

BROCADE FABRIC OS PRODUCT LINE GUIDE

**Leading-Edge Solutions for
Next-Generation Data Centers**

BROCADE

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 optimize their IT infrastructures 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 Fabric OS Product Family Overview
- Brocade Core Technology Overview
- Brocade Data Center Fabric Technology Overview
- Additional Brocade Resources

The integration of innovative core Fabric OS technology and data center 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).

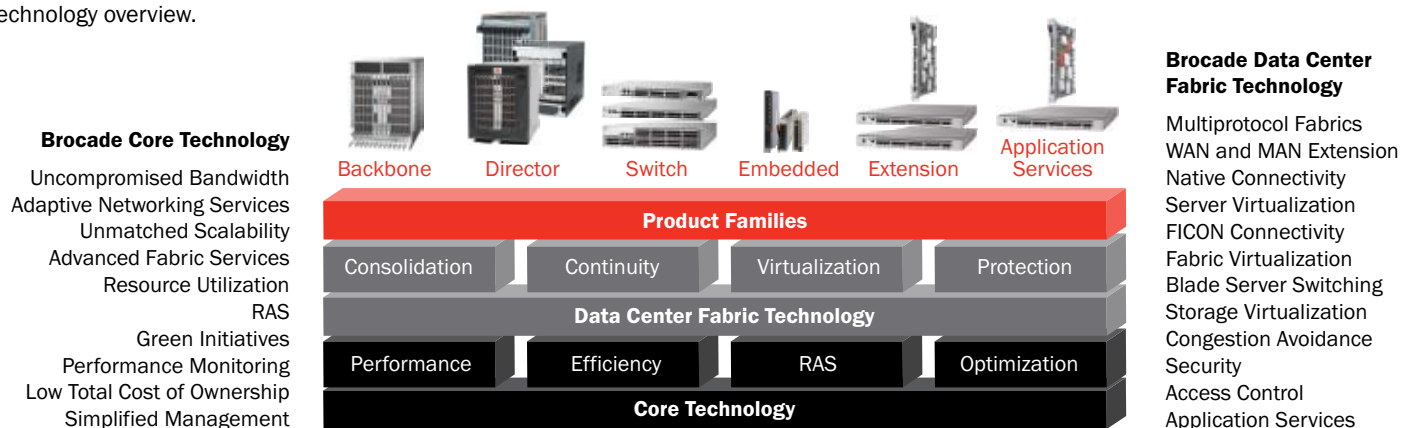
BROCADE FABRIC OS PRODUCT OVERVIEW

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

- **Backbones:** Brocade recently introduced the world's first data center backbone-class product, the Brocade DCX™ Backbone. It is designed to support the most demanding requirements for consolidation, continuity, virtualization, and protection—while delivering unprecedented performance; efficiency; Reliability, Availability, and Serviceability (RAS); and optimization along with investment protection. Backbone products play a key role in the Brocade Data Center Fabric (DCF) architecture for building next-generation data centers. The Brocade DCX meets the most demanding Fibre Channel and FICON® traffic requirements today and provides a strategic foundation for emerging standards, such as 10 Gbit/sec Converged Enhanced Ethernet (CEE) and Fibre Channel over Ethernet (FCoE).
- **Directors:** Brocade introduced the director product category to the industry, and these products are designed for high performance and availability with excellent initial and ongoing costs. To simplify management and protect investments, all Brocade director products can interoperate with the Brocade backbone, switch, embedded switch, extension, and application product families.

- **Switches:** Brocade switches are ideal for organizations that require flexible performance and scalability options to meet their growth requirements. These high-density switches provide cost-effective building blocks for both smaller fabrics and the edge of enterprise data center environments.
- **Embedded switches:** Brocade embedded switch products 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.
- **Extension and routing products:** For more than 20 years, Brocade has been delivering robust extension and routing products, including those that support ESCON, FICON, and Fibre Channel over IP (FCIP). These products are available in chassis, 1U, and blade form factors (which can reside in the Brocade DCX Backbone and Brocade 48000 Directors).
- **Application services:** Brocade application services provide hardware-assisted performance for storage and data management applications, including virtualization, migration, and replication. By increasing performance and scalability while reducing cost and complexity, these products extend the benefits of advanced storage and data management across the data center.

