

Brocade Fabric OS Product Line

GEN 5 FIBRE CHANNEL

Gen 5 Fibre Channel is the purpose-built, data center-proven network infrastructure for storage, delivering unmatched reliability, simplicity, and 16 Gbps performance. Brocade Fabric OS combined with Gen 5 Fibre Channel unleashes the full potential of high-density server virtualization, cloud architectures, and next-generation storage.

Leading-Edge Solutions for Next-Generation Data Centers

As a leading provider of data center networking solutions, Brocade helps organizations around the world connect, share, and manage their information in the most efficient manner. Organizations that use Brocade® products and services are better able to ensure maximum availability and uptime, optimize their IT infrastructures, and reduce costs for a clear competitive advantage.

This guide summarizes the Brocade Fabric OS® (FOS) product family and the innovative features that make Brocade the leading choice in cost, quality, and performance. It includes:

- Brocade FOS product family overview
- Brocade core technology overview
- Brocade Fabric Vision™ technology
- Additional RAS features
- Brocade Storage Area Network (SAN) fabric technology overview
- Additional Brocade resources

The integration of innovative core Brocade FOS technology and Gen 5 Fibre Channel SAN fabric technology uniquely enables Brocade products to provide the building blocks that solve today's challenges and act as a strategic foundation for next-generation data centers (see Figure 1).

Brocade FOS Product Overview

The Brocade FOS family includes a wide range of industry-leading products, including:

- **Backbones:** Brocade DCX® 8510 Backbones with Gen 5 Fibre Channel and Brocade DCX Backbones are the industry's most reliable, scalable, and high-performance switching infrastructure for mission-critical storage. They are designed to increase business agility while providing non-stop access to information and reducing infrastructure and administrative costs. Networks need to evolve in order to support the growing demands of highly virtualized environments and private cloud architectures. Fibre Channel is the de facto standard for storage networking in the data center. Brocade DCX 8510 Backbones with Gen 5 Fibre Channel deliver a new level of scalability

and advanced capabilities for this robust, reliable, and high-performance technology. This enables organizations to continue leveraging their existing IT investments as they grow their businesses and solve their most difficult business challenges. It also enables organizations to consolidate their SAN infrastructures to simplify management and reduce costs.

- **Switches:** Brocade fixed-port switches with Gen 5 Fibre Channel are ideal for first-time SAN environments as well as for the edge of large enterprise data center fabrics. Available in 8- to 96-port configurations with flexible Ports on Demand (PoD) capabilities, Brocade switches provide 8 Gbps and 16 Gbps performance, high port density in 1U or 2U form factors, and unmatched energy efficiency.
- **Embedded switches:** Brocade embedded switches are designed to meet the unique and demanding requirements of the blade server market. These products can operate in Brocade Access Gateway mode, increasing scalability and simplifying management since the embedded switch does not appear as a traditional fabric switch.

- **FCoE/DCB solutions:** Brocade Fibre Channel over Ethernet (FCoE) and Data Center Bridging (DCB) solutions enable server I/O consolidation by leveraging Brocade FCOE10-24 Blades for Brocade DCX Backbones. Combining Fibre Channel and IP traffic over the same physical connection simplifies server connectivity to LANs and SANs, and reduces cable clutter, cooling expenses, and power consumption.
- **Encryption solutions:** Brocade fabric-based encryption solutions enable the broad application of data-at-rest encryption to help protect information assets and ensure data confidentiality. Brocade provides unmatched performance and value with up to 96 Gbps of encryption processing power, seamless installation, and support for leading key management systems. These products are available in fixed-port switch and Brocade DCX 8510 blade form factors.
- **Extension solutions:** For more than 25 years, Brocade has been delivering robust ESCON, FICON®, FCP over FCIP (Fibre Channel over IP), and IP extension solutions. These products are available in fixed-port switch and Brocade DCX 8510 blade form factors.

Figure 1: Brocade product and technology overview.

