OPENFABRICS ALLIANCE

12th ANNUAL WORKSHOP 2016

RDMA AND USER SPACE ETHERNET BONDING

Tzahi Oved

Mellanox

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AGENDA

- **Introduction**
  - NIC Teaming
  - RoCE and ib_device
  - Application view
- **RDMA Device HW Bonding**
- **HW Bond and virtualization**
  - Embedded Switch SW Model
  - Embedded Switch and HW Bonding
- **Multi-PCI Socket NIC**
  - Introduction
  - HW Bonding for app transparency
- **Summary**

INTRODUCTION

Bonding / Team drivers

- **IEEE 802.3ad defines how to combine multiple physical network ports to single logical port for:**
  - High Availability
  - Load balancing
- **Linux uses Bonding/Teaming device for building Link Aggregation trunk**
- **Both expose software net_dev that provides LAG I/F toward the networking stack**
- **Team/bond is considered “upper” device to “lower” enslaved NICs net_devices**
- **Different modes of operation**
  - Active/Passive
  - 802.3ad (LAG) static and dynamic (LACP)
- **Traditional network stack sees single “upper” net_dev**

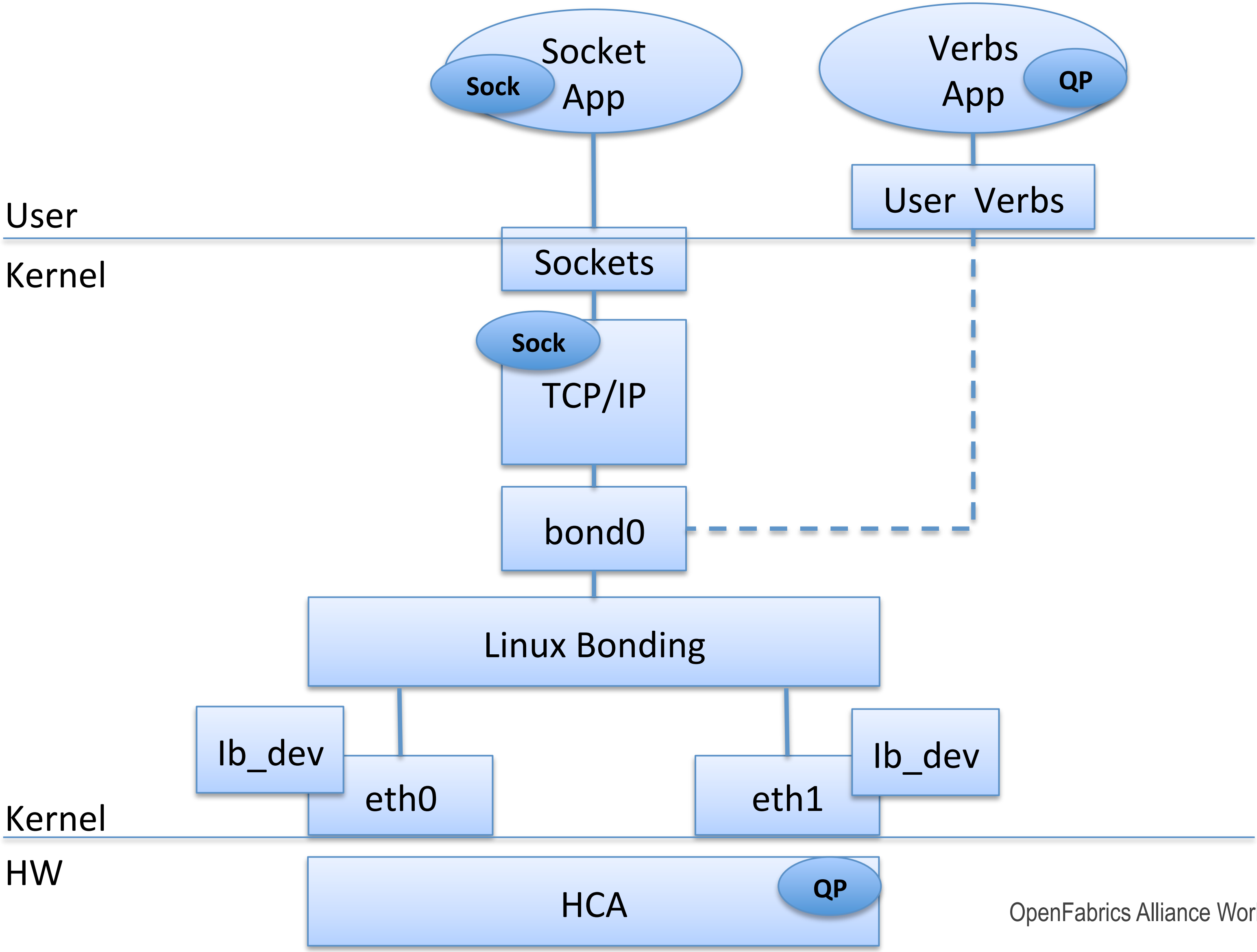
INTRODUCTION

RDMA over Ethernet (RoCE) / RDMA-CM

- **The upstream RDMA stack supports multiple transports: RoCE, IB, iWARP**
- **RoCE – RDMA over Converged Ethernet, RoCE V2 (upstream 4.5), IBTA RDMA headers over UDP.**
- **RoCE uses IPv4/6 addresses set over the regular Eth NIC port net_dev**
- **RoCE apps use RDMA-CM API for control path and verbs API for data path**
- **RDMA-CM API *(include/rdma/rdma_cm.h*)**
  - Address resolution – Local Route lookup + ARP/ND services (rdma_resolve_addr())
  - Route resolution – Path lookup in IB networks (rdma_resolve_route())
  - Connection establishment – per transport CM to wire the offloaded connection (rdma_connect())
- **Verbs API**
  - Send/RDMA – Send message or perform RDMA operation (post_send())
  - Poll– Poll for completion of Send/RDMA or Receive operation (poll_cq())
    - Async completion handling and fd semantics are supported
  - Post Receive Buffer – Hand receive buffers to the NIC (post_recv())
- **RDMA Device – ib_device**
  - The DEVICE structure, exposes all above operations
  - ***Associated with net_device***
- **Available for both RoCE and user mode Ethernet programming (e.g. DPDK)**

