



DATA CENTER

The Benefits of Brocade Gen 5 Fibre Channel

The network matters for storage. This paper discusses key server and storage trends and technology advancements and explains how Brocade Gen 5 Fibre Channel and Fabric Vision technology delivers the performance, reliability, and simplicity needed to meet the new requirements of today's data center.

BROCADE

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INTRODUCTION

Gen 5 Fibre Channel is the latest evolution in Storage Area Networks (SANs). Based on technology developed by the T11 technical committee that defines Fibre Channel interfaces, Gen 5 Fibre Channel doubles the data throughput of 8 Gbps links, from 800 Megabytes per second (MB/sec) to 1600 MB/sec with Gen 5 Fibre Channel.

The benefits of faster networking technology are easy to understand. Data transfers are faster, fewer links are needed to accomplish the same task, fewer devices need to be managed, and less power is consumed when Gen 5 Fibre Channel is used. Several server and storage technology advances are pushing up demand for greater SAN bandwidth, including application and storage capacity growth, high-density server virtualization, new Gen 5 Fibre Channel storage arrays, and Solid State Drive (SSD) or Flash-based storage. Gen 5 Fibre Channel enables enterprise data centers to unleash the full potential of these and other advanced technologies.

The advantages of Gen 5 Fibre Channel, however, extend beyond performance and higher throughput. Gen 5 Fibre Channel delivers several important capabilities that take SAN reliability, availability, and management simplicity to the next level, driving down operational costs. It is these advantages that are driving the unprecedented adoption rate of Gen 5 Fibre Channel.

OVERVIEW OF GEN 5 FIBRE CHANNEL

Deployed in 90 percent of Fortune 1000 data centers, Fibre Channel (FC) is the de facto standard for storage networking in the data center. Gen 5 Fibre Channel is the proven, purpose-built network infrastructure for data center storage, delivering unmatched reliability, scalability, and 16 Gbps performance.

Brocade offers a comprehensive Gen 5 Fibre Channel SAN portfolio with unique innovations delivered through the Gen 5 Fibre Channel Application-Specific Integrated Circuit (ASIC) in combination with Brocade Fabric OS® (FOS) and Brocade Network Advisor. Brocade Gen 5 Fibre Channel offers:

- Unmatched performance for critical and virtualized applications
- Hardware and software reliability, consistently delivering six-nines availability
- UltraScale chassis connectivity, providing 64 Gbps parallel Gen 5 Fibre Channel to drive massive infrastructure consolidation and simplification
- Brocade Fabric Vision technology, an advanced hardware and software solution that maximizes uptime, optimizes application performance, and simplifies SAN management through innovative diagnostic, monitoring, and management technology
- A comprehensive Gen 5 Fibre Channel portfolio—from entry level switches to massively scalable backbones

Brocade switches with Gen 5 Fibre Channel unleash the full potential of high-density server virtualization, cloud architectures, and Flash storage. This enables organizations to fully leverage existing and new IT investments as they solve their most difficult business challenges and address the evolving requirements of today's data center.

THE NEED FOR GEN 5 FIBRE CHANNEL

Emerging and evolving critical workloads, higher-density virtualization, and cloud-based architectures are continuing to push the limits of SAN infrastructure. In addition, new technologies such as Flash-based storage and new Gen 5 Fibre Channel storage arrays are shifting the focus from storage to interconnect. This trend is driving ever higher Input/Output (I/O) and bandwidth requirements, driving the need for higher speeds, as well as more reliable networks.

Multiple server and storage trends and technology advances are driving the need for Gen 5 Fibre Channel, including:

- Increased number and size of applications
- High-density server virtualization
- Solid State Drives (SSDs) and Flash-based storage
- New 16 Gbps disk arrays

Application Growth

The big growth in all computing environments is the increasing size and number of software applications. The digitization of information and growing use of rich media and interactive Web 2.0 applications drive greater storage capacity and bandwidth requirements. From mobile access to email to cloud computing, data needs to be transported over longer distances at high speeds. In addition, applications such as databases and other mission-critical applications are growing rapidly, yet continue to require non-stop availability. With shrinking or non-existent maintenance windows, performance issues or downtime that impact data access are simply not acceptable. The storage network must be prepared to handle increased capacity, greater throughput, and higher levels of resiliency.