Figure 1.
Brocade product and technology overview.



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 with breakthrough products.

Performance

Data center fabrics have the most stringent performance requirements of any network technology. They must have low latency and guaranteed delivery while accommodating bursts in application data flows without disrupting applications—the capabilities provided by the Fabric OS 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 and director 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.

Product Family	Switch Bandwidth Performance	Port Speeds	Maximum Ports
Backbone	Up to 6,528 Gbit/sec	1, 2, 4, 8, 10 Gbit/sec	32 to 384
Director	Up to 3,264 Gbit/sec (at 4 Gbit/sec)	1, 2, 4, 8, 10 Gbit/sec	32 to 384
Switch	Up to 1,360 Gbit/sec	1, 2, 4, 8 Gbit/sec	8 to 80
Embedded	Up to 408 Gbit/sec	1, 2, 4, 8 Gbit/sec	12 to 24

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 0.4 watts per Gbit/sec for Brocade backbone products and as low as 0.13 watts per Gbit/sec for Brocade switch 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 40 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). Key features 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.
- **Product availability:** Brocade backbone and director products average “five nines” (99.999 percent) availability or greater, and feature “hot” replacement of components without taking the products offline.

Table 1. Brocade switching product scalability.

- **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.
- **BB_Credit recovery:** Under some conditions (such as long-distance links over xWDM and WAN connections), flow control BB_Credits can be lost. This feature enables extended distance ports to recover lost BB_Credits.
- **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.
- **Brocade Fabric Watch:** This utility tracks critical fabric events and provides automatic notification when event counters exceed defined thresholds.
- **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 (Fabric OS). The resulting traffic and bandwidth optimization improve utilization, avoid congestion, and simplify operations. Moreover, management optimization simplifies configuration, monitoring, and administration to reduce TCO.

Advanced Performance Monitoring

This licensed set of features provides monitoring services and tools that enhance bandwidth utilization and product performance. Key features include:

- **Top Talker reports:** Leverage Brocade Adaptive Networking fabric dynamic profiles to rank bandwidth utilization by source and destination IDs.
- **Trunking performance:** Monitors trunks for bandwidth utilization and queue latency.
- **Frame filtering-SCSI payload:** Monitors the first 64 bytes of a frame, providing deeper analysis of potential causes of congestion.
- **CRC error statistics:** Identifies Cyclic Redundancy Check (CRC) errors, which indicate corrupt payloads that can cause subsequent congestion as exchanges are resent.

Management

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

- **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.
- **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 reroute delay:** Prevents frame loss when switches are added to or removed from the fabric, and routing tables are updated.
- **Alias server:** Simplifies management by enabling easy-to-read names for device addresses.

- **Fabric Device Management Interface (FDMI):** Enables Brocade Fabric Manager to manage Host Bus Adapter (HBA) configuration, simplifying end-to-end fabric management.
- **Network time protocol support:** Synchronizes all time stamps to a central time server for uniform event correlation, improving fault isolation.
- **SNMP MIBs:** Supports Simple Network Monitoring Protocol (SNMP) v1 and v3 for fabric monitoring, and Brocade also publishes a Management Information Base (MIB) for all products.
- **Brocade SMI-S Agent:** Supports the SMI-S agent standard to simplify device management.
- **IPv6 addressing:** Enables full addressing flexibility for management traffic.
- **Integrated device and fabric management:** Features an integrated management suite, including Brocade Enterprise Fabric Connectivity Manager (EFCM), that centralizes device management as well as fabric configuration for zoning and routing of Brocade and Brocade M-Series products.
- **Simple switch configuration:** Provides the EZSwitchSetup wizard (Microsoft Simple SAN-certified) to significantly simplify switch configuration and setup.

Scalability

Brocade offers several features that help reduce TCO, including on-demand scalability that enables organizations to add switch ports by activating a license key. Key features include:

- **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 Fibre Channel Routing services, Traffic Isolation, Quality of Service (QoS), broadcast zones for IPFC traffic, and Frame Redirection.