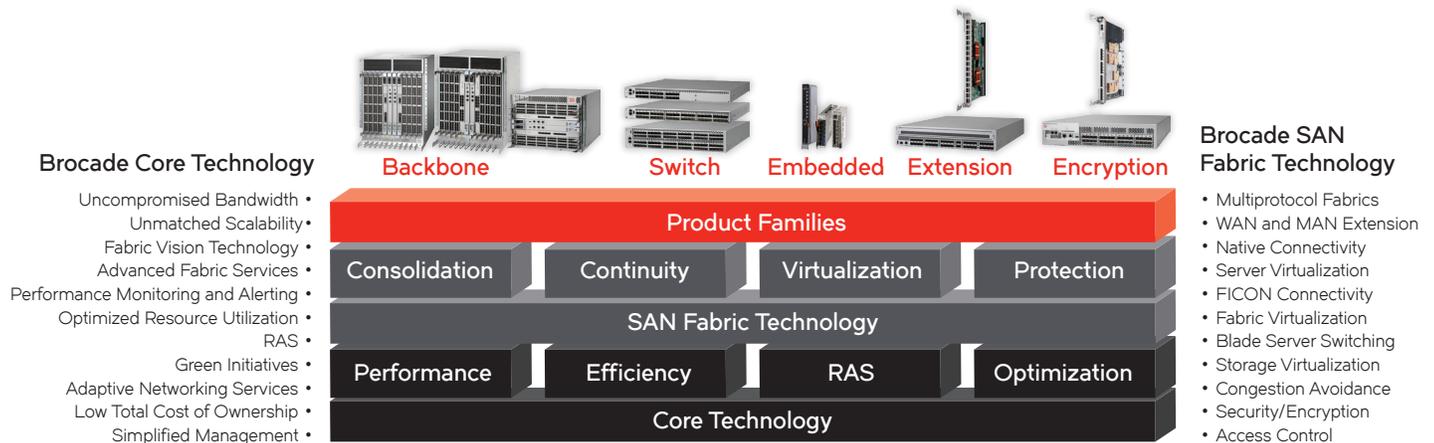


Table 1: Brocade switching product scalability.

Product Family	Chassis/Switch Bandwidth (Gbps, data rate)	Slot Bandwidth (Gbps, data rate)	Port Speeds (Gbps)	Ports
Backbone	Up to 8,192	512	2, 4, 8, 10, 16	32 to 512
Switch	Up to 1,536	NA	2, 4, 8, 10, 16	8 to 96
Embedded	Up to 384	NA	1, 2, 4, 8, 10, 16	12 to 24

Brocade Core Technology Overview

All Brocade products are based on a foundation of innovative, industry-leading core technologies that help improve performance, efficiency, RAS, and optimization at an affordable cost. Brocade created the first Fibre Channel switching products, and continues to lead the development of Fibre Channel standards, offering breakthrough Gen 5 Fibre Channel products and innovative Brocade Fabric Vision technology.

Performance

Fibre Channel SAN fabrics have the most stringent performance requirements of any network technology. They must have low latency and guaranteed delivery while supporting growing workloads and accommodating bursts in application data flows without disrupting applications—capabilities provided by the Brocade FOS family of products.

Bandwidth

Switching products must have enough bandwidth to avoid congestion for all data traffic. Brocade provides a wide range of price/performance options so organizations can choose the right solutions for their unique business requirements. Brocade backbone products provide both core switch engines and port switch engines, or local switching. This capability boosts performance for high-bandwidth applications.

Scalability

Because fabric traffic increases as storage and server connections grow, a fabric must provide excellent scalability. In turn, switching bandwidth must be large enough to meet the combined requirements of thousands of applications simultaneously. Table 1 shows key scalability metrics for the Brocade switching product categories.

Efficiency

Data center efficiency has become essential for organizations that must manage data growth within their existing power, cooling, and floor space constraints. Brocade is at the forefront of innovative data center efficiency, driving energy use down to 0.23 watts per Gbps for Brocade DCX 8510 Backbones with Gen 5 Fibre Channel and as low as 0.14 watts per Gbps for Brocade Gen 5 Fibre Channel switching products.

