

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. It adds a hardware abstraction layer that removes the direct coupling between them. 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. Using Virtual Connect interconnect modules provides the following capabilities:

- Reduces the number of cables required for an enclosure, compared to using pass-through 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, reducing equipment and administration costs, reducing latency and improving 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 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 updated addresses, and wait for them to make the appropriate updates to their infrastructure. With Virtual Connect, a server profile holds the MAC addresses and WWNs constant, so the server administrator can apply the same networking profile to new hardware. This can significantly reduce the time for a service event.

Virtual Connect Flex-10 technology further simplifies network interconnects. Flex-10 technology lets you split a 10Gb Ethernet port into four physical function NICs (called FlexNICs). This lets you replace multiple, lower-bandwidth NICs with a single 10Gb adapter. Prior to Flex-10, a typical server blade enclosure required up to 40 pieces of hardware (32 mezzanine adapters and 8 modules) for a full enclosure of 16 virtualized servers. Use of HP FlexNICs with Virtual Connect interconnect modules reduces the required hardware up to 50% by consolidating all the NIC connections onto two 10Gb ports.

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

Building on these capabilities is the new Virtual Connect Flex-10/10d interconnect, which when used with VC firmware 4.01 or later, implements the Data Center Bridging (DCB) standard to extend converged networking beyond the uplinks of the VC module and enables Fibre Channel over Ethernet (FCoE) to be forwarded to an upstream DCB-capable switch in a dual-hop configuration. That means that SAN storage traffic for Fibre Channel targets does not have to break out into the SAN fabric at the back of the enclosure and can be passed via Ethernet to the next switch, further reducing cabling and simplifying the fabric, thereby keeping port cost to a minimum.

A key HP innovation for Virtual Connect is the ability to connect directly to HP 3PAR StoreServ Storage Systems by eliminating SAN Fabric. You can either 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 direct-attach Fibre Channel storage capability has the potential to reduce SAN acquisition and operational costs significantly while reducing the time it takes to provision storage connectivity.

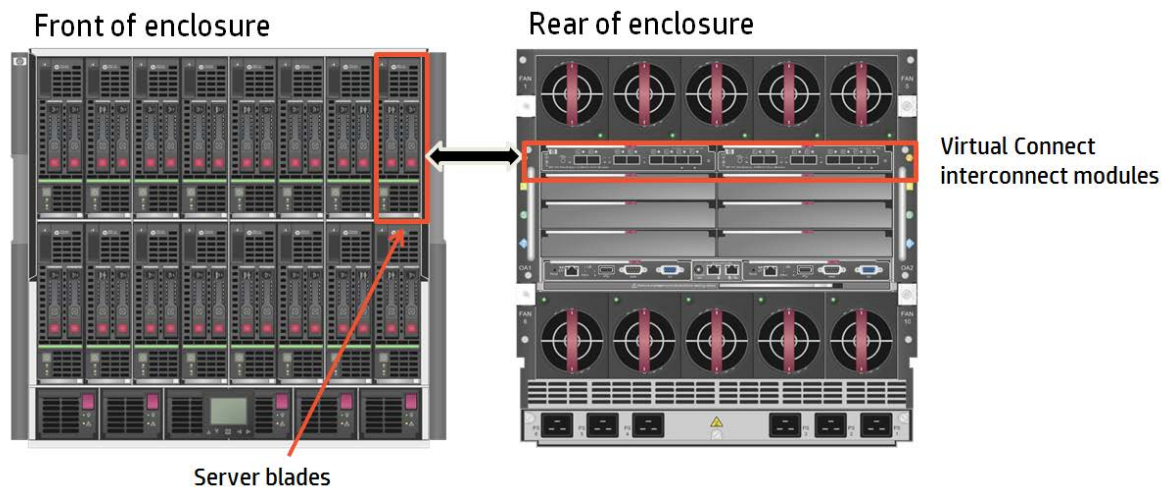
In writing this paper, we assume that you are somewhat familiar with BladeSystem architecture. If not, the [“HP BladeSystem c-Class architecture”](#) technology brief provides helpful background information. This paper provides an overview of the Virtual Connect technologies. For details about the capabilities of specific modules and adapters, see 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, Flex-10/10D, or Fibre Channel modules—plug directly into the interconnect bays in the rear of the HP BladeSystem c Class enclosure. The modules connect to the server blades through the enclosure midplane. The Ethernet-based modules support 1 or 10Gb uplinks and downlinks, allowing customers to purchase 1 Gb SFPs and upgrade to 10Gb SFP+ transceivers when the rest of their infrastructure is ready to support it.
- Flex-10 and FlexFabric adapters are available as either LAN-on-motherboard (LOM) devices or mezzanine cards. Virtual Connect technology also works with 1 GbE adapters and FlexibleLOM devices for ProLiant BL Gen8 servers. A FlexibleLOM uses a special slot/connector on the motherboard and 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) and also provides a text interface (CLI) to meet the needs of individual users and tasks.
- Virtual Connect Enterprise Manager is an optional software application that lets you manage up to 250 Virtual Connect domains and up to 1000 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.

