

Overview of HP Virtual Connect technologies



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Introduction

HP developed Virtual Connect technology to simplify networking configuration for the server administrator using an HP BladeSystem c-Class environment. The baseline Virtual Connect technology virtualizes the connections between the server and the LAN and SAN network infrastructure. Virtual Connect adds a hardware abstraction layer that removes the direct coupling between the LAN and SAN. Server administrators can physically wire the uplinks from the enclosure to its network connections once, and then manage the network addresses and uplink paths through Virtual Connect software.

Virtual Connect interconnect modules provide the following capabilities:

- Reduces the number of cables required for an enclosure, compared to using pass-thru modules.
- Reduces the number of edge switches that LAN and SAN administrators must manage.
- Allows pre-provisioning of the network, so server administrators can add, replace, or upgrade servers without requiring immediate involvement from the LAN or SAN administrators.
- Enables a flatter, less hierarchical network, which reduces equipment and administration costs, reduces latency, and improves performance.
- Delivers direct server-to-server connectivity within the BladeSystem enclosure. This is an ideal way to optimize for east/west traffic flow, which is becoming more prevalent at the server edge with the growth of server virtualization, cloud computing, and distributed applications.
- Provides direct-attach SAN and dual-hop Fibre Channel over Ethernet (FCoE) capabilities to extend cost benefits further into the storage network.

Without Virtual Connect abstraction, changes to server hardware (for example, replacing the system board during a service event) typically implies changes to the MAC addresses and WWNs. The server administrator must then contact the LAN/SAN administrators, give them the updated addresses, and wait for them to make the appropriate updates to their infrastructure. With Virtual Connect, a server profile keeps the MAC addresses and WWNs constant, so the server administrator can apply the same networking profile to new hardware. This feature can significantly reduce the time required to complete a service event.

Virtual Connect Flex-10 and the new Virtual Connect Flex-20 technology further simplifies network interconnects. Flex-10/Flex-20 technology allows you to split a 10 Gb or 20 Gb Ethernet port into four physical function NICs (called FlexNICs). This feature lets you replace multiple lower-bandwidth NICs with a single 10 Gb or 20 Gb adapter. Prior to Flex-10, a typical server blade enclosure required up to 40 pieces of hardware (32 mezzanine adapters and eight modules) for a full enclosure of 16 virtualized servers. Using HP FlexNICs with Virtual Connect interconnect modules reduces the required hardware by up to 50 percent by consolidating all NIC connections onto two 10 Gb or 20 Gb ports.

Virtual Connect FlexFabric adapters broadened the Flex-10/Flex-20 capabilities by providing a way to converge network and storage protocols on a 10 Gb/20 Gb port. Virtual Connect FlexFabric-20/40 F8 modules and FlexFabric adapters can (1) converge Ethernet, Fibre Channel, or accelerated iSCSI traffic into a single 10 Gb/20 Gb data stream; (2) partition a 10 Gb or 20 Gb adapter port into four physical functions with adjustable bandwidth per physical function; and (3) preserve routing information for all data types. Flex-10/Flex-20 technology and FlexFabric adapters reduce management complexity; the number of NICs, HBAs, and interconnect modules needed; and the associated power and operational costs. Using FlexFabric technology enables you to reduce the hardware requirements by 95 percent for a full enclosure of 16 virtualized servers—from 40 components to two Virtual Connect FlexFabric-20/40 F8 modules.

Further extending this foundation, the new HP Virtual Connect FlexFabric-20/40 F8 modules empower businesses to easily step up to higher bandwidth across the network infrastructure from the server to the cloud. With ground-breaking 20 Gb downlinks and 40 Gb uplink connectivity, the HP Virtual Connect FlexFabric-20/40 F8 modules deliver a number of firsts in the Virtual Connect module family, while extending the benefits of wire-once connectivity and fabric-ready performance for the next generation of enterprises and cloud foundations.

When used with Virtual Connect firmware 4.01 or later, the Virtual Connect Flex-10/10D interconnect implements the Data Center Bridging (DCB) standard to extend converged networking beyond the uplinks of the Virtual Connect module. The Virtual Connect Flex-10/10D interconnect also enables FCoE to be forwarded to an upstream DCB-capable switch in a dual-hop configuration. The result—SAN storage traffic for Fibre Channel targets does not have to break out into the SAN fabric at the back of the enclosure. Instead, it can be passed via Ethernet to the next switch, further reducing cabling and simplifying the fabric, thereby minimizing port costs.



A key HP innovation for Virtual Connect is the ability to connect directly to HP 3PAR StoreServ Storage systems by eliminating the SAN fabric. You can eliminate the intermediate SAN infrastructure or have both direct-attached storage and storage attached to the SAN fabric. Server administrators can manage storage device connectivity and LAN network connectivity using Virtual Connect Manager. The Virtual Connect FlexFabric-20/40 F8 modules offer direct-attach capability with 3PAR Fibre Channel storage. This capability has the potential to significantly reduce SAN acquisition and operational costs, while also reducing the time required to provision storage connectivity.

In writing this paper, we assumed that readers would be somewhat familiar with the HP BladeSystem architecture. If you are not, the document titled, “[Architecture and Technologies in the HP BladeSystem c7000 Enclosure](#),” provides helpful background information. This paper provides an overview of the Virtual Connect technologies. For details about the capabilities of specific modules and adapters, please visit the [Virtual Connect](#) website.

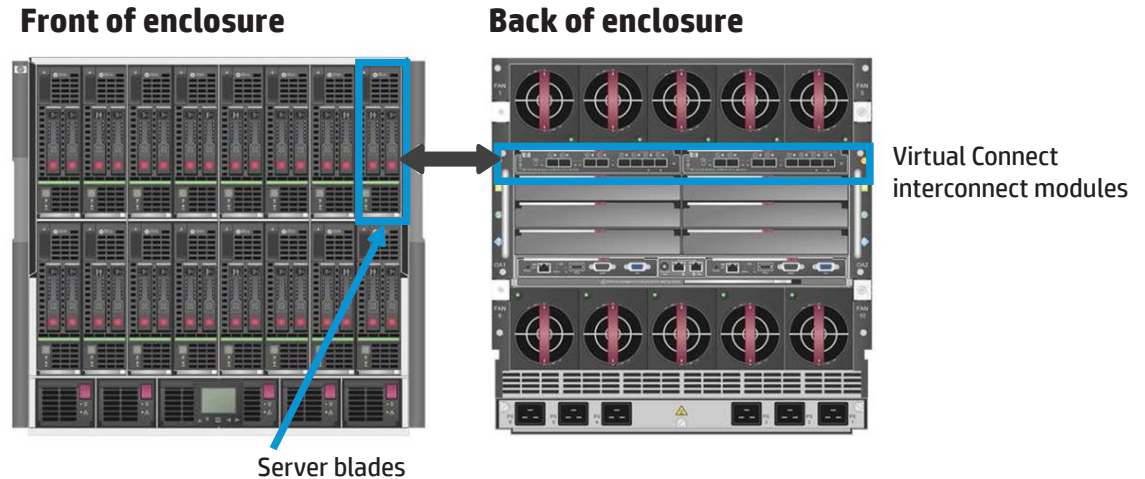
Virtual Connect components

Virtual Connect is a portfolio of interconnect modules, adapters, embedded software, and an optional management application:

- Virtual Connect interconnect modules—FlexFabric-20/40 F8, Flex-10/10D, and Fibre Channel—plug directly into the interconnect bays in the rear of the HP BladeSystem c-Class enclosure. The modules connect to server blades through the enclosure midplane. The Ethernet-based modules support 1 Gb, 10 Gb or 40 Gb on uplinks, and 1 Gb, 10 Gb or 20 Gb on downlinks, enabling you to purchase 1 Gb SFPs and upgrade to 10 Gb SFP+ transceivers when the rest of your infrastructure is ready to support it. In addition, Virtual Connect FlexFabric-20/40 F8 modules offer 2/4/8 Gb Fibre Channel on uplinks with Flexports; these universal ports can be configured as Ethernet or Fibre Channel ports.
- Flex-10, Flex-20 and FlexFabric adapters are available as either LAN-on-motherboard (LOM) devices or mezzanine cards. Virtual Connect technology also works with 1GbE adapters and FlexibleLOM devices for HP ProLiant BL Gen8 servers. A FlexibleLOM uses a special slot/connector on the motherboard; it lets you choose the type of NIC that is “embedded” on the ProLiant Gen8 server.
- Virtual Connect Manager (VCM) firmware is embedded in the Virtual Connect Flex-10/10D and FlexFabric interconnect modules. VCM manages a single domain of up to four enclosures. VCM is accessible with a web browser (GUI), but also provides a text interface (CLI) to meet the needs of individual users and tasks.
- Virtual Connect Enterprise Manager (VCEM) is an optional software application that lets you manage up to 250 Virtual Connect domains and up to 1,000 enclosures within those domains, containing up to 16,000 blade servers. The VCEM software provides automation and group-based management capabilities beyond what VCM offers.
- HP OneView provides a single collaborative management platform built for speed. It allows IT teams to work and collaborate in a more natural and automated way. HP OneView also provides a software-based approach to lifecycle management, which automates operations to reduce the cost and the time required to deliver IT services. HP OneView supports an open development platform designed to rapidly adapt to changing business needs. This programmable platform, built on the REST API, allows you to scale beyond data center walls, all the way to the cloud.



Figure 1. An internal midplane in the BladeSystem c-class enclosure connects the server blades in the front to the Virtual Connect interconnect modules at the back of the enclosure



Virtual Connect virtualizes the LAN and SAN connections

The Virtual Connect technology adds an abstraction layer between the edge of the server and the edge of the existing LAN and SAN. As a result, the external networks connect to a shared resource pool of MAC addresses and WWNs, rather than to MACs/WWNs of individual servers.

Server profiles and server identity

Using the concept of a “server profile,” Virtual Connect links information assigned to a specific server bay to the server hardware and its network connections. A server profile lets you manage the server’s internal identity (server serial number, UUID, BIOS settings, SAN boot parameters, and PXE boot parameters) and a server’s external identity (MACs, WWNs, VLAN assignments, and SAN fabric assignments).

Virtual Connect manages the server’s internal identity by presenting the managed serial numbers and a managed UUID to the OS image and applications, rather than the serial numbers and UUID assigned by HP at time of manufacture. When you include managed serial numbers within a server profile, you can migrate any software that is licensed to a particular server, based on either the serial number or UUID value, to new server hardware without a new software license. This way, you do not have to reinstall software associated with a specific serial number after a system recovery.

For the external server identity, Virtual Connect creates and manages new WWNs and MAC addresses; it does not use the addresses assigned at time of manufacture. Although the hardware ships with default MAC addresses and WWNs, Virtual Connect resets the MAC addresses and WWNs prior to boot, so PXE/SAN boot and all operating systems will see only the values managed by Virtual Connect. Assigning the addresses before OS boot is important because other methods in the industry require OS and network switches to be aware of virtual WWNs and MAC addresses. This method requires extra overhead by the network switches and server CPUs, increases complexity of troubleshooting, and increases licensing complexities. For environments that require the use of hardware default MACs and WWNs, Virtual Connect also supports this option.

Configuring the network and fabric profiles

Configuring the network and server profiles consists of a few simple steps. First, the LAN and SAN administrators define the available networks, or VLANs, on which they want the servers to communicate (figure 2). Similarly, the Fibre Channel SAN fabric can be created, naming the uplinks to the fabrics.

Figure 2. Administrators can configure the network in three basic steps

The screenshot displays the HP Virtual Connect Manager web interface. The left sidebar shows the navigation menu with categories like Domain Status, Domain Settings, Connections, and Hardware. The main content area is titled 'Edit Shared Uplink Set: UplinkSet_1'. Three callout boxes with arrows point to specific configuration steps:

- Step 1:** Create a Shared Uplink Set (SUS)
SUS = 802.1q trunk. This points to the 'Uplink Set Name' field which contains 'UplinkSet_1'.
- Step 2:** Assign physical ports to the trunk
LACP automatically enabled. This points to the 'External Uplink Ports' table.
- Step 3:** Add VLANs in the trunk. This points to the 'Associated Networks (VLAN tagged)' table.

External Uplink Ports Table:

| Port | Port Name | Port Status | Connector Type | Connected To | PD | Speed/Duplex | Action |
|----------------------------|-----------|----------------|----------------|----------------------|----|--------------|--------|
| 1Z34AB7890: Bay 5: Port X5 | NA | Linked-Active | 1 Gb SFP-RJ45 | 80-1c:2e:9b:76:c0c33 | | Auto | Delete |
| 1Z34AB7890: Bay 5: Port X6 | NA | Linked-Standby | 1 Gb SFP-SX | 80-1c:2e:9b:76:c0c47 | | Auto | Delete |

Associated Networks (VLAN tagged) Table:

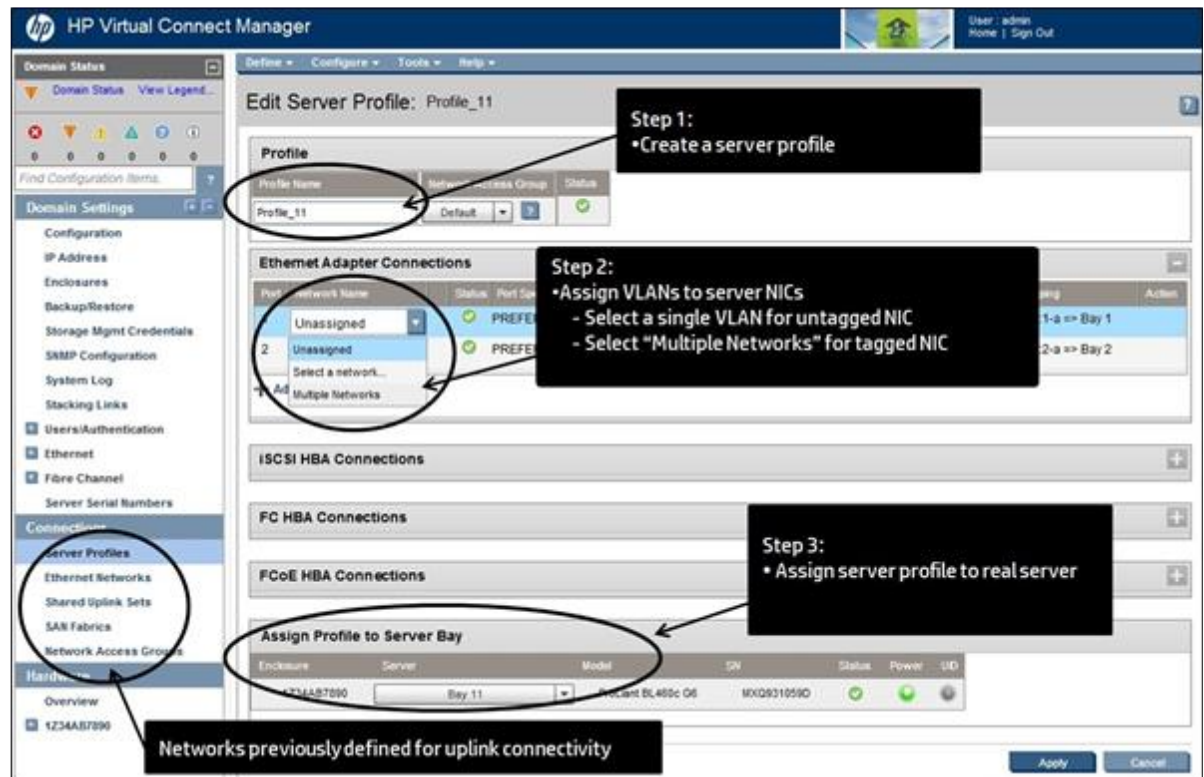
| Network Name | VLAN ID | Native | Smart Link | Private Network | Action |
|---------------------------------------|---------|--------|------------|-----------------|--------|
| <input type="checkbox"/> Network_22_A | 22 | false | true | false | Edit |
| <input type="checkbox"/> Network_23_A | 23 | false | true | false | Edit |
| <input type="checkbox"/> Network_24_A | 24 | false | true | false | Edit |
| <input type="checkbox"/> Network_25_A | 25 | false | true | false | Edit |

Configuring the server profiles

After configuring the network and fabric profiles, the administrator configures the server profile (figure 3). The administrator defines Virtual Connect networks (vNets) based on the pre-defined VLANs. Internal to Virtual Connect, we use standard IEEE 802.1 VLAN Q-in-Q tagging to correlate the vNets to the external LAN connections and send the network packets to the correct server.