Green Initiatives

Green technology must be deeply integrated into product design. Today, Brocade products have the industry's best power-to-bandwidth ratios, the highest port density to minimize floor space consumption (as high as 48 ports per rack unit), and the smallest carbon footprint (as low as 4.2 metric tons per year).

Utilization

Maintaining high fabric resource utilization is paramount to implementing green technology initiatives and achieving a low Total Cost of Ownership (TCO). The following features help increase resource utilization:

- **Frame-based trunking:** Data flows are automatically distributed over multiple physical Inter-Switch Link (ISL) connections and logically combined into a trunk to provide full bandwidth utilization while reducing congestion.
- **Exchange-based trunking with Dynamic Path Selection (DPS):** For long-distance links between data centers over xWDM or WANs, exchange-based trunking provides high utilization to accommodate the larger latencies common over MAN and WAN distances.
- **Connection-based load balancing with Dynamic Link Selection (DLS):** This feature monitors link or trunk utilization to ensure load balancing. DLS can be used with either frame-based or exchange-based trunking when multiple trunks or ISLs are available between two switches.
- **Fibre Channel Routing Inter-Fabric Links (IFLs):** Fibre Channel Routing ensures the highest utilization of IFLs, which route traffic between fabrics. IFL trunking logically groups multiple links into a single high-bandwidth trunk to ensure efficient bandwidth utilization between individual fabrics and Fibre Channel routers.

Reliability, Availability, and Serviceability (RAS)

RAS describes several features of a product's design that affect its reliability (failure incidence), availability (uptime), and serviceability (ease of fault isolation and service). The Brocade FOS product family offers advanced capabilities to deliver unmatched reliability, availability, and management simplicity.

Brocade Fabric Vision Technology

Brocade Fabric Vision technology, an extension of Gen 5 Fibre Channel, provides unprecedented insight and visibility across the storage network with powerful built-in monitoring, diagnostic, and management tools that dramatically increase uptime, optimize performance, and reduce costs. Key advantages include:

• Simplified monitoring:

- Deploy more than 15 years of SAN best practices in one click to simplify the deployment of monitoring with pre-defined, threshold-based rules, actions and policies
- Instantly identify latency and congestion issues in the fabric through increased instrumentation and granularity
- Provide comprehensive visibility into the network health and performance using browser-accessible dashboards with deep drill-down capabilities

• Increased availability:

- Avoid 50 percent of common network problems with proactive monitoring and advanced diagnostic tools that address problems before they impact operations

- Identify hot spots and automatically mitigate network problems before they impact application performance through intuitive reporting, trend analysis, and integrated actions
- Minimize downtime and accelerate troubleshooting with live monitoring, integrated diagnostics, and point-in-time playback

• Dramatically reduced costs:

- Eliminate nearly 50 percent of maintenance costs through automated testing and diagnostic tools that validate the health, reliability, and performance of the network prior to deployment
- Save up to millions of dollars on CapEx costs by eliminating the need for expensive third-party tools through built-in monitoring and diagnostics
- Leverage specialized tools for pre-testing and validating IT infrastructure to accelerate deployment, simplify support, and reduce operational costs

Monitoring and Alerting Policy Suite

The Monitoring and Alerting Policy Suite, or MAPS, provides an easy-to-use solution for policy-based threshold monitoring and alerting. MAPS proactively monitors the health and performance of the SAN infrastructure to ensure application uptime and availability. By leveraging pre-built rule-/policy-based templates, MAPS simplifies fabric-wide threshold configuration, monitoring, and alerting. Administrators can configure the entire fabric (or multiple fabrics) at one time using common rules and policies, or customize policies for specific ports or switch elements—all through Brocade Network Advisor.

The integrated dashboard in Brocade Network Advisor displays an overall switch health view, along with details on out-of-policy conditions, to help administrators quickly pinpoint potential issues and easily identify trends and other behaviors occurring on a switch or fabric.

Brocade ClearLink Diagnostics

Organizations can use this Fabric Vision technology tool to ensure optical and signal integrity for Gen 5 Fibre Channel optics and cables, simplifying deployment and support of high-performance fabrics. It leverages ClearLink Diagnostic Port (D_Port) capabilities of Gen 5 Fibre Channel platforms.

