Lab Validation Report

Brocade VCS Fabric Technology

Bringing Scalable, Distributed Intelligence to the Data Center with Ethernet Fabric

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by Brocade.

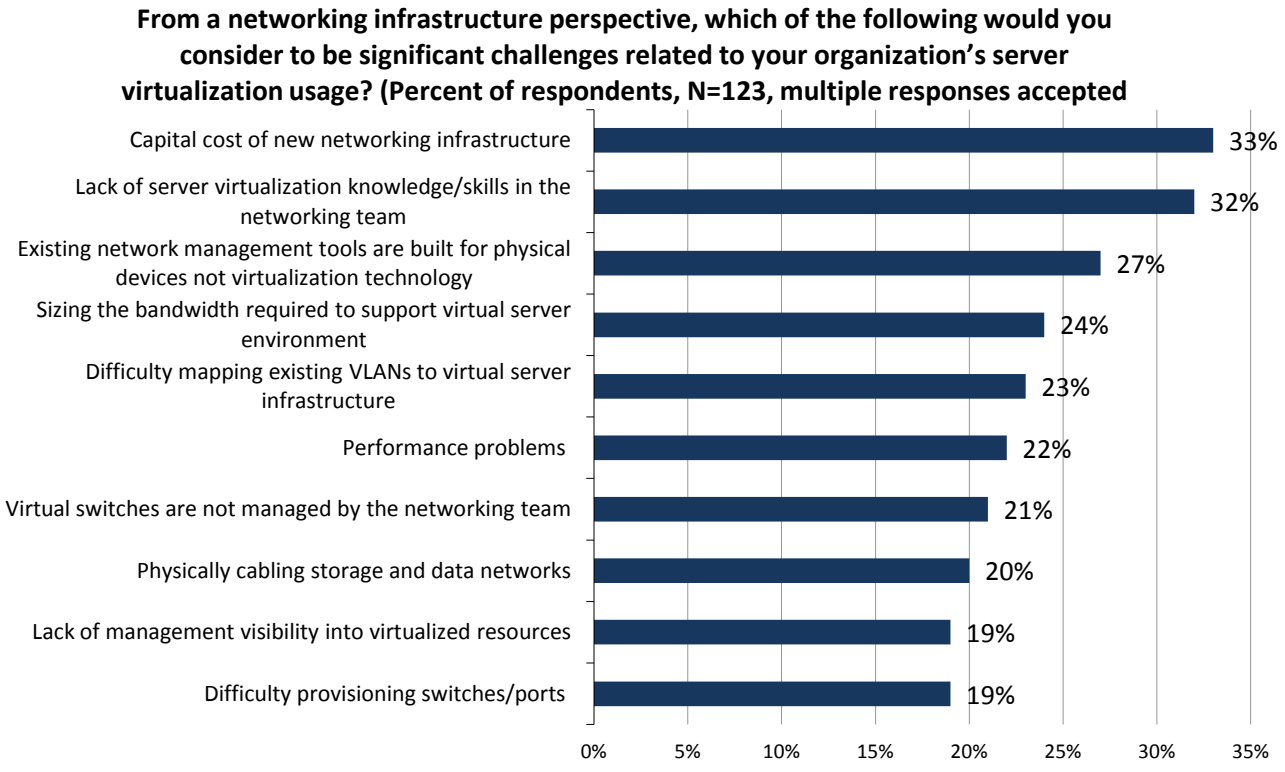
Introduction

The needs of today's virtualized server environments present new and increasingly difficult challenges to traditional network infrastructure. With bandwidth-intensive virtualization options like vMotion combined with increased levels of automation, IT administrators have a difficult time providing the appropriate performance and service levels at the moment they are required. This ESG Lab Validation examines Brocade VDX Data Center Switches leveraging Brocade VCS Technology, validating its ability to provide a network environment that is easy to implement and manage, and optimized for virtualization.

Background

As shown in Figure 1, organizations report multiple challenges with network infrastructure when supporting server virtualization's requirements.[1] The number one challenge reported was the cost of new network infrastructure, closely followed by the need to keep network professionals understanding of virtualization up to date as well as the prevalence of network management tools built with only physical devices in mind. The clash of physical and virtual environments seems to be foremost in the minds of network administrators, with some raising concerns that existing network management tools are not designed for virtual technology and others pointing to the difficulties associated with mapping VLANs to new virtual server infrastructure.

Figure 1. Networking Challenges with Virtualization



Source: Enterprise Strategy Group, 2011.

