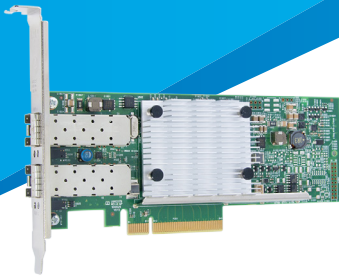


Concurrent NIC Partitioning and SR-IOV

Do More with Less in Server Virtualization!



- Reduces Capital and Operational Expenditures
- Eliminates Dependency on a Captive Switch
- Simplifies Deployment and Management
- Improves Ability to Scale the Business
- Delivers a Flexible I/O Virtualization Solution

EXECUTIVE SUMMARY

Virtualization of networks, storage, servers, and applications continues to grow in the data center. While virtualization provides many benefits, virtual deployment workloads have increased the demands placed on the network I/O infrastructure, which can significantly impact system and application performance.

Architectural improvements are occurring on the interface between the CPUs and the network interface hardware. Virtualization of I/O using Single Root I/O Virtualization (SR-IOV) for individual servers and switch-independent NIC Partitioning (NPAR) are technology standards that promise to improve the scalability, flexibility, throughput, and latency performance of networking operations.

With QLogic® FastLinQ™ 3400/8400 Series 10GbE Adapters, NPAR and SR-IOV can be used independently or simultaneously to divide a physical adapter port into multiple virtual ports. This QLogic unique capability allows customers to concurrently have access to storage offloading, have bandwidth Quality of Service (QoS), use NIC teaming, and use SR-IOV VF's enhanced I/O performance.

The following operating systems support both SR-IOV and NPAR modes:

- Windows Server 2012 Hyper-V
- Windows Server 2012 R2 Hyper-V
- Linux RHEL 6.4+ with KVM hypervisor
- Linux SLES 11.3+ with XEN hypervisor
- Citrix XenServer 6.2+
- VMware ESXi 5.5+

NIC PARTITIONING – HARDWARE-BASED QOS

The QLogic FastLinQ 3400/8400 Series Adapter NPAR technology is driving next-generation server I/O virtualization by allowing the seamless migration from 1GbE to 10GbE while preserving the bandwidth segregation that 1GbE brought to virtual server environments. NPAR or switch independent Network Partitioning divides a single physical 10GbE Ethernet port into multiple PCI physical functions or partitions using a flexible bandwidth capacity allocation.

This approach enables administrators to apply QoS to individual virtual machine or hypervisor service workloads, improving I/O performance while maintaining a low total cost of ownership (TCO). QLogic's implementation maps four PCI functions to each physical port of a QLogic FastLinQ 3400/8400 Series Adapter.

NPAR presents the eight PCI functions per device using standard PCI configuration space. Each function or partition is assigned a unique pair of MAC addresses. Each QLogic FastLinQ 8400 Series Adapter partition can support simultaneous networking or storage protocols, enabling flexible bandwidth provisioning to applications. Unlike competitive solutions, these partitions can be assigned to simultaneously run both networking and storage protocols (on any partition) with an implementation that is agnostic to the external Ethernet switch.

NPAR provides a non-captive (switch agnostic) solution to customers, thereby eliminating vendor lock-in.

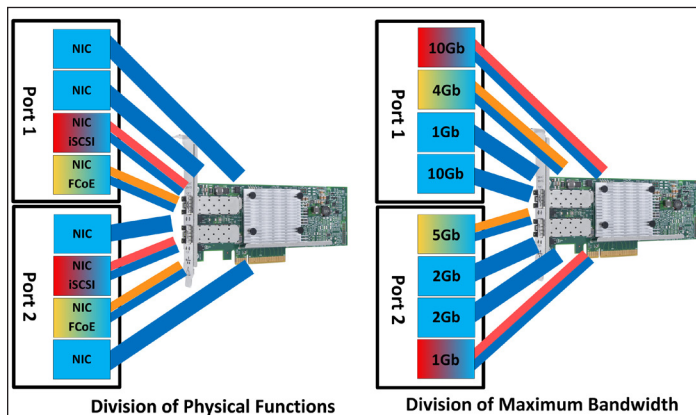


Figure 1. NPAR

PCI-SIG SR-IOV STANDARD

PCI special interest group (PCI-SIG®) has completed a suite of I/O virtualization specifications that work in conjunction with system virtualization technologies to allow multiple OSs running simultaneously within a single computer to natively share PCI Express® devices. I/O virtualization technology aims to resolve the performance, provisioning, and management problems of server I/O in highly virtualized and clustered data center environments.