Flow Vision

With Flow Vision, administrators can identify, monitor, and analyze specific application and data flows in order to maximize performance, avoid congestion, and optimize resources. Flow Vision includes:

- **Flow Monitor:** Allows administrators to non-disruptively monitor all flows from a specific host to multiple targets/LUNs, from multiple hosts to a specific target/LUN, or across a specific ISL. Additionally, they can perform LUN-level monitoring of specific frame types to identify resource contention or congestion that is impacting application performance.
- **Flow Learning:** Enables administrators to automatically and non-disruptively discover all flows that go to or come from a specific host or storage port, or traverse ISLs without having to explicitly identify all the devices.

- **Flow Generator:** Provides a built-in test traffic generator for pre-testing and validating the SAN infrastructure—including verification of routes and integrity of optics, cables, ports, and ISLs—for robustness before deploying applications.

Fabric Performance Impact Monitoring

Fabric Performance Impact (FPI)

Monitoring uses pre-defined thresholds and alerts in conjunction with MAPS to automatically detect and alert administrators to severe levels or transient spikes of latency, and identifies slow drain devices that might impact the network. This feature uses advanced monitoring capabilities and intuitive MAPS dashboard reporting to indicate various latency severity levels, pinpointing exactly which devices are causing or are impacted by a bottlenecked port. FPI monitoring also provides the ability to automatically mitigate the effects of slow drain devices, or even resolve the slow drain behavior at the source.

Configuration and Operational Monitoring Policy Automation Services Suite (COMPASS):

COMPASS simplifies deployment, safeguards consistency, and increases operational efficiencies of larger environments with automated switch and fabric configuration services. Administrators can configure a template, or adopt an existing configuration as a template, and seamlessly deploy the configuration across the fabric. In addition, they can ensure that settings do not drift over time with COMPASS configuration and policy violation monitoring within Brocade Network Advisor dashboards.

Critical Monitoring, Management, and Diagnostics

Fabric Vision technology includes several critical monitoring, management, and diagnostic capabilities that help to increase fabric resiliency, reduce downtime, and optimize application performance. The following features are included in base Brocade FOS releases:

- **Brocade ClearLink Diagnostics:** Helps ensure optical and signal integrity for Gen 5 Fibre Channel optics and cables, simplifying the deployment and support of high-performance fabrics. Non-Brocade devices require the Fabric Vision license.
- **Bottleneck Detection:** Identifies and alerts administrators about device or ISL congestion, as well as abnormal levels of latency in the fabric.
- **Forward Error Correction (FEC):** Enables recovery from bit errors in links, enhancing transmission reliability and performance.
- **Credit Loss Recovery:** Helps overcome performance degradation and congestion due to buffer credit loss.
- **MAPS Basic Monitoring:** Monitors system resources, FRU status, and overall switch health status through MAPS basic monitoring policy.

Additional RAS Features

The Brocade FOS product family offers additional advanced features that help ensure the highest level of reliability, availability, and serviceability.

They include:

- **Hot-code load/activation:** This ensures that firmware updates applied to fabric devices do not disrupt data flowing between applications and storage.
- **Auto daemon restart:** The embedded operating system used in Brocade products is strengthened with automated task restart features for increased reliability and availability.
- **Port fencing:** This feature tracks errors and events on a port against a specified threshold. When the threshold is exceeded, the port is turned off to prevent it from endangering other traffic in the fabric.
- **Port mirroring:** This feature copies (mirrors) frames as they flow through specified ports. The copies are sent (without fabric disruption) to a dedicated port attached to a protocol analyzer.
- **FCping/FC trace route:** These tracking features confirm that ports and paths are operational, and that latencies between ports are within expected limits.
- **Call Home:** This feature automatically notifies a central monitoring center about critical changes in product operations and can send notification alerts.
- **RAS event logging with NTP server:** Messages about events that impact RAS can be forwarded to a central collection point with synchronized time stamps provided by a central Network Time Protocol (NTP) server.
- **Change auditing:** This feature logs all changes in the fabric to improve management control.

