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RDMA Virtualization

ANNUAL INTERNATIONAL OPENFABRICS SOFTWARE DEVELOPERS' WORKSHOP

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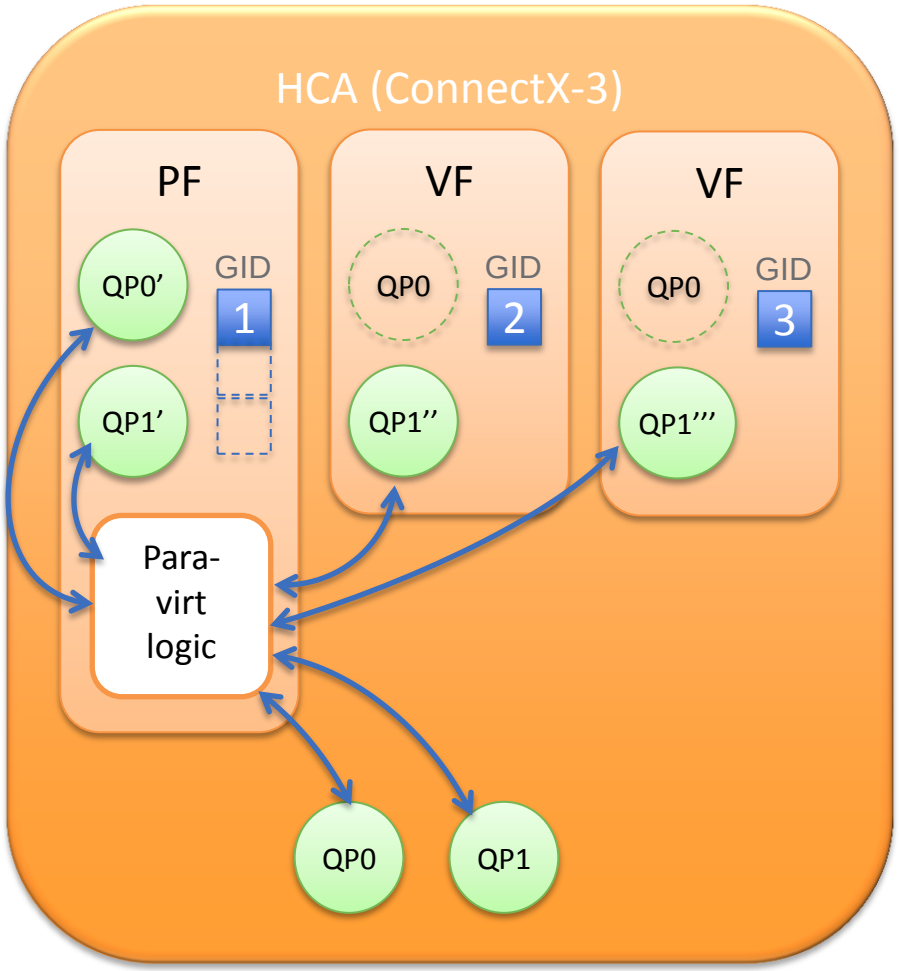
Agenda

- RDMA virtualization today
- Requirements and solution space
- Introducing Virtual Ports (VPorts)
- Virtualization software
  - Model
  - Subnet management
  - Subnet administration
  - Host stack
  - Backward compatibility
- Hypervisor APIs
- Conclusions

RDMA Virtualization Today

- Shared port model
- vHCAs are emulated by PF driver
  - Transaction ID mapping
  - GMP multiplexing
  - Multicast proxy
  - InformInfo proxy
  - Connection management proxy
- Not visible to Subnet Management
- Per-device sysfs APIs