Traditional enterprise IT environments supporting multiple business units with a wide range of needs and service level requirements are increasingly finding themselves competing with external service providers and are challenged to prove themselves the most agile, cost-effective option for the business. Cloud service providers are not immune to these same networking issues as they are tasked with the important challenge of managing virtualization amid the complexity of multi-tenant networks. As both enterprise and service provider networks grow

[1] Source: ESG Research Report, *The Evolution of Server Virtualization*, November 2010.

and demands for more scalability and elasticity of resources increase, the pain of maintaining complex network architectures to satisfy customer requirements will increase as well.

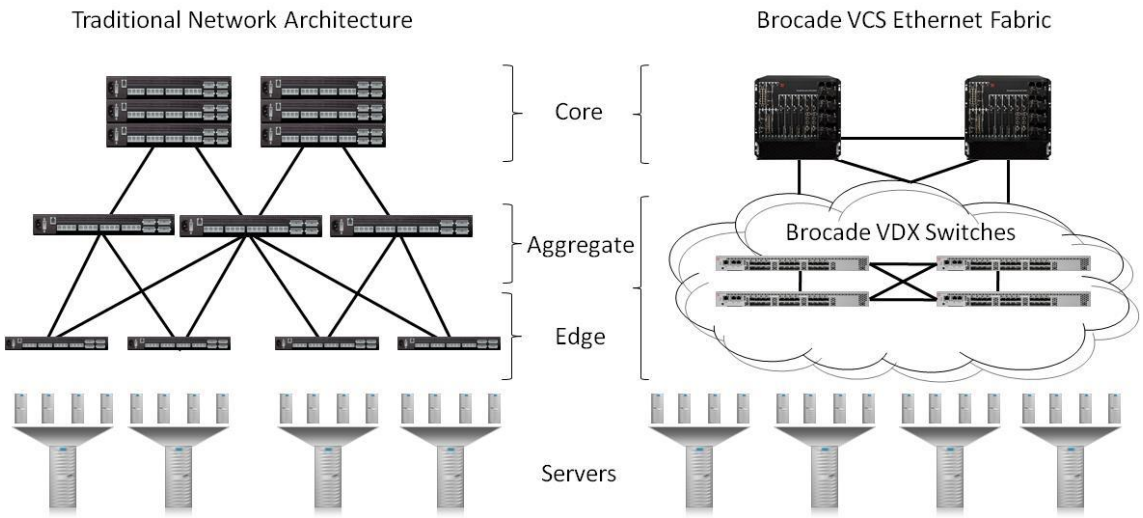
Ethernet Fabric

There has been a lot of discussion in the industry using the term "Ethernet Fabric" to describe new network technology and architecture designed with the lofty goal of shifting the network paradigm away from physical switch-based configuration and management toward a virtualized, automated network infrastructure that is self-discovering, self-aggregating, and optimized for virtualization. Without talking about specific vendors or protocols, there are a few elements that most can agree are attributes of Fabrics: They are flat, eliminating dependence on Spanning tree, but should still interoperate, to preserve existing investment. They are flexible, enabling a dynamic topology that changes as physical elements are added or removed. They are resilient, responding to failures and interruptions with no disruption to clients. Scalability is important, allowing for seamless addition of connectivity and bandwidth as needed and finally, the solution should be standards-based, enabling maximum interoperability. This is not a comprehensive list, but covers the most common attributes discussed around generic Ethernet Fabrics.

Brocade VCS Fabric Technology

Brocade VCS fabric technology builds on the foundation of Ethernet Fabric and adds powerful capabilities designed to resolve many of the traditional Ethernet-imposed challenges of server virtualization, while providing dynamic, virtualization-optimized automation and services that go beyond the capabilities provided by basic Ethernet Fabrics. Multiple interconnected VCS-enabled switches automatically form a single fabric, flattening the network architecture, reducing the number of tiers, and simplifying network design, as shown in Figure 2. The VCS fabric can be managed as a single switch with shared and dynamic control of network policies and behavior.

Figure 2. Brocade VDX Data Center Switch Solutions



The Brocade VDX family of data center switches, available in 16- through 60-port models with port on demand licensing, is the first to deliver Brocade VCS fabric technology. A new hardware design, combined with Brocade Network Operating System (Brocade NOS), is designed to improve network utilization, maximize application availability, increase scalability, and dramatically simplify network architecture in next-generation virtualized data centers. Some of the key benefits provided by Brocade VCS technology are:

- **Non-stop Networking–**Enterprise class availability, scalability, and resilience with domain based management of the network as a single 'logical chassis'.
- **Simplicity Through Automation–**Automatically aligning virtual machines with the correct network resources, anywhere in the data center with distributed intelligence.

- **Evolutionary**–Top of Rack architecture designed to address east-west (server to server) traffic growth with less disruption and a lower cost of entry than traditional aggregated data center networks or fabric architectures based on core switches.

