

Brocade X6 Directors



HIGHLIGHTS

- Enhances operational stability, maximizes application performance, and increases business agility with enterprise-class Gen 6 directors
- Accelerates application response time by up to 71 percent across 32 Gbps links
- Consolidates infrastructure with 128 Gbps Brocade UltraScale ICL connectivity for simpler, flatter, low-latency fabrics
- Simplifies end-to-end management of large-scale environments by automating monitoring and diagnostics
- Automatically detects degraded application or device performance through integrated network sensors
- Proactively monitors and optimizes the health and the performance of individual Virtual Machines (VMs) and identifies anomalies with VM Insight
- Extends replication over distance with a highly scalable extension solution for Fibre Channel, IP, and FICON
- Simplifies configuration automation and enables integrated advanced services across the fabric with standard REST APIs
- Seamlessly integrates next-generation NVMe over Fabrics with Gen 6 Fibre Channel networks without a disruptive rip and replace
- Mitigates risk with backward-compatibility while further protecting future investments with Gen 7-ready support

Network Innovation for the Virtualized, All-Flash Data Center

Digital transformation is pushing mission-critical storage environments to the limit, with users expecting data to be accessible from anywhere, at any time, on any device. Faced with exponential data growth, the network must evolve to enable businesses to thrive in this new era. To meet these dynamic and growing business demands, organizations need to deploy infrastructure that can deliver greater consistency, predictability, and performance. Legacy infrastructure, however, was not designed to support the performance requirements of evolving workloads and flash-based storage technology. In fact, an aging network will impede the performance of an all-flash data center. A new approach to storage networking is needed to enable databases, virtual servers, desktops, and critical applications, and to unlock the full capabilities of flash. By treating the network as a strategic part of a storage environment, organizations can maximize their productivity and efficiency even as they rapidly scale their environments.

The Brocade® X6 Director with Brocade Fabric Vision® technology combines innovative hardware, software, and integrated network sensors to ensure the industry's highest level of operational stability and redefine application performance. It provides a modular building block for increased scalability to accommodate growth for large-scale enterprise infrastructures.

Fabric Vision technology enhances visibility into the health of storage environments, delivering greater control

and insight to quickly identify problems and achieve critical Service Level Agreements (SLAs). Breakthrough 32 Gbps performance accelerates application response time by up to 71 percent, eliminating IO bottlenecks, and unleashes the full performance of flash and next-generation Non-Volatile Memory Express (NVMe)-based storage. And with diverse deployment options, organizations can seamlessly adapt and optimize their businesses to meet next-generation storage requirements.

GEN 6 FIBRE CHANNEL

Brocade Gen 6 Fibre Channel is the purpose-built network infrastructure for mission-critical storage, delivering operational stability, breakthrough performance, and increased business agility to accelerate data access, adapt to evolving requirements, and drive always-on business operations. The Brocade X6 Director with Gen 6 Fibre Channel and Brocade Fabric Vision technology delivers unmatched 32 Gbps performance, data center-proven availability, and seamless scalability to ensure greater consistency, predictability, and performance.

Purpose-Built for Enterprise Deployments

Designed to meet relentless growth and mission-critical application demands, Brocade X6 Directors are the right platform for large enterprise environments that require increased capacity, greater throughput, and higher levels of resiliency.

The Brocade X6 Director is available in two modular form factors. This modular chassis design increases business agility with seamless storage connectivity and flexible deployment offerings. Built for large enterprise networks, the 14U Brocade X6-8 has eight vertical blade slots to provide up to 384 32 Gbps Fibre Channel device ports and 32 additional 128 Gbps Brocade UltraScale Inter-Chassis Link (ICL) ports. Built for midsize networks, the 8U Brocade X6-4 has four horizontal blade slots to provide up to 192 32 Gbps Fibre Channel device ports and 16 additional 128 Gbps UltraScale ICL ports. Each blade slot can be populated with two optional blades. For device connectivity, the Brocade FC32-48 Fibre Channel device port blade provides 48 32 Gbps Fibre Channel ports. To support disaster recovery and data protection storage solutions over long distances, the Brocade SX6 Extension Blade provides 16 32 Gbps Fibre Channel ports, 16 1/10 Gigabit Ethernet

(GbE) ports, and 2 40 GbE ports for Fibre Channel and IP replication traffic.

Brocade directors build upon years of innovation and leverage the core technology of Brocade systems to consistently deliver five-nines availability in the world's most demanding data centers. And with non-disruptive, hot-pluggable components and a no-single-point-of-failure design, the Brocade X6 is truly the enterprise-class director for today's storage infrastructure.