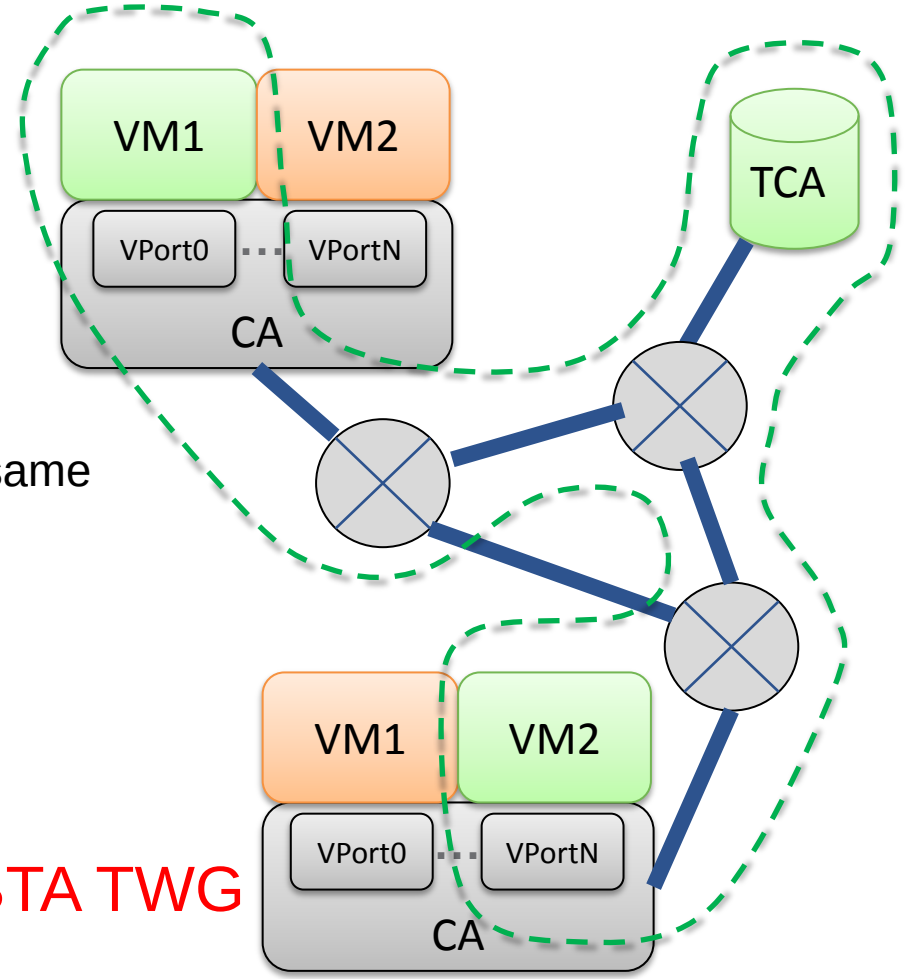


Virtualization Requirements

- Scalable
- Explicit Subnet Management
  - Virtual endpoints get full representation
- Simplicity
  - No PF-VF driver communication
  - No para-virtualization
- Backward compatibility
  - Legacy SM
  - Legacy nodes

Virtualization Approach

- Solution space
  - (Emulated) IB switch
  - (Emulated) extended IB switch
  - Virtual Port (VPort) array
- Proposal: VPort array
  - Similar to SRIOV
    - Multiple PFs and VFs share the same function space on the PCI
  - Similar to NPIV
    - vHCAs have a unique ID
      - But share the physical port
    - Recognized by the fabric
      - LUN masking, zoning, etc.
- Initial presentation given to IBTA TWG