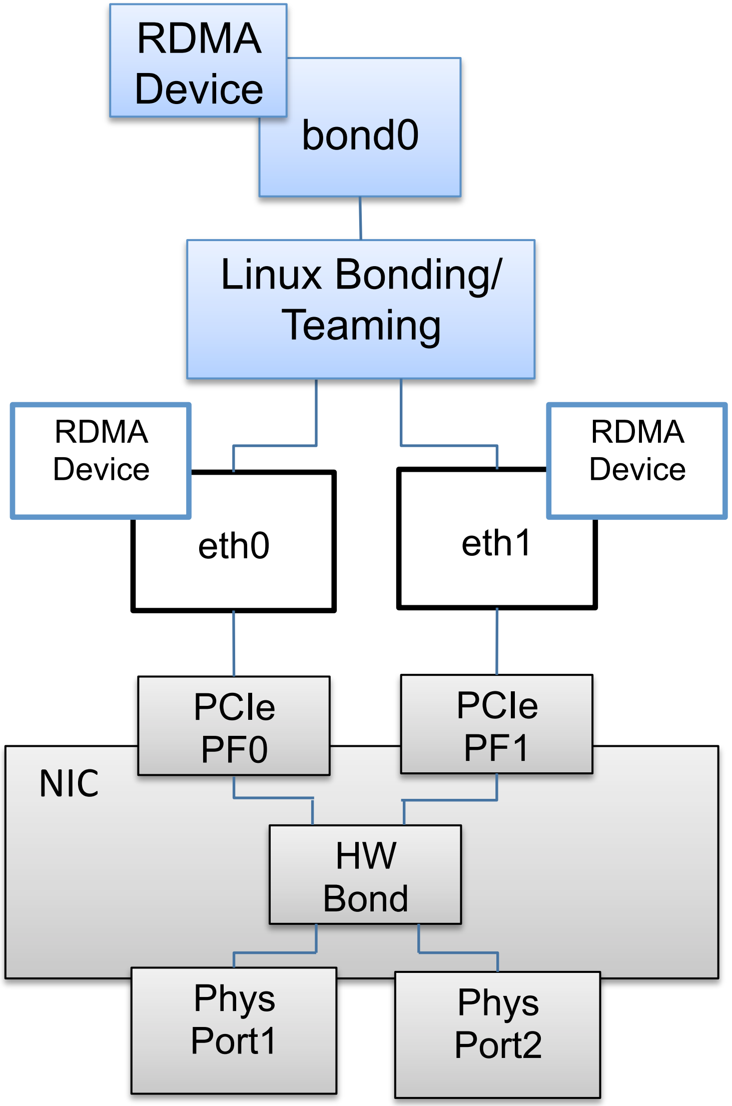
ETHERNET BONDING

Application Point of View



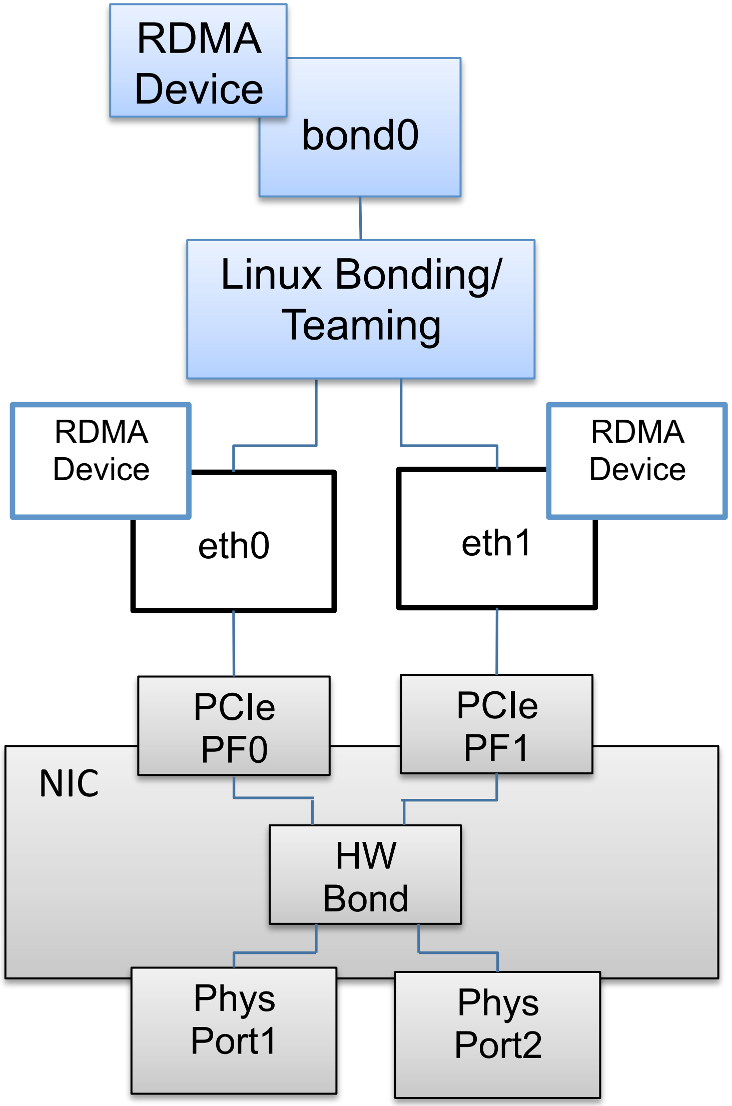
RDMA DEVICE HW BONDING

- **Register new ib_dev associated with the bond net_dev**
  - eth0, eth1 will listen on Linux bond enslavement netlink events
  - New device will use provider pick of PCIe Function (PF0/1 or both) for device I/O
- **Registered RDMA devices associated with eth0, eth1**
  - Will unregister and re-register to drop existing consumers on enslavement
  - Will be used for port management only through Port Immutable ops (get_port_immutable())
    - Alike the Linux Bonding enslaved net_devs