Enhanced Operational Stability for Always-on Business Operations

The Brocade X6 Director with Fabric Vision technology provides a breakthrough hardware and software solution that helps simplify monitoring, increase operational stability, and dramatically reduce costs. Brocade Fabric Vision technology now includes IO Insight and VM Insight, which provides organizations with deeper visibility into the performance of their environment and individual VMs. This enhanced visibility enables quick identification of degraded application or VM performance at the host and storage tiers, reducing time to resolution.

IO Insight proactively monitors IO performance and behavior through integrated network sensors, providing deep insight into problems and helping to ensure service levels. This capability non-disruptively and non-intrusively gathers IO statistics from any device port, then feeds them to a monitoring policy that sets thresholds and generates alerts. VM Insight applies the IO Insight visibility for each VM. Integrated VM, application, and device-level IO latency and IOPS monitoring enables administrators to set baseline application performance and identify the VM or physical layer responsible for the degraded performance. Integrated network sensors provide IO performance management that is

designed to avoid dependence on invasive and disruptive physical taps.

Innovative Fabric Vision monitoring, management, and diagnostic capabilities enable administrators to avoid problems before they impact operations. They include:

- **IO Insight:** Proactively and non-intrusively monitors storage device IO performance and behavior through integrated network sensors at the storage tier, providing deep insight into problems and ensuring service levels.
- **VM Insight:** Seamlessly monitors VM performance throughout a storage fabric with standards-based, end-to-end VM tagging. Administrators can quickly determine the source of VM/application performance anomalies, as well as provision and fine-tune the infrastructure based on VM/application requirements to meet service-level objectives.
- **Monitoring and Alerting Policy Suite (MAPS):** Leverages prebuilt, rule-/policy-based templates within MAPS to simplify 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. With Flow Vision and VM Insight, administrators set thresholds for VM flow metrics in MAPS policies in order to be notified of VM performance degradation.
- **Fabric Performance Impact (FPI) Monitoring:** Leverages predefined MAPS policies to automatically detect and alert administrators to different latency severity levels, and to identify slow drain devices that could impact network performance. This feature identifies various latency severity levels, pinpointing exactly which devices are causing or are impacted by a bottlenecked port, and quarantines slow drain devices automatically to prevent buffer credit starvation.

- **Dashboards:** Provides integrated at-a-glance views that display an overall SAN health view, along with details on out-of-range conditions, to help administrators easily identify trends and quickly pinpoint issues occurring on a switch or in a fabric.
- **Configuration and Operational Monitoring Policy Automation Services Suite (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 to seamlessly deploy a configuration across the fabric. In addition, they can ensure settings do not drift over time with COMPASS configuration and policy violation monitoring within Brocade Network Advisor dashboards.
- **Brocade ClearLink® Diagnostics:** Ensures optical and signal integrity for Fibre Channel optics and cables, simplifying deployment and support of high-performance fabrics. ClearLink Diagnostic Port (D_Port) is an advanced capability of Fibre Channel platforms.
- **Flow Vision:** Enables administrators to identify, monitor, and analyze specific application flows in order to simplify troubleshooting, maximize performance, avoid congestion, and optimize resources. Flow Vision includes:
 - **Flow Monitor:** Provides comprehensive visibility into flows within the fabric, including the ability to automatically learn flows and non-disruptively monitor flow performance. Administrators can monitor all flows from a specific host to multiple targets/LUNs, from multiple hosts to a specific target/LUN, or across a specific ISL or IFL. Additionally, they can perform LUN-level monitoring

of specific frame types to identify resource contention or congestion that is impacting application performance. With the IO Insight capability, administrators can monitor first IO response time, IO completion time, the number of pending IOs, and IOPS metrics for a flow from a specific host to a target or LUN. With VM Insight, administrators can monitor network throughput and IO statistics for each VM.

- **Flow Learning:** Enables administrators to non-disruptively discover all flows that go to or come from a specific host port or a storage port, or traverse ISLs/IFLs or FCIP tunnels, to monitor fabric-wide application performance. In addition, administrators can discover top and bottom bandwidth-consuming devices and manage capacity planning.
- **Flow Generator:** Provides a built-in traffic generator for pretesting and validating the data center infrastructure for robustness—including route verification and integrity of optics, cables, ports, back-end connections, and ISLs—before deploying applications.
- **Flow Mirroring:** Enables administrators to non-disruptively create copies of specific application and data flows or frame types that can be captured for in-depth analysis.
- **Forward Error Correction (FEC):** Enables recovery from bit errors in device connections and ISLs, enhancing transmission reliability and performance. Although mandated by the Gen 6 standard, Brocade FEC also works with Gen 5 devices that support FEC.
- **Credit Loss Recovery:** Helps overcome performance degradation and congestion due to buffer credit loss.