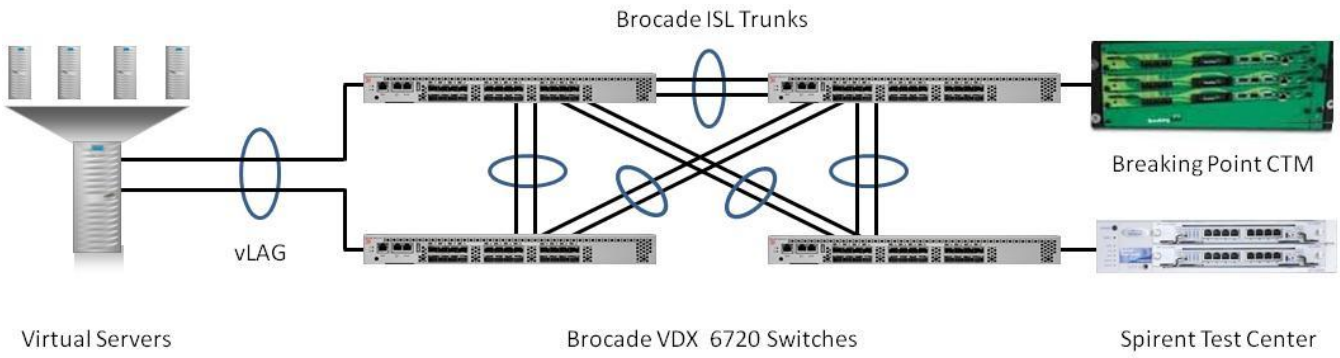
ESG Lab Validation

ESG Lab performed hands-on evaluation and testing of Brocade VCS technology and VDX data center switches at Brocade's San Jose, CA facilities. Testing was designed to document the capabilities of Brocade VDX 6720 switches leveraging VCS fabric technology to improve network performance and utilization while simplifying integration and increasing network flexibility.

Getting Started

The test bed used by ESG Lab is illustrated in Figure 3. An ESX server was connected to an Ethernet Fabric composed of four Brocade VDX 6720 Data Center Switches running VCS fabric technology. Traffic was simulated using BreakingPoint Storm CTM and Spirent TestCenter workload generators to create and measure various types of network traffic. Testing was designed to emulate traffic in an enterprise data center network environment.