Optimization

Optimization stems from the tight integration between hardware (the ASIC) and firmware (Brocade FOS). Moreover, management optimization simplifies configuration, monitoring, and administration to reduce TCO. Key performance monitoring and alerting features include:

- **Flow Monitoring:** Enables administrators to monitor both “transmit” and “receive” traffic from physical or virtual source devices all the way to destination devices, providing valuable insight into ISL and resource utilization. Flow Monitoring filters on a specific Fibre Channel frame type, such as SCSI reservations or ABTS frames, and generates an alert when defined thresholds are crossed.
- **Flow Learning:** Identifies and ranks the highest or lowest bandwidth data flows (source address, destination address) on individual F_Ports.
- **Trunking performance:** Monitors trunks for bandwidth utilization and queue latency.

Management Simplicity

Fabric configuration and management can become increasingly time-consuming and complex as fabric size grows. To address these challenges, Brocade offers the following features:

- **Integration with Brocade Network Advisor:** Offers a single point of management, with customizable health and performance dashboard views to pinpoint problems faster, simplify SAN configuration and management, and reduce operational costs.

- **Fabric-Assigned World Wide Name (FA-WWN):** Allows organizations to eliminate fabric reconfiguration when adding or replacing servers through the virtualization of host World Wide Names (WWNs). FA-WWN also enables configuration of servers before they are available, accelerating deployments.
- **Insistent Domain ID:** Ensures that switch addresses are reserved and not changed when switches are added or removed from a fabric.
- **Registered State Change Notification (RSCN) suppression:** Ensures that RSCN messages are sent only to devices requiring notification of a fabric event, reducing bandwidth and processor cycle consumption.
- **Link Cable Beacon:** Provides LED beaconing for ports on both ends of a physical link to simplify cable identification and management.
- **Read Diagnostic Parameter:** Allows diagnosis of transceiver and media problems for a link in a fabric from a single point, either a switch or a host.
- **Port speed-weighted Fabric Shortest Path First (FSPF):** Applies a weighting factor based on link speed to ensure that data traffic uses higher-speed paths between switches.
- **Fabric Device Management Interface (FDMI):** Enables Brocade Network Advisor to manage switch configuration, simplifying end-to-end fabric management.
- **Time Server support:** Synchronizes all time stamps either to a principal switch in a fabric or to a central Network Time Protocol (NTP) time server for uniform event correlation, simplifying fault isolation.
- **SNMP MIBs:** Supports Simple Network Management Protocol (SNMP) v1 and v3 for fabric monitoring and management, and Brocade also publishes a Management Information Base (MIB) for all products.
- **IPv6 addressing:** Enables full addressing flexibility, including IPv4 and IPv6 dual stack support for management traffic.
- **Integrated device and fabric management:** Features an integrated management suite—Brocade Network Advisor—that centralizes device management as well as fabric configuration for the zoning and routing of all Brocade products.
- **Simple switch configuration:** Provides the EZSwitchSetup wizard (Microsoft Simple SAN-certified) to significantly simplify switch configuration and setup.
- **Ports on Demand (PoD):** Activates specific switch ports only when growth dictates the need for more ports.
- **Dynamic PoD:** Enables blade server switches to automatically use any activated switch port rather than specific ports, simplifying blade server configuration.
- **Enhanced zoning services:** Enables zoning to configure peer zones, target-driven peer zones, Fibre Channel Routing services, Traffic Isolation, Quality of Service (QoS), broadcast zones for IPFC traffic, and Frame Redirection.
- **Port decommissioning:** Provides the ability to non-disruptively remove an ISL from service.

Brocade SAN Fabric Technology Overview

The Brocade Gen 5 Fibre Channel SAN fabric technology strategy is based on meeting real-world requirements for next-generation data centers. The key drivers of this strategy include higher levels of consolidation, continuity, virtualization, and data protection.

Consolidation

Data growth and relentless cost reduction are fueling an unprecedented drive for consolidation in the data center. To support this need, Brocade delivers key technologies for consolidation—including multiprotocol support, native connectivity, FICON and blade server connectivity, congestion control, and innovative bandwidth aggregation such as that used in backbone UltraScale Inter-Chassis Links (ICLs). To enable the consolidation of server connectivity in the data center, Brocade provides leading-edge DCB and FCoE solutions.

