BROCADE
A Broadcom Company

Product Brief

Brocade® Fabric OS

Gain Control and Insight for Next-Generation Data Centers

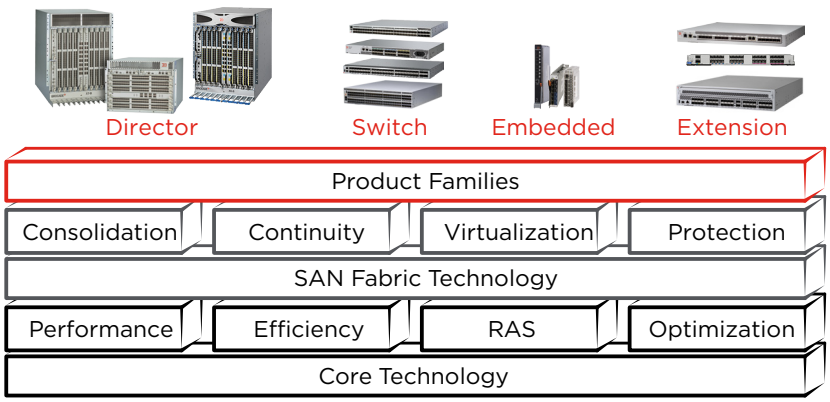
Overview

The use of virtualization, flash storage, and automation tools has allowed applications and services to be deployed faster while shattering performance barriers. The unprecedented number of application and service interactions has also increased the complexity, risk, and instability of mission-critical operations. As a result, IT administrators need their infrastructure to be able to monitor application performance, identify network congestion, and prioritize bandwidth. The infrastructure needs to automatically isolate issues to a configuration error or a malfunctioning device regardless of brand of device in the data center. They also need new tools that can help ensure nonstop operations, quickly identify potential points of congestion, and maximize application performance while simplifying administration.

As a leading provider of data center networking solutions, Brocade, a Broadcom company, 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 SLAs, optimize their IT infrastructures for always-on operations, and reduce costs by simplifying administration.

Fabric OS® Product Overview

- Directors: Brocade directors provide a modular building block for increased scalability to accommodate growth for large-scale enterprise infrastructures, and they provide the tools to optimize NVMe storage and automate SAN management tasks.
- Switches: Brocade powerful Fibre Channel switches shatter application performance barriers and simplify scale-out network architectures—in an enviably small footprint. And with built-in instrumentation, you gain greater insight and control to reduce cost, management complexity, and risk.
- Embedded Switches: Maximize the benefits of your consolidation efforts with the industry's best-in-class SAN I/O modules for blade servers.
- Extension: To address disaster recovery requirements, Brocade extension solutions are designed to give organizations flexible deployment options for replication. Brocade extension switches and blades are robust platforms for large-scale, multisite data center environments that implement block, file, and tape data protection solutions. Brocade extension is a purpose-built solution that securely moves more data over distance faster while minimizing the impact of disruptions.



Brocade Core Technology

- Uncompromised Bandwidth
- Unmatched Scalability
- Fabric Vision Technology
- Advanced Fabric Services
- Performance Monitoring and Alerting
- Optimized Resource Utilization
- RAS
- Green Initiatives
- Low Total Cost of Ownership
- Simplified Management

Brocade SAN Fabric Technology

- Multiprotocol Fabrics
- WAN and MAN Extension
- Native Connectivity
- Server Virtualization
- FICON Connectivity
- Fabric Virtualization
- Blade Server Switching
- Storage Virtualization
- Congestion Avoidance
- Security/Encryption
- Access Control

Brocade Core Technology Overview

Brocade storage networking delivers industry-leading, innovative technologies that help improve performance, efficiency, and optimization. Brocade Fibre Channel switching products were first to market and continue to lead the development of Fibre Channel standards, offering breakthrough Gen 7 Fibre Channel hardware products and innovative software, including Brocade Fabric Vision® technology and the autonomous SAN.

- 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 Fabric OS® (FOS) family of products.
- 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.
- Bandwidth: Switching products must have enough bandwidth to avoid congestion for all data traffic. The Brocade switching portfolio provides a wide range of price/performance options so organizations can choose the right solutions for their unique business requirements. Brocade director products provide both core switch engines and port switch engines, or local switching. This capability boosts performance for high-bandwidth applications.
- Efficiency: Data center efficiency has become essential for organizations that must manage data growth within their existing power, cooling, and floor space constraints. Brocade networking is at the forefront of innovative data center efficiency, driving energy use down per Gb/s for Brocade directors and switches.
- Utilization: Maintaining high fabric resource utilization is paramount to implementing green technology initiatives and achieving a low total cost of ownership (TCO).