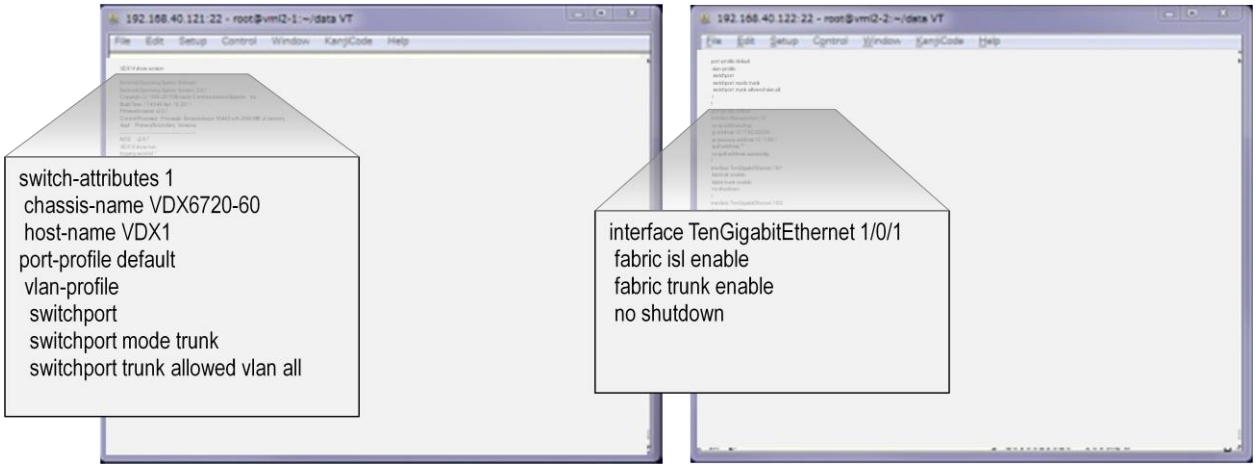
Figure 3. ESG Lab Test Bed



ESG Lab Testing

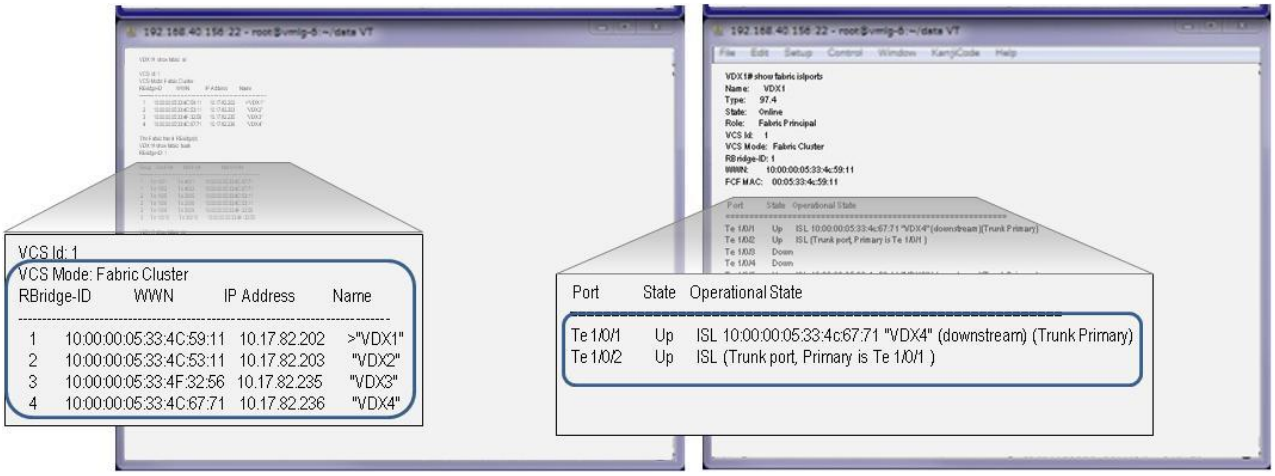
ESG Lab used the VDX switches' CLI to view the default settings and examine the steps needed to add and configure new switches. When a new VDX switch was connected to the existing fabric, it inherited the configuration of the fabric, automatically created ISLs (inter-switch links) between switches, and became available immediately. ESG Lab started with one switch in its default configuration as shown in Figure 4.

Figure 4. Brocade VDX 6720-60 Default Configuration



ESG Lab then connected three additional VDX 6720 switches to the fabric and examined the switch configuration again. As shown in Figure 5, the Ethernet fabric included all four switches as well as Brocade ISL Trunks which were automatically created between switches when multiple ISL connections were made.

Figure 5. Brocade VDX Data Center Switch Solutions



In less than ten minutes, a fully meshed network was created with inter-switch links automatically created between all four switches with no manual configuration required. In ESG Lab's experience, the process required significantly less time and effort than installing and configuring traditional Ethernet switches.

Why This Matters

Many organizations are struggling to keep up with the massive changes brought on by server virtualization. They often lack the tools and technology needed to take advantage of the dynamic nature of server virtualization and cloud computing. When ESG asked IT professionals and managers to name their most significant network-related challenges, network management tools not designed for virtual infrastructure and bandwidth to support the virtual servers' environment were near the top of the list. Brocade's VDX Data Center Switches with VCS are designed to provide networks the ability to support highly scalable server virtualization environments with less hardware and reduced administration effort.

ESG Lab found VDX switches to be easy to configure and deploy, dynamically adapting to changing physical topology and automatically creating a resilient fabric of four switches.

Scalability and Performance

Application response time—and the ability to scale network capacity to meet increasing demands—are key challenges for any network environment. Brocade VDX switches with VCS technology offer 'Ports on Demand' with wire speeds of up to 10GbE across all ports, enabling an easy and cost-effective scaling model where users purchase only the quantity of ports required with the ability to seamlessly scale by applying a software license to enable additional ports as needed. In this way, individual VDX switches can scale from 16 to 60 ports. VCS technology enables VDX switches to inherit the fabric configuration as they are attached to the network and automatically create ISL trunks between switches, scaling performance on demand.

