Open vSwitch

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Enabling OVS Hardware Offload using LiquidIO

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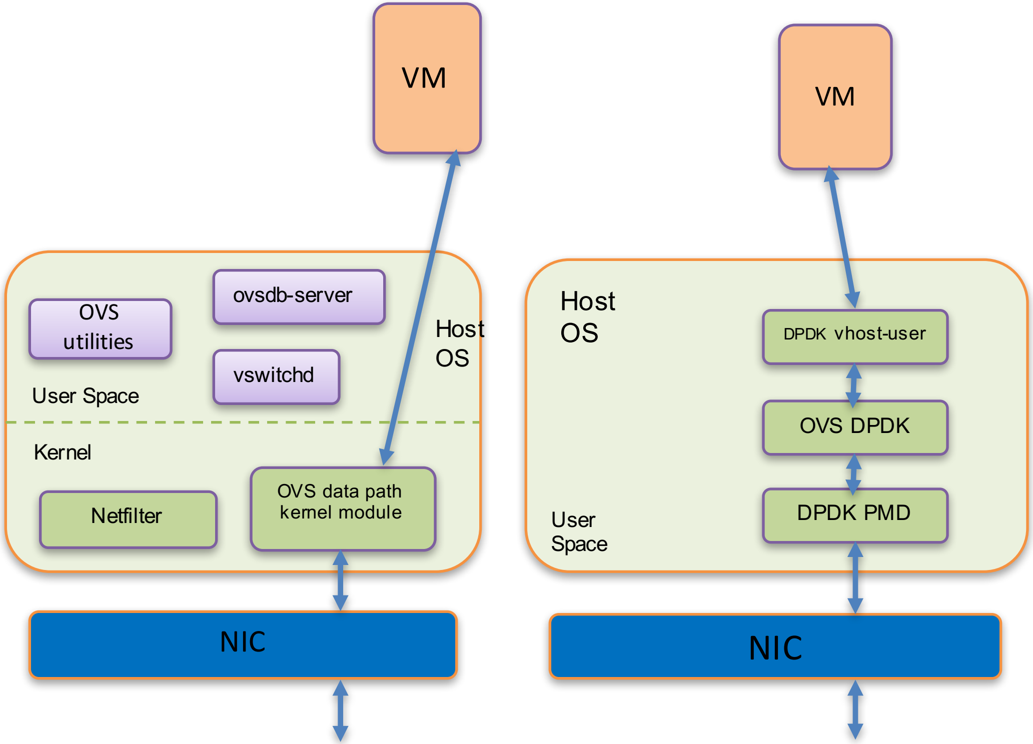
Open vswitch software models



- Two different models –
  - Data plane in kernel; Control in user space;

    Packets switched within kernel to VM.
  - Data and control plane in user space;

    Packets bypass kernel completely;

    Packets switched entirely in user space.
- Both models supported by open source community
- Hardware independent

Why move vSwitch out of the host?

Limitations with a pure software based vSwitch

- Requires significant host CPU cycles to get packets to the VM.
- Reduces host CPU cores available to run VMs.
- Challenge in keeping up with increasing bandwidth requirements.

Customers need a resolution to some or all of the above issues in their current deployment.

