High Performance Fibre Channel Switch vs. Unified Port Switch Technology

Evaluation report prepared under contract with Brocade

Executive Summary

Fibre Channel switches are purpose-built for storage networks, meeting the requirements for high reliability, high availability, predictable performance and low latency. Brocade 16 Gbps Fibre Channel switches are designed and built with these requirements in mind.

General purposes switches with unified port technology such as the Cisco Nexus 5500 Series Switches offer enhanced flexibility and consolidation through multi-protocol switching technology. However, as with many IT equipment choices, customers need to carefully consider the tradeoffs of purpose-built Fibre Channel vs. general purpose unified port switching infrastructure for critical storage traffic.

Brocade commissioned Demartek to evaluate the performance and functionality of the 16 Gbps Fibre Channel Brocade 6510 switch compared with unified port technology on the Cisco Nexus 5548UP when used with Fibre Channel connections.

This report outlines the tradeoffs and technical differences when evaluating purpose-built Fibre Channel and general purpose unified port switches for SAN infrastructure.

1 – Background Environment

Many data centers today are struggling to adapt to changing data center requirements with their aging infrastructure. As VM densities increase and new mission critical applications are deployed, data center customers are evaluating new network infrastructure to address performance, availability, and cost-optimization requirements.

One of the choices confronting data center customers in this transition is the choice between purpose-built Fibre Channel and general purpose unified port switches. A dedicated Fibre Channel SAN provides data-center proven availability, performance, and functionality. Unified port switches are a new class of switching infrastructure that provides multi-protocol flexibility and switch consolidation.

Fibre Channel SANs, like those from Brocade, are optimized for block-based storage applications. They do require a different skill set to manage and come at a price premium over iSCSI and direct-attached storage alternatives. However, because of its superior reliability and performance, Fibre Channel is still the de-facto standard storage network for mission-critical and virtualized application infrastructure.

Unified port switches, such as the Cisco Nexus 5548UP offer the promise of network convergence that results in switch consolidation and protocol convergence on Ethernet. However, if you are connecting existing SAN switches, servers, and storage, unified port switches aren't optimized for Fibre Channel.

Limitations of Unified Port Solutions

The biggest challenge of unified port switches is delivering all of the Ethernet, Fibre Channel and FCoE switching capabilities in a single switch. This one-size-fits-all approach sacrifices performance and functionality in order to provide multi-protocol flexibility. The Cisco Nexus 5500 Series port speed is limited to 8 Gbps and latency is significantly higher than purpose-built Brocade Fibre Channel switches. In addition, configuring Cisco Nexus 5548UP port identities may require a switch reboot, resulting in disruptions to SAN fabrics.

Another less obvious challenge is the administration and management of a unified port switch within the data center IT organization. Often described as "layer 8 and 9"challenges, this refers to the people and organizational infrastructure within the data center. Which IT organization (LAN or SAN) manages a unified port top-of-rack (TOR) switch or multi-switch fabric? When there are network problems, which organization diagnoses and resolves the issue? How are SLAs enforced or managed? Issues like administrative downtime require more careful planning due to the shared switch platforms.

Purpose-built Fibre Channel Switch

Brocade 6510 Switch

The Brocade 6510 Switch provides exceptional price/performance value, combining flexibility, simplicity, and enterprise-class functionality for virtualized data centers and private cloud architectures. Designed to enable maximum flexibility and investment protection, the Brocade 6510 is configurable in 24, 36, or 48 ports and supports 2, 4, 8, 10, or 16 Gbps speeds in an

efficiently designed 1U package. It also provides a simplified deployment process and a point-and-click user interface – making it both powerful and easy to use.

General-purpose Data Center Switch

Cisco Nexus 5548UP Switch

With choice of front-to-back or back-to-front cooling, copper or fiber access ports, and rear-facing data ports, the Cisco Nexus 5500 Series is designed for a broad range of physical, virtual, storage access, and high-performance computing environments, thus giving customers deployment flexibility. The Cisco Nexus 5548UP is a 1RU 10/1 Gigabit Ethernet, 8/4/2/1 Gbps Fibre Channel, and 10 Gigabit Ethernet FCoE switch on up to 48 ports. The switch has 32 unified ports and one expansion slot with up to an additional 16 unified ports.