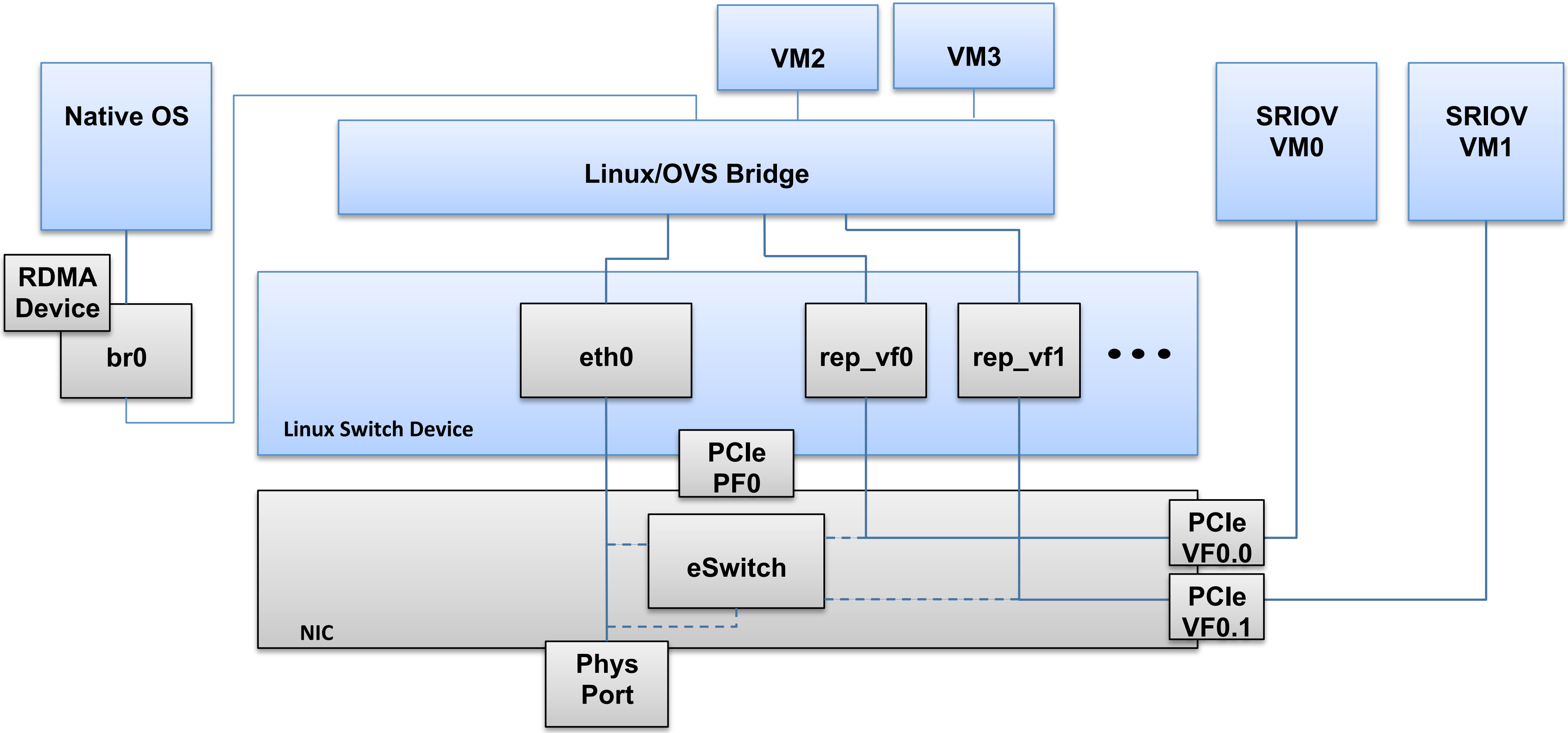
RDMA DEVICE HW BONDING – CONT.

- **HW Bond**
  - NIC logic for HW forwarding of ingress traffic to bond/ team RDMA device
  - net_dev traffic is passed directly to owner net_dev according to ingress port
- **Failover**
  - RoCE and user mode Eth traffic transport object (QP) port is migrated transparently in HW
  - Traditional net_dev I/F traffic remains associated with slave net_dev
- **Verbs**
  - Use transport object (QP) attribute: port affinity
- **Configuration**
  - Native Linux administration
  - RoCE Bonding is mainly auto configured
- **LACP ((802.3ad)**
  - Either handled by Linux bonding/teaming driver
  - Or in HW/FW for supporting NICs (required for many PFs to single phys port configurations)