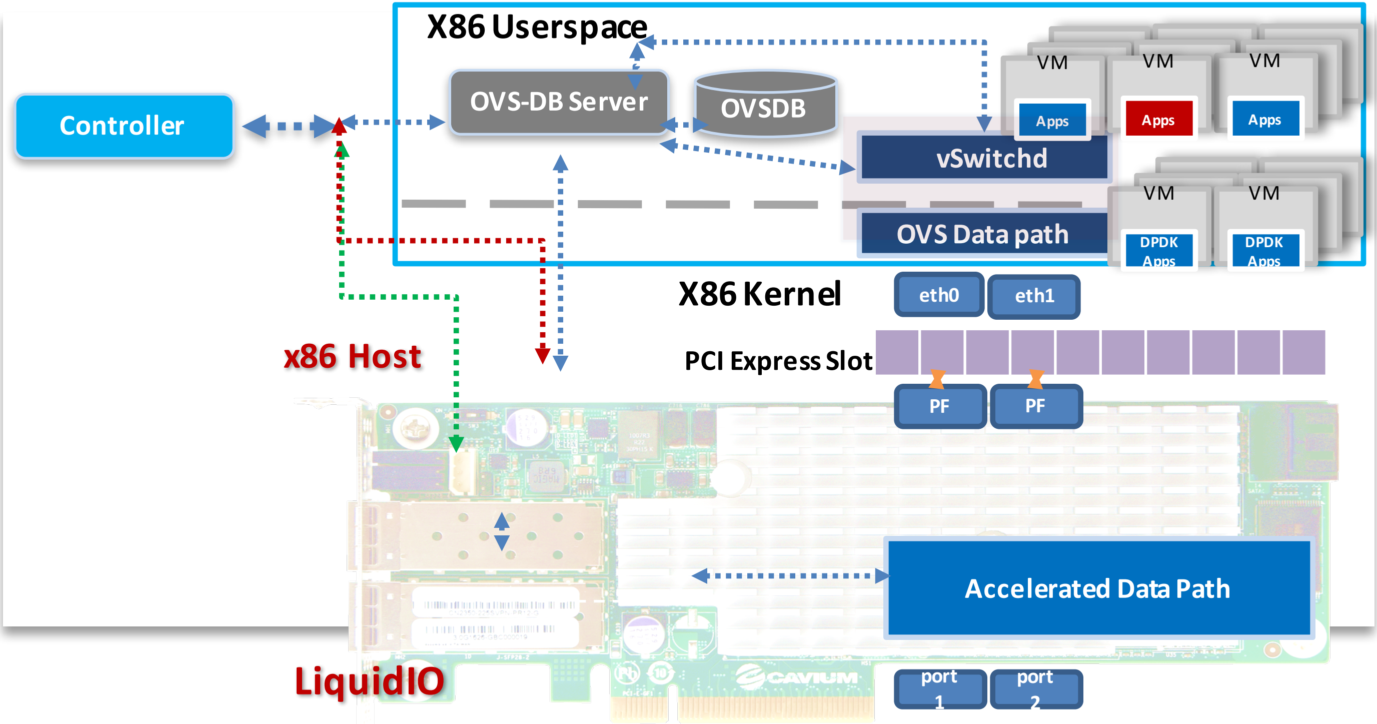
- Cavium's customers also had other reasons to offload vSwitch to a NIC adapter
  - Manage vSwitch independent of host OS. Host OS could be under tenant control.
  - Upgrade or manage OVS or customization to vSwitch without modifying host OS.

Models to offload Open vSwitch to NIC adapters

- Data plane offload model
  - Uses PCI pass-through of VF to VM to bypass host CPU.
  - OVS Control plane continues to be on host OS.
  - The vswitch bridge exists in the host
  - Uses representors of the VFs attached to VM as ports in the bridge.
  - Has enablers in the Linux kernel including support for
    - switchdev
    - TC/Flower based flow offload to network devices

