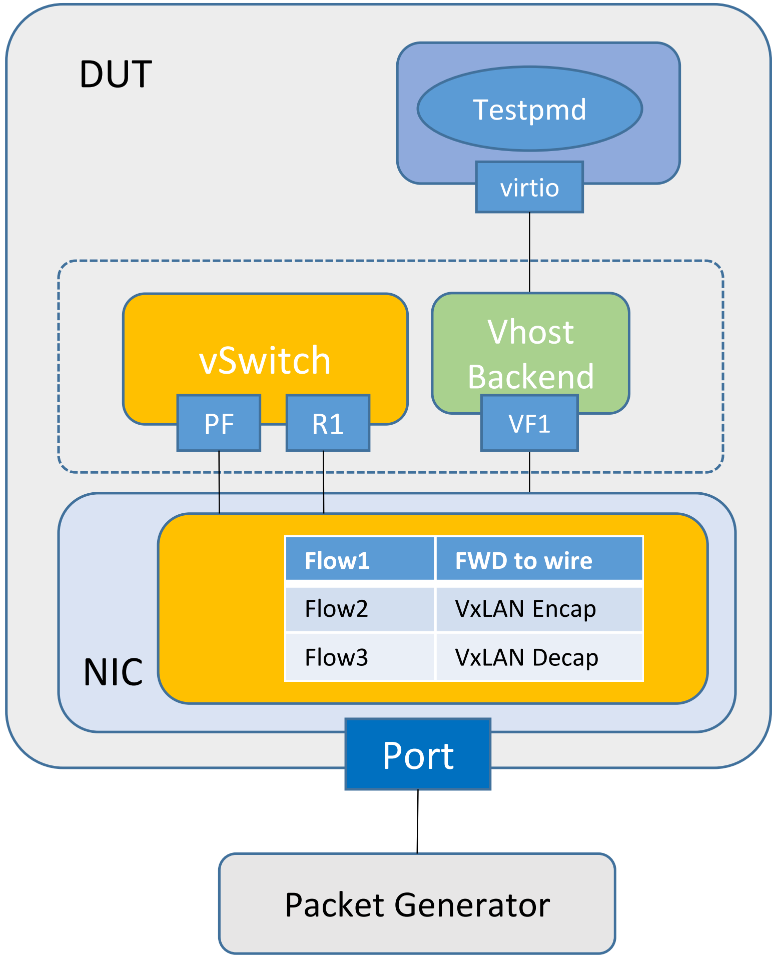
System Configuration:

(1) E5-2650 V4 @ 2.20GHz

(2) Mellanox 100G ConnectX-5 NIC

(3) Performance Metric: Mpps at 64byte

- Overhead caused by HW Encap/Decap on the path from/to VM can be minimized.
- If vhost-backend is strong enough, HW Offloading can bring high performance to virtio also.



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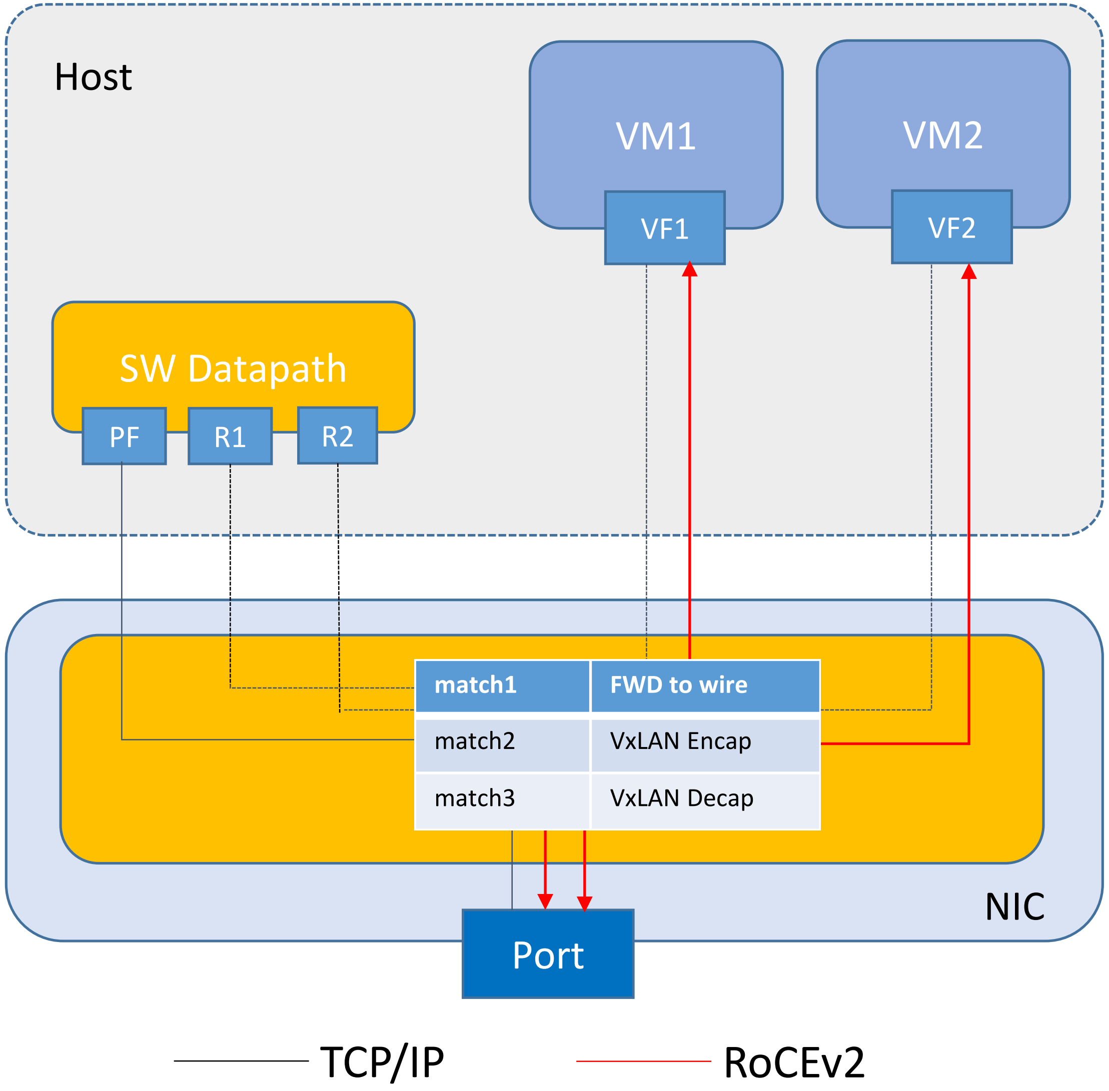
Flow3	VxLAN Decap