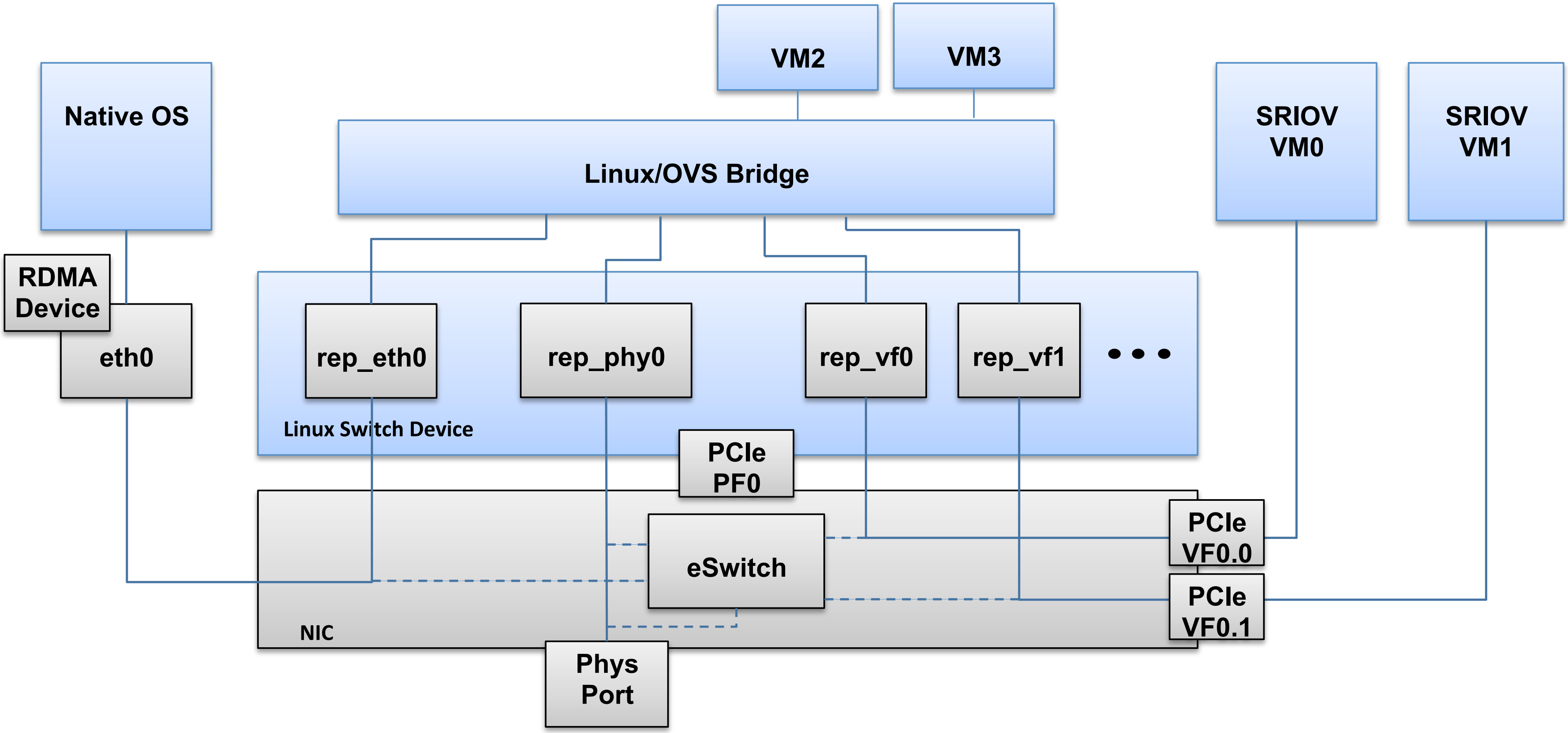
HW BOND AND VIRTUALIZATION

eSwitch Software Model – Option I



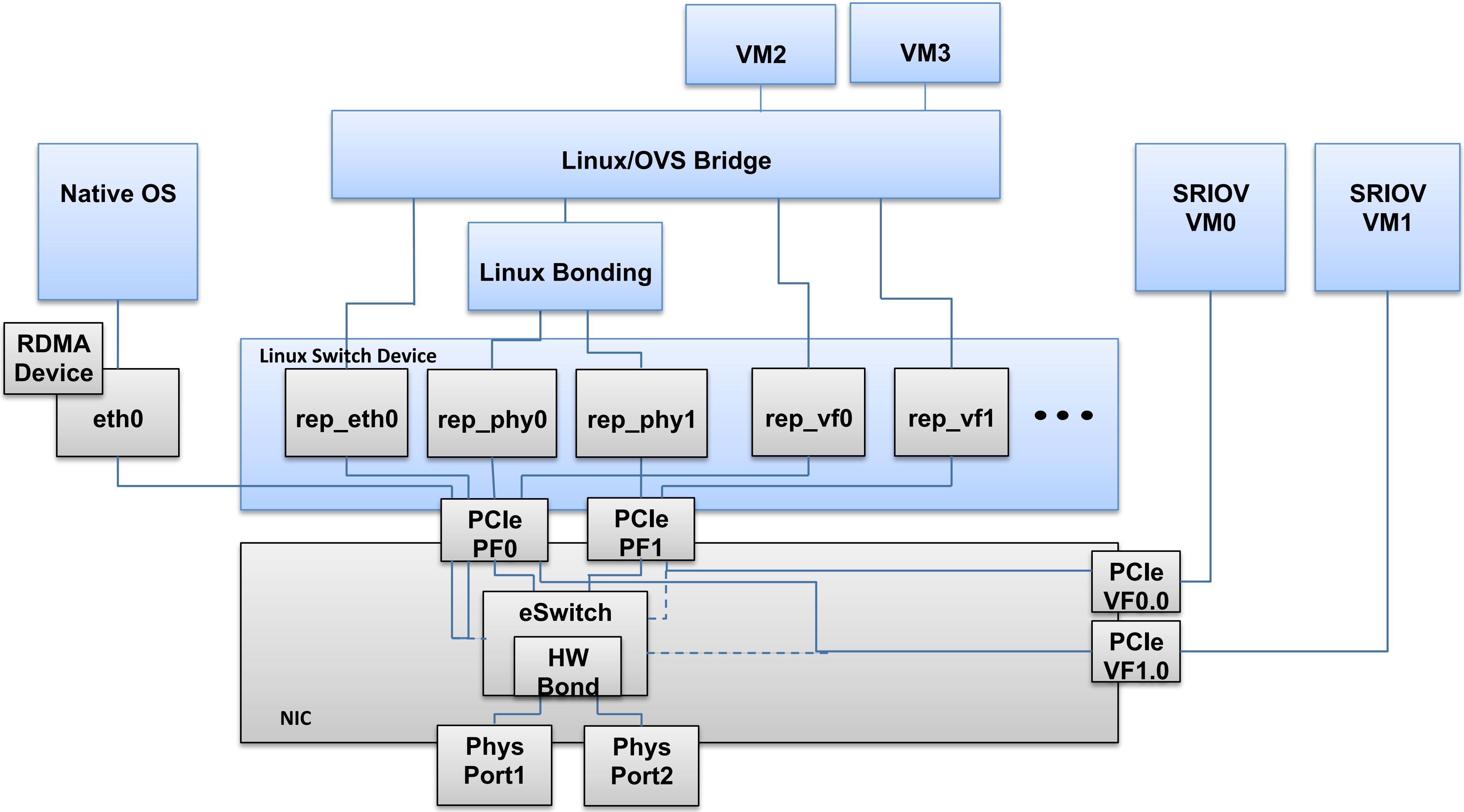
HW BOND AND VIRTUALIZATION

eSwitch Software Model – Option II



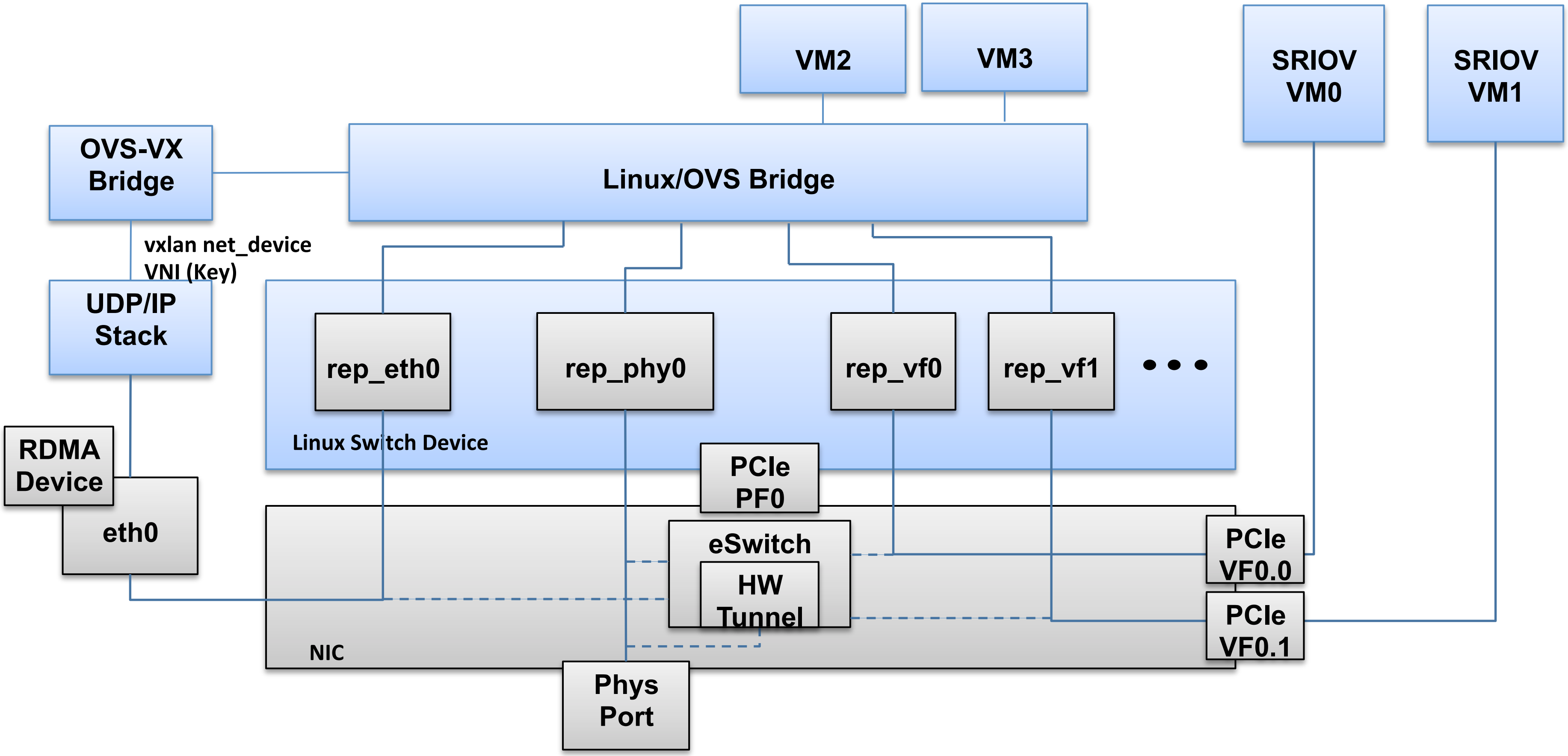
HW BOND AND VIRTUALIZATION

eSwitch Software Model with HA