Multiprotocol Support

Fibre Channel is the underlying technology in most SAN fabrics, supporting both open systems SCSI channels (FCP) and System z mainframe channels (FICON). To meet a broad spectrum of customer requirements, Brocade protocol support includes Fibre Channel over IP (FCIP), Fibre Channel over Ethernet (FCoE), Fibre Channel Routing, and IP over Fibre Channel (IPFC).

Native Connectivity

Brocade Fibre Channel Routing provides connectivity between Brocade and Brocade M-Series (McDATA) fabrics, protecting infrastructure investments.

FICON Connectivity

Fibre Channel supports a variety of “upper-layer protocols” such as FICON used in IBM System z environments. Brocade has partnered with IBM to create high-integrity fabric characteristics for System z environments, including:

- **FICON cascading:** Developed jointly by Brocade and IBM to extend System z environments to one-hop configurations, FICON cascading helps increase fabric scalability without sacrificing critical FICON channel performance.
- **FICON intermix:** Brocade, in collaboration with IBM, provides a FICON intermix solution that combines FICON and FCP traffic in the same fabric for greater resource utilization.
- **FICON Management Server (CUP):** Brocade was the first switch vendor to provide FICON Management Server—Control Unit Port (CUP)—so mainframe-hosted tools could manage connectivity between ports, monitor fabric performance, and collect critical diagnostic information.
- **System z mainframe innovations:** Brocade was the first vendor to provide FICON-capable switches, and the first with secure fabrics utilizing the DH-CHAP authentication protocol.

Blade Server Connectivity in Brocade Access Gateway Mode

Blade servers are provided by most of the leading server vendors (Dell, Fujitsu, HP, Hitachi, IBM, and others), and they include embedded switches. Because these switches have low port counts, the number of switches (domains) in a fabric increases quickly and can limit fabric size. Brocade has addressed this issue with Brocade Access Gateway mode, which eliminates the switch address for an embedded switch.

Key features include:

- **Auto port configuration:** Automatically maps server ports to Brocade Access Gateway links connected to a fabric switch. Organizations can add blade servers without having to reconfigure the fabric.
- **Path failover:** Automatically reroutes traffic to the remaining links if a link fails between the Brocade Access Gateway and the fabric switch.
- **Brocade Access Gateway ISL trunking:** Provides frame-based trunking across multiple links for higher bandwidth utilization and congestion avoidance.
- **Multi-fabric connectivity:** Increases availability by enabling Brocade Access Gateway links to extend to one or two fabrics. If one fabric path becomes unavailable, multi-path drivers in the blade server reroute application traffic to the second fabric.
- **Proactive monitoring and alerting:** Brocade Access Gateway supports Fabric Watch and Advanced Performance Monitoring to help ensure network availability, optimize bandwidth utilization, and maximize fabric performance.
- **ClearLink Diagnostics support:** With Brocade FOS 7.1 and higher, Brocade Access Gateway supports ClearLink Diagnostic Ports (D_Ports), accelerating fabric deployments and troubleshooting times.
- **Automatic error recovery:** With Brocade FOS 7.1.0 and higher, Brocade Access Gateway supports Buffer Credit Recovery and Forward Error Correction (FEC) to improve resiliency and enhance overall application performance and availability.

Adaptive Networking Services

Server and storage consolidation increases fabric bandwidth requirements. And, as virtual servers concentrate more applications on a single server and dynamically move Virtual Machines (VMs) and their applications between physical servers, unexpected congestion can occur in the fabric. Brocade provides the following features to avoid fabric congestion:

- **Quality of Service (QoS):** Helps ensure that high-priority applications receive priority service if congestion occurs.
- **Ingress Rate Limiting:** Limits the amount of bandwidth entering the fabric from a port so lower-priority applications cannot cause congestion.
- **Traffic isolation:** Isolates higher-bandwidth traffic to dedicated links, avoiding congestion and disruption to other traffic flows in the fabric.
- **Fabric dynamic profiles:** Includes special ASIC registers that provide detailed, dynamic information about data flows at each switch port to dynamically optimize performance.