RoCEv2 Support

- Only support SRIOV interface
- All RoCEv2 must go through HW datapath.
- ARP should be handled by SW datapath so that two endpoints of RoCEv2 can exchange address information.
- All RoCEv2 should be sent to wire or local VFs directly through configured rules like following
  - match {ip_proto=udp, dport=RoCE, dmac=<mac of VF1>} action {fwd to VF1}
  - match {ip_proto=udp, dport=RoCE, dmac=<mac of VF2>} action {fwd to VF 2}
  - match {ip_proto=udp, dport=RoCE} action {fwd to wire}
- New HW support VxLAN Encap/Decap for RoCEv2
  - Encap header can be based on inner (src ip, dst ip) + VNI.
  - ECN information need be copied from outer header to inner header after decap on RX.



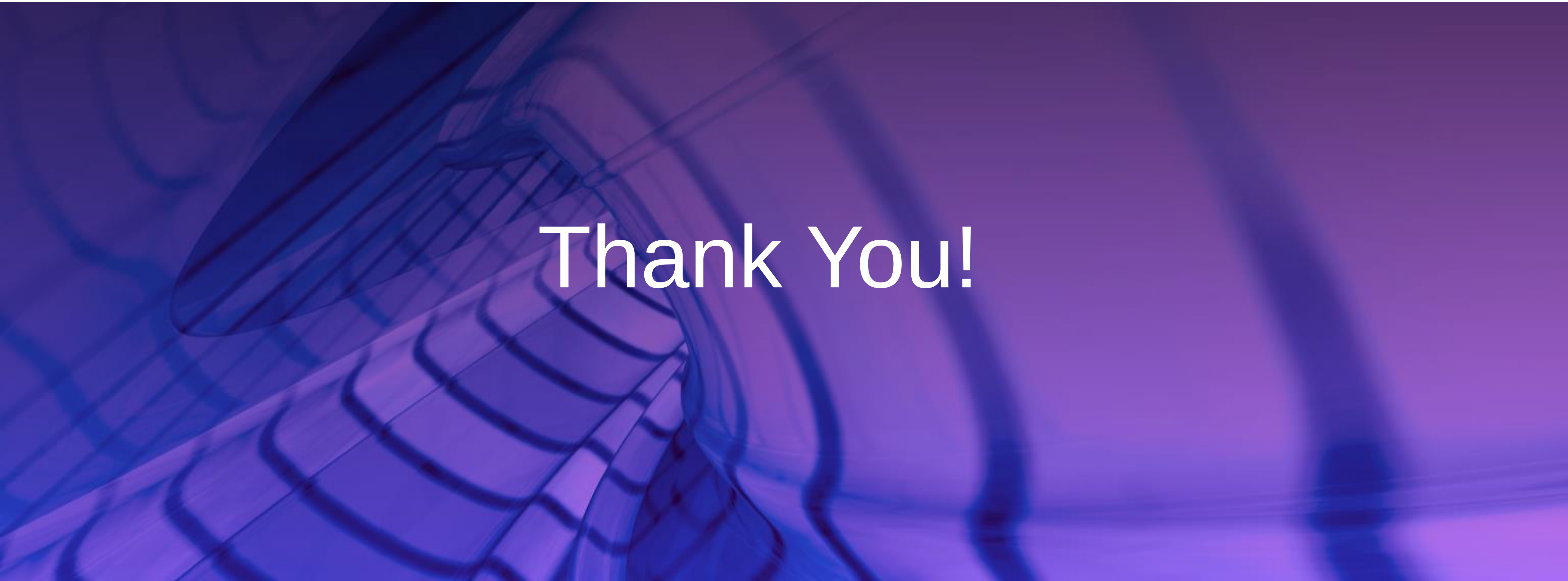
match1	FWD to wire
match2	VxLAN Encap
match3	VxLAN Decap

Other key Consideration

- **VF LAG**: VM sees only one VF while it can use two physical ports for Load balancing and link redundancy.
- **VF Mirroring**: mirroring the traffic from/to one VF to a dedicate admin VF for monitoring and traffic analysis.
- **Connection Track**: sending TCP packets with specific flags to software for processing connection state.
- **Live Upgrade**: update to new instance, need migrate both SW & HW datapath and interfaces from current instance to new instance.
- **SRIOV Live Migration**: VM with SRIOV VF can be migrated from one machine to another machine.

DPDK

DATA PLANE DEVELOPMENT KIT



Thank You!