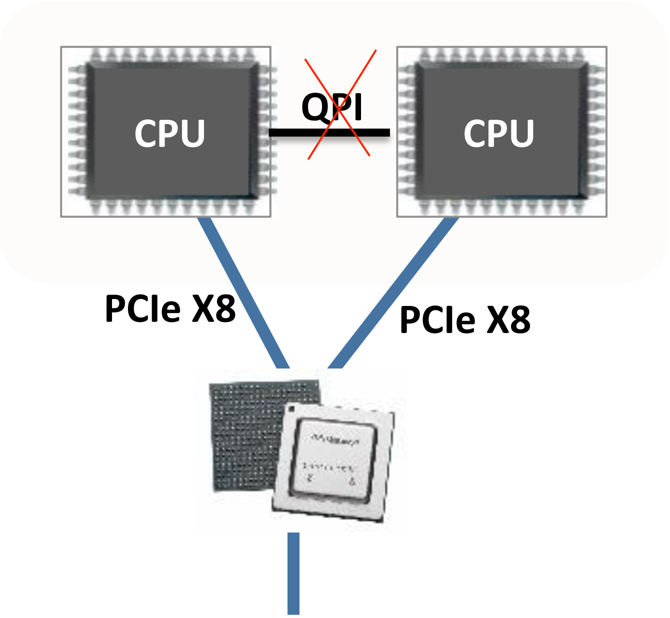
HW BOND AND VIRTUALIZATION

eSwitch Software Model with Tunneling



MULTI-PCI SOCKET NIC

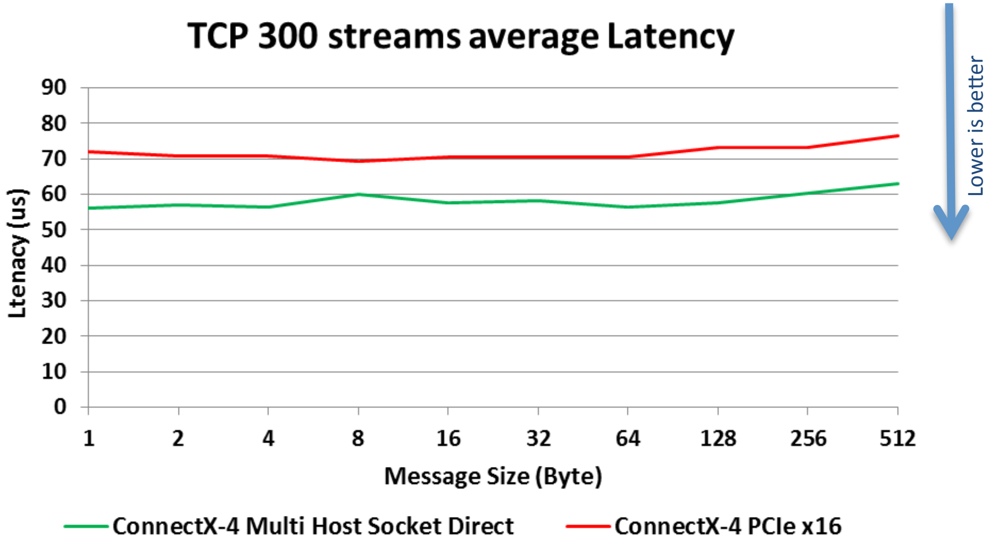
- **Single NIC can be connected through one or more PCIe buses**
- **Each PCIe bus is connected through different NUMA node**
- **For OS, exposed as 2 or more net_device each with it's own associated RDMA device**
- **Application enjoy direct device to local NUMA access**
  - Using local network I/F per NUMA node
- **Boosting performance for HPC and Cloud**
  - QPI avoidance for I/O – Optimal performance
  - Enables GPU / peer direct on both slots
  - Enables Direct Data I/O (DDIO) acceleration for both sockets