BROCADE FABRIC VISION TECHNOLOGY

Brocade Fabric Vision technology with IO Insight, an extension of Gen 6 Fibre Channel, provides unprecedented insight and visibility across the storage network with powerful integrated monitoring, management, and diagnostic tools that enable organizations to:

Simplify monitoring:

- *Deploy more than 20 years of storage networking best practices with a single click*
- *Leverage visibility into storage IO health and performance with key latency and performance metrics to maintain SLA compliance*
- *Gain comprehensive visibility into the fabric using browser-accessible dashboards with drill-down capabilities*

Increase operational stability:

- *Avoid 50 percent of common network problems with proactive monitoring*
- *Identify hot spots and automatically mitigate network problems—before they impact application performance*
- *Identify IOs that deviate from expected behavior to facilitate fault isolation and troubleshooting*

Dramatically reduce costs:

- *Eliminate nearly 50 percent of maintenance costs through automated testing and diagnostic tools*
 - *Save up to millions of dollars on CapEx costs by eliminating the need for expensive third-party tools through integrated network sensors, monitoring, and diagnostics*
 - *Tune device configurations with integrated IO metrics to optimize storage performance and increase ROI*
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Brocade Network Advisor

Brocade Network Advisor simplifies Gen 6 Fibre Channel management and helps organizations proactively diagnose and resolve issues to maximize uptime, increase operational efficiency, and reduce costs. The wizard-driven interface dramatically reduces deployment and configuration times by allowing fabrics, switches, and ports to be managed as groups. Customizable dashboards graphically display performance and health indicators out of the box, including all data captured using Brocade Fabric Vision technology. To accelerate troubleshooting, administrators can use dashboard playback to quickly review past events and identify problems in the fabric. Dashboards and reports also can be configured to show only the most relevant data, enabling administrators to more efficiently prioritize their actions and maintain network performance.

Brocade Network Advisor provides organizations with a programmable Web-based interface through a standard REST API to reduce operational tasks by automating zoning, scripting, and reporting. To further simplify management tasks, administrators can quickly search through events, historical data, and base inventory, and apply filters. In addition, the standard REST API leverages Brocade Fabric Vision technology to gain fabric-wide health and performance visibility via easy-to-read dashboards.

Maximum Performance for Mission-Critical and Highly Virtualized Workloads

Evolving critical workloads and higher density virtualization are continuing to demand greater, more predictable performance. The Brocade X6 Director features industry-leading Gen 6 Fibre

Channel that increases performance for demanding workloads across 32 Gbps line-speed links and up to 16.2 Tbps of chassis bandwidth to address next-generation I/O- and bandwidth-intensive applications. Gen 6 Fibre Channel technology provides up to 566 million frames switched per second per ASIC, unlocking the full capability of flash storage. This breakthrough performance speeds up data-intensive application response times, allows more transactions in less time, and enables improved SLAs. In addition, the Brocade X6 Director increases scalability with double the throughput for high-density VM deployments and larger fabrics. This allows organizations to support more storage devices and meet bandwidth requirements using the same number of Fibre Channel links.

Brocade X6 Directors provide unmatched chassis, slot-to-slot, and port performance and bandwidth. In addition, local switching capabilities ensure that data traffic within the same port group does not consume slot bandwidth, maximizing the number of line-rate ports while reducing latency. Performance capabilities include:

- Brocade X6-8: Non-blocking architecture
 - Up to 384 ports (equivalent to 512 with UltraScale ICLs) at 32 Gbps
 - > 16 Tbps aggregate chassis bandwidth
 - > 12 Tbps Fibre Channel port bandwidth
 - > 4 Tbps UltraScale ICL bandwidth
 - 1.5 Tbps bandwidth per slot, providing line-rate performance for the Brocade FC32-48 blade

- Brocade X6-4: Non-blocking architecture
 - Up to 192 ports (equivalent to 256 with UltraScale ICLs) at 32 Gbps
 - > 8 Tbps aggregate chassis bandwidth
 - > 6 Tbps Fibre Channel port bandwidth
 - > 2 Tbps UltraScale ICL bandwidth
 - 1.5 Tbps bandwidth per slot, providing line-rate performance for the Brocade FC32-48 blade

Simplified, Scale-out Network Design

Organizations need to adapt to continuous data growth and seamlessly scale-out their storage environments. Brocade UltraScale chassis connectivity leverages optical Inter-Chassis Links (ICLs), which provide 128 Gbps bandwidth through a QSFP link. These links can support up to 2 kilometers and connect up to 12 Brocade X6 Directors, enabling flatter, faster, and simpler fabrics that increase consolidation while reducing network complexity and costs.