WAN Congestion Control

Storage traffic increasingly moves over the WAN as disaster recovery extends to more data. To account for this need, Brocade provides Ethernet and IP optimizations to minimize the impact of WAN congestion on extended Fibre Channel links:

- **Ethernet Class of Service (CoS):** Brocade supports VLAN (802.1Q) and CoS (802.1P), enabling FCIP tunnels to be assigned to an Ethernet CoS.

- **IP Differentiated Service Code Point (DSCP):** Fibre Channel traffic can be tunneled over the WAN with FCIP. DSCP provides QoS prioritization at the IP layer for FCIP traffic, which helps manage bandwidth according to priority, reducing dropped frames in IP networks.

UltraScale Inter-Chassis Links (ICLs)

Brocade DCX 8510 Backbones with Gen 5 Fibre Channel provide dedicated, high-bandwidth optical UltraScale ICLs that connect two or more backbone switches without consuming ports on the port blade. This allows up to 2 Tbps of dedicated bandwidth between Brocade DCX 8510 Backbones, enabling flatter, faster, and simpler fabrics that increase consolidation while reducing network complexity and costs.

Continuity

Data centers have become strategic assets charged with ensuring business continuity. Consequently, fabric-assisted data protection is an important asset in keeping up with data growth and the financial and regulatory penalties incurred when data is lost or inaccessible.

Extension

SAN extension over MAN and WAN distances is an essential technology for disaster recovery infrastructures.

Key technologies include:

- **FC and IP:** Creates an extended fabric using IP networks to connect devices between remote sites, supporting 1 GbE, 10 GbE, and 40 GbE. Tunneling over a WAN creates a single extended fabric supporting Fibre Channel, FICON, and IP.

- **Extension Trunking:** Combines multiple WAN connections into a single, logical, high-bandwidth trunk, providing active load balancing and network resilience to protect against WAN link failures.
- **IPsec support:** Ensures secure transport over WAN links by encrypting data-in-flight with a standard 256-bit AES algorithm without a performance penalty.
- **Unparalleled, extremely efficient architecture:** Uniquely permits the high-speed, low-latency processing of frames, making extension of synchronous applications possible.
- **Adaptive Rate Limiting:** Dynamically adjusts bandwidth sharing between minimum and maximum rate limits to optimize bandwidth utilization and maintain WAN performance during disruptions.
- **Advanced compression architecture:** Provides multiple modes to optimize compression ratios for various throughput requirements.
- **WAN-optimized TCP:** Provides an aggressive TCP stack, optimizing TCP window size and flow control, and accelerating TCP transport for high-throughput storage applications
- **Priority TCP Quality of Service (PTQ):** Provides high-, medium-, and low-priority handling of initiator-target flows within the same tunnel for transmission over the WAN, with individual TCP sessions per QoS class.
- **FCIP Fast Write:** Accelerates SCSI write processing, maximizing performance of synchronous and asynchronous replication applications across high-latency WAN connections over any distance.

- **Open Systems Tape Pipelining:** Accelerates read and write tape processing over distance, significantly reducing backup and recovery times over distance anywhere in the world.
- **Brocade Advanced Accelerator for FICON:** Uses advanced networking technologies, data management techniques, and protocol intelligence to accelerate IBM zGM, mainframe tape read and write operations, and z/OS host connection to Teradata warehousing systems over distance.
- **xWDM:** Supports FCP and FICON links over xWDM networks at 1, 2, 4, 8, 10, and 16 Gbps link rates with optimized BB_Credit allocation based on link distance, so full xWDM bandwidth is available.

Virtualization

Virtualization increases the utilization of shared resources, including servers, the SAN fabric, and storage devices. Brocade Adaptive Networking services help ensure the highest utilization of shared resources by avoiding congestion and application disruption. Key features include:

- **Virtual Channels:** Brocade Virtual Channels enable traffic separation and classification within a single physical connection, supporting QoS so high-priority traffic continues to flow when congestion occurs.
- **NPIV (switch and Brocade Access Gateway mode):** N_Port ID Virtualization (NPIV) is used with Brocade Access Gateway mode to multiplex blade server connections onto a single high-bandwidth switch port and with VMs to match fabric services to application service levels.