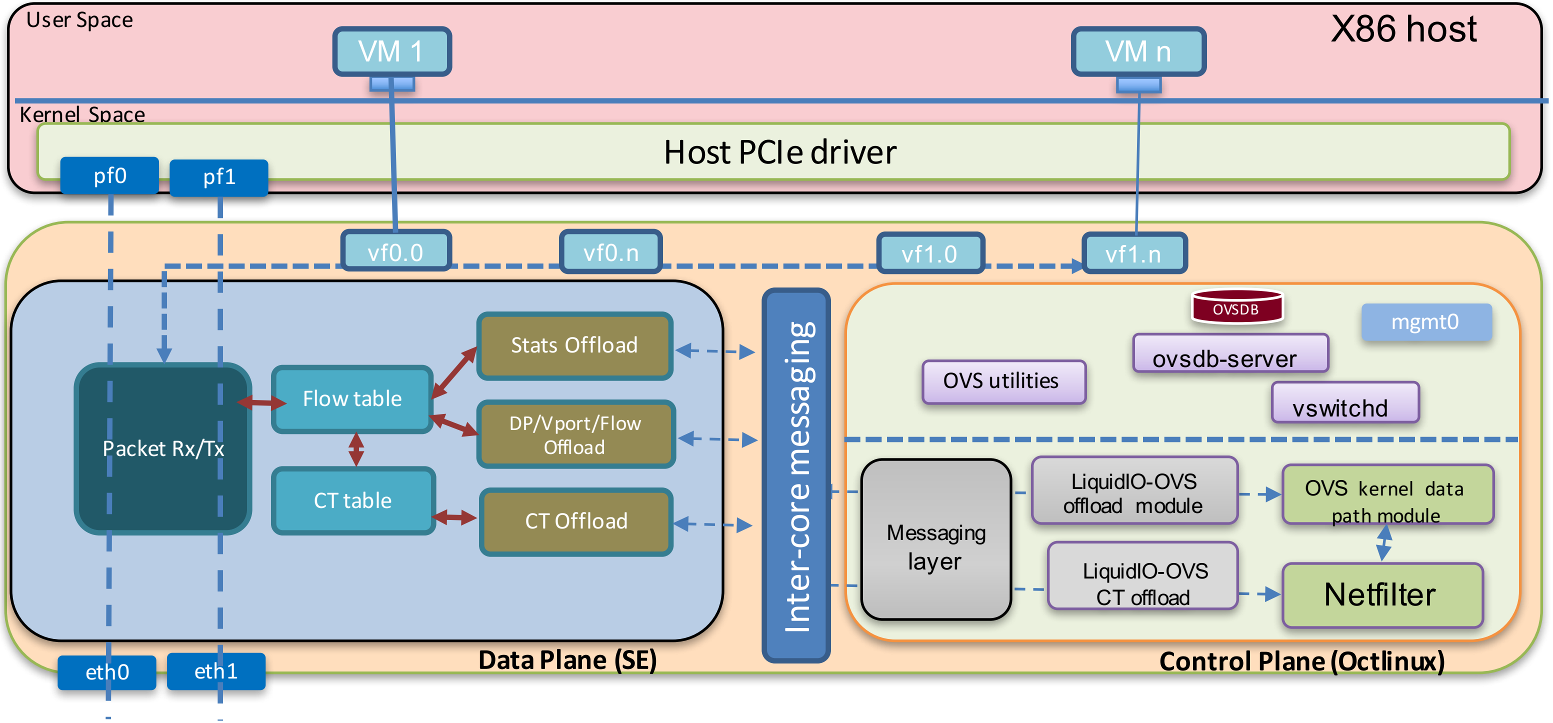
- Full Open vSwitch offload (control and data plane)
  - Leverages PCIe SRIOV and PCI pass-through of VF to VM to bypass host CPU.
  - The OVS control and data plane operate from within the NIC adapter
  - Does not require VF representors or switchdev for normal OVS operation.
  - **This is the LiquidIO model**