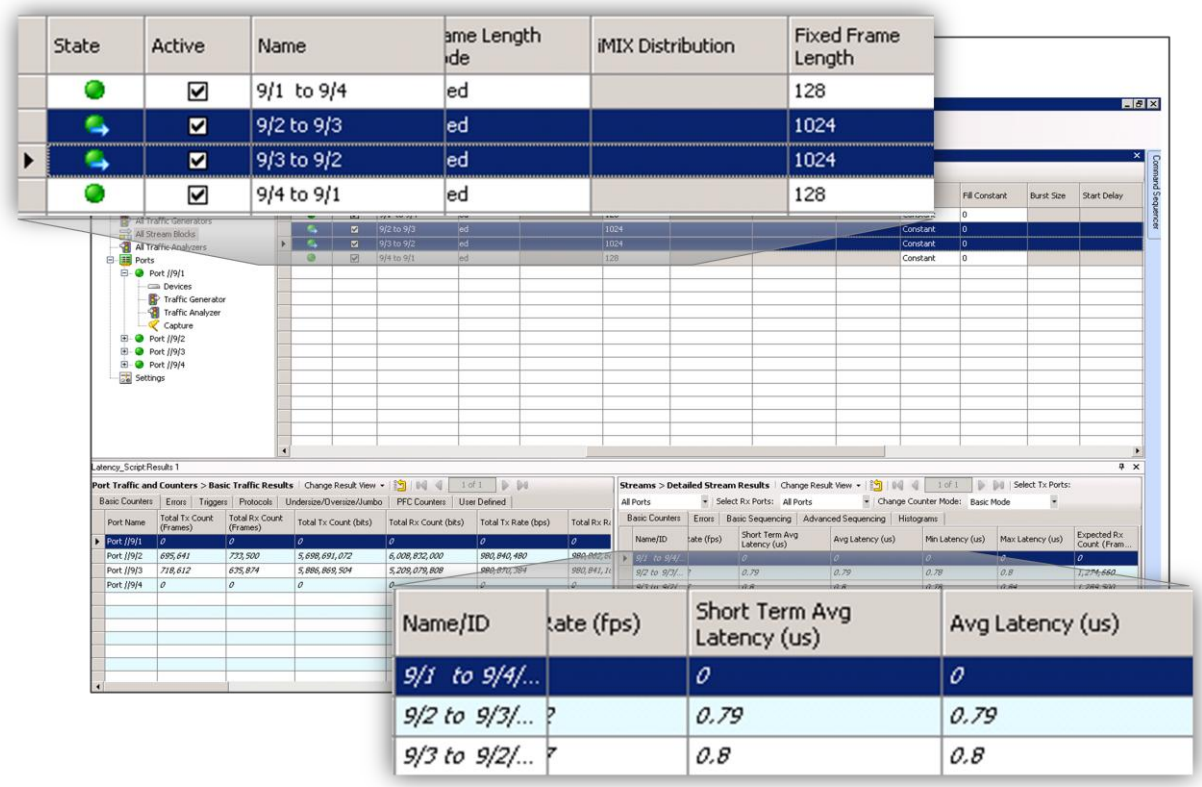
ESG Lab Testing

First, ESG Lab connected an ESX server to the network using two Emulex Converged Network Adapters (CNAs) and a Brocade MLX router with Multi-chassis Trunking (MCT) enabled. Then virtual Link Aggregation Groups (vLAGs) were configured. vLAGs provide active-active links for core router connections to the Brocade VCS fabric as well as active-active links for server connections to the Brocade VCS fabric.

Next, ESG Lab tested performance by generating 40,000 sessions of client to server and server to server traffic using the Spirent TestCenter simulator. Client-server applications simulated included HTTP and HTTPS workloads like Twitter, Facebook, and Instant Messaging, while server-server traffic emulated NFS, and CIFS protocols as used by Oracle and SQL Server. In a traditional Ethernet network using the Spanning Tree Protocol for network resilience, half of the inter-switch links would be unusable, limiting available inter-switch bandwidth. Using the Brocade VDX CLI, ESG Lab confirmed that all inter-switch links configured in the vLAGs were passing traffic.

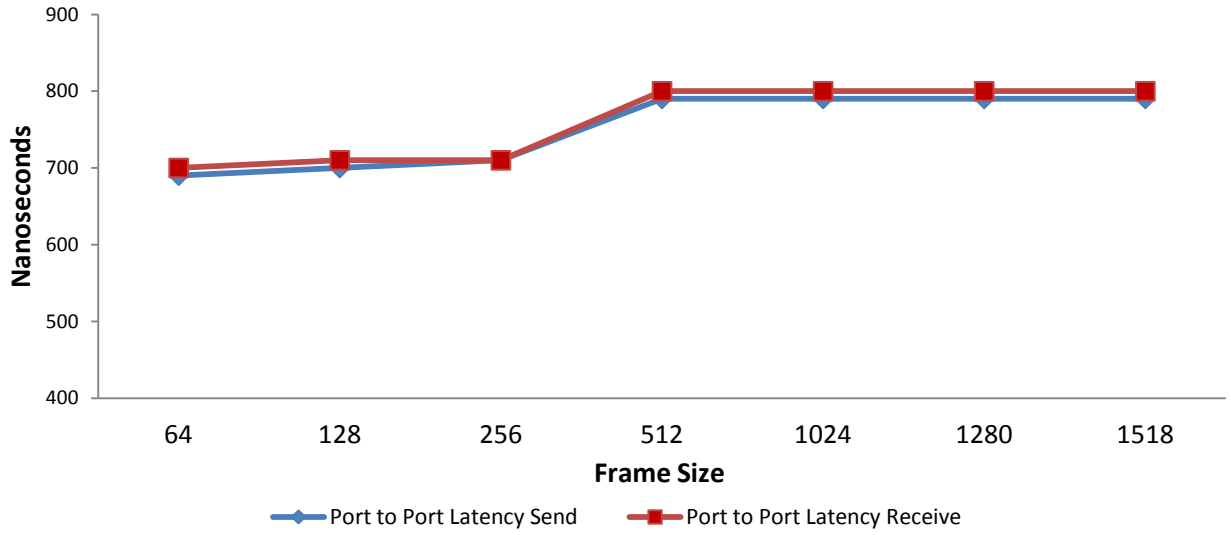
Next, ESG Lab generated the same mix of network traffic using the Spirent TestCenter to measure latency between ports on an individual switch as well as between physical switches. The test started with 64 byte frames and walked up to 1518 byte frames passing data through one switch. Latency was measured by Spirent TestCenter's traffic analyzer. Figure 6 shows the latency for 1024 byte frames, measured in microseconds.