Switch Overview Comparison

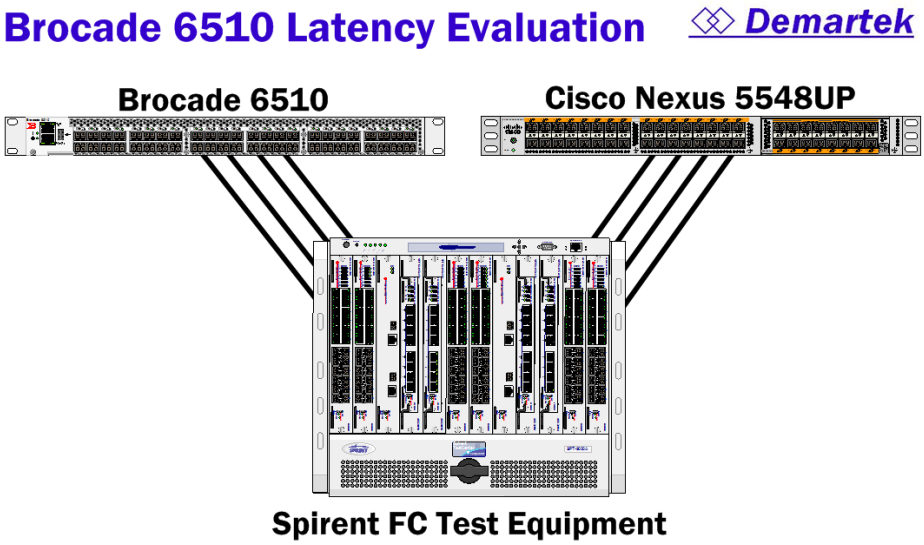
	Brocade 6510	Cisco Nexus 5548UP
Total line rate ports (FC)	48 @ 16 Gbps	48 @ 8 Gbps
Total bandwidth (FC)	768 Gbps	384 Gbps
Switch latency	See test results	See test results
Energy consumption	0.4 Amps	2.4 Amps
Physical size – Width	17.23 in.	17.3 in.
Physical size – Height	1.7 in.	1.72 in.
Physical size – Depth	17.45 in.	29.5 in
Weight	20.2 lbs.	35 lbs.
Non-disruptive administration	Yes	Changes in port configurations may require switch reboot

2 – Performance Testing: Understanding Latency

While high IOPS and bandwidth are frequently the metrics used for assessing storage networking performance, in many cases latency is equally important. There are many applications where low latency, or round trip response times, are critically important, even more so than the IOPS or bandwidth metrics. For a switch in the middle of a busy storage network, lower latencies are very desirable.

A series of tests measuring latency of various combinations of Fibre Channel switch ports was conducted. These tests used special Fibre Channel test equipment from Spirent to drive workloads through various Fibre Channel switches.

The basic configuration of the switches and test equipment is shown below. Additional connections were made between the switches and test equipment as needed. The test equipment was connected to only one brand of switch at a time while the tests were running, and the same ports on the test equipment were used for testing both brands of switches.



These tests include:

Single-switch

- Balanced 4-port
- Fan-in 3 ports to 1 port
- 8-port full mesh

Two switch

- 4-ports each

Fibre Channel Switch Architecture

Fibre Channel switches are generally deployed in environments that require high reliability, high availability, predictable performance and very often, low latency. In enterprise environments, it is

not uncommon for all the ports on a Fibre Channel switch to be busy with storage traffic, so each port should provide consistent performance and latency across all the switch ports.

If a Fibre Channel switch is designed to sustain high levels of traffic across all ports, then the latency will be consistent across the ports, regardless of where the port is located on the switch.

By comparing the test results of the switches under test, we can discern important differences in their design and implementation. If the latency results vary depending on which switch ports are tested, then storage administrators may not always get optimal performance and may need to "work around" limitations in the switch design.

The typical design for a Fibre Channel switch is to include a number of ASICs inside the switch, with each ASIC controlling a set of ports. A number of ports are controlled by a single ASIC and these are known as a port group. Traffic may flow between ports within the same port group, or may flow between ports in different port groups.

Some switch designs include "mainboard" and "expansion" sets of ports where the expansion ports are somewhat segregated from the mainboard ports. Depending on the design and implementation, additional latency may be introduced as traffic flows between ports on the mainboard and expansion areas of the switch.