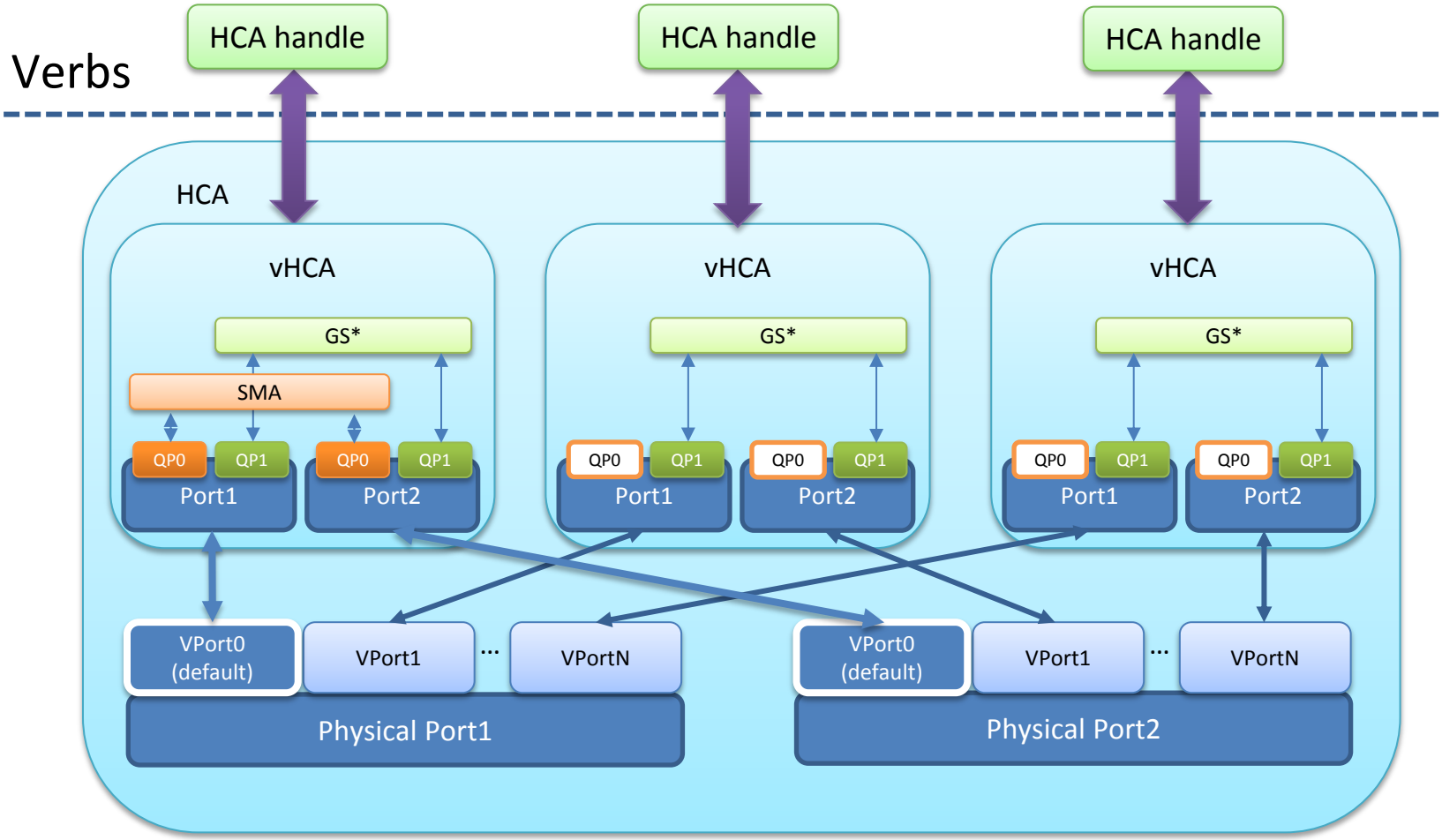


Virtualization Software

- Implications of virtual transport endpoints (VPort array)
  - Device model
  - VPort properties
  - OpenSM
    - Subnet management
    - Subnet administration
  - Host stack
  - Backward compatibility

- Track IBTA progress
  - Model, packet relay, Verbs semantics, management, MAD formats, etc.

Device Model



VPort Properties

- Independent transport attributes
  - Gid Table
  - P_KeyTable
  - (Logical) LinkState
  - Capability Mask
  - P_KeyViolations counter
  - Q_KeyViolations counter
  - ClientReregister
- L2 attributes are shared
  - LID, LMC, SL2VL, VL arbitration, etc.