UltraScale ICLs enable scalable core-edge and active-active mesh chassis topologies. These high-density chassis topologies reduce inter-switch cabling by 75 percent and free up to 25 percent of ports for servers and storage. This maximizes overall port density within the smallest amount of rack space while freeing up front-facing device ports for server and storage connectivity.

The Brocade X6-8 supports 32 UltraScale ICL ports, providing the equivalent of 128 32 Gbps ports (4.096 Tbps), and the Brocade X6-4 supports 16 UltraScale ICL ports, providing the equivalent of 64 32 Gbps ports (2.048 Tbps). Gen 6 UltraScale ICLs are backward-compatible and can connect to Gen 5 ICL ports, including connectivity with 2 km QSFPs at Gen 5 speeds of 16 Gbps (4×16).

UNMATCHED MAINFRAME TECHNOLOGY INNOVATION AND LEADERSHIP

The Brocade X6 Director delivers seamless FICON connectivity for mainframe storage environments. Brocade X6 complements z System mainframes by offering the industry's fastest, most reliable, and scalable FICON infrastructure, along with unique, innovative features—all of which help deliver the greatest ROI. Brocade builds on more than 20 years of mainframe leadership that includes designing the FICON standard and authoring many FICON patents.

Extended Distance and Replication with a Scalable, Multiprotocol Extension Solution

Connecting distributed data centers enables data mobility for advanced data protection. Enterprise data centers need their disaster recovery infrastructure to ensure fast, continuous, and easy replication of mission-critical data to anywhere in the world. Storage administrators need to replicate large amounts of data quickly, securely, reliably, and simply while minimizing operational and capital expenses.

With the Brocade SX6 Extension Blade, the Brocade X6 Director provides integrated metro and global connectivity with a purpose-built data center extension solution for Fibre Channel and IP storage environments. This solution delivers unprecedented performance, strong security, continuous availability, and simplified management to handle the unrelenting transfer of data between data centers and to maintain SLAs. Additionally, native 10 Gbps Fibre Channel connections are also available on the Brocade 48P-32G port blade and include

in-flight encryption and compression as well as optional support for 10 Gbps Fibre Channel over DWDM and dark fiber.

The Brocade X6 Director can scale up to four Brocade SX6 blades per chassis. Each Brocade SX6 Extension Blade provides 16 32 Gbps Fibre Channel/FICON® ports, 16 1/10 GbE ports, and 2 40 GbE ports to deliver the high bandwidth, port density, and throughput required for maximum application performance over WAN connections, and to address the most demanding disaster recovery requirements.

Extending Brocade Fabric Vision technology between data centers provides unprecedented insight and visibility across the storage network. With its powerful, integrated monitoring, management, and diagnostic tools, Fabric Vision technology enables organizations to minimize the impact of disruptions and outages for non-stop business operations. Consolidating Fibre Channel/FICON flows and IP storage flows into a single tunnel contributes significantly to operational excellence. And by using custom, browser-accessible dashboards for combined Fibre Channel and IP storage, storage administrators have a centralized management tool to monitor the health and performance of their networks.

Adapting to Next-Gen Storage Requirements with Flexible Deployment Options

To realize the full benefits of flash, organizations will need to transition their high-performance, latency-sensitive workloads to flash-based storage with NVMe over Fibre Channel. The simplicity and efficiency of NVMe enable significant performance gains for flash storage. Moreover, NVMe enables users to achieve faster application response times and harness the performance of hundreds

of solid state drives for better scalability across virtual data centers with flash.

Organizations can seamlessly integrate Brocade Gen 6 Fibre Channel networks with next-generation NVMe without a disruptive rip and replace. Leveraging the efficiency of NVMe, combined with the high performance and low latency of Brocade Gen 6 Fibre Channel, organizations can accelerate IOPS to deliver the performance, application response time, and scalability needed for next-generation data centers.