The server profile also establishes the storage fabric connection to iSCSI, Fibre Channel or Fibre Channel over Ethernet, and names the uplinks that will carry the traffic. For FC or FCoE connections, N_Port ID Virtualization (NPIV) is used to seamlessly extend the fabric to the server WWNs.

Figure 3. Administrators can configure the server profile in three basic steps



LAN-safe

From the external networking view, Virtual Connect FlexFabric, Flex-10, and Ethernet uplinks appear to be multiple NICs on a large server. Virtual Connect ports at the enclosure edge look like server connections. These views are analogous to a VMware environment that provides multiple MAC addresses to the network through a single NIC port on a server. See the paper titled, "[HP Virtual Connect for the Cisco administrator](#)," for the complete explanation of how Virtual Connect is analogous to a virtual machine environment.

Virtual Connect works seamlessly with your external network:

- Does not participate in Spanning Tree Protocol (STP) on the network uplinks to the data center. This avoids potential STP configuration errors that can negatively affect switches in the network and the servers connected to those switches.
- Uses an internal loop prevention algorithm to automatically detect and prevent loops inside a Virtual Connect domain. Virtual Connect ensures that there is only one active uplink for any single network at one time.
- Allows aggregation of uplinks to data center networks (using LACP and fail-over).
- Supports VLAN tagging on egress or pass-thru of VLAN tags in tunneled mode.
- Supports Link Layer Discovery Protocol (LLDP) and Jumbo Frames.

SAN-safe

Virtual Connect Fibre Channel uplinks appear to be multiple host bus adapters (HBAs) connecting to the SAN by using N_Port ID Virtualization technology. NPIV is an industry-standard Fibre Channel protocol that provides a method for assigning multiple Fibre Channel addresses on a single physical link. Each Fibre Channel connection has its own N_Port ID and WWN.

Virtual Connect works seamlessly with the external storage fabrics:

- Supports industry-standard NPIV on both uplinks and downlinks.
- Consumes no Fibre Channel domain IDs; therefore, Virtual Connect has no effect on the total number of devices that you can connect to an individual SAN Fabric.
- Is compliant and compatible with SAN switches from any standards-based vendor.
- Transparently supports Cisco virtual storage area network (VSAN), Cisco inter-VSAN routing (IVR), and Brocade Virtual Fabric features.

Virtual Connect modules supporting Fibre Channel must attach to NPIV-capable SAN switches. Most enterprise-class SAN switches today support NPIV. You can also connect Virtual Connect FlexFabric modules directly to HP 3PAR StoreServ Storage arrays using the Virtual Connect 3.70 and higher firmware (see the [Direct-attach Fibre Channel for 3PAR Storage Systems](#) section of this document).

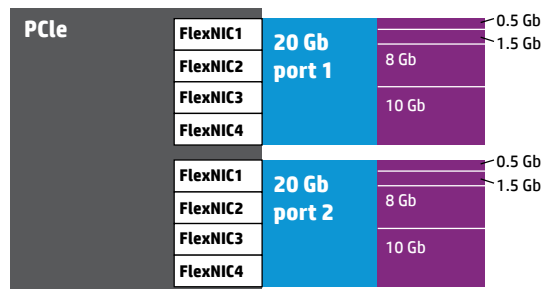
Depending on the module, Virtual Connect-Fibre Channel modules can aggregate up to 255 physical or virtual server HBA ports through each of the module's uplink ports. This aggregation method is especially important to SAN administrators who struggle with SAN fabric segmentation and Fibre Channel domain ID consumption.

Virtual Connect Fibre Channel modules make it easier to provision virtual machines by facilitating multiple HBA WWNs on the physical server. Each virtual machine can have its own unique WWN, which remains associated with that virtual machine even when you move it. Now SAN administrators can manage and provision storage to virtual HBAs—up to 128 per server blade—with the same methods and quality of service as physical HBAs.

FlexNIC capabilities

Flex-10/Flex-20 and FlexFabric adapters allow you to partition a 10 Gb/20 Gb link into several smaller-bandwidth FlexNICs. Virtual machine applications often require increased network connections per server, which increases network complexity, while also reducing the number of server resources. Virtual Connect addresses this issue by enabling you to divide a 10 Gb/20 Gb network connection into four independent FlexNIC server connections (figure 4). A FlexNIC is a physical PCIe function (PF) that appears to the system ROM, OS, and hypervisor as a discrete physical NIC with its own driver instance. A FlexNIC is not a virtual NIC contained in a software layer.

Figure 4. Flex-20 adapters allow administrators to partition bandwidth based on application requirements



20 Gb ports partitioned by FlexNICs

With FlexNICs, you can:

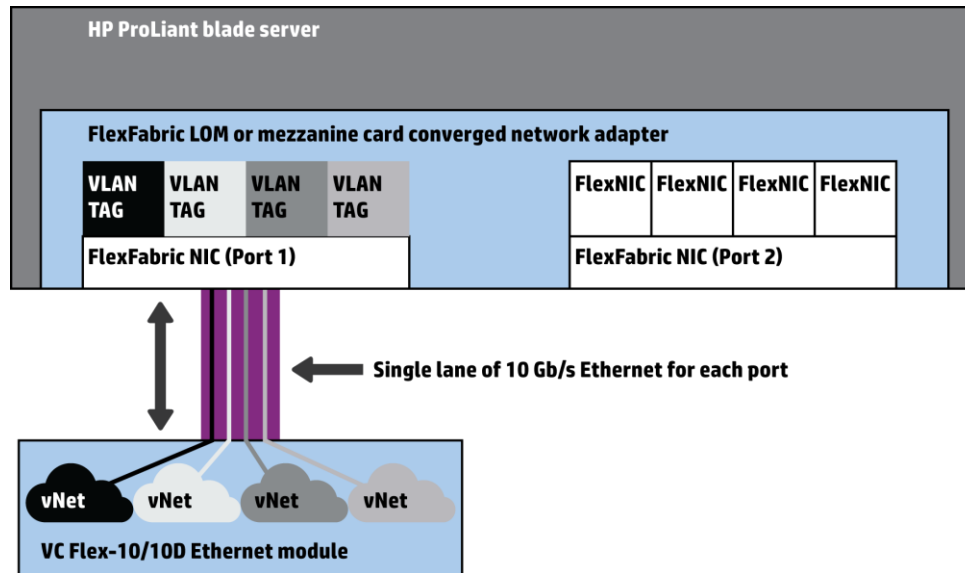
- Configure bandwidth on each FlexNIC from 100 Mb up to 10 Gb/20 Gb
- Dynamically adjust the bandwidth in 100 Mb increments without requiring a server reboot
- Provide just the right amount of bandwidth based on application needs
- Correctly provision bandwidth; you no longer need to over-provision or under-provision. By virtue of bandwidth optimization (i.e., setting Min and Max values for individual FlexNICs), Virtual Connect allocates unused bandwidth from FlexNICs to those FlexNICs whose bandwidth demands exceed minimum values. Min assures guaranteed bandwidth all the time, and Max is a best effort, depending upon available bandwidth in other FlexNICs. Flex-20-supported adapters now have the capability to support full-speed protocols such as 10 GbE and 8 Gb FC simultaneously.