High-Density Server Virtualization

When Fibre Channel was first launched, a server was dedicated to a specific application, resulting in low utilization of server resources. The introduction of server virtualization changed that paradigm, allowing multiple applications to share a single physical server, increasing efficiency and driving up server utilization rates. According to ESG's annual IT spending intentions survey, increased use of server virtualization has been the top overall priority of IT organizations for more than two years running. Today, evolving critical workloads and Tier 1 applications are being hosted on Virtual Machines (VMs). In addition to increased use of server virtualization, VM densities (the number of VMs hosted on each physical server) are steadily increasing to 10, 20, or more VMs per physical server—all booting from the SAN and accessing SAN resources. The increased usage, criticality, and density of VMs drive demand for higher performance (bandwidth and I/O), as well as increased reliability and availability from the storage infrastructure. In highly virtualized environments, any congestion, poor I/O performance, or failures in the storage network impact a larger number of applications.

Solid State Drives

Flash-based storage and SSDs are driving incredible advances in storage, dramatically reducing the historical I/O performance gap between the server side (with multi-core processors and faster memory) and the storage side. SSD storage addresses both I/O and throughput bottlenecks, enabling faster block- and file-based storage performance for high-density virtualized workloads and traditional mission-critical applications. However, this assumes that the storage network can keep pace. Whether they are deployed as standalone SSD-based arrays or directly connected to the server CPU and memory bus, SSDs accelerate I/O performance, driving the need for higher I/O bandwidth performance and greater availability from the storage network.

Gen 5 Fibre Channel Storage Arrays

New 16 Gbps-capable Fibre Channel storage arrays from leading storage providers are becoming available. To take full advantage of the capabilities offered by this next generation of storage, users must make sure that the network is not a bottleneck. Data center managers looking to deploy new Gen 5 Fibre Channel arrays to gain a competitive advantage need to take a close look at their storage network infrastructure to determine whether it is capable of delivering the reliability, performance, and operational simplicity the new technology requires. If not, the bottleneck has simply moved, and you will not gain the benefits you seek.

These and other data center evolutions are driving the need for Gen 5 Fibre Channel infrastructures.

THE BENEFITS OF HIGHER SPEED

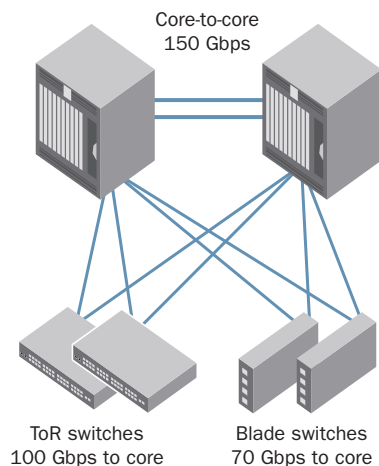
The benefits of faster tools are always the same—more work in less time. By doubling the speed, Gen 5 Fibre Channel reduces the time to transfer data between two ports. When more work can be done by a server or storage device, fewer servers, Host Bus Adapters (HBAs), links, and switches are needed to accomplish the same task. The benefits of higher speed with Gen 5 Fibre Channel add up, and they include:

- Reduced number of links, HBAs, and switch ports to do the same workload
- Reduced power consumption per bit
- Easier cable management

Reduced Number of Links

As with previous generations of Fibre Channel, the first application of new Fibre Channel speeds is on Inter-Switch Links (ISLs) between switches. Large fabrics are composed of many switches, which are connected via multiple ISLs. Reduction of the number of ISLs between switches is a key benefit of each higher speed. Brocade switches will continue to support frame-based trunking of 16 Gbps FC links, to yield 128 Gbps FC bandwidth between any two switches.

The table in Figure 1 shows a simple comparison of the number of links in an 8 Gbps FC fabric and a 16 Gbps FC fabric. The higher-speed links of 16 Gbps FC eliminate tens or hundreds of ports as compared to an 8 Gbps FC fabric. The real savings occur when the number of HBAs, switches, and end devices can be decreased, given the higher performance of 16 Gbps FC. In the example in Figure 1, a Top of Rack (ToR) switch needs 100 Gbps of bandwidth, so the user needs 8×16 Gbps FC ISLs instead of 16×8 Gbps FC ISLs. Similar comparisons between 16 Gbps FC ISLs and 8 Gbps FC ISLs are listed in the table in Figure 1, to show how fewer ports and links are needed at 16 Gbps FC.



	8 Gbps FC Links	Gen 5 Fibre Channel (16 Gbps) Links
ISLs from ToR switch to core	16	8
ISL from blade switch to core	10	5
Core to core	24	12
Total ISLs	50	25
Total ports	100	50

Figure 1. Network design implications of Gen 5 Fibre Channel.