The SR-IOV specification designates how a hardware device can expose multiple “light-weight” Virtual Functions (VFs) for use by VMs. VFs are focused primarily on data movement and are associated with a Physical Function (PF). The PF is equivalent to the regular PCIe® physical function device’s fully featured PCI functions. The PF is responsible for arbitration relating to policy decisions (such as link speed or MAC addresses in use by VMs in the case of networking) and for I/O from the parent partition itself.

For example, the QLogic FastLinQ 3400/8400 Series Adapters support up to 64 VFs per port in single PF mode and NPAR multiple PF mode. In SF mode, up to 64 VFs can be assigned per port along with both storage (iSCSI-Offload and FCoE-Offload) personalities enabled. In NPAR mode, administrators can assign the port’s VFs [via QLogic Control Suite 4 (QCS4) or the pre-boot Comprehensive Configuration Management (CCM) utility] to any PF (that does not have a storage personality enabled), in groups of 8 where the total number of VFs on the port’s PFs is equal to or less than 64.

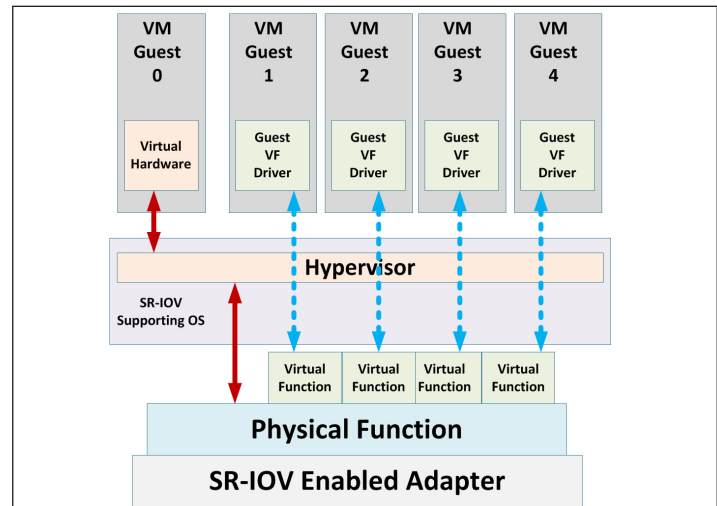


Figure 2. Diagrammatic Representation of SR-IOV

With NPAR, each physical port is partitioned into multiple physical functions on the PCIe bus. QLogic’s unique concurrent NPAR and SR-IOV technology allows the physical ports to be further partitioned into multiple virtual functions. This feature allows administrators to deploy NPAR in both bare metal (non-virtualized) OSs and virtualized OSs. In contrast, SR-IOV is primarily targeted toward virtualized platforms. Combining the two allows them to share their unique benefits— independent PFs with or without storage personalities, host teaming of selected PFs (for host applications and select vSwitches) while being able to use SR-IOV VFs to select VMs through the other PFs of the same physical port with VM teaming of SR-IOV VFs when needed.

Currently, a single VM can have no more than eight VFs assigned to it.

Virtual Server Architectures leveraging concurrent NPAR and SR-IOV

Figures 3 and 4 show examples of network architectures for virtual server deployments on Windows Server 2012/2012R2 Hyper-V.

- Host applications (such as LiveMigration) can use a partition directly (pNIC) or through a Host Team (tNIC) or through a “shared” vSwitch connection (vNIC).
- Hyper-V vSwitches can use a partition directly or through a Host Team.
- VM vNICs can use a vSwitch connection or SR-IOV VF connection.
- VMs can team vNIC connections from any source (from a vSwitch or VF).
- The partitions Maximum BW and Relative (Minimum) BW Weight QoS settings apply to all transmit traffic (Host, VM vSwitch, and VM VF) passing through it.
- A partition with a Host Team (both SF and NPAR mode) or with Storage enabled (NPAR mode only) cannot use SR-IOV VFs; otherwise, the PF and multiple VF connections can share the same partition.