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 baseline 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 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 prevents having 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, not the addresses assigned at 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 requires extra overhead by the network switches and server CPUs, increases complexity of troubleshooting, and increases licensing complexities.

Configuring the network and fabric profiles

Configuring the network and server profiles consists of simple steps. First, the LAN and SAN administrators define the available networks, or VLANs, that they want the servers to communicate on (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 shows the HP Virtual Connect Manager interface. The left sidebar contains a navigation menu with categories like Domain Status, Domain Settings, Connections, Hardware, and Network Access Groups. The main content area is titled 'Edit Shared Uplink Set: UplinkSet_1' and is divided into three sections: 'Ethernet Shared External Uplink Set', 'External Uplink Ports', and 'Associated Networks (VLAN tagged)'. Three callout boxes with arrows point to specific elements in the interface:

- 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, which lists two ports: '1Z34AB7890: Bay 5: Port X5' and '1Z34AB7890: Bay 5: Port X6'.
- Step 3:** Add VLANs in the trunk. This points to the 'Associated Networks (VLAN tagged)' table, which lists four networks: 'Network_22_A', 'Network_23_A', 'Network_24_A', and 'Network_25_A'.

The 'Associated Networks (VLAN tagged)' table has the following data:

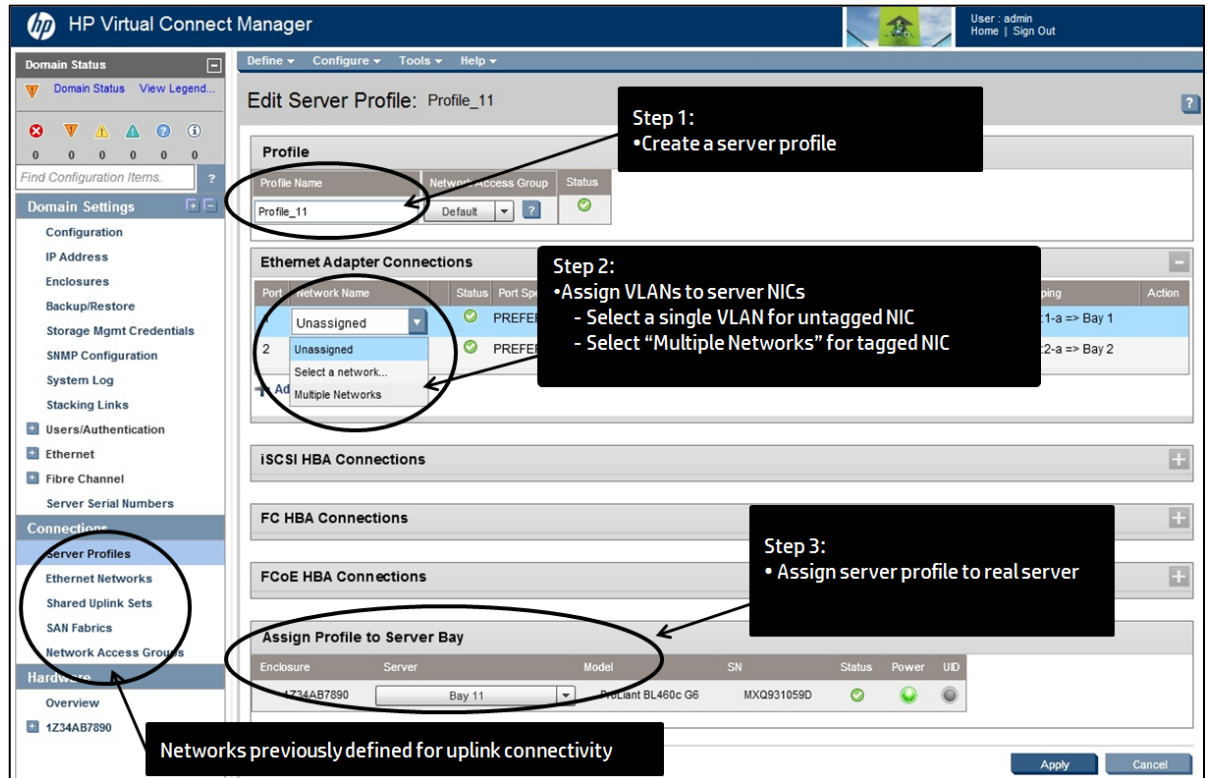
| Network Name | VLAN ID | Native | Smart Link | Private Network | Action |
|---------------------------------------|---------|--------|------------|-----------------|----------------------|
| <input type="checkbox"/> Network_22_A | 22 | false | true | false | Edit |
| <input type="checkbox"/> Network_23_A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

Then 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 utilized to extend the fabric to the server WWNs seamlessly.