Reduced Power Consumption per Bit

Besides the reduction in equipment that cuts power consumption dramatically, Gen 5 Fibre Channel also reduces the power required to transfer bits on the link. When the cost of cabling and Operating Expense (OpEx) such as electricity and cooling are considered, the Total Cost of Ownership (TCO) is often less when links are run at twice the speed. The goal of Gen 5 Fibre Channel design is for a 16 Gbps FC port to consume less power than 2 × 8 Gbps FC links, which deliver the same throughput. Initial estimates for power consumption indicate that Gen 5 Fibre Channel SFP+ consumes 0.75 watts of power, while 8 Gbps FC SFP+ consumes 0.5 watts of power. These estimates show that a Gen 5 Fibre Channel link consumes 25 percent less power than 2 × 8 Gbps FC ports.

Easier Cable Management

If fewer links are needed, cable management becomes simpler. Managing cables behind a desktop or home entertainment center is difficult enough, but managing hundreds of cables from a single switch or bundles of cable from a server is a daunting task. The reduction of cables means less troubleshooting and recabling. The cost of cabling is significant; reducing the number of links by using Gen 5 Fibre Channel links reduces the work and cost involved in cable management.

Simplified Infrastructure Upgrades

Deploying a Gen 5 Fibre Channel SAN now also makes server and storage upgrades easier down the road. With a Gen 5 Fibre Channel infrastructure in place, you can easily and non-disruptively swap out servers and upgrade storage arrays to take advantage of technology advancements as needed, without impacting the rest of the infrastructure. This approach is far easier than having to swap out the fabric as well as the server and storage when an upgrade is needed.

BROCADE GEN 5 FIBRE CHANNEL UNIQUE INNOVATION

The benefits associated with higher throughput are compelling. Brocade Gen 5 Fibre Channel offers additional advantages to meet new and evolving requirements, including:

- Low latency and high I/O Operations per Second (IOPS) performance maximizes the number of virtual hosts per physical server.
- Data center-proven, purpose-built architectures minimize risk and fault domains of high-density server virtualization.
- Non-stop networking and automated management minimizes operational cost and complexity.
- Integrated advanced diagnostics, monitoring, and Reliability, Availability, and Serviceability (RAS) capabilities simplify management and increase resiliency.
- Integrated ISL data compression and encryption offers bandwidth optimization and data protection.
- Backward-compatibility with existing infrastructure minimizes the need to rip out and replace.
- Low overhead and low latency eliminates I/O bottlenecks and unleashes the full performance of Flash, SSD, and 16 Gbps-capable storage.

In addition, Brocade Gen 5 Fibre Channel platforms offer breakthrough technologies that dramatically simplify SAN deployment and management and drive down operational costs. These unique capabilities are explored in more detail in the following sections:

- UltraScale chassis connectivity enables higher density and simpler fabrics that reduce network complexity and cost.
- Fabric Vision technology maximizes uptime, optimizes application performance, and simplifies SAN management through innovative diagnostic, monitoring, and management technology.

UltraScale Chassis Connectivity

Brocade UltraScale chassis connectivity provides dedicated 64 Gbps parallel Gen 5 Fibre Channel inter-chassis links (ICLs) to connect up to 10 Brocade DCX® 8510 Backbones, enabling flatter, faster, and simpler fabrics that increase consolidation while reducing network complexity and costs. UltraScale ICLs preserve server and storage ports and enable highly scalable core-edge and active-active mesh chassis topologies, as shown in Figures 2 and 3.

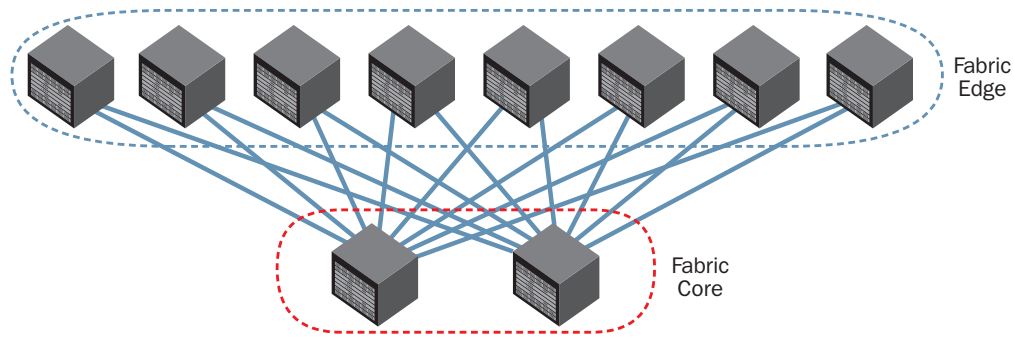


Figure 2. Core-edge topology with two core chassis and eight edge chassis.