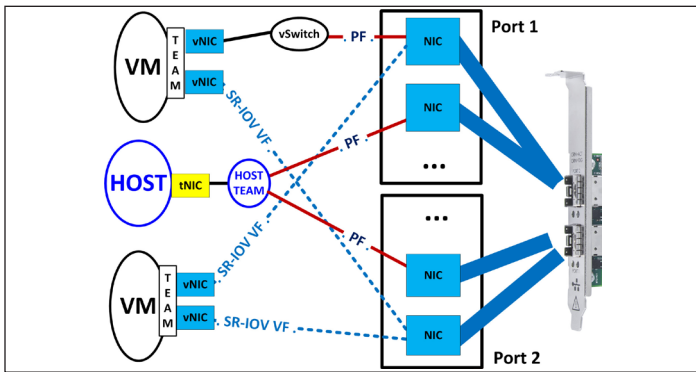


Figure 3. QLogic FastLinQ 3400 Enables Concurrent Hypervisor and VM Teams with a Single Adapter

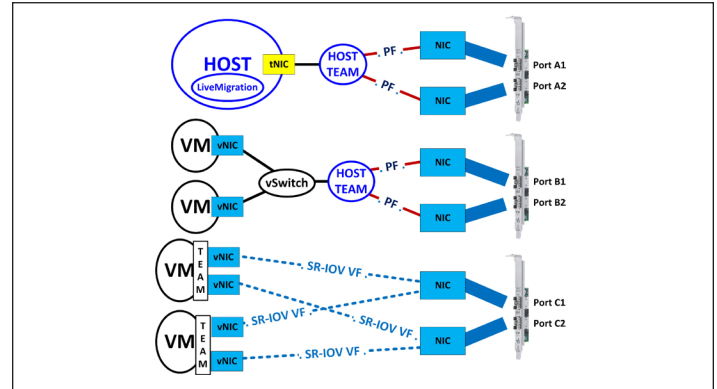


Figure 5. SR-IOV without NPAR

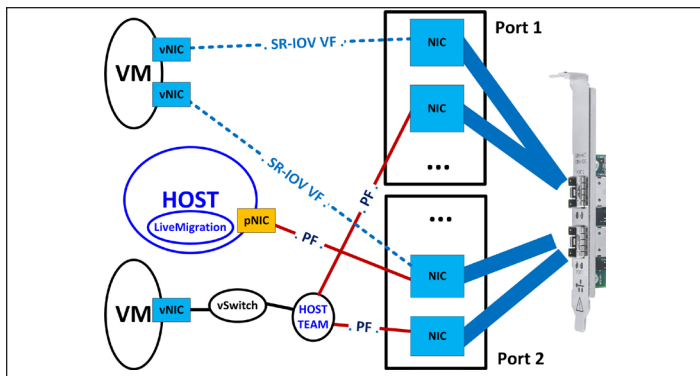


Figure 4. QLogic FastLinQ 3400 Enables QoS Across All Hypervisor and VM Services with a Single Adapter

For example (Figure 5), if you wanted to provide redundant load balanced 10GbE paths for all traffic (Host LiveMigration/Management/etc, VM vSwitched, and VM SR-IOV VF) on a virtualized server (such as with Hyper-V) using different VLANs, you would need at least **six** separate 10GbE ports (without NPAR mode).

- One pair of 10GbE ports would need to be teamed together (at the Host level) and could be used by the various Host applications (each application could be on its own VLAN).
- Another pair of 10GbE ports would need to be teamed together (at the Host level) and used by the VM vSwitched traffic that does not need the advantages of SR-IOV—with each vNIC connection pair possibly being on its own VLAN.
- The final pair of 10GbE ports would not be teamed together (at the host level) but would instead use SR-IOV VF connection pairs to the desired VMs (which would team those vNIC connections inside the VM to provide load balancing and failover for those traffic pathways) and each of these pairs could be on their own VLAN.

With QLogic FastLinQ 3400/8400 Series Concurrent NPAR and SR-IOV mode (Figure 6), all of this could be done by simply using two 10GbE ports (each with four shared partitions).