For investment protection, Brocade X6 Directors offer three generations of backward-compatibility support for connectivity to 4, 8, and 16 Gbps Fibre Channel products. Furthermore, the Brocade X6 supports future Fibre Channel generations as a Gen 7-ready storage networking platform. The Brocade X6 Director allows for current Gen 6 and future generation switch blade modules to be added within the chassis.

Brocade Global Services

Brocade Global Services has the expertise to help organizations build scalable, efficient cloud infrastructures. Leveraging 20 years of expertise in storage, networking, and virtualization, Brocade Global Services delivers world-class professional services, technical support, and education services, enabling organizations to maximize their Brocade investments, accelerate new technology deployments, and optimize the performance of networking infrastructures.

Maximizing Investments

To help optimize technology investments, Brocade and its partners offer complete solutions that include professional services, technical support, and education. For more information, contact a Brocade sales partner or visit www.brocade.com.

Brocade X6 Director Specifications

System Architecture

Chassis	<p>Single chassis: The Brocade X6-8 provides up to 384 32 Gbps ports or a 512-port equivalent with 128 Gbps (4×32 Gbps) UltraScale ICL ports (32 Gbps×4 QSFP ports). The Brocade X6-4 provides up to 192 32 Gbps ports or a 256-port equivalent with 16 UltraScale ICL ports.</p> <p>Each provides support for (E, F, D, M, SIM, AE, and EX) Fibre Channel ports using 48-port 32 Gbps Fibre Channel blades.</p>
Control processor	Redundant (active/standby) control processor modules
Scalability	Full-fabric architecture of 239 switches
Certified maximum	6,000 active devices per switch; 56 switches, 19 hops in Brocade Fabric OS® (FOS) fabrics; larger fabrics certified as required
Fibre Channel blades	Brocade FC32-48 port blade provides 48 ports of 32 Gbps Gen 6 Fibre Channel
Extension blades	Brocade SX6 Extension Blade provides Fibre Channel extension (16×32 Gbps Fibre Channel ports) and IP extension over IP networks (16×1/10 GbE and 2×40 GbE ports)
Performance	<p>Fibre Channel:</p> <ul style="list-style-type: none"> • 4 Gbps line speed, full duplex • 8 Gbps line speed, full duplex • 10 Gbps line speed, full duplex • 16 Gbps line speed, full duplex • 32 Gbps line speed, full duplex <p>Autosensing of 4, 8, 16, and 32 Gbps port speeds depending on SFPs used. Speed matching between 4, 8, 16, and 32 Gbps port speeds. 10 Gbps port speeds with dedicated SFPs.</p>
ISL trunking	Frame-based trunking with up to eight 32 Gbps ports per ISL trunk; up to 256 Gbps per ISL trunk Exchange-based load balancing across ISLs with DPS included in Brocade FOS
UltraScale ICL trunking	<p>Chassis-to-chassis linkage through connectors on the Core Routing (CR) blade</p> <p>Can configure the following maximum QSFPs per trunk depending on blade type, connecting:</p> <ul style="list-style-type: none"> • Up to four 4×32 Gbps QSFP ports in a trunk group to form a 512 Gbps trunk between two Brocade CR32-4 blades. For trunks containing four or fewer QSFP ports, ports in a trunk must be located in the same port group on each blade. • Up to four 4×32 Gbps QSFP ports in a trunk group to form a 512 Gbps trunk between a Brocade CR32-4 and CR32-8 blade. For trunks containing four or fewer QSFP ports, ports in a trunk must be located in the same port group on each blade. <p>A minimum of two QSFP connections are required for a trunk, and up to four 4×16 Gbps QSFP trunks between pairs of Brocade CR32-8 (CR32-4) and CR16-8 (CR16-4).</p>
Multichassis with UltraScale ICL ports	Up to 4,608 non-blocking 32 Gbps Fibre Channel ports; UltraScale ICL ports (32 for 8-slot or 16 per 4-slot chassis, optical QSFP) connect up to nine chassis in a full mesh topology or up to 12 chassis in a core-edge topology.
UltraScale ICL bandwidth	<p>Brocade X6-8: 4.096 Tbps; 32 UltraScale ICL ports provide the equivalent of 128 32 Gbps ports. Each UltraScale ICL port provides 128 Gbps bandwidth over a QSFP (32 Gbps×4) link.</p> <p>Brocade X6-4: 2.048 Tbps; 16 UltraScale ICL ports provide the equivalent of 64 32 Gbps ports. Each UltraScale ICL port provides 128 Gbps bandwidth over a QSFP (32 Gbps×4) link.</p> <p>Both models: Frame-based trunking is enabled between four UltraScale ICLs. DPS distributes exchanges across all frame trunks.</p>
Chassis bandwidth	<p>Brocade X6-8: 12.2 Tbps per chassis (384 ports×32 Gbps) data rate + 4.096 Tbps UltraScale ICL bandwidth (32×128 Gbps)</p> <p>Brocade X6-4: 6.1 Tbps per chassis (192 ports×32 Gbps) data rate + 2.048 Tbps UltraScale ICL bandwidth (16×128 Gbps)</p>
Slot bandwidth	1,536 Gbps (line rate)