Subnet Management

- Virtualization is an extended CA capability
  - Enabled by a virtualization-aware SM
- Virtual ports discovered and configured just like physical ports
  - Partitioning
  - PortState
- MAD processing
  - Virtualization discovery and management
    - Target physical port
  - Virtual ports properties
    - PortState, P_Keys, etc.
    - Target specific VPort
  - Dynamic Virtual Port monitoring
    - Aggregate VPortState
    - VPortState Change Trap

OpenSM Operation

- Fabric initialization
  - Physical subnet discovery and initialization
    - Fabric sweep, routing configuration, port initialization
  - Virtual Ports discovery and initialization
    - Discover enabled VPorts, configure partitioning

- Fabric maintenance
  - Physical fabric changes
    - Periodic sweep or PortState Change trap
  - Virtual Ports changes
    - VPort State Change trap from a physical port

Subnet Administration

- Process GMPs with GRH
  - Assuming that VPorts are identified by GIDs
- Partition checks apply to VPort P_Key tables
- SA query subsystem VPort support for
  - PathRecord
  - MCMemberRecord
  - InformInfoRecord
  - ServiceRecord
  - MultiPathRecord

Host Stack

- Verbs
  - **ibv_query_device**() returns VHCA properties
  - **ibv_query_port**() returns VPort transport properties
  - Transport APIs refer to VHCA resources

- Unaffiliated asynchronous errors and events
  - Transport events
    - Refer to VHCA transport resources
  - IBV_EVENT_PORT_ACTIVE/_ERR
    - Refers to VPortState
  - IBV_EVENT_CLIENT_REREGISTER
    - Reported for both physical and virtual ports
  - IBV_EVENT_GID_CHANGE and IBV_EVENT_PKEY_CHANGE
    - Refers to changes in VPort GID and P_Key tables

Host Stack (cont.)

- Virtualization is not transparent to software
  - Concise with explicit IB management
  - Mostly informational
    - Used only by OpenSM or other management utilities

Essentially ***no*** changes to OFED applications that work with GIDs

Backward Compatibility

- Possible approach: nominate one VPort as special
  - E.g., VPort0 on each physical port
  - Typically would be assigned to the PF in SRIOV
- Mirrors physical port transport attributes
  - GID table, P_Key Table, Capabilities, etc.
- Default steering target
  - Traffic with no GRH
  - Miss on DGID match
- Privileged
  - SMPs
  - Raw Ethertype
  - Raw IPv6

Provides ***full*** backward compatibility with
- Legacy SM
- Legacy OFED Stack running on PF
- Legacy OFED stack running on peers

Hypervisor APIs

- Control VF
  - Identity
  - Port state
  - QoS (e.g., rate limit)
  - Resource quotas
- Exposed by PF IPoIB interfaces (ndo_* ops)
  - Reuse existing functions for IB ports

```
int (*ndo_set_vf_rate)(struct net_device *dev, int vf, int min_tx_rate, int max_tx_rate);
int (*ndo_set_vf_link_state)(struct net_device *dev, int vf, int link_state);
```

  - Extend rtnetlink + ndo_* ops for IB specific operations

```
int (*ndo_set_vf_node_guid)(struct net_device *dev, int vf, u64 guid);
int (*ndo_set_vf_port_guid)(struct net_device *dev, int vf, u64 guid); /* port implied by netdev */
Int (*ndo_set_vf_hca_resources(struct net_device *dev, int vf, struct nlattr *resources[]);
```

Conclusions

- The time is ripe for RDMA virtualization
- Virtualization should be an equal citizen in RDMA fabrics
  - Discovery
  - Network services
- IBTA requested to take on standardization
  - Virtual transport endpoints (VPorts) look like a promising direction
- Virtualization software required!
  - Host stack, OpenSM, management tools

Thank You

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