FOS Features and Benefits

Brocade FOS is the foundation for enabling the ability to proactively monitor billions of physical-layer, protocol-layer, and application-layer data points in real time and translate the information gathered into actionable insights on the performance and health of the storage area network (SAN). 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.

Autonomous SAN

The ability of Brocade FOS to collect and extract actionable insights from the SAN is the foundation for realizing a self-learning, self-optimizing, and self-healing autonomous SAN. Leveraging a collection of FOS features with Brocade SANnav™ Management Portal, Brocade technology can quickly understand the health and performance of the environment and identify any potential impacts or trending problems. The information collected by Fabric Vision is transformed into visual insights to quickly identify and isolate problems through SANnav Management Portal and Global View. Combining all of these elements delivers a massive step forward in achieving autonomous infrastructure.

Fabric Vision Technology

Fabric Vision increases visibility into the network and supports highly automated management functions. These functions dramatically reduce operational costs by simplifying management, so you can preempt potential problems and accelerate application deployments. Fabric Vision combines capabilities from hardware and Fabric OS. With IO Insight, Fabric Vision technology provides organizations with even deeper visibility into the relationship between the physical and application layers. VM Insight seamlessly monitors virtual machine (VM) performance throughout a storage fabric with standards-based, end-to-end VM tagging. With the addition of VMID+, VM Insight is available regardless of storage array capability, allowing administrators to use VM Insight to quickly determine the source of VM and application performance anomalies to provision and fine-tune the infrastructure.

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 offers MAPS, ClearLink™, and Flow Vision features that deliver unmatched reliability, availability, and management simplicity.

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 feature 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 decommissioning: This feature provides the ability to nondisruptively remove an ISL from service.
- FCping/FC trace route: These tracking features confirm that ports and paths are operational and that latencies between ports are within expected limits.
- RAS event logging with an NTP server: Messages about events that impact RAS can be forwarded to a central collection point with synchronized timestamps provided by a central Network Time Protocol (NTP) server.
- Change auditing: This feature logs all changes in the fabric and forwards the change event logs to centralized Syslog and Secure Syslog servers to improve management control and security.

Fabric Automation

IT organizations spend nearly half of their time performing repetitive daily management tasks, such as zoning, inventory reporting, and operational validation checks. By automating these repetitive tasks, IT organizations can significantly improve their efficiency and dramatically decrease the risk of operational mistakes. Automation in large-scale IT environments integrates diverse infrastructure components with consistency and predictability to deliver greater operational efficiency and agility. With more than 25 years of storage networking experience, Brocade products are built with the understanding of the nuances that go into infrastructure management and the tasks that can benefit from automation. By introducing REST APIs directly into Fabric OS and management products, Brocade products offer a broad range of choices to enable any SAN management solutions. IT organizations that couple Brocade's robust data collecting capabilities with automation and orchestration tools (such as Ansible) gain the ability to automate configuration tasks and the visibility to monitor and detect any performance or health changes. In addition, organizations that leverage Brocade SANnav Management Portal can stream all of the collected SAN telemetry data to third-party applications via Kafka streaming.

Security

The sophistication and volume of cybercriminal behavior have dramatically increased as a direct result of the added reliance on digital data by businesses. Counterfeiting and tampering with hardware and software have become a lucrative illegal trade that leads to billions of dollars in losses across all industries. This counterfeiting and tampering within the data center can cause serious damage and risk to your environment.

A Brocade Gen 7 cyber-resilient network protects against security threats, enables nonstop operations, and maximizes management automation. Fibre Channel fabrics are secure by design based on controlled access between servers and storage and isolation within the data center. Brocade Gen 7 technology further reduces the risk of vulnerabilities from malware and hijacking attacks by validating the integrity of the switch operating system, security settings, and hardware.

Brocade FOS adds additional security enhancements to validate the integrity and security of Brocade hardware and software. These features include Secure Boot, Brocade Trusted FOS (TruFOS) Certificates, FOS hardening with removal of root access, and automated distribution of SSL certificates via SANnav Management Portal. Brocade TruFOS Certificates ensure that enterprises running Brocade directors and switches are currently covered with support and securely enabled to perform critical operations without having to worry about whether the operating system has been tampered with. In addition, Brocade FOS has been hardened by removing root-level access to the operating system to protect the SAN against malware and hijacking attacks.

Those enterprises using Brocade SANnav Management Portal have the ability to automatically distribute SSL certificates across the SAN to ensure authenticity and encryption settings. In addition, security features are built into Brocade SANnav Management Portal to help administrators protect their network. With Brocade SANnav, administrators can set up monitoring and alerting for security configuration changes, customize security thresholds, give proper access control to individual admins, and view switch security events.