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



LAN-safe

From the external networking view, Virtual Connect FlexFabric, Flex-10, or Ethernet uplinks appear to be multiple NICs on a large server. Virtual Connect ports at the enclosure edge look like server connections. This is analogous to a VMware environment that provides multiple MAC addresses to the network through a single NIC port on a server. See the [“HP Virtual Connect for the Cisco administrator”](#) paper for the full 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 HBAs connecting to the SAN by using N_Port ID Virtualization (NPIV) technology. NPIV is an industry-standard Fibre Channel protocol that provides a method to assign 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.
- Doesn't consume Fibre Channel Domain IDs; therefore Virtual Connect doesn't affect the total number of devices that you can connect to an individual SAN Fabric.
- 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 VC FlexFabric modules directly to HP 3PAR StoreServ System arrays using the Virtual Connect 3.70 firmware (see the [Direct-Attach Fibre Channel for 3PAR Storage Systems](#) section).

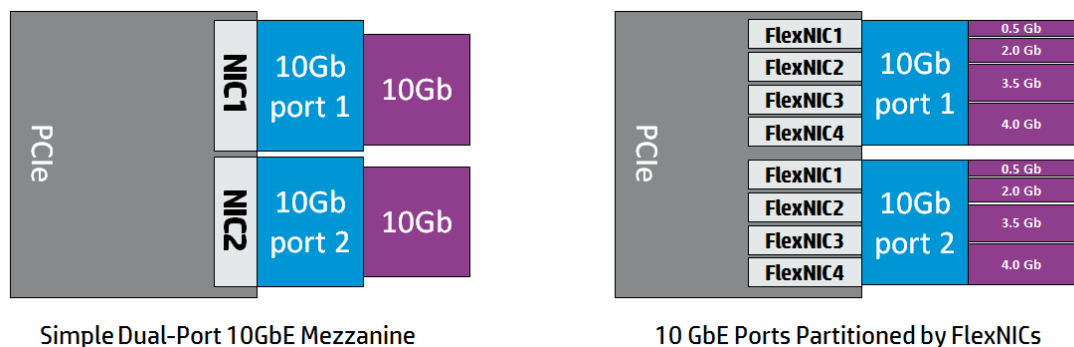
Depending on the module, Virtual Connect-Fibre Channel modules can aggregate up to 255 physical or virtual server HBA ports through each of the module's uplink ports. This aggregation method is especially important to SAN administrators who struggle with SAN fabric segmentation and Fibre Channel Domain 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 that remains associated with that virtual machine even when you move the virtual machine. 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 and FlexFabric adapters allow you to partition a 10Gb link into several smaller bandwidth FlexNICs. Virtual machine applications often require increased network connections per server, increasing network complexity while reducing the number of server resources. Virtual Connect addresses this issue by letting you divide a 10Gb 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, or hypervisor as a discrete physical NIC with its own driver instance. It is not a virtual NIC contained in a software layer.

Figure 4: Flex-10 adapters allow administrators to partition bandwidth based on application requirements.