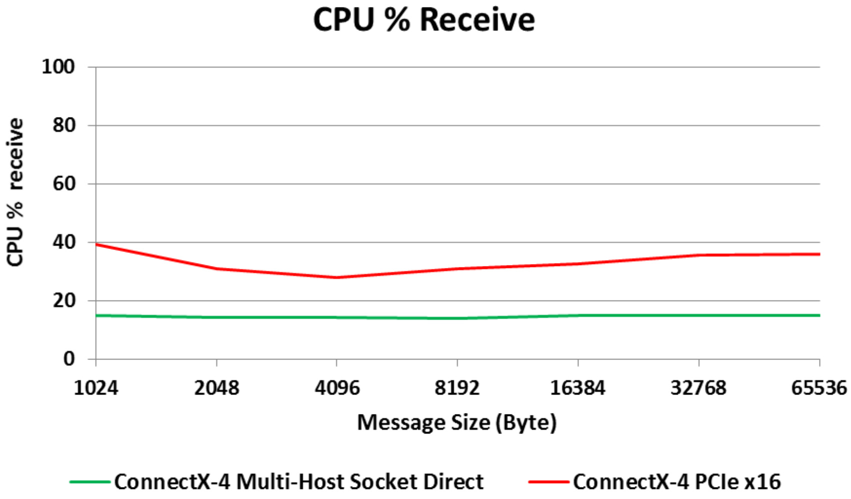


MULTI-PCI SOCKET NIC

Benchmark

20% Lower Latency



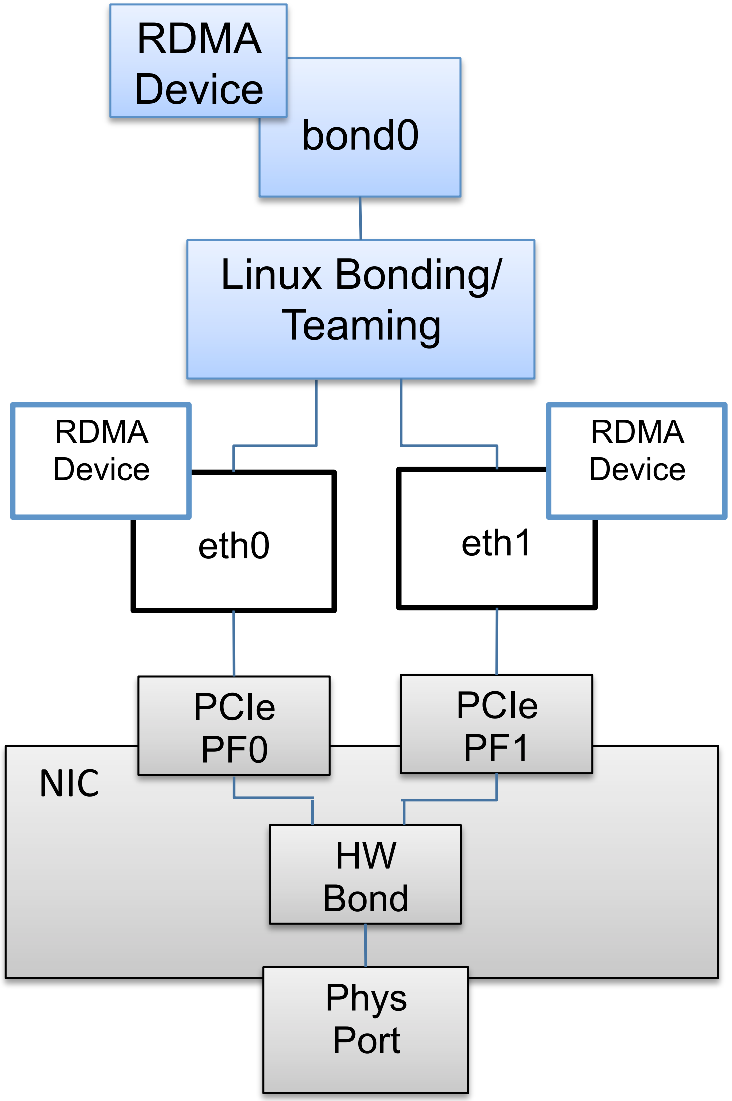


50% of CPU Overhead

MULTI-PCI SOCKET NIC

Transparency to the App

- **Application use & feel – would like to work with single net I/F**
- **Use Linux bonding with RDMA device bonding**
- **For TCP/IP traffic**
  - On TX, select slave according to TX queue affinity
  - On RX, use accelerated RFS to educate the NIC which slave to use per flow
- **For RDMA/User mode ETH traffic select slave according to:**
  - Explicit - Transport object (QP) logical port create affinity attribute
  - Or transport object creation thread CPU affinity attribute
  - QPn namespace is divided across slaves
    - On receive use QPn to slave mapping
      - From BTH or from Flow Steering action
- **Don't share HW resources (CQ, SRQ) on different CPU sockets**
  - each device has it's own HW resources



SUMMARY

- **Traditional stack transport logic is managed in software (TCP/IP)**
- **RDMA transport logic is managed in NIC HW**
- **Migrating the HW managed transport object from failed port requires HW aid**
  - Currently limited to phys port of the same adaptor
- **Building on top of existing infrastructure provides seamless administrative and application wise configuration**
  - Allows HW awareness of the configuration and failover event
- **Same logic may be used for representing multiple logical devices to single phys device interface**

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