LiquidIO OVS offload



LiquidIO accelerates OVS Data path and restores CPU cores back to the server

The LiquidIO model

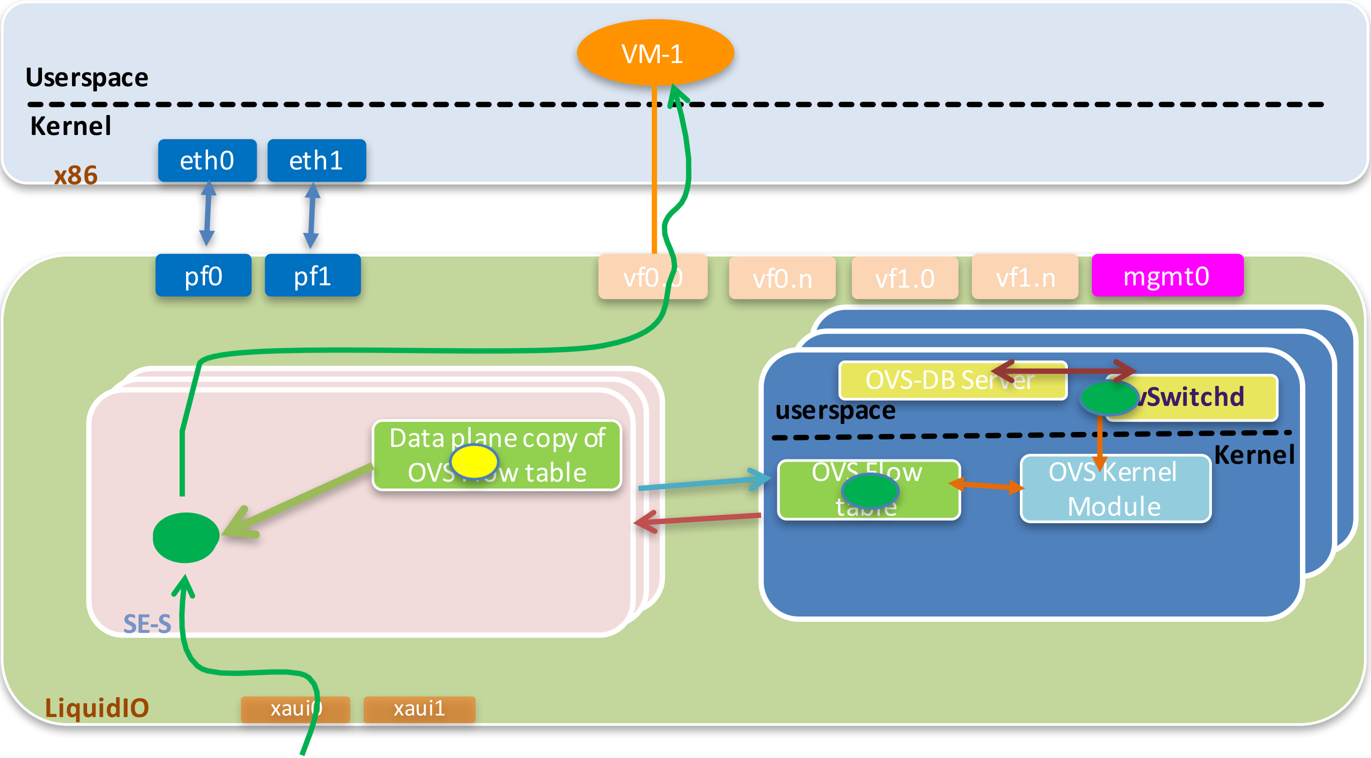


Inter-core messaging protocol allows control to data plane communication.

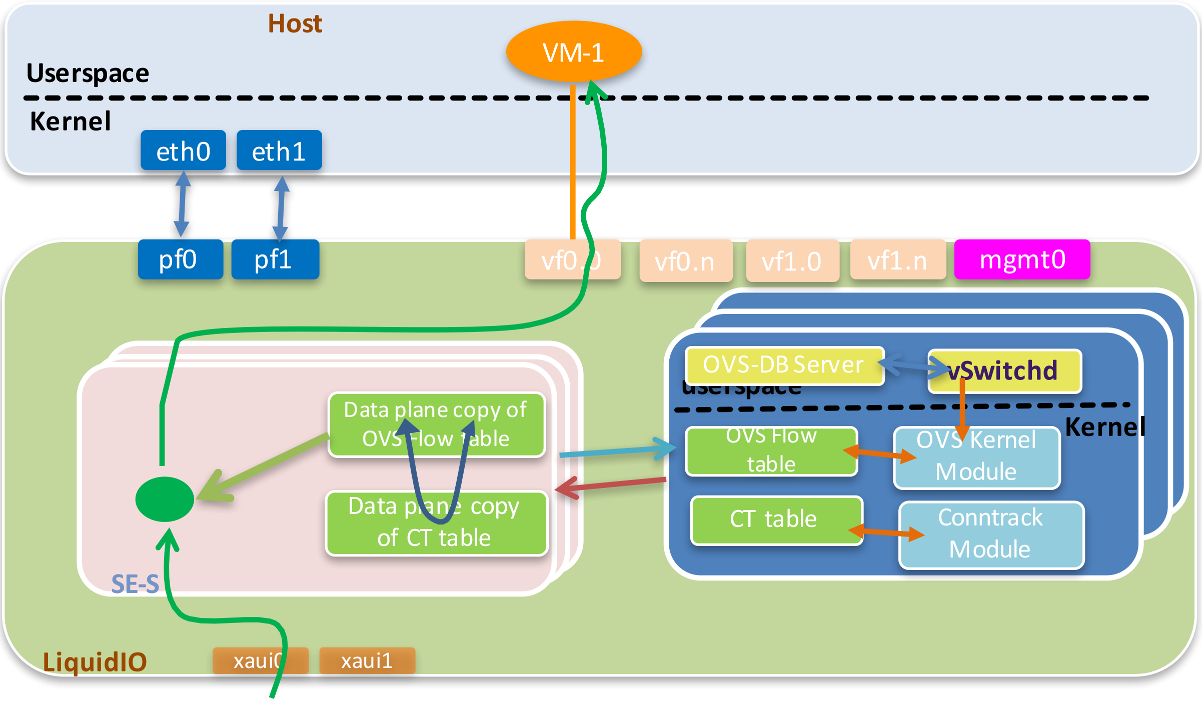
LiquidIO Open vSwitch offload

- Data plane leverages acceleration for multi-core packet processing, packet parsing and scheduling provided by hardware.
- Uses hardware support for implementing message passing layer.
- Zero host CPU utilization for OVS processing.
- Uses standard LiquidIO VF drivers in VM. No VF representor required.
- Supports conntrack + NAT.
- Also supports encryption of network traffic.