Virtual Connect tells the network adapter how to configure each of the four physical functions. Then the adapter defines each of those physical functions, provisions them into the OS as individual NICs, and allocates the appropriate bandwidth. HP works with each NIC vendor to ensure that their products meet our Virtual Connect requirements for splitting the PCIe function and allocating bandwidth to each physical function.

Traffic moves from the Flex-10 NIC device (LOM or mezzanine card) to the Flex-10/10D module on a single physical pathway. Although FlexNICs share the same physical port, traffic flow for each is designated by its own MAC address and VLAN tags (figure 5).

Figure 5. FlexNICs share a physical link, but isolate the traffic using VLAN tags



Currently available Flex-10 NIC devices are dual-port LAN-on-motherboard NICs or mezzanine cards that support up to four FlexNICs per port. You can also use Flex-10/10D interconnect modules with traditional (not Flex-10) 10 Gb and 1 Gb NIC devices.

Because Flex-10 technology is hardware-based, FlexNICs eliminate the processor overhead required to operate virtualized NICs in virtual machines and with traditional operating systems. You can present up to eight FlexNICs without adding more server NIC mezzanine cards and associated interconnect modules.

Prior to Flex-10, a typical server blade enclosure required up to 40 separate components (32 mezzanine adapters and eight modules) to give 16 servers the best-practice connections they require to support a virtualized environment (three redundant NICs and a redundant HBA per server). HP Flex-10 NICs and Virtual Connect Flex-10/10D modules reduce that hardware up to 50 percent by consolidating all of the NIC connections onto two 10 Gb ports (see figure 7 for complete details).

Convergence with Virtual Connect FlexFabric adapters

Virtual Connect FlexFabric adapters can converge Ethernet, Fibre Channel, or accelerated iSCSI traffic into a single 10 Gb data stream. A FlexFabric adapter provides more functionality than an off-the-shelf converged network adapter (CNA). A FlexFabric adapter provides standard NIC functions, FlexNIC capabilities, and Fibre Channel or iSCSI FlexHBA capabilities.

Each FlexFabric adapter contains two 10 Gb/20 Gb Ethernet (a.k.a. DCB) ports that you can partition into four physical functions (PFs) per port—either FlexNICs or FlexHBAs. You can adjust the bandwidth of the PFs manually or by using scripting tools.

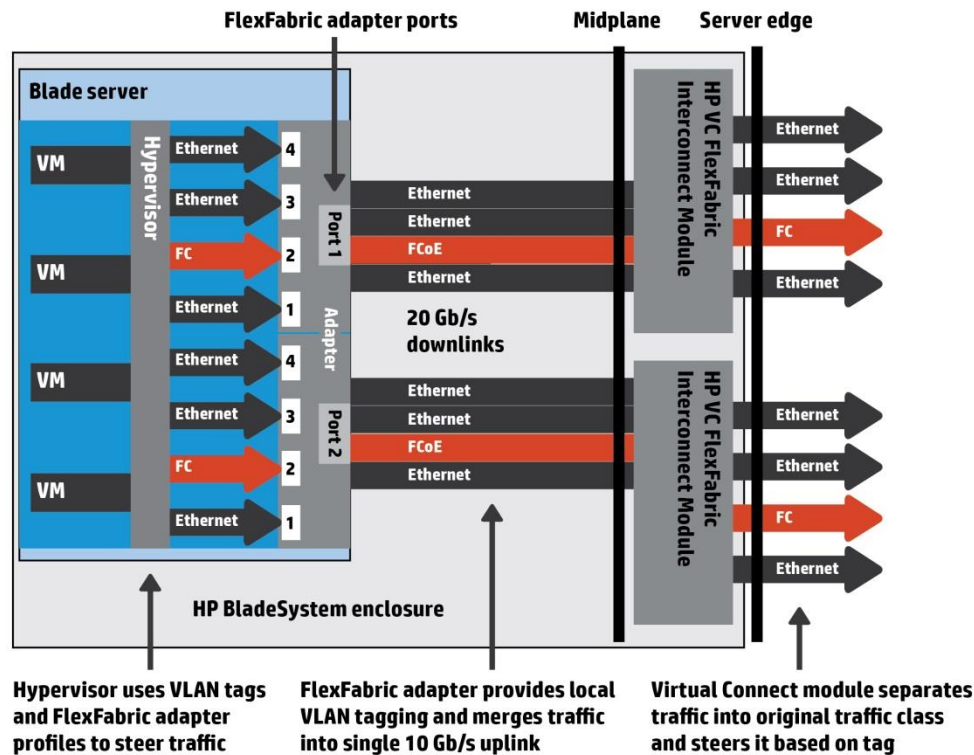
A FlexHBA is an actual PCIe physical function on the FlexFabric adapter that you can configure to handle storage traffic. The server ROM, OS, and hypervisor recognize the PCIe function as an HBA device. You can assign storage traffic (Fibre Channel or SCSI) as a FlexHBA only to the second PF of each FlexFabric adapter port. We use the second PF of each port as the storage function because in a traditional CNA, this is the PF used for storage access. If you do not need block storage access, you can disable the FlexFabric adapter storage function and configure the second PF as another FlexNIC function. The first, third, and fourth PFs work only as FlexNIC devices. However, a FlexFabric adapter will support either Fibre Channel or iSCSI with TCP off-load engine (TOE) and iSCSI boot functionality on the second physical function.



Virtual Connect FlexFabric-20/40 F8 interconnect

When used with the Virtual Connect FlexFabric-20/40 F8 interconnect, the FlexFabric adapter encapsulates Fibre Channel packets as FCoE and consolidates the Fibre Channel and Ethernet traffic into one 10 Gb/20 Gb data stream. The FlexFabric-20/40 F8 interconnect module separates the converged traffic. Fibre Channel and Ethernet traffic continue beyond the server-network edge using the existing native Ethernet and Fibre Channel infrastructure (see figure 6). For more details about how traffic flow works with Virtual Connect FlexFabric, refer to the paper titled, “[HP Virtual Connect traffic flow](#).”

Figure 6. FCoE traffic travels only between the FlexFabric adapter and the FlexFabric interconnect module; standard Fibre Channel traffic travels from the server edge to the external network



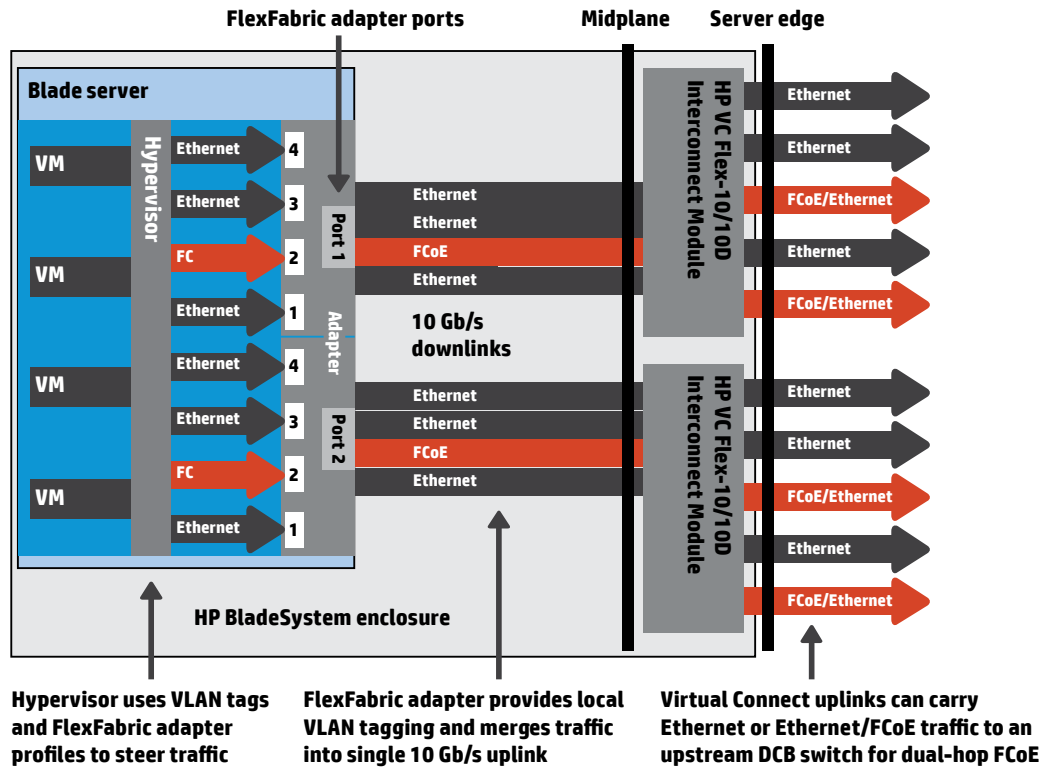
Virtual Connect Flex-10/10D interconnect