The designs of the Brocade and Cisco switches are different with respect to port groups and expansion ports. The Brocade 6510 is designed so that all 48 ports are accessible from the mainboard and all 48 ports can run at full speed simultaneously. The Cisco switch has 32 ports on the mainboard and 16 ports in an expansion unit. The Cisco switch uses "unified ports" which can be configured for 10 Gbps Ethernet or native 8 Gbps Fibre Channel. For our tests, we configured all the ports on the Cisco switch for testing as Fibre Channel ports.

2 – Single Switch Tests

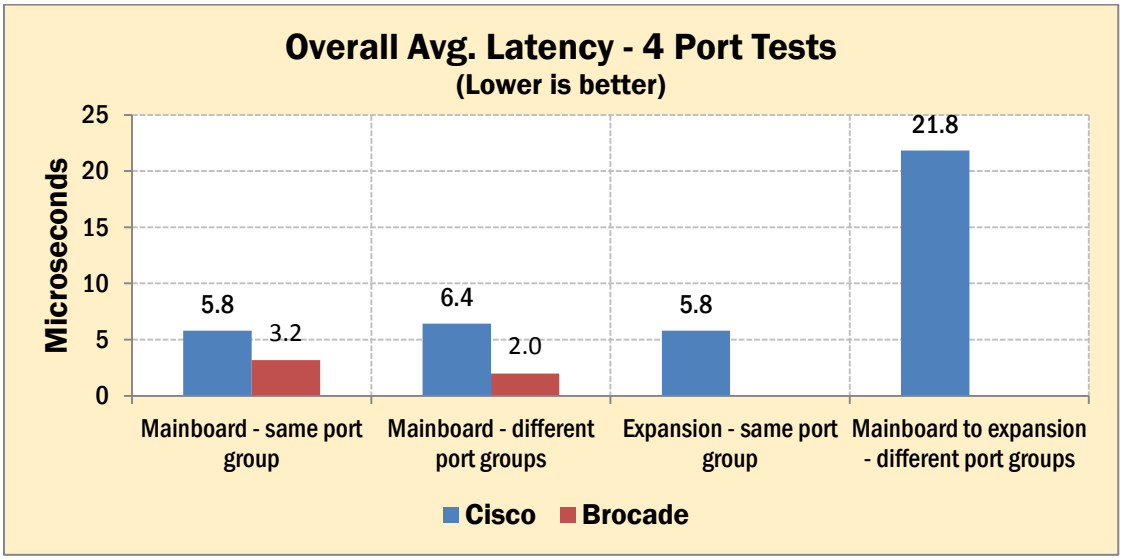
The single switch tests included:

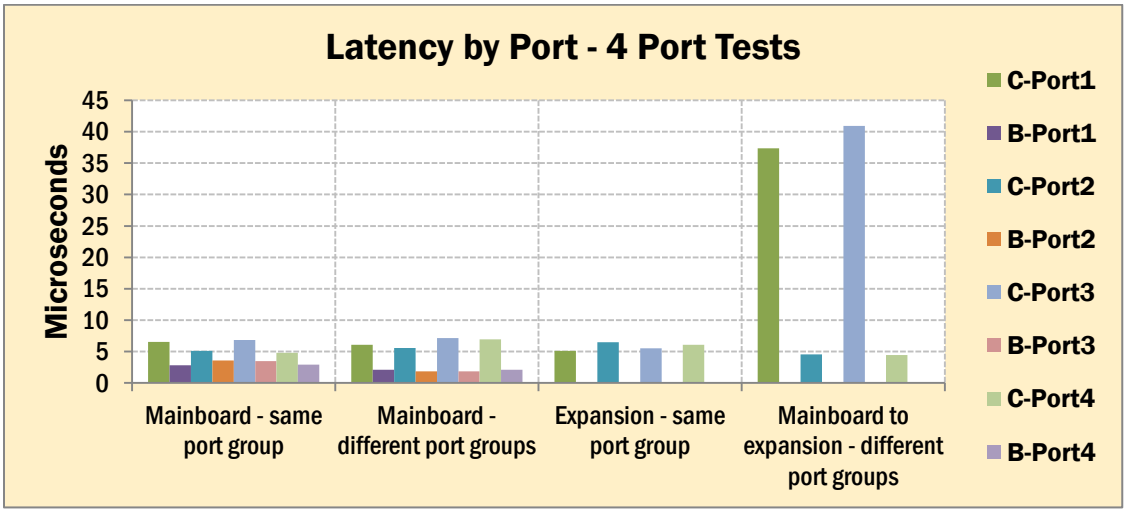
- Balanced 4-port
- Fan-in 3-port to 1-port
- Balanced 8-port full mesh