BROCADE DATA CENTER FABRIC TECHNOLOGY OVERVIEW

The Brocade data center 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 Inter-Chassis Links (ICLs).

Multiprotocol Support

Traditionally, Fibre Channel has been the underlying technology in most SAN fabrics, supporting both open systems SCSI channels (FCP) and System z mainframe channels (FICON). Today, however, Brocade protocol support includes Fibre Channel over IP (FCIP), Fibre Channel Routing, iSCSI, and IP over Fibre Channel (IPFC) with planned support for emerging protocols.

Native Connectivity

As Fibre Channel was implemented, vendors optimized a portion of the protocol for E_Ports to create Inter-Switch Links (ISLs). These optimizations are called “fabric modes” and all E_Ports on all switches in a fabric operate in the same fabric mode. Today, however, Brocade offers “native connectivity” for fabrics with Brocade and Brocade M-Series (McDATA) products—including all McDATA E_Port modes as well as Fibre Channel Routing between fabrics running in any McDATA mode.

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 (IBM, HP, Intel, Dell, Fujitsu-Siemens, NEC, Huawei, 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 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 Access Gateway and the fabric switch.
- **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 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.

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 and their applications between physical servers, unexpected congestion can occur in the fabric. Brocade provides the following features to avoid fabric congestion:

- **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.

Inter-Chassis Links (ICLs)

Brocade backbone products provide dedicated, high-bandwidth ICLs that connect two backbone switches without consuming ports on the port cards. This enables up to 1,000 Gbit/sec of dedicated bandwidth between Brocade DCX Backbones, allowing compact, high-port-count connectivity for demanding enterprise-class environments.

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.

Application Services for Continuity

Brocade offers an application services platform that facilitates data protection applications. These services are integrated with Brocade partner-supplied applications for continuous data protection (synchronous replication), continuous remote replication (asynchronous replication), data migration, and virtual tape libraries.

Extension

Fabric extension over MAN and WAN distances is an essential technology for disaster recovery infrastructures. Key technologies include:

- **FCIP:** Creates an extended fabric using IP networks to connect devices between remote sites. FCIP Tunneling creates a single extended fabric over an IP WAN. Fibre Channel Routing enables connectivity to remote fabrics without merging the fabrics.
- **Storage Optimized/TCP:** Dramatically improves TCP performance using optimizations such as sliding window size, fast-start, and improved response to lost packets.
- **Optimized BB_Credit allocation:** Utilizes “dynamic distance mode” to automatically discover the optimum BB_Credit allocation based on the link distance, avoiding wasteful over-provisioning of BB_Credits for extended links.
- **Fast Write:** Eliminates SCSI transaction latency over long distances, significantly increasing usable bandwidth for disaster recovery applications.
- **Tape Pipelining:** Eliminates latency over long distances for writes (and reads for FICON traffic) to increase usable bandwidth.
- **FICON device support:** Provides FICON device emulation to significantly reduce latency, extending the distance for FICON traffic between data centers.
- **xWDM:** Supports FCP and FICON links over xWDM networks at 1, 2, 4, 8, and 10 Gbit/sec link rates with ample BB_Credit resources, 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 Access Gateway mode):** N_Port ID Virtualization (NPIV) is used with Access Gateway mode to multiplex blade server connections onto a single high-bandwidth switch port.
- **Virtual fabrics with Administrative Domains:** Organizations can divide fabric management into distinct management domains. They can assign distinct management roles, limiting access to critical fabric operations and improving security.
- **Application services for virtualization:** The Brocade application services platform provides hardware acceleration for storage virtualization, boosting the performance and scalability of virtual storage applications.
- **Frame Redirection:** This feature eliminates the need to reconfigure zoning for hosts and storage when storage virtualization applications 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 integration with Microsoft Active Directory, Role-Based Access Control (RBAC), password policies, RADIUS, 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, and P-EAP/MS-CHAP for RADIUS.
- **Encryption (AES/3-DES):** Brocade provides AES 128- and 256-bit 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.
- **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.

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/productinfo
- **White papers and technology briefs:**
www.brocade.com/resources
- **Brocade training courses:**
www.brocade.com/education

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