With FOS v9.2.0, Default Secure can be used to set security best practice configurations including disabling non-secure protocols and using strong cryptographic profiles.

Access Control

Access controls are critical tools for data protection, identifying who or what is allowed to connect, communicate, and move data. Root access has been removed from Brocade products to help mitigate security risks. Brocade products support user and management application access controls, including HTTPS, Secure Shell (SSH), Transport Layer Security (TLS), Secure Copy (SCP), LDAP/OpenLDAP integration with Microsoft Active Directory, Role-Based Access Control (RBAC), password policies, RADIUS, TACACS+, and IP filters.

Technical Features

Traffic Optimizer

FOS v9.1 introduced advanced Traffic Optimizer policies on Brocade Gen 7 platforms to automatically optimize SAN traffic based on speed, protocol (SCSI or NVMe), and latency characteristics. Traffic flows with the same attributes, such as flow destination speed and protocol, are grouped logically in a performance group. A performance group provides dedicated resources and thereby traffic separation from concurrent traffic with different characteristics, avoiding the adverse performance impact to flows due to dissimilar traffic characteristics. Traffic Optimizer is supported and enabled by default for all Gen 7 platforms and includes automatic oversubscription detection and isolation. This feature provides the self-optimizing benefit for the autonomous SAN.

Fabric Congestion Notification

FOS v9.x automatically notifies end devices of detected congestion points and the types of congestion. Brocade FOS or end devices will automatically mitigate and recover from congestion to achieve self-healing of a SAN. This feature provides the self-healing benefit for the autonomous SAN.

Fabric Performance Impact Notification (FPIN) is a fabric service that automatically detects fabric performance degradation and communicates with devices (host and storage) so they can take corrective action or change their behavior to resolve performance issues. FPIN takes alerts generated by FPI monitoring and MAPS and, based on the condition detected, automatically notifies devices in the SAN. The notifications include detected link integrity or congestion issues, which upon receipt the devices can take corrective action on.

Management Simplicity

- Integration with Brocade SANnav Management Portal: 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 OS Web Tools: A free lightweight element management tool that is launched directly from web browsers to provide switch, port, zoning, and other common configuration and monitoring features with a modern and secure UI.
- 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 that require 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 FOS and Brocade SANnav Management Portal to maintain end device information, simplifying end-to-end fabric management.
- Time server support: Synchronizes all timestamps either to a principal switch in a fabric or to a central Network Time Protocol (NTP) server for uniform event correlation, simplifying fault isolation.
- NTP server authentication (available in FOS v9.1): Verifies that the NTP servers are trusted Time Protocol providers.
- SNMP MIBs: Supports Simple Network Management Protocol (SNMP) v1 and v3 for fabric monitoring and management. A Management Information Base (MIB) is published for all Brocade products.
- IPv6 addressing: Enables full addressing flexibility, including IPv4 and IPv6 dual stack support for management traffic.
- DHCP/DHCPv6: Supports automatic IPv4 and IPv6 address assignments to Gen 6 directors and switches.
- Integrated device and fabric management: Features an integrated management suite—Brocade SANnav Management Portal and SANnav Global View—that centralizes device management and fabric configuration for the zoning and routing of all Brocade products.
- Dynamic Ports on Demand (PoD): Activates specific switch ports only when growth dictates the need for more ports. Dynamic PoD enables switches to automatically use any activated switch port rather than specific ports, simplifying switch and blade server configuration.
- Enhanced zoning services: Enables zoning to configure peer zones, target-driven peer zones, Fibre Channel Routing services, and Quality of Service (QoS).
- Dynamic port name: Assigns a switch port name automatically and dynamically based on a predefined or user-configured template and port type.

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 is supported with both local users, Federated Authentication and classical AAA using the following protocols: OAuth 2.0, CHAP, DH-CHAP, FCAP, IKE, IPsec, RADIUS, TACACS+, and P-EAP/MS-CHAP for RADIUS.
- Encryption (AES/3-DES): Brocade products provide AES-128 and AES-256 encryption and 168-bit 3-DES encryption for IP links on extension products and management connections. Brocade products also support AES and 3-DES with IPsec. These solutions provide high-performance encryption and compression.
- In-flight encryption over ISLs: Brocade X6 Directors with Gen 6 Fibre Channel port blades, Brocade X7 Directors with Gen 6 or Gen 7 Fibre Channel port blades, and Brocade G720, G630, and G620 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 to achieve regulatory compliance.
- Secure Boot: A switch validates the integrity and authenticity of the FOS boot image to establish a hardware-based root of trust through the manufacturing supply chain.