Balanced 4-port Tests

The balanced 4-port series of tests includes measures of full-duplex latency through four ports using different combinations of port groups. These combinations are:

- Mainboard – same port group
- Mainboard – different port groups
- Expansion – same port group (applies to Cisco only)
- Mainboard to Expansion – different port groups (applies to Cisco only)



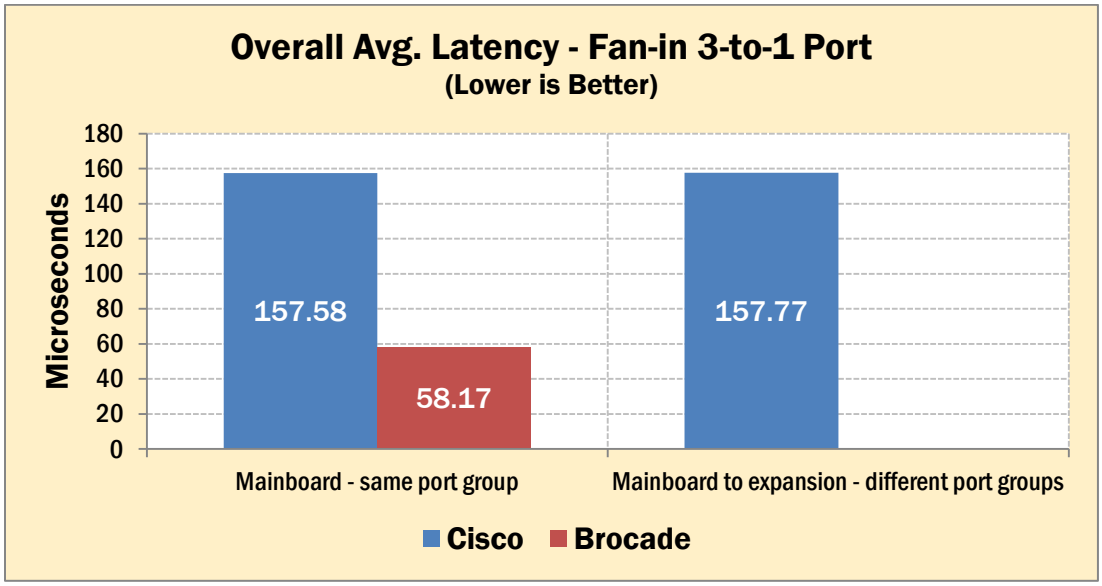


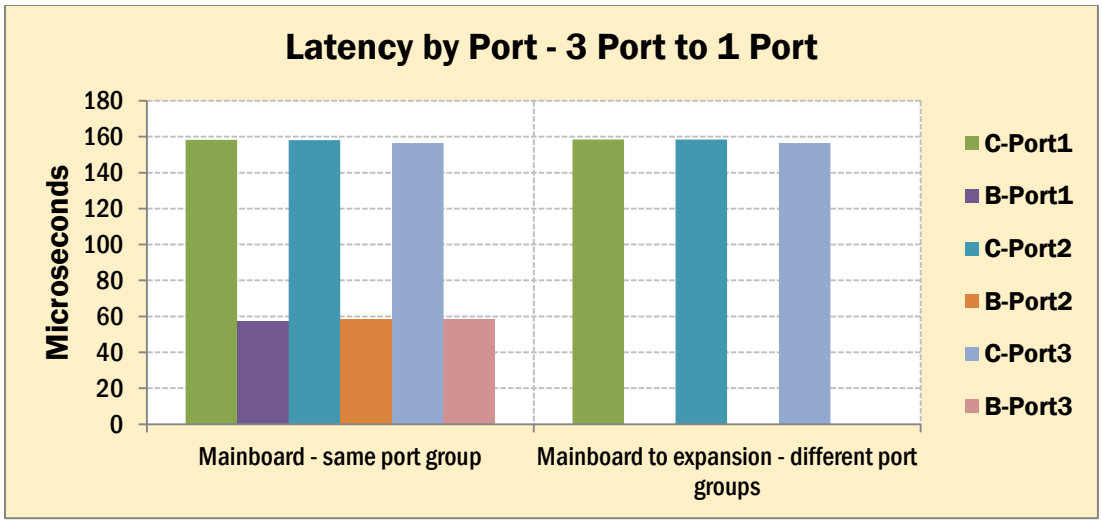
The Brocade switch demonstrated consistently lower latencies for each of the port group combinations, especially when connections crossed port groups.