LiquidIO OVS offload – life of a packet



LiquidIO OVS offload – conntrack



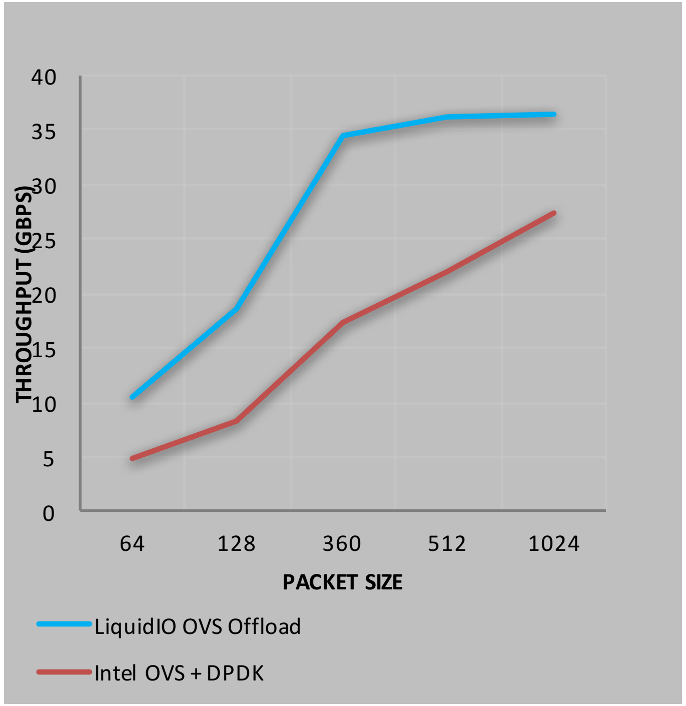
- Leverages conntrack module from the Linux kernel running on LiquidIO cores.
- Message passing layer to keep copy of CT table in the data plane.
- All packets continue to go to conntrack module in Linux kernel and decision made in kernel on flow update.
- When connection gets to established state, the flow and CT table are updated in the data plane.
- Once offloaded, CT state lookup happens in data plane.
- Data plane supports timeout of CT entries

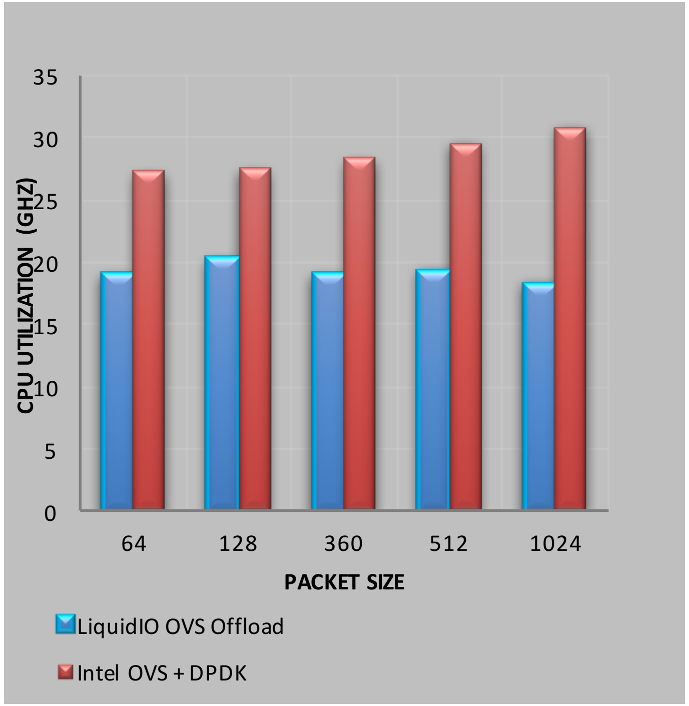
LiquidIO OVS customization – customer use cases

LiquidIO support all standard OVS vswitch operations but customers need to tweak firmware to fit in their deployment.