Access Control

- 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.
- Federated Authentication (FA) (available in FOS v9.2.1 and above): Delegates authentication to a federated Identity Provider (IdP) Multi-factor Authentication (MFA) and access is granted through access tokens from the IdP upon successful authentication.
- Zoning: Identifies which devices (servers, storage, tape) are allowed to connect to each other and exchange data.
- Fabric Configuration Server (FCS): Ensures that 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.

Utilization

- Frame-based trunking: Data flows are automatically distributed over multiple physical inter-switch link (ISL) connections and are 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 trunking 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.

Multiprotocol Support

Fibre Channel is the underlying technology in most SAN fabrics, supporting open systems SCSI channels (FCP), NVMe (FC-NVMe), and System Z mainframe channels (FICON). To meet a broad spectrum of customer requirements, Brocade protocol support includes FCIP and Fibre Channel Routing. To deploy or consolidate IP storage within data centers, Brocade Unified Storage Fabric (USF) on the Brocade X7 Directors with the Brocade FC64-48 port blade provides support for IP storage connectivity. In addition, to support disaster recovery and data protection storage solutions over long distances, Brocade FOS supports IP storage extension within Brocade 7810 Extension Switches and Brocade X7 and X6 Directors.

FICON Connectivity

Fibre Channel supports a variety of upper-layer protocols such as FICON used in IBM System Z environments. Brocade storage networking creates a high-integrity fabric for System Z environments, including the following:

- FICON cascading: Extending System Z environments to one-hop configurations, FICON cascading helps increase fabric scalability without sacrificing critical FICON channel performance.
- FICON intermix: Brocade products provide a FICON intermix solution that combines FICON and FCP traffic in the same fabric for greater resource utilization.
- FICON Management Server (CUP): Brocade products were the first to provide FICON Management Server—Control Unit Port (CUP)—so that mainframe-hosted tools could manage connectivity between ports, monitor fabric performance, and collect critical diagnostic information.
- System Z mainframe innovations: Brocade products were the first to provide FICON-capable switching and secure fabrics that utilize the DH-CHAP authentication protocol.

IP Storage Connectivity with Brocade Unified Storage Fabric (USF)
Brocade USF, available with FOS v9.2.1, supports IP Storage connectivity in parallel with Fibre Channel on Brocade X7 Directors.

Provisioning IP storage logical switches within a Fibre Channel SAN Fabric ensures full separation of IP storage and Fibre Channel while consolidating traffic, to simplify management within the storage network team. This eliminates dependencies on the network team and provides the performance, reliability, and security of Fibre Channel SAN to IP-based storage critical applications.

Blade Server Connectivity in Brocade Access Gateway Mode
Blade servers are provided by most of the leading server vendors (Dell, Fujitsu, Hitachi, HPE, Huawei, 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 Access Gateway mode addresses this by eliminating the domain ID for an embedded switch. Key features include the following:

- Auto port configuration: Automatically maps server ports to Brocade Access Gateway links that are 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.
- Multifabric connectivity: Increases availability by enabling Brocade Access Gateway links to extend to one or two fabrics. If one fabric path becomes unavailable, multipath drivers in the blade server reroute application traffic to the second fabric.
- Proactive monitoring and alerting: Brocade Access Gateway supports MAPS and Flow Vision to help bandwidth utilization and maximize fabric performance.
- ClearLink Diagnostics support: Brocade Access Gateway supports ClearLink Diagnostic Ports (D_Ports), accelerating fabric deployments and troubleshooting time.
- Automatic error recovery: 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 products provide the following feature to avoid fabric congestion:

- Quality of Service (QoS): Helps ensure that high-priority applications receive priority service if congestion occurs.

Brocade Global Support

Global Support has the expertise to help organizations build resilient, efficient SAN infrastructures. Leveraging over 25 years of expertise in storage networking, Global Support delivers world-class technical support, implementation, and migration services to enable organizations to maximize their hardware and software investments, accelerate new technology deployments, and optimize the performance of their overall network.

Brocade Support Link

Active Support Connectivity (ASC), embedded in FOS, performs periodic and continuous data collection on each switch, including configuration, performance metrics, and alerts. Utilized by Brocade Support Link, proactive analysis is performed, identifying fabric configuration inconsistencies, root issues causing congestion, integrating automatic support case creation and Support Save collections for customer environments, providing customers with a highly integrated, automated support experience.

Maximizing Investments

To help optimize technology investments, Brocade technology, together with our storage partners, offers complete solutions that include professional services, technical support, and education.

For more information, contact a Brocade sales partner or visit www.broadcom.com/brocade.

For information about supported SAN standards, visit www.broadcom.com/sanstandards.

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