When used with the Virtual Connect Flex-10/10D interconnect, the FlexFabric adapter also enables Fibre Channel over Ethernet. However, instead of requiring the converged stream to be split and sent to separate Ethernet and Fibre Channel uplinks as they egress the Virtual Connect module (as with Virtual Connect FlexFabric), an additional hop for the converged traffic is possible when the next upstream switch is enabled for Data Center Bridging (DCB) technology and is acting as a Fibre Channel Forwarding switch. This means that all traffic is carried over Ethernet from the Virtual Connect module to the next point, typically a top-of-rack (ToR) switch.

This capability is called “dual-hop FCoE.” It has the greatest impact on cost because it is operating at the widest part of the SAN fabric. With dual-hop, the first hop is from the server blade to the Virtual Connect interconnect, and the second hop is from the interconnect to the upstream switch. While in the future, additional hops of FCoE traffic will be possible with hardware upgrades and other developments, each successive hop yields diminishing returns, because there are fewer connections and switches required as the traffic ascends the hierarchy to reach the SAN.

One important advantage that Virtual Connect Flex-10/10D offers is the ability to work with virtual SANs or VSAN technology.

Figure 6a. FCoE traffic travels from the FlexFabric adapter and through the Flex-10/10D interconnect module to an upstream switch where it will be broken out into separate FC and Ethernet uplinks



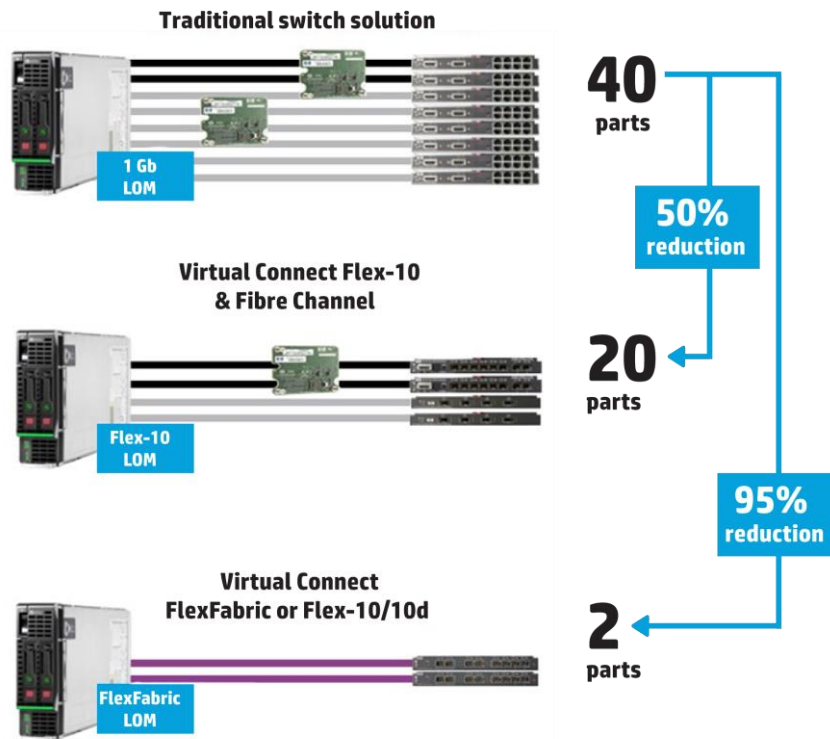
The Virtual Connect Flex-10/10D module can be used to implement dual-hop FCoE (as illustrated above). It can also be used as an interconnect for Ethernet and paired with companion Virtual Connect Fibre Channel modules and Fibre Channel HBAs in the server blades. This capability enables you to implement Virtual Connect in an environment not yet ready to transition to converged network traffic, while providing a path for the future.

Convergence reduces costs

Converged network technology significantly reduces cabling, switches, and required ports at the server edge. With the Virtual Connect Flex-10/10D and FlexFabric-20/40 F8 modules and adapters, you have the flexibility to provision from two to eight connections on each half-height server (using the embedded LOMs), and even more on full-height servers. This is the ideal solution for virtualized infrastructures, such as those following the VMware recommendation of six NICs and two HBAs for virtualized servers.

If you were going to implement a virtualized server blade infrastructure without Virtual Connect, you would need a dual-port LOM, an extra quad-port NIC mezzanine, a dual-port HBA, six Ethernet switch modules, and two Fibre Channel switch modules. As shown in figure 7, the typical server blade solution requires 40 components, compared to the Virtual Connect FlexFabric-20/40 F8 solution, which requires only FlexibleLOM dual-port FlexFabric adapters on servers (no mezzanine cards) and two Virtual Connect FlexFabric modules. In addition to the reduced qualification, purchase, and installation requirements, you'll require fewer spares and fewer firmware updates. With the Virtual Connect FlexFabric-20/40 F8 implementation, uplink ports X1–X8 can be designated to carry Fibre Channel traffic to an upstream Fibre Channel switch for one hop, or carry FCoE traffic to an upstream DCB-enabled switch for dual-hop. In FlexFabric-20/40 F8, dual-hop implementation is applicable to X1–X8 ports. With Virtual Connect Flex-10/10D, all 10 uplinks can carry converged traffic to the upstream DCB switch; at that point, the traffic separates into pure Ethernet and native Fibre Channel uplinks. This capability extends the benefits of Virtual Connect and converged networking one more hop beyond the enclosure for a total of two hops, reducing the number of switches needed and eliminating cabling within the rack.

Figure 7. Virtual Connect FlexFabric solutions reduce cost and components, compared to traditional switch solutions

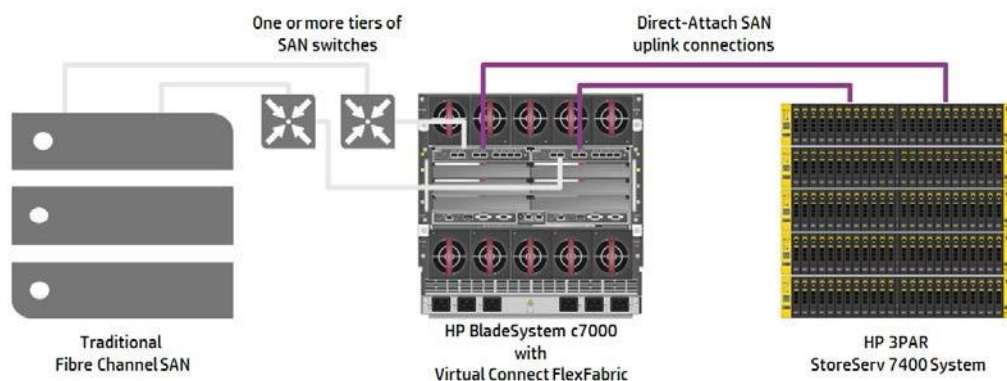


Direct-attach Fibre Channel for 3PAR StoreServ Storage systems

In an enterprise data center, traditional Fibre Channel disk storage has many shortcomings. A total solution has a high capital acquisition cost, including the SAN fabric switches and the management software/licenses required for the switch and the disk storage management. There are also high operational costs, with multiple management points (HBA, enclosure edge switches, SAN core switches, target systems) that often require manual and complex coordination among the systems.