- Secure Access model
  - Deny host access to OVS running on LiquidIO.
  - OVS is remotely managed using proprietary management plane.
- Custom tunneling protocols
  - Uses custom tunneling protocols instead of Vxlan, GRE.
  - Uses custom management plane. Control of OVS via network or from the local host.
- IPSec support for VM payload
  - IKE runs in VM; xfrm offload module allows SA offload to LiquidIO.
  - LiquidIO can perform IPsec operation for VM traffic and encapsulate in tunnel as per OVS action.
- Custom core vswitch
  - Uses custom data plane with modified flow tables.
  - Openflow is still used to apply rules.
  - Control plane applications are also customized.

LiquidIO OVS Offload – TCP performance





Netperf TCP bi-directional (8 flows) with Vxlan

LiquidIO VF in PCI passthrough, Intel with OVS+DPDK using virtio.

Setup

Dell T630 with 14 cores E5-2690v4 @ 2.6 Ghz

Host OS: CentOS 7.3
Guest OS: CentOS 7.3

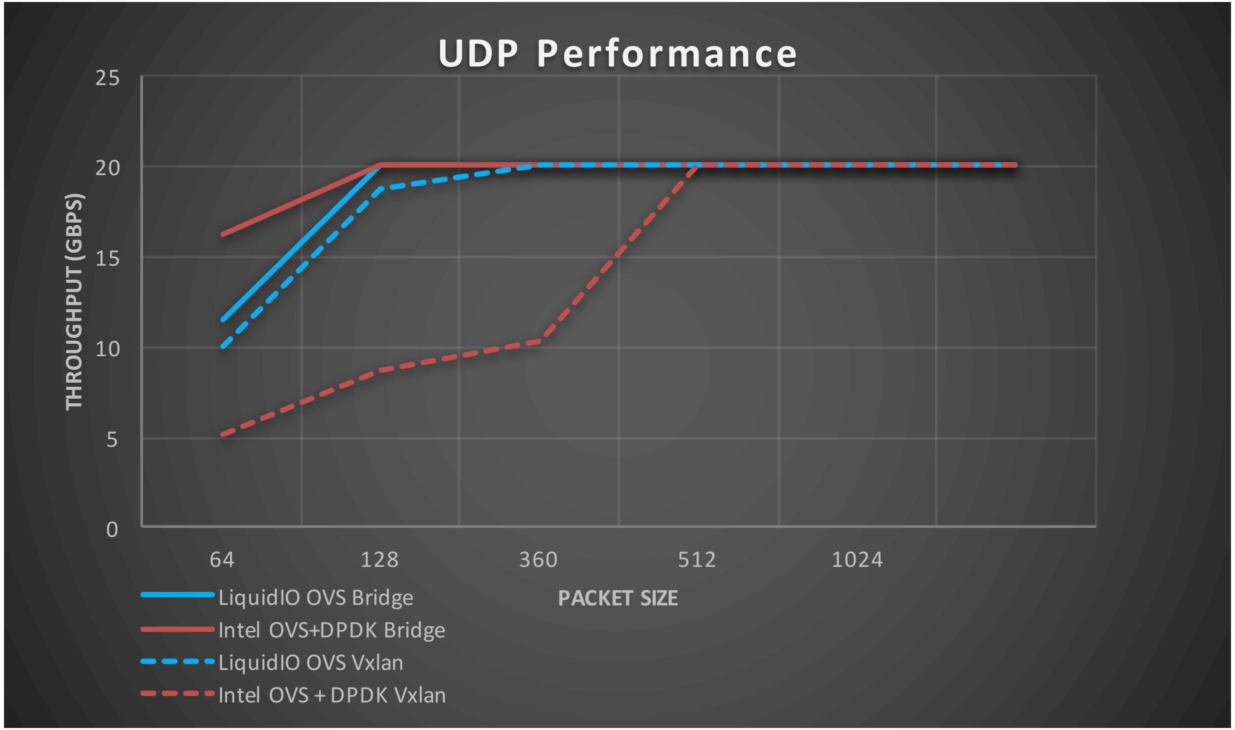
2 VMs each with 4 vCPUs

Adapters:
Intel X710 10G – DA4
LiquidIO 2360-210

Intel tests with OVS+DPDK on 4 host CPUs.

Tested with TCP traffic on 2 x 10G ports.

LiquidIO OVS Offload – UDP performance



DPDK testpmd running Rx mode in VM (100 flows)

LiquidIO VF in PCI passthrough, Intel with OVS+DPDK using virtio.