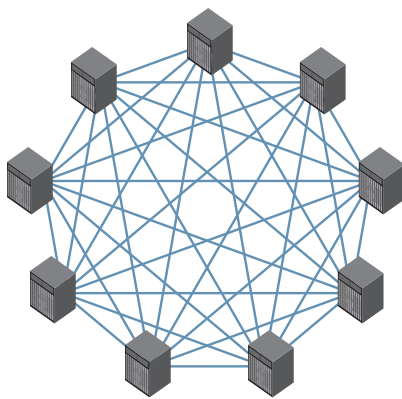


Figure 3. Nine-chassis mesh topology.

Brocade UltraScale—based on Quad Small Form Factor Pluggable (QSFP) technology—connects the core routing blades of two Brocade DCX 8510 chassis. Each QSFP-based UltraScale port combines four 16 Gbps links, providing up to 64 Gbps of throughput within a single cable. Available with Brocade Fabric OS (FOS) v7.0 and later, Brocade offers up to 32 QSFP UltraScale ports on the Brocade DCX 8510-8 and up to 16 QSFP UltraScale ports on the Brocade DCX 8510-4.

The optical form factor of the Brocade QSFP-based UltraScale technology offers support for cable distances up to 100 meters (108 yards), providing greater architectural design flexibility. Second, the combination of four cables into a single QSFP provides incredible flexibility for deploying a variety of different topologies, including a massive 9-chassis full-mesh design with only a single hop between any two points within the fabric.

In addition, the Brocade DCX 8510 UltraScale chassis connectivity provides dramatic reduction in the number of ISL cables required—a four to one reduction compared to traditional ISLs with the same amount of interconnect bandwidth. And since the QSFP-based UltraScale connections reside on the core routing blades instead of consuming traditional ports on the port blades, up to 33 percent more FC ports are available for server and storage connectivity.

Fabric Vision Technology

Brocade Fabric Vision technology introduces a breakthrough hardware and software solution that combines capabilities of the Gen 5 Fibre Channel ASIC, Brocade Fabric OS, and Brocade Network Advisor to maximize uptime, simplify SAN management, and provide unprecedented visibility and insight across the storage network. Offering innovative diagnostic, proactive monitoring, and management capabilities, Brocade Fabric Vision technology helps administrators avoid problems, maximize application performance, and reduce operational costs.

Brocade Fabric Vision technology extends Brocade Gen 5 Fibre Channel, offering technology innovation that is unmatched in the industry. Fabric Vision technology includes:

ClearLink Diagnostics: As network speeds increase, media and cable tolerance become critical for avoiding degraded performance and avoiding Cyclic Redundancy Check (CRC) errors over time. Brocade ClearLink diagnostics, a patent-pending technology, leverages a unique operational Diagnostic Port (D_Port) mode to ensure optical and signal integrity for Gen 5 Fibre Channel optics and cables, simplifying the deployment and support of high-performance fabrics. By proactively verifying the integrity of critical transceivers, customers can quickly address any physical layer issues without the need for special optical testers.

ClearLink is diagnostics technology that allows users to automate a battery of tests to measure and validate latency and distance across the switch links, as well as to verify the integrity of the fiber and 16 Gbps transceivers in the fabric—either prior to deployment or when there are susceptible physical layer issues. In addition, ClearLink diagnostics requires only the individual ports that are attached to the link being tested to go offline, leaving the rest of the ports to operate online, in isolation from the link being tested.

In addition to switch-to-switch link validation, Brocade FOS v7.1 provides dynamic ClearLink support between Gen 5 Fibre Channel switches and Brocade 1860 Fabric Adapters when running at 16 Gbps speed. Brocade FOS v7.1 also provides ClearLink support for 16 Gbps switches running in Access Gateway mode, as well as for UltraScale chassis connectivity links on Brocade DCX 8510 Backbones.