Fan-in 3-port to 1-port

The fan-in 3-port to 1-port tests includes measures of half-duplex latency with three ports communicating to one port using different combinations of port groups. This traffic pattern is typical of multiple servers communicating with one storage target, or one server communicating with multiple storage target ports. These combinations are:

- Mainboard – same port group
- Mainboard to expansion – different port groups (applies to Cisco only)

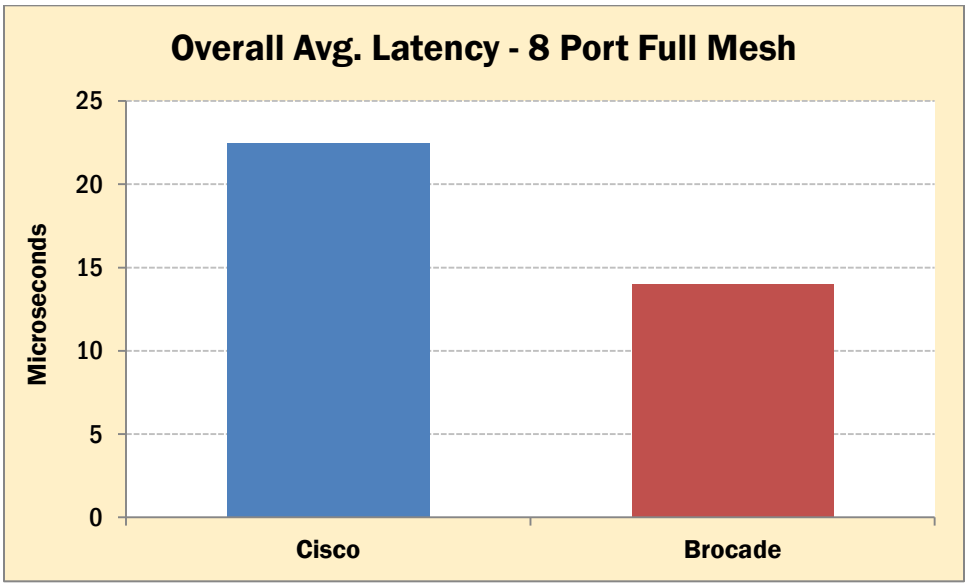


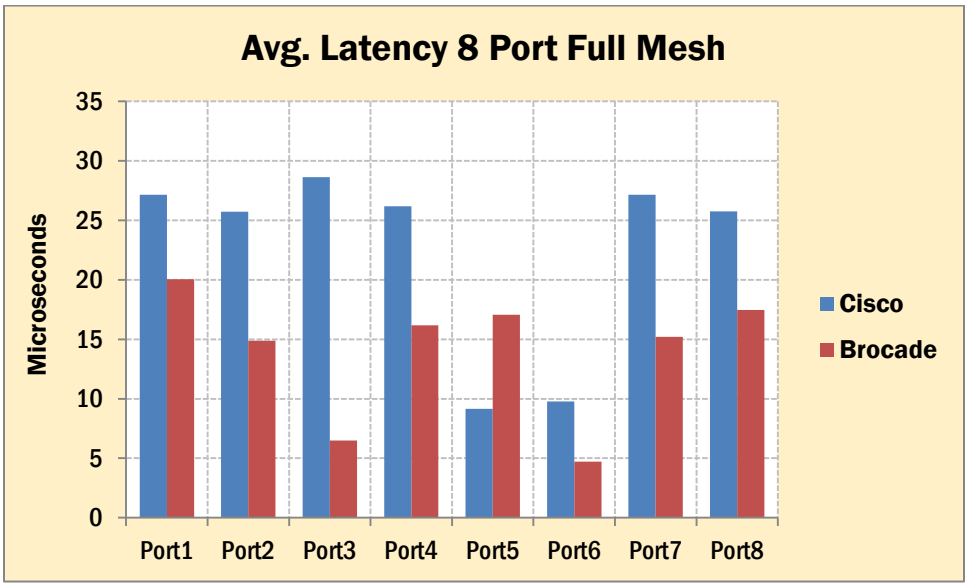


Balanced 8-port Mesh Tests

The balanced 8-port mesh series of tests includes measures of full-duplex latency through eight ports using different combinations of port groups. These tests are:

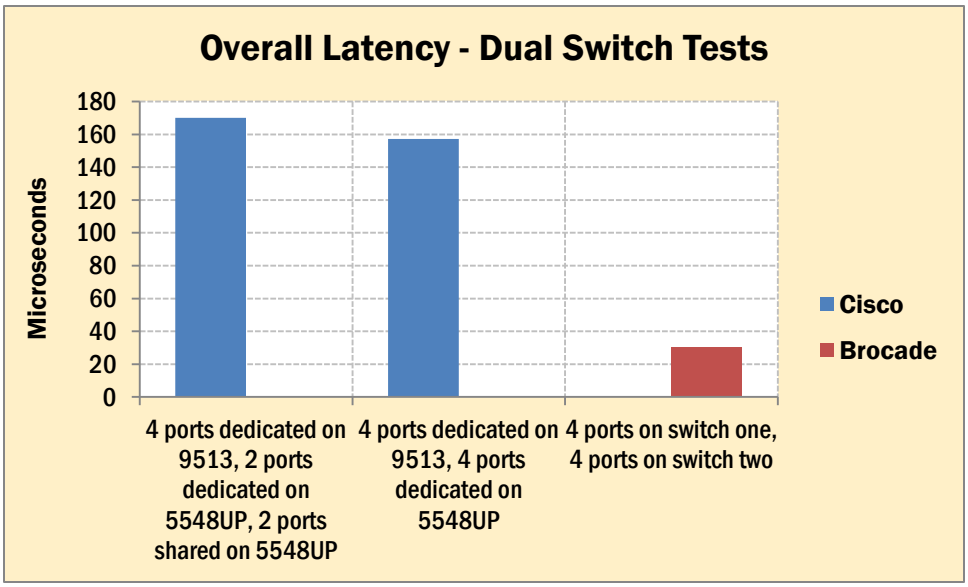
- 4 ports each on two port groups

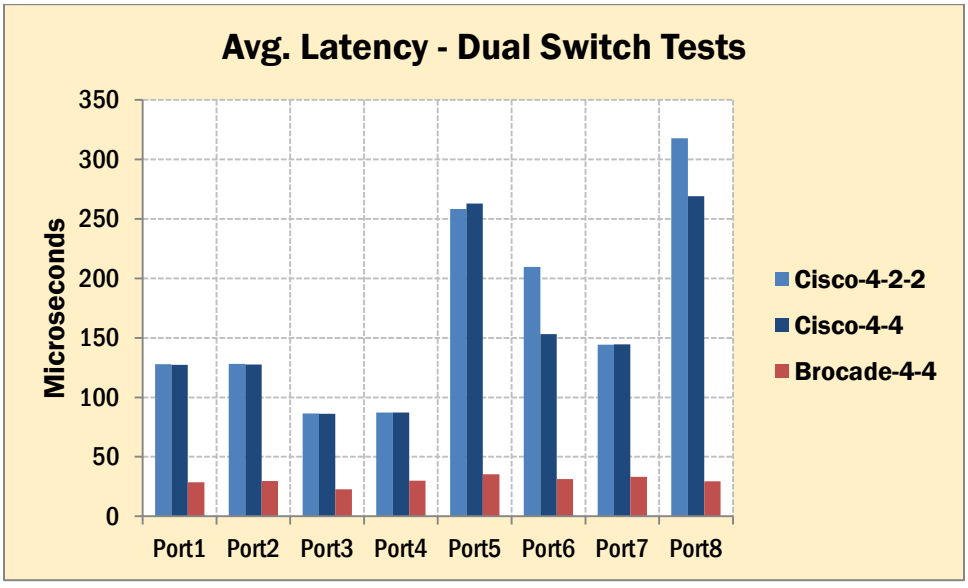




3 – Dual Switch Tests

The dual switch tests demonstrate trunking between switches. In these tests, four ports of one switch are connected to four ports of a second switch. For the Cisco switch, ports can be "dedicated" or "shared". For the Cisco configuration, we used one 5548 and one 9513 switch. For the Brocade configuration, we used two Brocade 6510 switches.