Figure 6. Latency Test Port to Port



ESG Lab then repeated the test moving the data across two switches to capture the switch to switch latency. The port to port latency of the Brocade VDX switches is graphed in Figure 7.

Figure 7. Latency Test Port to Port



The VDX switches showed extremely consistent port to port latency of less than a microsecond throughout the range of frame sizes tested. The detailed results are shown in Table 1.

Table 1. Brocade VDX Port to Port and Switch to Switch Latency

Frame Size	Port to Port Latency - Send (Nanoseconds)	Port to Port Latency - Receive (Nanoseconds)	Switch to Switch Latency - Send (Microseconds)	Switch to Switch Latency - Receive (Microseconds)
64	690	700	1.27	2.27
128	700	710	1.29	1.74
256	710	710	1.32	1.33
512	790	800	1.34	1.35
1024	790	800	1.42	1.43

What the Numbers Mean

- Brocade VDX 6720 switches showed a very consistent port to port latency between 690 and 800 nanoseconds as frame size was increased.
- Switch to switch latency was also consistently low and, in combination with observed port to port latency, validates the VDX's highly scalable performance compared to traditional Ethernet switches ESG Lab has worked with.

Why This Matters

The network is the IT foundation on which the business relies. High performance, resilience, and the ability to grow with the environment are all absolute necessities for any network. Performance degradation can have direct financial consequences if application response times are not delivered as required and service level agreements are not met.

ESG Lab tested the scalability and performance of the VDX network using VCS technology and saw significant improvements over a traditional network configuration in both available bandwidth and extremely low latency. Creating resilient, high bandwidth, inter-switch vLAGs was extremely easy, with minimal administration required.

High Availability and Optimization

Server mobility presents multiple challenges in static networking environments. IP addresses must be changed, and router, switch, VLAN, and ACL configurations all need to be updated to ensure access to the moved server and applications. Brocade employs network policy portability as part of VCS technology, which allows virtual machines to migrate within a subnet without requiring changes to the network or the IP address of the virtual machine.

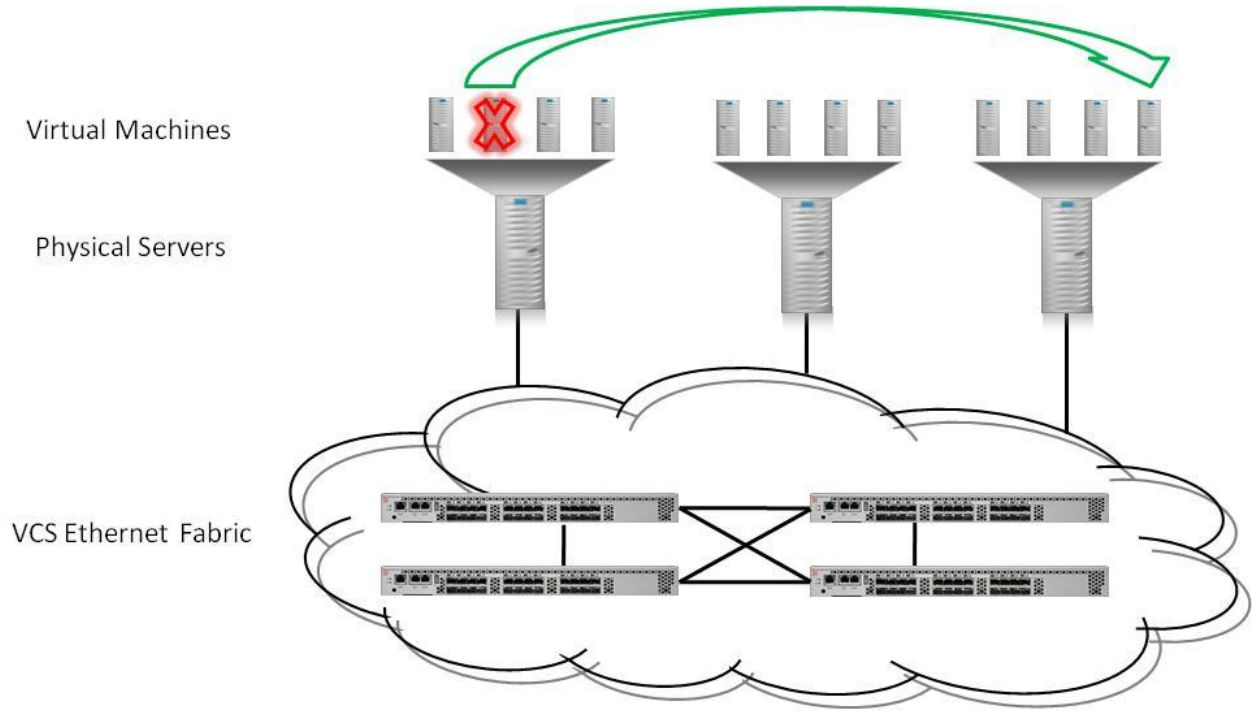
Automated Migration of Port Profiles (AMPP)