HP solves these problems by collapsing the storage network and removing the edge-core architecture. The direct-attach Fibre Channel solution provides an enterprise storage solution without requiring an expensive external SAN fabric. The direct-attach Fibre Channel solution combines the scalability of HP 3PAR StoreServ systems with the simplicity of Virtual Connect (see figure 8).

Figure 8. Direct-attach Fibre Channel for 3PAR Storage Systems reduces cost and components, compared to traditional SAN fabric solutions.



Highly scalable 3PAR StoreServ Storage systems provide connectivity to up to 192 Fibre Channel host ports and 1.6 PB of storage using a single P10000 V-800 storage system. Combined with 3PAR's advanced features—such as adaptive and dynamic optimization, thin provisioning, peer motion, and space reclamation—this direct-connect technology provides another way for Virtual Connect to simplify your environment.

As shown in figure 8, your network can have both direct-attach and fabric-attach storage simultaneously. The Virtual Connect FlexFabric modules will continue to support traditional fabric connectivity, but they will also support direct-attach Fibre Channel storage with only minimal changes to the Virtual Connect firmware. Simply choose the Direct-Attach mode when configuring Virtual Connect, and the firmware will allow 3PAR storage arrays to connect to Fibre Channel uplinks of the Virtual Connect FlexFabric module. This way, you can have data center-wide connectivity through VCM. You will not need separate licenses for the SAN/storage fabric or training on various management tools. You can manage your LAN and your storage from VCM or with higher-level HP CloudSystem Foundation/Enterprise management and orchestration tools.

Management capabilities

The primary management tools for Virtual Connect are Virtual Connect Manager, Virtual Connect Enterprise Manager and HP OneView. Beyond that, Virtual Connect uses SNMP to integrate with other management tools such as HP Systems Insight Manager, HP Intelligent Management Center, HP Network Node Manager, and other third-party SNMP-based consoles. Virtual Connect supports enterprise management tools from partners, such as the Brocade SAN Network Advisor. HP also developed Insight Control extensions for VMware vCenter and Microsoft System Center that allow administrators to use Virtual Connect Manager directly from their respective consoles. HP also provides tools for developing your own utilities based on the VCEM CLI and the published VCEM APIs. With Virtual Connect firmware 4.20, the industry-standard sFlow protocol has been added. This protocol allows performance information at the application level to be sent to an sFlow connector and analyzed by an sFlow-capable management application, such as the HP Intelligent Management Center with Network Traffic Analyzer.

HP OneView

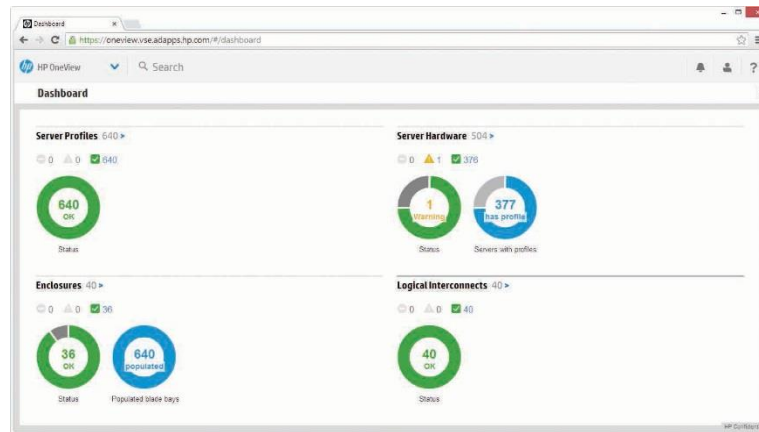
Shifting the focus from “devices” to “how people work,” HP OneView offers a fresh approach to converged infrastructure management. HP OneView features an innovative architecture and a consumer-inspired experience that aligns with how users interact with complex and highly dynamic systems—making tasks and collaboration much more automated, natural, and streamlined. As a result, HP OneView simplifies the management of compute, network, and storage resources in physical and virtual environments.

HP OneView’s software-defined approach to infrastructure management is designed to automate the delivery of IT services, so they are much faster, cost-effective and reliable. This open and programmable platform is very extensible. It integrates seamlessly with HP, partner and third-party management tools to efficiently orchestrate IT service delivery workflows. HP OneView can do the work of many current tools.

HP OneView provides:

- A consumer-inspired experience that aligns with how users leverage technology in their everyday lives. HP OneView employs concepts such as search and news feeds to rapidly pinpoint devices of interest and quickly transmit relevant information to users and applications that need it.
- Software-defined management for automating the delivery of IT services in a fast repeatable and reliable manner, at lower cost and with fewer errors.
- Support for automation by exposing all management functions through four standards-based REST commands. (HP OneView is the only solution that provides this capability today.) This programmable platform allows you to scale beyond your data center walls to the cloud.



Figure 9. HP OneView transforms the way you manage your IT infrastructure

Virtual Connect Manager

VCM includes a web-based console integrated into the firmware of every Ethernet-capable module. You can use VCM to manage single Virtual Connect domains (up to four enclosures). You can access VCM through a browser-based GUI or through the VCM CLI. VCM domain management makes it simple to set up and manage server connections because you can use it to control networks, SAN fabrics, server profiles, and user accounts.

For example, you can use the VCM CLI to perform debugging and troubleshooting for the Virtual Connect system and networking issues. VCM CLI telemetry commands enable you to monitor system health, resource utilization, MAC addresses and the associated FlexNICs, uplink status, and NIC throughput data on all physical ports. For more details, please refer to the document titled, "[Efficiently managing Virtual Connect environments.](#)"

Virtual Connect Enterprise Manager

VCEM is the best way to manage Virtual Connect environments across the data center. VCEM is a highly scalable software solution that centralizes network connection management and workload mobility for thousands of servers that use Virtual Connect. VCEM is a plug-in for HP Systems Insight Manager (HP SIM), and VCEM benefits from the rich feature set HP SIM offers.

VCEM provides the following core capabilities:

- A single intuitive console that controls up to 250 Virtual Connect domains (up to 1,000 BladeSystem enclosures and 16,000 server blades).
- A central repository that administers more than 256K MAC addresses and WWNs for server-to-network connectivity. This capability simplifies address assignments and eliminates the risk of conflicts. The central repository removes the overhead of managing network addresses manually. With VCEM, administrators can use the unique HP-defined addresses, create their own custom address ranges, and establish exclusion zones to protect existing MAC and WWN assignments.
- Discovery and aggregation of existing Virtual Connect domain resources into the VCEM console and address repository.
- Group-based management of Virtual Connect domains using master configurations. You can use a group to push Virtual Connect domain configuration changes—such as network assignments or parameter modifications—to all members of the domain group simultaneously. This capability increases infrastructure consistency, limits configuration errors, and simplifies enclosure deployment.
- GUI and a scriptable CLI that allow fully automated setup and operations. This capability lets you move server connection profiles and associated workloads between BladeSystem enclosures so that you can add, change, and replace servers across the data center without affecting production or LAN and SAN availability.

For more details, please refer to the document titled, "[Understanding the Virtual Connect Enterprise Manager.](#)"

Enterprise-wide HP management consoles

You can use other HP tools such as HP Insight Control, HP Intelligent Management Console, and the HP CloudSystem operating environment (Cloud OS) software to perform inventory, monitoring, and troubleshooting functions beyond the Virtual Connect domains.