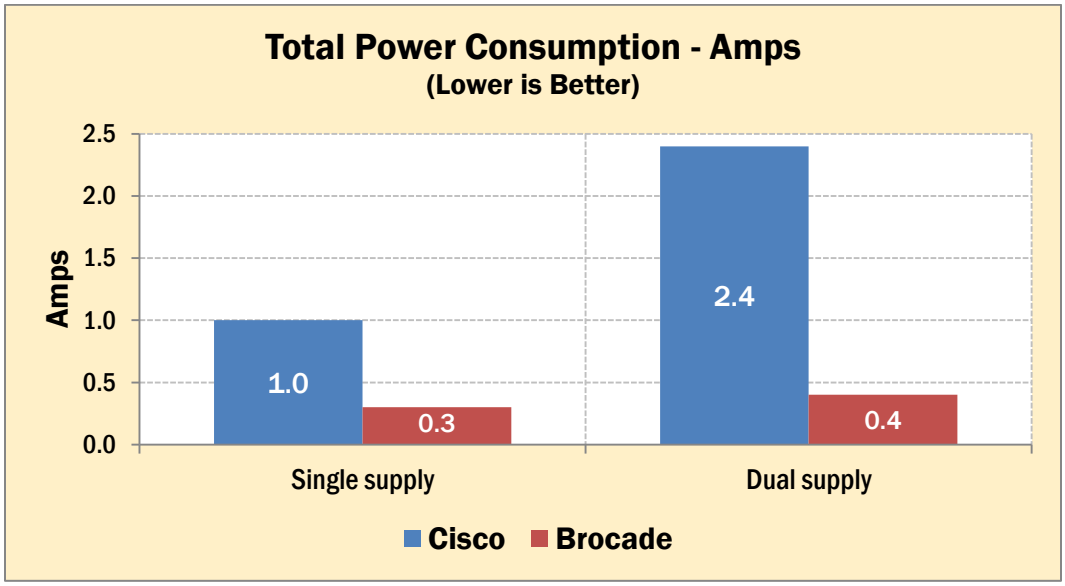
Legend:

- Cisco-4-2-2 – 4 ports on 9513, 2 dedicated ports on 5548UP, 2 shared ports on 5548UP
- Cisco-4-4 – 4 ports on 9513, 4 dedicated ports on 5548UP
- Brocade-4-4 – 4 ports on Brocade 6510 #1, 4 ports on Brocade 6510 #2

4 – Power Consumption and Physical Characteristics

Decreasing power consumption in the datacenter is increasingly becoming a priority for CIOs and datacenter managers. While power consumption should be reduced, performance and service levels must be maintained.

During the tests, we checked the power consumption of each switch. We measured the power consumption of each switch with one power supply connected to a power source and with two power supplies connected to a power source. The Brocade 6510 provides excellent performance while consuming surprisingly low amounts of power.