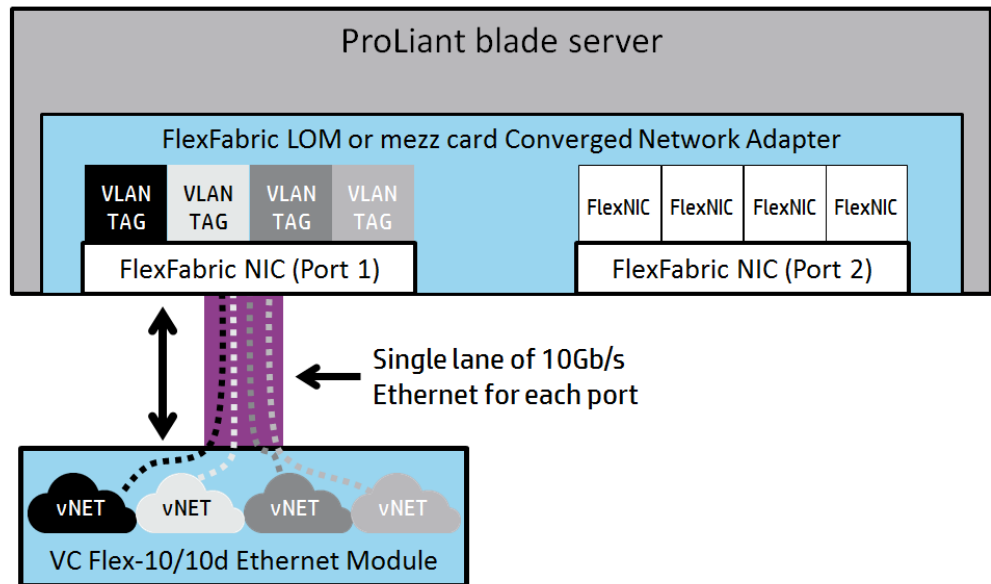


You can configure bandwidth on each FlexNIC from 100 Mb up to 10Gb, and dynamically adjust the bandwidth in 100 Mb increments without requiring a server reboot. You can provide just the right amount of bandwidth based on application needs. You no longer need to over-provision or under-provision bandwidth. By virtue of Bandwidth optimization by setting Min and Max values for individual FlexNICs, Virtual Connect allocates unused bandwidth from FlexNICs to those FlexNICs whose bandwidth demands exceeds minimum. Min assures guaranteed bandwidth all the time and Max is best effort depending upon available bandwidth in other FlexNICs.

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. We work with each NIC vendor to ensure that they 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 (LOMs) 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) 10Gb and 1Gb 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 8 modules) just to give 16 servers the best practice connections they require to support a virtualized environment (3 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% by consolidating all of the NIC connections onto two 10Gb ports.

Convergence with Virtual Connect FlexFabric adapters

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

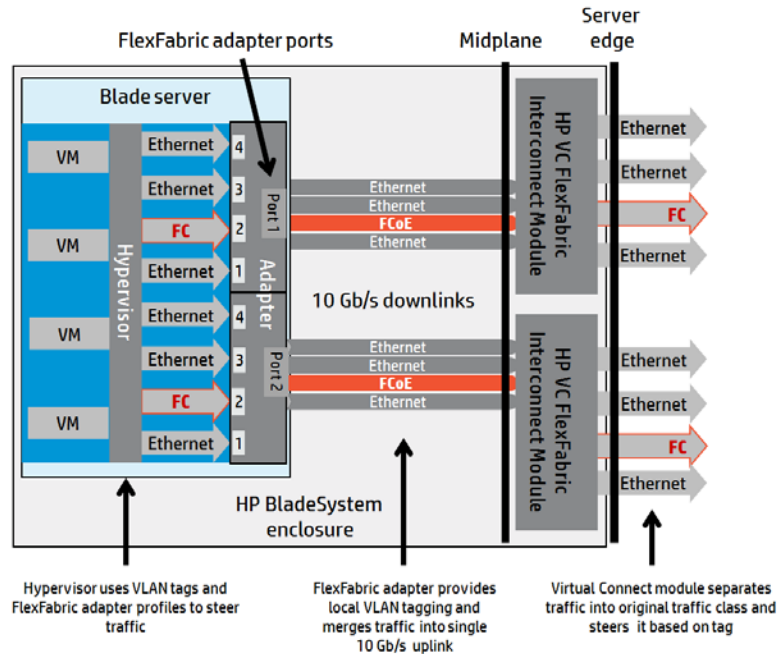
Each FlexFabric adapter contains two 10Gb Ethernet ports that you can partition into four Flex-10 physical functions (PFs) per port—either FlexNICs or FlexHBAs. You can adjust the bandwidth of the PFs manually or by using scripting tools.

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 physical function 2.

Virtual Connect FlexFabric interconnect

When used with the Virtual Connect FlexFabric interconnect, the FlexFabric adapter encapsulates Fibre Channel packets as FCoE and consolidates the Fibre Channel and Ethernet traffic into one 10Gb data stream. The FlexFabric 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, see the paper [“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.