- **Virtual Fabrics:** Starting with Brocade FOS 6.2, this ANSI T11 standard feature enables organizations to define logical switches and fabrics that overlay the physical switching layer. In large fabrics, this approach provides better resource utilization, improved fault isolation, and distinct management domains.
- **Frame redirection:** This feature eliminates the need to reconfigure zoning for hosts and storage when storage virtualization applications and fabric encryption services are used.

Data Protection

Data protection has become a mission-critical requirement for next-generation data centers. Brocade has more than 25 years of data center experience, and has developed an extensive suite of data protection features for access control and security.

Access Control

Access controls are critical tools for data protection, identifying who or what is allowed to connect, communicate, and move data. Brocade products support user and management application access controls, including HTTPS, Secure Shell (SSH), Secure Socket Layer (SSL), Secure Copy (SCP), LDAP/OpenLDAP integration with Microsoft Active Directory, Role-Based Access Control (RBAC), password policies, RADIUS, TACACS+, IP filters, and Passive FTP.

Additional innovative fabric and device access controls include:

- **Switch Connection Control (SCC) policies:** Restrict which switches can connect in a fabric using an Access Control List (ACL). SCC policies can be centrally managed and pushed to the entire fabric.

- **Device Connection Control (DCC) policies:** Restrict which devices (servers, storage, tape) can connect to which switch ports. DCC policies can be centrally managed and pushed to the entire fabric.
- **Password control database:** Contains user accounts, roles, and account passwords, and is distributed to all switches in a fabric to ensure a uniform access control policy.
- **Zoning:** Identifies which devices (servers, storage, tape) are allowed to connect to each other and exchange data.

Security

Security entails authentication and encryption to restrict access and protect data from unauthorized access. Brocade products support a wide range of authentication, encryption, and management tools to protect fabrics and data from unauthorized access.

- **Authentication:** Authentication protocol support includes CHAP, DH-CHAP, Internet Key Encryption (IKE), IPsec, RADIUS, TACACS+, and P-EAP/MS-CHAP for RADIUS.
- **Encryption (AES/3-DES):** Brocade provides AES-128 and AES-256 encryption and 168-bit 3-DES encryption for IP links on extension products and management connections. Brocade also supports AES and 3-DES with IPsec. With the release of the Brocade Encryption Switch and Brocade FS8-18 Encryption Blade, Brocade offers AES-256 in-fabric encryption for data-at-rest. These solutions provide high-performance encryption and compression, and are integrated with key management systems from leading suppliers.

- **In-flight encryption over ISLs:** Brocade DCX 8510 with Gen 5 Fibre Channel port blades and the Brocade 6520 and 6510 Switches support in-flight encryption for traffic over ISLs to minimize the risk of unauthorized access to data within the data center and over long-distance links. Data-at-rest and data-in-flight encryption are complementary technologies that serve different purposes, and each may be required in order to achieve regulatory compliance.
- **Fabric Configuration Server (FCS):** All security policies are stored and accessed from the FCS (a designated switch), which simplifies management of all security policies and unifies the application of policies across the fabric.

Brocade Global Services

Brocade Global Services has the expertise to help organizations build scalable, efficient cloud infrastructures. Leveraging 15 years of expertise in storage, networking, and virtualization, Brocade Global Services delivers world-class professional services, technical support, network monitoring services, and education, enabling organizations to maximize their Brocade investments, accelerate new technology deployments, and optimize the performance of networking infrastructures.

Additional Brocade Resources

A wide variety of Brocade product data sheets, white papers, and technical briefs that describe key technologies and solutions are available online. In addition, Brocade provides classroom, self-paced, and virtual classroom training materials. Self-paced materials are also available online to provide just-in-time training. To learn more, refer to the following resources:

Product data sheets:

www.brocade.com/products

White papers and technology briefs:

www.brocade.com/resources

Brocade training courses:

www.brocade.com/education

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