AMPP is a Brocade VCS feature which addresses virtualization challenges in Ethernet environments by virtualizing network policies and detaching them from physical ports in a VDX switch. This enables servers to move at will throughout the environment, carrying their network profile with them automatically, without administrator intervention.

ESG Lab Testing

ESG Lab tested network policy portability by moving a virtual machine between two vSphere servers located on different IP subnets on different physical switches. As seen in Figure 8, the test environment contained multiple virtual machines hosted on multiple physical servers and attached to multiple physical switches in a simulated data center. Some virtual machines were configured on different subnets and VLANs to validate that AMPP network policies were consistent after a VM migration.

Figure 8. Automatic Migration of Port Profiles



ESG Lab configured network policies to enable communication between two virtual machines in a single subnet and prohibit traffic to virtual machines on another subnet. The policy was assigned to a virtual machine's MAC address and then vMotion was used to move the running virtual machine to another vSphere server located on a different physical switch. A continuous workload was executed between the migrating host and another server on its subnet. The virtual machine moved, retaining its IP address, VLAN ID, and connectivity to the server on its subnet with no disruption to communication. ESG Lab also confirmed that the moved virtual machine was still unable to communicate with virtual machines on the prohibited subnet.

Next, network resilience was tested to validate that link addition or failure is non-disruptive. For this test, multiple high bandwidth workloads were simulated using the Spirent TestCenter that included both HTTP/HTTPS Internet

workloads (webmail, IM, streaming video) as well as traditional data center workloads like Oracle, SQL, and file services (NFS/CIFS). In total 40,000 sessions were simulated during these tests.

While traffic was flowing, a link was added to the Brocade ISL Trunk between two switches. ESG Lab observed zero disruption, even as the newly added link began passing traffic.

ESG Lab next pulled a cable on one VDX switch to simulate a hardware failure and monitored the traffic using the Spirent Test Center's GUI to observe the results of the broken link. There was no disruption to connectivity as traffic continued to flow over the Brocade ISL Trunk. This differs from traditional Spanning Tree protocol failover where all traffic travels over one path (or aggregate) and fails over to a second path when a connection is lost. This can take tens of seconds to make the switch to the new data path, depending on the size and complexity of the network, which can lead to application timeouts and very noticeable loss of connectivity.

ESG Lab observed extremely rapid fabric convergence time for high availability, when compared to traditional Ethernet, where convergence can take from seconds to minutes. Failover from the removed path and recovery to the restored path were both instantaneous with no detectable impact from frame loss.

Why This Matters

As companies look to expand their investments in virtual technology, it's apparent that networks need to provide the flexibility to allow IT to effectively manage the resource demands required in the enterprise. Both virtualized data centers and private clouds must be able to quickly move server resources to where they are most needed, and virtualization makes that mobility possible. The network is the challenge: in complex network architecture, a single server move can require configuration changes in routers, switches, VLANs, and ACLs.

Brocade AMPP was particularly impressive. The ability to move any physical or virtual machine anywhere on the network without having to reconfigure network interfaces or IP addresses greatly reduces the amount of time and effort required to manage large scale virtualized data centers, where servers move on a regular basis. In a static network, the router, switch, VLAN, and ACL configurations all need to be modified when a virtual server moves between physical switches, which could take minutes to accomplish for each move. Using AMPP, no interaction was required, effectively reducing the management time required to zero.