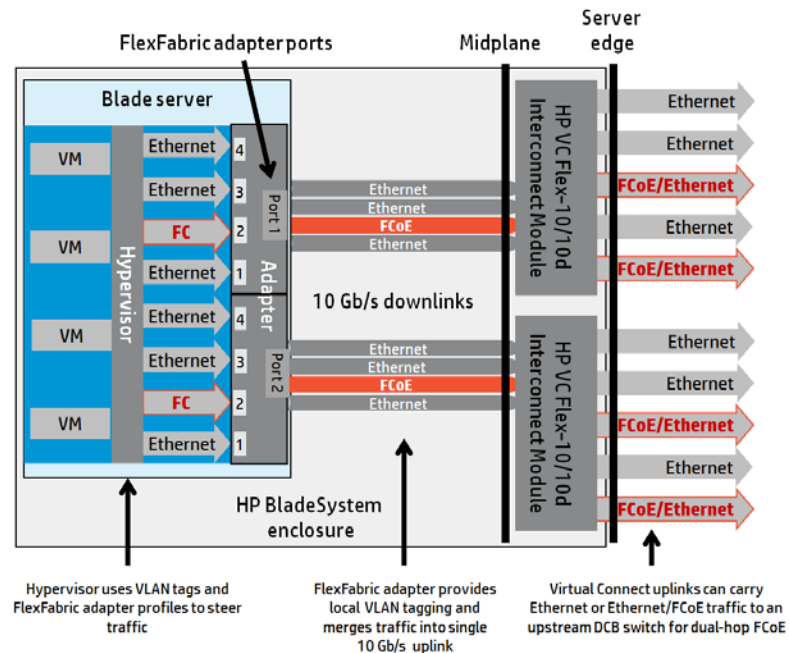
Virtual Connect Flex-10/10d interconnect

When used with the Virtual Connect Flex-10/10d interconnect, the FlexFabric adapter also enables Fibre Channel over Ethernet, but 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 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 VC module to the next point, typically a top-of-rack (ToR) switch.

This capability is called “dual-hop FCoE,” and has the greatest impact on cost because it is operating at the widest part of the SAN fabric. Dual-hop describes the fact that the first hop is from the server blade to the VC 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 will be with diminishing returns, since there are fewer and fewer connections and switches required as the traffic ascends the hierarchy to reach the SAN itself.

One big advantage that Virtual Connect Flex-10/10d also brings 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.



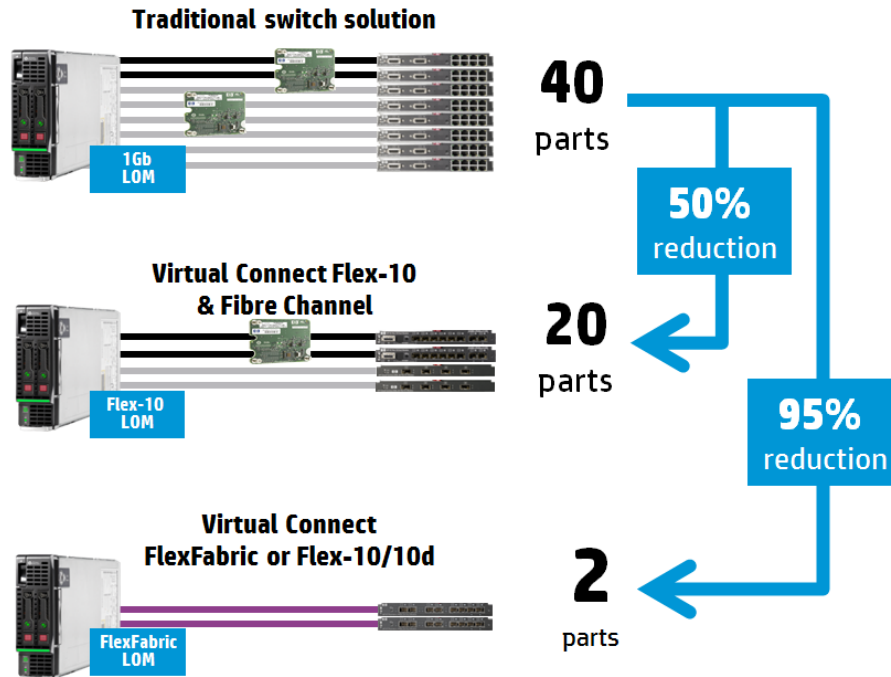
The Virtual Connect Flex-10/10d module can be used as illustrated above to implement dual-hop FCoE, but it also can be used as just an interconnect for Ethernet and paired with companion Virtual Connect Fibre Channel modules and Fibre Channel HBAs in the server blades. This provides the ability to implement Virtual Connect in an environment not 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 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. That's ideal for virtualized infrastructures such as those using 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 solution. The Virtual Connect FlexFabric solution requires only embedded 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 VC FlexFabric implementation, uplink ports X1-X4 can be designated to either carry Fibre Channel traffic to an upstream FC switch for one-hop or they can carry FCoE traffic to an upstream DCB-enabled switch for dual-hop. Uplink ports X5-X8 can only carry standard Ethernet. Dual-hop is supported on VC FlexFabric as well. It is applicable to X1-X4 ports only unlike Flex-10/10D all 10 ports can be used for dual-hop. With VC Flex-10/10d all 10 of the uplinks can carry converged traffic to the upstream DCB switch, and it's at that point the traffic separates into pure Ethernet and native FC uplinks. This extends the benefits of Virtual Connect and converged networking one more hop beyond the enclosure for a total of 2 hops, reducing the number of switches needed and eliminating cabling within the rack itself.