- One pair of partitions (port 1 partition 1 + port 2 partition 1) could be teamed together (at the Host level) and be used by the Host applications (each application on its own VLAN).
- Another pair of partitions (port 1 partition 2 + port 2 partition 2) could be teamed together (at the Host level) and be used by the VM vSwitched traffic that does not need the advantages of SR-IOV – with each vNIC connection pair possibly being on its own VLAN.
- The final pair of partitions (port 1 partition 3 + port 2 partition 3) could use up to 64 SR-IOV VF connection pairs to the desired VMs (which could use teaming of those vNIC connections at the VM level to provide load balancing and failover for those traffic pathways) and each of these connection pairs could be on their own VLAN. Additionally, FCoE-Offload and/or iSCSI-Offload could be used on the remaining partition pair or share the first or second teamed partition pair to provide storage connections with MPIO-ed load balancing and failover protection. And each partition can have its own QoS settings.

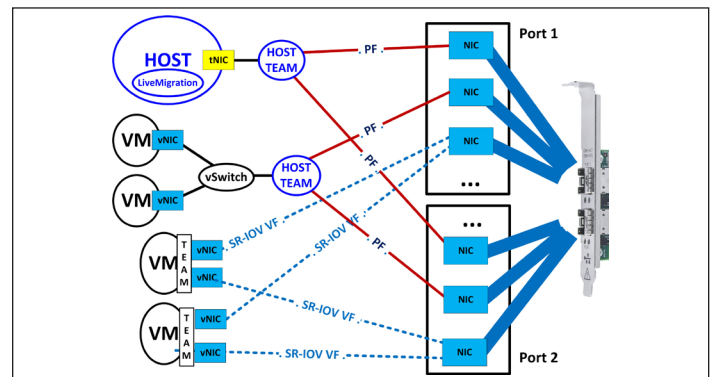


Figure 6. SR-IOV with NPAR

This would reduce the number of NIC ports needed, the number of switch ports consumed, and the associated cabling—this does not even consider the power savings and QoS benefits.

KEY BENEFITS

Here are some of the ways NPAR with SR-IOV deliver value to an enterprise and/or MSP data center:

NPAR Benefits:

- Reduced Capital and Operational Expenditures
 - Enables hardware consolidation of multiple 1GbE ports into a single 10GbE port
 - Allows the creation of multiple partitions (both PF and VF) for flexible bandwidth provisioning on 10GbE adapters
 - Provides lower adapter, cabling, switch port, and management costs
- Eliminates Dependency on a Captive Switch
 - Removes dependency on an external Ethernet switch to regulate and manage bandwidth
 - Offers customers the freedom to choose an Ethernet switch of their choice
- Simplified Deployment and Management
 - Provides concurrent support for Ethernet, FCoE, and iSCSI protocols, which appear as discrete functions similar to native OS, minimizing deployment disruptions
 - Eliminates the need for OS changes to implement flexible bandwidth provisioning
- Quality of Service (QoS)
 - Provides maximum bandwidth QoS of all traffic through a specific PF
 - Provides relative (minimum) bandwidth weight QoS of all traffic through a specific PF (in non-DCB mode)
 - Provides DCB-ETS minimum bandwidth weight QoS of all traffic through a physical port (in DCB mode)

SR-IOV Benefits:

- Improved Ability to Scale the Business
 - Reduces I/O emulation overhead
 - Assigns I/O hardware directly to VMs
 - Allows the dedication of bandwidth (QoS) for VMs and associated applications
 - Conserves PCIe slots in all server environments
 - Enables high I/O performance in virtualized environments

SR-IOV over NPAR Combined Benefits:

- All of the previous two benefits plus
 - Allows cohabitation of host teaming, storage, VM vSwitching, and SR-IOV VFs on significantly less physical ports
 - Quality of Service for a group of SR-IOV virtual functions associated with a physical function
 - Seamless co-existence of teaming and Direct I/O (SR-IOV) on the same physical adapter port
 - Reduces the number of 10GbE adapter and switch ports required to host a high availability high performance virtual server deployment by half

SUMMARY

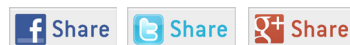
Most OS and hypervisor vendors support SR-IOV. It enables virtualization of I/O data paths at the server level. QLogic is the only solution provider that offers SR-IOV and NPAR operating concurrently as a standard way of addressing the customer needs of today for the network partitioning function. QLogic's NPAR is the OS-, platform-, and switch-agnostic solution available today. NPAR in combination with SR-IOV provides a comprehensive solution for the heterogeneous enterprise data center while delivering CAPEX savings by reducing the total number of physical 10GbE ports required.



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