ESG Lab used vMotion to successfully move a virtual machine running a network workload from one ESX server to another on a different physical switch without changing the network configuration or disrupting services to the VM.

ESG Lab Validation Highlights

- ☑ When a new VDX switch was added to an existing fabric, the new switch inherited the fabric configuration, automatically created ISL links, and joined a Brocade ISL Trunk between switches with none of the manual configuration required with traditional networks.
- ☑ Brocade VCS technology's Logical Chassis functionality can provide the ability to scale and manage the Ethernet fabric as a single logical switch.
- ☑ Network configuration for vMotion was simplified using AMPP as all Mac, IP, and ACL information was transferred with the virtual machine as it moved in the network compared to having to update that information manually as is necessary in static networks.
- ☑ ESG Lab verified port to port latency on a VDX 6720-60 as low as 690 nanoseconds.
- ☑ During a link failure, the VDX switch experienced a sub-second pause in traffic flow with zero to minimal frame loss. In traditional Ethernet Networks, recovery could take tens of seconds to minutes depending on complexity of the network.

Issues to Consider

- ☑ The benefits specific to Brocade VCS technology require a homogenous network of Brocade VCS enabled switches. It's important to note that VCS technology still operates non-disruptively within standard Ethernet architectures, even if fabric architectures from different vendors are not interoperable amongst themselves. Although Brocade VCS fabrics are interoperable with existing networks, that does not mean Brocade VCS technology features extend to existing infrastructure.
- ☑ Advanced functionality like network extension over distance, native Fibre Channel connectivity, Layer 4 - 7 services (such as Brocade Application Resource Broker), and enhanced security services (such as firewalls and data encryption) can be attached to a VCS Ethernet fabric but are not presently supported within the fabric itself. Brocade has discussed plans for future releases with ESG, where switches with these unique capabilities will be able to join the Ethernet fabric, adding a network service layer that is available across the entire fabric.

The Bigger Truth

Server virtualization has been a disruptive technology that has allowed companies to recognize true capital savings by consolidating server infrastructure and reducing data center floor space while also maximizing utilization of existing assets. It's no surprise, then, that increased use of server virtualization (30%) tops the list for IT spending priorities according to ESG research.[2] As server virtualization deployments grow, IT faces an increasing challenge to keep up with the demands of virtualization, including application mobility, load balancing and resilience within existing network infrastructures.

Virtualization is also the catalyst that has allowed the emergence of cloud solutions promising further cost capital reductions as enterprise IT services begin to move out of corporate data centers. The promise of cloud computing solutions that deliver scalability and elasticity will be difficult to achieve with today's traditional networking architectures. A network that performs with the same flexibility and ease of management that is attained with virtual servers will be required as cloud solutions mature and become ubiquitous.

Brocade has developed an enterprise-ready, virtualization-aware network solution that delivers on that promise. Brocade VCS technology solves more than just network problems, enabling VM machine mobility free from network reconfiguration requirements.

With VCS technology, enterprises and service providers can rapidly create flexible, resilient, high performance networks without the management overhead that exists with traditional Ethernet switch architectures today. These networks can be managed as a single logical chassis, significantly simplifying physical topology, load balancing, and path management.

ESG Lab was able to build a fully meshed Ethernet Fabric with resilient inter switch links in minutes, by simply powering on and plugging switches together. Load balancing was automatic and incredibly flexible, even load balancing traffic from a single user running a single stream across multiple links using vLAGs. Link failures were handled instantly and completely non-disruptive to running applications. Automatic Migration of Port Profiles enabled the movement of a virtual server running a live workload between switches using while retaining its IP address, VLAN tags and network policies.

As companies look to build networks that can respond to the business needs of increasingly virtualized enterprises, VCS technology from Brocade is a much needed step toward providing a truly scalable, flexible, and resilient network to enable and enhance the value of server virtualization customers are beginning to achieve today.

[2] Source: ESG Research Report, *2011 IT Spending Intentions Survey*, January 2011.

Appendix

Table 2. ESG Lab Test Bed

Switches	
4 Brocade VDX 6720 24 Port Switches	VDX 6720-24
Firmware	2.0.1
Network Operating System (NOS)	2.0.1
Cloud Simulation and Traffic Generation	
BreakingPoint Storm CMT	4x 10Gbps Interfaces
Spirent TestCenter 3.70	4x 10Gbps Interface Modules
Servers	
VMware ESX Server (2 ESX Servers)	ESXi version 4.1
Virtual Machines (2)	Windows Server 2008 R2

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