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

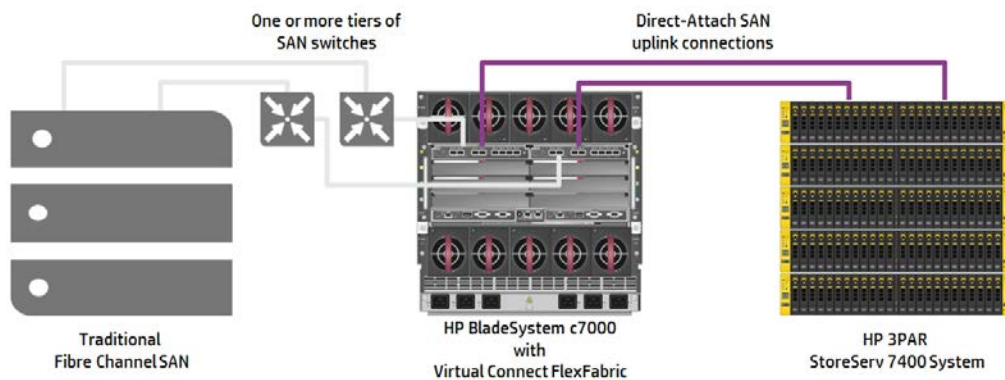


Direct-Attach Fibre Channel for 3PAR StoreServ Storage Systems

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 these 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 Storage 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 a traditional SAN fabric solution.



Highly scalable 3PAR StoreServ 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 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.

Also 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 will be enhanced to support direct-attach Fibre Channel storage with only minimal changes to Virtual Connect firmware. You 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. Now you can have data center-wide connectivity through VCM. You won't need separate licenses for the SAN/storage fabric or training on different management tools. You can manage your LAN and your storage from VCM or higher-level CloudSystem Matrix management and orchestration tools.

Management Capabilities

The primary management tools for Virtual Connect are Virtual Connect Manager (VCM) and Virtual Connect Enterprise Manager (VCEM). 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 has developed the 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 you tools to develop your own utilities based on the VCEM CLI and the published VCEM APIs.

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 Command Line Interface (CLI). VCM domain management makes it simple to set up and manage server connections because it includes control of 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 let you monitor system health, resource utilization, MAC addresses and the associated FlexNICs, uplink status, and NIC throughput data on all physical ports. For more details, see the paper [“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 benefits from the rich feature set HP SIM offers.

VCEM provides these core capabilities:

- A single intuitive console that controls up to 250 Virtual Connect domains (up to 1000 BladeSystem enclosures and 16,000 servers).
- A central repository that administers more than 256K MAC addresses and WWNs for server-to-network connectivity. This 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 configuration profiles. You can use a group to push Virtual Connect domain configuration changes—such as network assignment or parameter modifications—to all members of the domain group simultaneously. This increases infrastructure consistency, limits configuration errors, and simplifies enclosure deployment.
- GUI and a scriptable CLI that allow fully automated setup and operations. This 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, see the paper [“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 Matrix Operating Environment (Matrix OE) 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 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