HP Insight Control

Insight Control discovers and monitors Virtual Connect from a system management perspective. VCM and VCEM feed server and network configuration data into HP SIM and Insight Control so that you can access that data for management, health monitoring, and coordination of your servers from a single management console that covers the entire data center.

HP Intelligent Management Console

The Intelligent Management Console (IMC) from HP Networking provides robust discovery, monitoring, and network topology views of Virtual Connect and other HP and third-party network infrastructure. You can use IMC to monitor mission-critical Virtual Connect networks across the data center. IMC reads Virtual Connect device SNMP MIBs and provides visibility to information such as port count and statistics.

HP Matrix Operating Environment

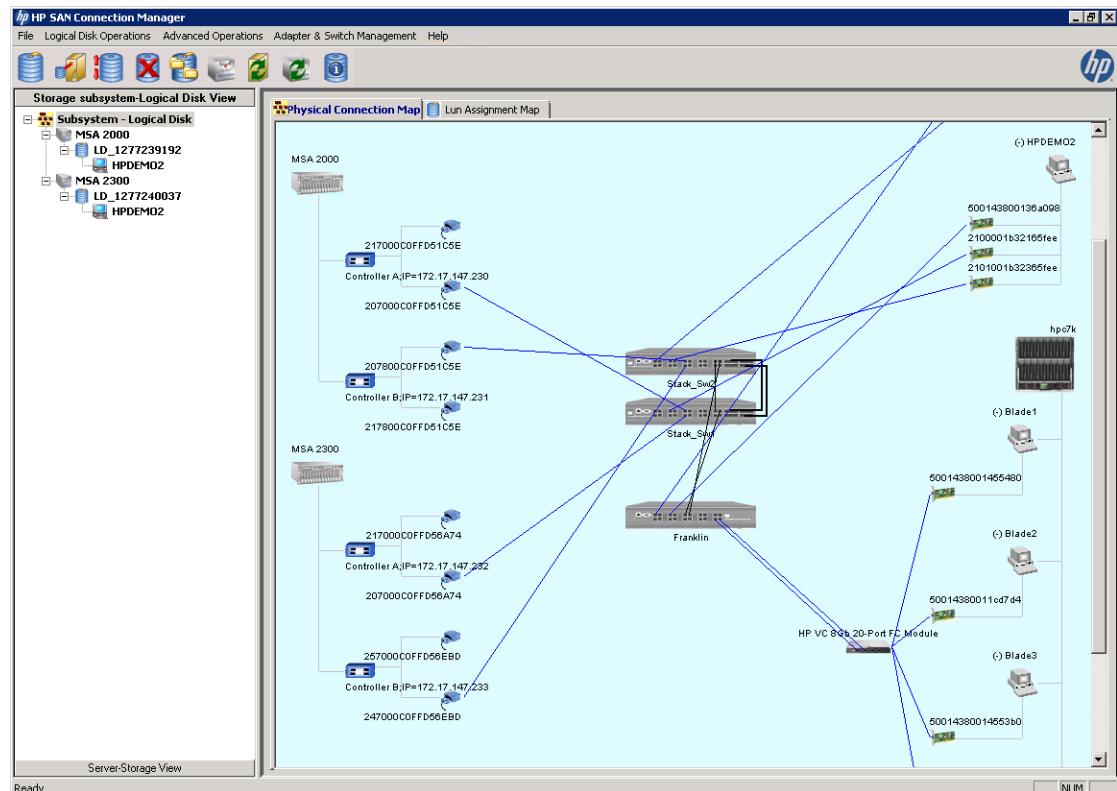
HP Matrix OE is an integrated infrastructure management stack containing the tools needed to build and manage cloud offerings such as infrastructure-as-a-service. Device data provided by VCEM and HP Insight Control provide the foundation for logical server deployment and orchestration delivered with HP Matrix OE. For more information, see the [“HP Matrix Operating Environment 7.0 Logical Server Management User Guide.”](#)

HP SAN Connection Manager

Offering similar functionality for Fibre Channel SANs and storage resources, the HP SAN Connection Manager lets you complete basic handling of SAN components such as HBAs, switches, and storage arrays in a single wizard-based GUI. You can integrate SAN Connection Manager with VCEM to display the associations between the server blades and storage hosts, as shown in figure 10.

For more information about integrating Virtual Connect with SAN Connection Manager, see the [“HP SAN Connection Manager User Guide.”](#)

Figure 10. The SAN Connection Manager lets you visualize the SAN and VC connections



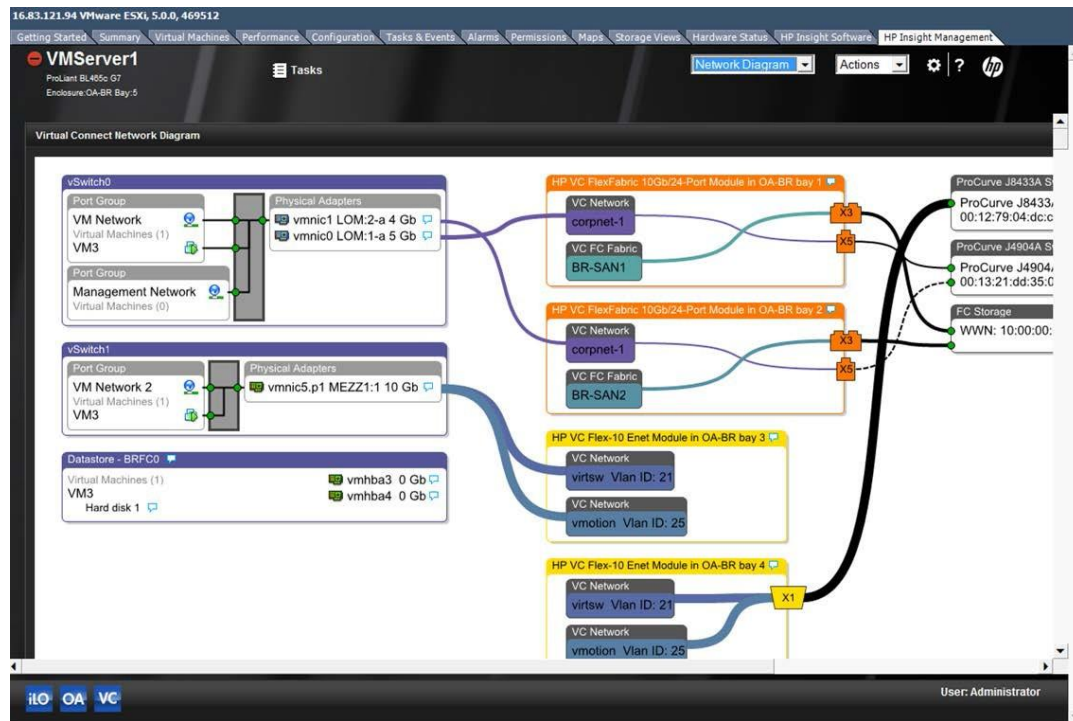
Integration with third-party tools

HP works with other vendors to expose Virtual Connect information in consoles used by server, virtualization, storage, and networking teams.

HP Insight Control for VMware vCenter

An excellent example of a third-party tool is the HP Insight Control plug-in for VMware vCenter. This plug-in allows vCenter to discover and display Virtual Connect status in a unique topology view—from guest virtual machines all the way to upstream networking devices (figure 11). The plug-in enables you to monitor the relationship between VMware virtualized networking and Virtual Connect.

Figure 11. HP Insight Control for VMware vCenter lets you view Virtual Connect status from your VMware console



HP Insight Control for Microsoft Systems Center

With HP Insight Control for Microsoft Systems Center 7.3, a new fabric manager is available. This fabric manager visualizes the downlinks from Virtual Connect to the server blade, through the vSwitch to the virtual machine, to the uplinks, and through to the upstream switch. For administrators who spend most of their time performing tasks in Microsoft System Center, this plug-in provides end-to-end visibility of the physical and virtual infrastructures. Admins can access this information for troubleshooting and for day-to-day operations, without having to log in to another application and correlate information between the two.