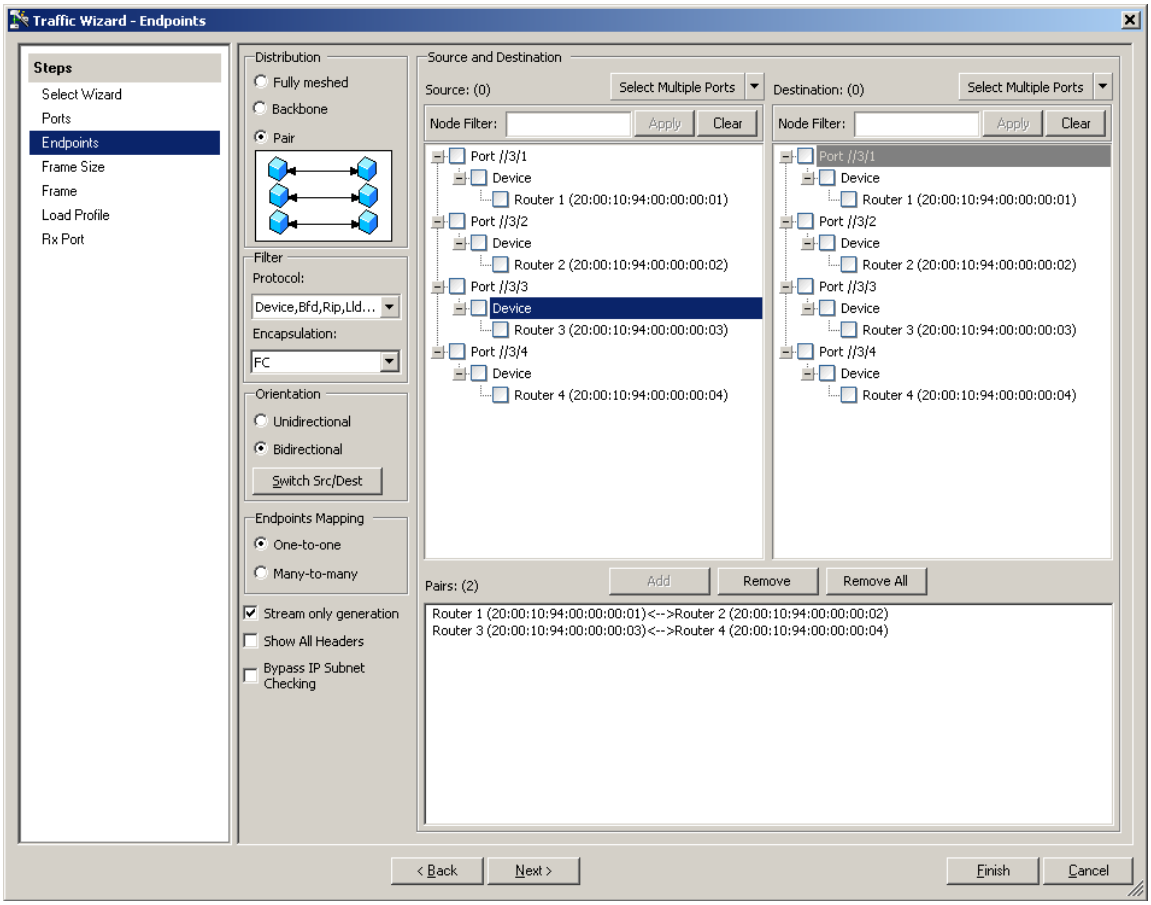
5 – Configuration and Administration

The Cisco Nexus 5500 Series requires careful planning when configuring Fibre Channel ports. Almost any configuration change increasing or decreasing the number of Fibre Channel ports requires a switch reboot, leading to SAN fabric rebuilds and potential for disruption. During configuration, ports must be enabled and configured sequentially from right to left for Fibre Channel and left to right for 10GbE. No random or out-of-order port configurations are allowed.

Configuring the ports on the Brocade 6510 does not require a switch reboot.

6 – Test Management

We used the Spirent Test Center to conduct the tests. The Spirent Test Center allows for a variety of configurations. In the screen shot below, we see some of the parameters for the balanced 4-port tests.



We configured the test equipment to drive each port to 100% load with 2K payloads for all the tests.

Conclusion

For those desiring the benefits of unified port converged switching infrastructure, the Cisco Nexus 5548UP can be a good solution. However, you need to understand the capabilities of this emerging technology and evaluate these against your application infrastructure requirements. Through our testing and evaluation of the Cisco Nexus 5548UP, Demartek found several areas of concern relative to the switch's Fibre Channel switching capabilities.

Comparing the purpose-built Brocade 6510 and the general purpose Cisco Nexus 5548UP, we found the following results. Over a series of latency and performance tests, the Brocade 6510 consistently outperformed the Cisco Nexus 5548UP for native Fibre Channel traffic. In addition, the performance of the Cisco Fibre Channel expansion module ports was generally lower than the ports in the main Cisco Nexus 5548UP switch, especially when traffic had to traverse from the main ports to the expansion ports. These performance numbers should be considered based on the potential impact to latency-sensitive applications and highly virtualized environments.

In addition to performance issues, Demartek found several functionality issues that should be considered. Configuration changes that require a switch reboot are the bane of SAN administration. The Cisco Nexus 5548UP frequently requires a switch reboot every time a unified port protocol is changed. The Cisco Nexus 5548UP is currently limited to 8 Gbps for native Fibre Channel traffic. The physical and environmental factors such as size, weight and power consumption are all better with the Brocade 6510.

If your environment requires only native Fibre Channel switching, we recommend that you evaluate the Brocade 6510.

Links for additional information:

- Brocade: www.brocade.com

The original version of this report is available at http://www.demartek.com/Demartek_Brocade6510_Latency_Evaluation.html.