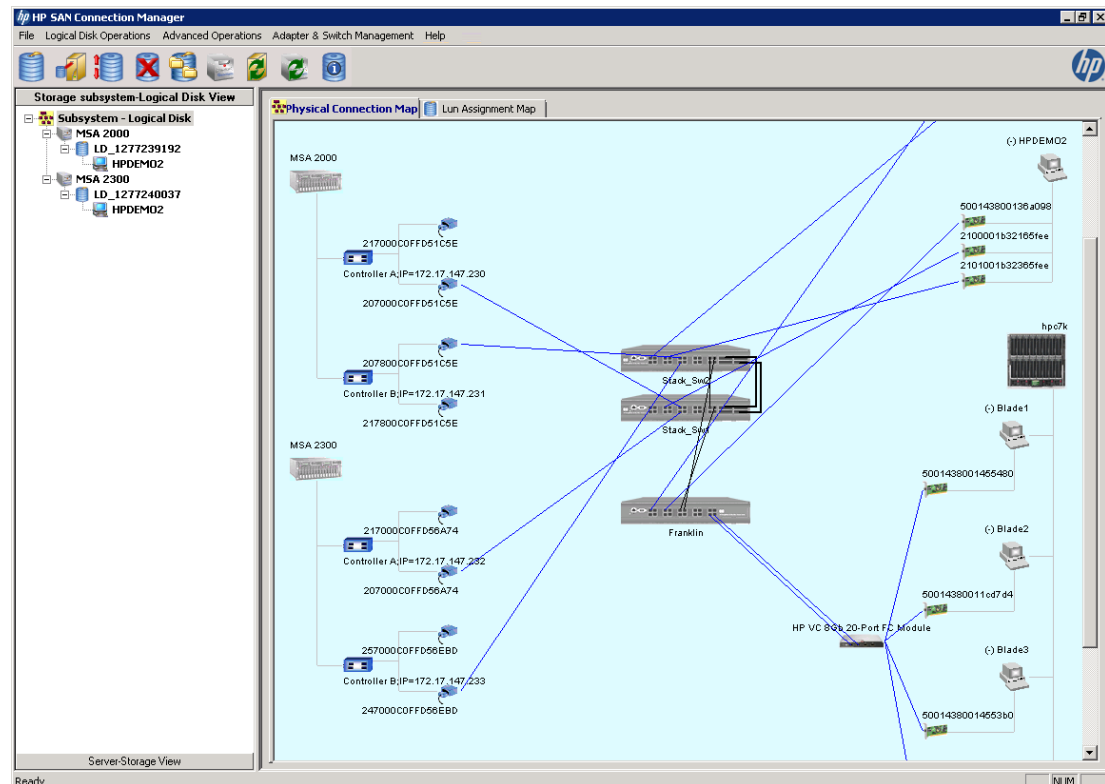
HP Matrix OE is an integrated infrastructure management stack containing the tools needed to build and manage cloud offerings such as infrastructure-as-a-service. Device data provided by VCEM and HP Insight Control provide the foundation for logical server deployment and orchestration delivered with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

HP SAN Connection Manager

HP SAN Connection Manager offers similar functionality for Fibre Channel SANs and storage resources. The SAN Connection Manager lets you do basic handling of SAN components such as HBAs, switches, and storage arrays in a single wizard-based GUI. You can integrate SAN Connect 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 9: The SAN Connection Manager lets you visualize the SAN and VC connections.



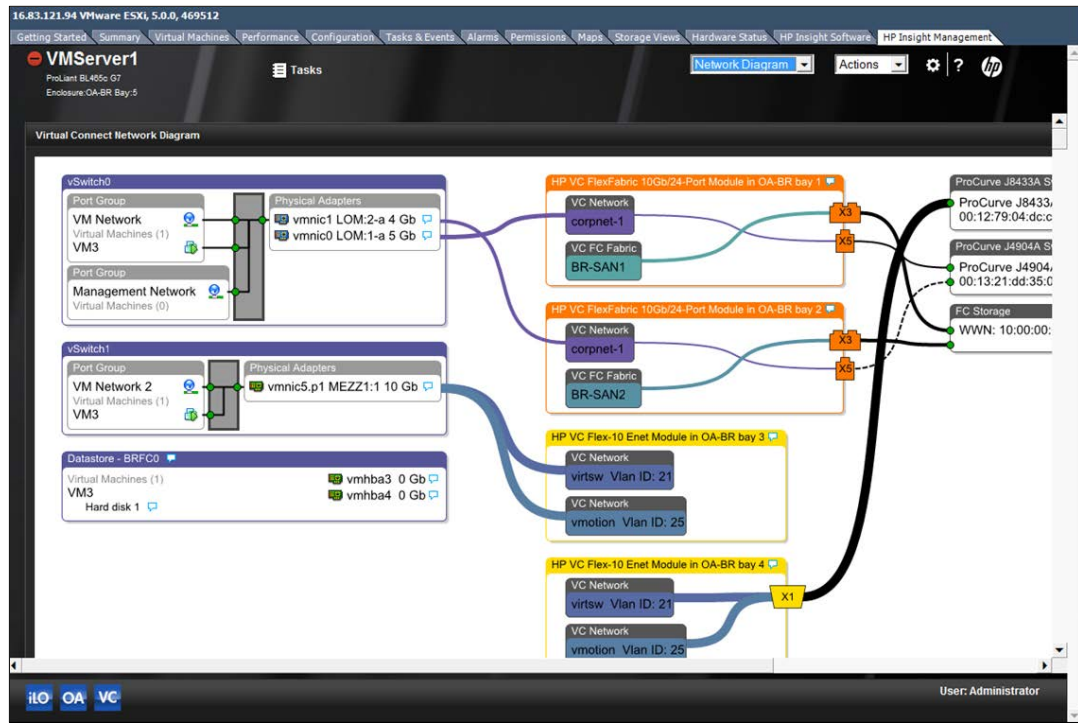
Integration with third-party tools

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

A great example 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 9). It allows you to monitor the relationship between VMware virtualized networking and Virtual Connect.