Setup

Dell T630 with 14 cores E5-2690v4 @ 2.6 Ghz

Host OS: CentOS 7.3
Guest OS: CentOS 7.3

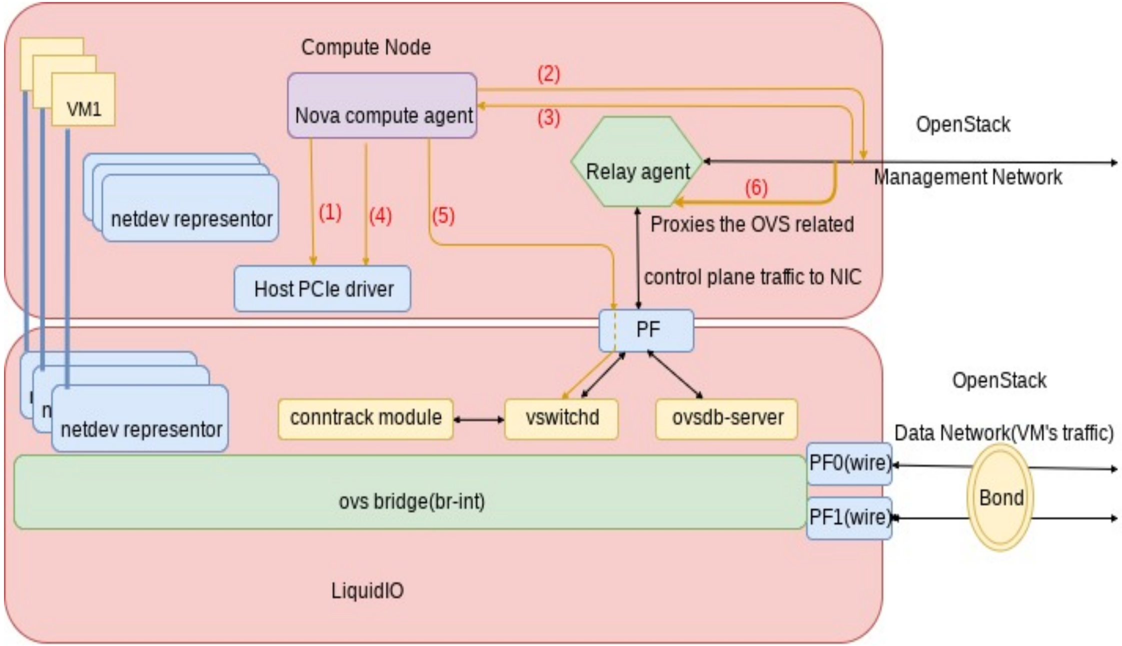
Single VM with 4 vCPU

Adapters:
Intel X710 10G – DA4
LiquidIO 2360-210

Intel tests with OVS+DPDK on 4 host CPUs.

Tested with UDP traffic on 2 x 10G ports.

LiquidIO OVS Offload - Openstack integration



- Uses VF representors in host to allow Neutron server to bind LiquidIO VF to compute node VMs.
- Uses relay agent to allow Neutron server to reach OVS control plane running on LiquidIO.
- Integration bridge is implemented in the LiquidIO adapter itself.
- Slow path continues to be within the LiquidIO but VF stats are updated for the VF representor in the hypervisor.
- No changes to Neutron for this model.
- Proof of concept completed for ODL & OVN with Pike based RDO.

LiquidIO OVS offload – pros & cons

- Advantages
  - Slow path avoids PCI overhead.
  - Host isolation – vswitch can be remotely managed.
  - Migration to new OVS version without kernel or host OS changes.
  - Supports all tunneling protocol available with OVS – Vxlan, NVGRE, GENEVE.
  - Support for conntrack + NAT.
- Limitations
  - VMs connect to the data network using a single adapter.
  - Openstack components lacks flexibility to support full offload.
  - Data plane requires tweaks to support new OVS features.
  - Live migration requires attach to VM using virtio.
    - PCI passthrough to VM cannot support Live Migration.

LiquidIO OVS Offload – looking ahead

- Add support for OVS 2.8
- Infrastructure to support TC/Flower based offload
- Support next generation ARM based LiquidIO adapters
- Improve conntrack implementation
- Add support for ebpf offload
- How can the community help with full offload?
  - Allow control and data plane to exist in different domains. Some support for TCP based connections but this could be fully extended.
  - OVN currently expects vswitch to run on the local processor.

LiquidIO OVS Offload

Thank You!