Providing high levels of security

Virtual Connect uses security practices that continue to improve as the Virtual Connect capabilities expand. For example, Virtual Connect includes the following capabilities:

- Strong security across management interfaces with support for SSL and SSH—including 2048-bit SSL certificates, Payment Card Industry Data Security Standard, and Common Criteria EAL 4+ compliance.
- Role-based security that offers authentication, authorization, and accounting (activity logging) based on assigned roles. You can specify the VCM role as domain, network, server, or storage, and now with Virtual Connect firmware 4.01, a domain role can be given granular permission for tasks such as firmware updates, port monitoring, exporting support files or saving/restoring domain configurations. These roles are configurable for all types of authentication methods.
- Authentication methods that include local authentication, Lightweight Directory Access Protocol (LDAP), Terminal Access Controller Access-Control System Plus (TACACS+), and Remote Authentication Dial-In User Service (RADIUS).
- Session timeouts for both Web GUI and CLI users that default to 15 minutes (user-configurable from 10 to 1440 minutes) to prevent unauthorized access caused by an administrator walking away from his/her station without logging out.
- Diagnostic and management technologies that match your established preferences and investment. Each data center team can use its preferred method on the same module with simultaneous multi-mode access.
- Network Access Groups that let you control which networks to allow into the same server profile. You can assign a VLAN to one or more groups; this prevents administrators from using networks from different security domains in the same server profile.
- Local accounts that are disabled when remote authentication is enabled and active. If a network team only allows TACACS+ credentials, the Virtual Connect firmware disables local authentication if the network can connect to a TACACS+ server.
- Increased minimum required length for the local account passwords, with user-configurable lengths of up to 40 characters. Strong passwords can also be optionally enabled, which would impose a requirement to use a password that meets at least three of four criteria: uppercase letter, lowercase letter, number, and symbol.
- Security protection for SNMP access beyond the read community string. User can now specify authorized SNMP management stations for SNMP access to Virtual Connect devices. All unauthorized management stations will be denied access.

Data center traffic flow and Virtual Connect

Traditional Ethernet topologies are top-down constructs. They have a core set of switching capabilities arranged around a high-speed backbone with successive levels of switches cascading down from there, frequently at lower speeds until they reach an end point. While this topology was effective for many years, modern demands on today's networks compromise the ability of this design. In some cases, the issue could be addressed by deploying higher-bandwidth devices in selected areas of the hierarchy, but bandwidth alone fails to address the latencies and bottlenecks of the architecture.

Evolving away from hierarchical architecture

The growth of virtual machines, cloud-computing models, distributed applications, and mobile access devices are causing shifts in data center networking traffic patterns toward more server-to-server (east-west) traffic flow. Industry sources indicate that more than 80 percent of data center traffic will be east-west (E-W) by 2014. VMware vMotion is one example of server-to-server communications, where an entire VM's memory image—typically at least 4 GB—must be rapidly transferred from one machine to another.

Implementing Virtual Connect technology is an ideal way to optimize for east-west traffic flow at the server edge. Unlike other more hierarchical structures, Virtual Connect delivers direct server-to-server connectivity within an enclosure. You can also connect multiple Virtual Connect Ethernet modules to allow all server NICs in the Virtual Connect domain (up to four enclosures) to communicate with each other, while keeping the traffic within the Virtual Connect domain. The result—reduced core switch traffic.



Quality of Service (QoS)

The fundamental goal of a network is to deliver traffic according to an expected level of service. Meeting these service levels requires more than just bandwidth. Ideally, you should be able to tag traffic with a given level of priority so that important packets reach their destinations as if they were in the express lane, and lower-priority traffic waits its turn. The ability to transport traffic with special requirements is referred as Quality of Service or QoS.

Virtual Connect firmware 4.01 supports priority QoS queues. This capability is available on all Virtual Connect modules compatible with this version. The implementation of QoS and CoS in the Virtual Connect module complements the enforcement of prioritization at Flex-10-based adapters. VCM can allocate bandwidth based on up to eight traffic classes. Virtual Connect will queue frames aligned to these classes, and then a Virtual Connect scheduler will prioritize the traffic on both egress and ingress. Up to eight classes of service can be activated from the following selections:

- Two fixed—Best effort and lossless (FCoE)
- Two predefined—Real time and medium
- Four classes that can be user defined

Without QoS, Virtual Connect traffic flows on a first-in/first-out (FIFO) basis. When congestion exists, traffic at the tail of the queue might be dropped. With QoS configured, traffic flows according to resource allocation and priority of traffic to ensure that business-critical applications receive the correct priority.

Conclusion

The HP Virtual Connect architecture boosts the efficiency and productivity of data center server, storage, and network administrators. Virtual Connect virtualizes the connections between the server and the network infrastructure (server-edge virtualization) so that networks can communicate with pools of HP BladeSystem servers. This virtualization allows you to move or replace servers rapidly without requiring changes or intervention by the LAN and SAN administrators.

Virtual Connect is standards-based and complies with all existing and emerging standards for Ethernet, Fibre Channel, and converged networks. The Virtual Connect modules connect seamlessly with existing network infrastructure.

HP Virtual Connect Flex-10/Flex-20 technology is a hardware-based solution that lets you simplify network I/O by splitting a 10/20 Gb/s server network connection into four variable partitions. Flex-10/Flex-20 technology and products give you more NICs, yet they minimize the number of physical NICs and interconnect modules required to support multi-network configurations.

HP Virtual Connect FlexFabric-20/40 F8 modules and HP FlexFabric adapters extend the Flex-10/Flex-20 capabilities to include converged networking. This technology allows HP BladeSystem customers to connect servers to network and storage infrastructure with a single server connection and a single Virtual Connect interconnect module supporting Ethernet and Fibre Channel or iSCSI networking. Virtual Connect FlexFabric requires up to 95 percent less hardware to qualify, purchase, install, and maintain in HP BladeSystem enclosures. You can reduce costs by converging and consolidating server, storage, and network connectivity onto a common fabric with a flatter topology and fewer switches.

With direct-attach capabilities for 3PAR StoreServ Storage systems enabled by Virtual Connect FlexFabric, HP takes another step forward in flattening and simplifying the data center architecture. You can now move the storage network from an edge-core implementation to an edge implementation directly connected to storage.

The Virtual Connect Flex-10/10D interconnect extends the concepts of Flex-10 for Ethernet to allow converged network and storage traffic to flow to an upstream switch featuring Data Center Bridging Ethernet technologies—enabling dual-hop Fibre Channel over Ethernet.

Virtual Connect management tools provide the framework that allows administrators to easily set up and monitor network connections, server profiles, and how the networks map into virtual machines. Management tools such as HP OneView are designed to manage converged infrastructure.



Additional links

HP Virtual Connect general information

hp.com/go/virtualconnect

Architecture and Technologies in the HP BladeSystem c7000 Enclosure

h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-8125ENW&cc=us&lc=en

HP Virtual Connect for the Cisco administrator

hp.com/bc/docs/support/SupportManual/c01386629/c01386629.pdf

HP Virtual Connect traffic flow

hp.com/bc/docs/support/SupportManual/c03154250/c03154250.pdf

Efficiently Managing Virtual Connect environments

h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-8167ENW&cc=us&lc=en

Understanding the Virtual Connect Enterprise Manager

hp.com/bc/docs/support/SupportManual/c03314921/c03314921.pdf

HP OneView Product Page

hp.com/go/oneview

HP Matrix Operating Environment 7.0 Logical Server Management User Guide

hp.com/bc/docs/support/SupportManual/c03132774/c03132774.pdf

HP Virtual Connect: Common Myths, Misperceptions, and Objections, Second Edition

hp.com/bc/docs/support/SupportManual/c02058339/c02058339.hires.pdf

Effects of virtualization and cloud computing on data center networks

hp.com/bc/docs/support/SupportManual/c03042885/c03042885.pdf

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