Monitoring and Alerting Policy Suite (MAPS): A new policy-based monitoring and alerting tool available with Brocade FOS v7.2, MAPS simplifies and automates fabric-wide threshold configuration and monitoring. MAPS takes the guesswork and complexity out of defining appropriate threshold-based policies and alerts. It offers predefined monitoring groups as well as predefined policies, rules, and actions—all based on more than 15 years of Brocade experience and expertise—to make fabric-wide threshold-based monitoring and alerting simple. You can configure the entire fabric (or multiple fabrics) at one time, using common rules and policies, or you can customize policies for specific ports—all through a single dialog. The integrated dashboard rolls up the overall switch health report, along with details on out-of-policy conditions, to help pinpoint potential issues. In addition, customers can use MAPS and Brocade Network Advisor v12.1 to deploy a consistent configuration policy across the network, further simplifying network operations.

Brocade Fabric Watch customers can easily take advantage of new MAPS capabilities and usability enhancements. Fabric Watch users can automatically import existing thresholds into a MAPS policy, enabling a seamless migration to MAPS.

Brocade Flow Vision: A comprehensive tool that allows administrators to identify, monitor, and analyze specific application and data flows in order to maximize performance, avoid congestion, and optimize resources. Available with Brocade FOS v7.2, Flow Vision includes these features:

- *Flow Monitoring application:* Provides comprehensive visibility into flows in the fabric, including the ability to automatically learn (discover) flows and non-disruptively monitor flow performance. Users can monitor all flows from a specific host to multiple targets and Logical Unit Numbers (LUNs) or from multiple hosts to a specific target/LUN. Users can also monitor all flows across a specific ISL or perform LUN-level monitoring of specific frame types to identify resource contention or congestion that is impacting application performance.
- *Flow Generator application:* Provides a built-in test traffic generator for pretesting and validating the SAN infrastructure—including internal connections within a switch—for robustness, before deploying applications.

- *Flow Mirroring application:* Provides the ability to non-disruptively create copies of specific application and data flows or frame types that can be captured for deeper analysis. Flow Mirror is used for in-depth analysis of flows of interest or specific frame types, such as analysis of Small Computer Systems Interface (SCSI) Reservation frames, Abort Sequence (ABTS) frames, flows going to a bottlenecked device, or frames during link bring-up.

Bottleneck Detection: Identifies and alerts administrators of device or ISL congestion as well as abnormal levels of latency in the fabric. When applied to F_Ports, Bottleneck Detection can continuously monitor for medium or high levels of latency on a device port and provides notification on the nature and duration of the latency. Bottleneck Detection can also serve as a confirmation to host information when storage latencies are suspected as the cause of poor host performance. The reverse (eliminating the storage as the source of poor performance) is also true. When applied to E_Ports, Bottleneck Detection can alert when it detects high levels of latency on an ISL, often the result of congestion or latency from elsewhere in the fabric, but also a condition that can occur due to the cumulative effect of device latencies from multiple flows.

Brocade Network Advisor works in conjunction with Bottleneck Detection to automatically monitor and detect network congestion and latency in the fabric, providing visualization of bottlenecks in a connectivity map and product tree. Brocade Network Advisor can also show exactly which devices and hosts are impacted by a bottlenecked port.

Forward Error Correction: Automatically detects and recovers from bit errors, enhancing transmission reliability and performance.

Virtual Channel-level BB_Credit Recovery: Automatically detects and recovers buffer credit loss at the Virtual Channel level, providing protection against performance degradation and enhancing application availability.

In addition, Fabric Vision technology will continue to be enhanced with new capabilities and technologies throughout 2013, including:

Brocade Fabric Vision technology is integrated into Brocade Network Advisor, providing customizable health and performance dashboard views to simplify SAN configuration and management, enable proactive management by pinpointing problems faster, and reduce operational costs. With Fabric Vision technology, Brocade Network Advisor provides all critical status in one screen, including a summary of switch health, out-of-policy conditions, top application flows, and historical data, so you can quickly see trends.

SUMMARY

Higher throughput is important for keeping up with the many server and storage technology advancements, but the true value of Brocade Gen 5 Fibre Channel goes well beyond faster links. Higher reliability and innovative, breakthrough technologies such as UltraScale chassis connectivity and Fabric Vision technology dramatically simplify SAN deployment and management and drive down operational costs.

As the recognized leader and innovator in storage networks, Brocade Fibre Channel is the most trusted, most deployed network infrastructure for enterprise storage. Brocade continues to drive future Fibre Channel open standards and technology advancements that deliver unparalleled business value.

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