Figure 10: HP Insight Control for 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 which visualizes both the downlinks from VC to the server blade, and even on through the vSwitch to the virtual machine, but also the uplinks through to the upstream switch. For administrators that spend most of their time with tasks in Microsoft System Center, this enables the kind of end-to-end visibility of what's going on in their physical and virtual infrastructure that is necessary for troubleshooting or even just day-to-day operations, without having to login to another application and try to correlate information between the two.

Virtual Connect provides 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.
- 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 VC 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 station without logging out.
- Diagnostic and management technologies that match your established preferences and investment. Each data center team can use their 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 will impose a requirement to use a password that meets at least 3 of 4 criteria: upper case letter, lower case 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 with a core set of switching capability 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 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 doesn't 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 all causing shifts in data center networking traffic patterns toward more server-to-server (East-West) traffic flow. Industry sources indicate that more than 80 % of data center traffic will be East-West (E-W) by 2014. For example, VMware vMotion capability is one example of server-to-server communications, in which an entire VM's memory image—typically at least 4 GB—has to be transferred rapidly 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 without the traffic leaving the domain. This reduces the core switch traffic, because internal communication stays inside the Virtual Connect domain.

Quality of Service (QoS)

The fundamental goal of a network is to deliver traffic in keeping with an expected level of service. To meet these service levels, bandwidth alone is not sufficient. Ideally, the need is to be able to tag traffic with a given level of priority, so that important packets reach their destination as if they were taking the express lane, and lower priority traffic waits its turn. The ability to transport traffic with special requirements is referred to as “Quality of Service”.

VC firmware 4.01 supports priority QoS queues and is available on all VC modules compatible with this version. The implementation of QoS and CoS in the VC module complements the enforcement of prioritization at Flex-10 based adapters. VCM can allocate bandwidth based on up to 8 traffic classes. VC will queue frames aligned to these classes, and then a VC scheduler will prioritize the traffic on both egress and ingress. Up to 8 classes of service can be activated from the following selections:

- 2 Fixed – best effort and lossless (FCoE)
- 2 Predefined – real time and medium (latter not enabled at this time)
- 4 classes that can be user-defined

Without QoS, VC traffic flows on a first-in/first-out (FIFO) basis. When there is congestion, there is the potential for traffic at the tail of the queue to be dropped. With QoS configured, traffic flows according to resource allocation and priority of traffic to ensure that business critical applications get right priority.

Conclusion

HP Virtual Connect architecture boosts the efficiency and productivity of data center server, storage, and network administrators: It virtualizes the connections between the server and the network infrastructure (server-edge virtualization) so networks can communicate with pools of HP BladeSystem servers. This virtualization lets you 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 technology is a hardware-based solution that lets you simplify network I/O by splitting a 10Gb/s server network connection into four variable partitions. Flex-10 technology and products give you more NICs, yet they minimize the number of physical NIC and interconnect modules required to support multi-network configurations.

HP Virtual Connect FlexFabric modules and HP FlexFabric adapters extend the Flex-10 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% less hardware to qualify, purchase, install, and maintain in blade 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 to 3PAR 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 to storage.

The Virtual Connect Flex-10/10d interconnect builds on the concepts of Flex-10 for Ethernet and extends it to allow converged network and storage traffic to flow to an upstream switch featuring Data Center Bridging (DCB) 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 the network connections, the server profiles, and even how the networks map into virtual machines.

Additional links

HP Virtual Connect general information

hp.com/go/virtualconnect

HP BladeSystem c-Class architecture technology brief

hp.com/bc/docs/support/SupportManual/c00810839/c00810839.pdf

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

hp.com/bc/docs/support/SupportManual/c03028646/c03028646.pdf

Understanding the Virtual Connect Enterprise Manager

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

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

Comparison of HP BladeSystem servers with Virtual Connect to Cisco UCS

hp.com/bc/docs/support/SupportManual/c03094466/c03094466.pdf

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