Brocade X6 Director Specifications *(continued)*

Switch latency	Brocade FC32-48 blade at Gen 6 32 Gbps speeds: ≤ 900 ns (including FEC); any-port-to-any-port local switching and 2.7 μs blade to blade at 32 Gbps, cut-through routing Brocade SX6 blade, Fibre Channel to Fibre Channel: ≤ 900 ns (including FEC) and 2.7 μs any-port-to-any-port at 32 Gbps, cut-through routing
Maximum frame size	2,112-byte payload
Frame buffers	15,360 per switching ASIC
Classes of service	Class 2, Class 3, Class F (inter-switch frames)
Fibre Channel port types	Brocade FC32-48 port blade: F_Port, E_Port, EX_Port, M_Port, SIM, and D_Port Brocade SX6 Extension Blade: F_Port, E_Port, and EX_Port on FC, and VE_Port on GbE NOTE: Self-discovery is based on switch type (U_Port) with an optional port-type control.
Data traffic types	Fabric switches supporting unicast, multicast (255 groups), and broadcast
Media types	Brocade FC32-48 port blade: Supports hot-pluggable Brocade Fibre Channel SFP+ at 32 Gbps SWL/LWL and SFP+ at 16 Gbps SWL/LWL/ELWL, 10 Gbps SWL/LWL SFP Brocade SX6 Extension Blade: Supports hot-pluggable Brocade Fibre Channel SFP28 at 32 Gbps SWL/LWL; SFP+ at 16 Gbps SWL/LWL/ELWL; SFP at 10 Gbps FC SWL/LWL and Ethernet SFP+ at 1 GbE copper, 1 GbE 1000BASE-SX/LX/CWDM, SFP+ at 10 GbE SR/LR; SFP+ at 10 GbE tunable DWDM 80 km, and QSFP at 40 GbE SR4/LR4/ER4. Core Routing (CR) blades, Brocade CR32-4 and CR32-8: Support hot-pluggable Brocade Fibre Channel QSFP at 4×32 Gbps SWL, 4×16 Gbps SWL and 4×16 Gbps 2 km QSFP for ICL connections
USB	One USB port per control processor for firmware download, support save, and configuration upload or download
Fabric services	Adaptive Networking (Traffic Isolation, QoS); BB credit recovery; Brocade Advanced Zoning (default zoning, port/WWN zoning, peer zoning, target-driven zoning, broadcast zoning); Dynamic Path Selection (DPS); Extended Fabrics; FDMI; FICON CUP; Flow Vision; Frame Redirection; FSPF; Integrated Routing; IPoFC; ISL Trunking; Management Server; Monitoring and Alerting Policy Suite (MAPS); Configuration and Operational Monitoring Policy Automation Services Suite (COMPASS); N_Port Trunking; NPIV; NTP v3; Port Fencing; Registered State Change Notification (RSCN); Reliable Commit Service (RCS); Simple Name Server; Virtual Fabrics (Logical Switch, Logical Fabric)
Extension	Supports DWDM, CWDM, and FC-SONET devices; Fibre Channel, in-flight compression (Brocade LZO) and encryption (AES-GCM-256); BB credit recovery; FCIP, IP Extension, Adaptive Rate Limiting (ARL), data compression, Fast Write, read/write Tape Pipelining, QoS
FICON	FICON cascading; support for lossless DLS; FICON CUP; Advanced Accelerator for FICON (IBM z/OS Global Mirror and read/write Tape Pipelining)
System Components	
Fibre Channel ports	Brocade X6-8: Up to 384 32-Gbps ports, universal (E_Port, F_Port, EX_Port, M_Port, D_Port, SIM Port, FICON) Brocade X6-4: Up to 192 32-Gbps ports, universal (F_Port, E_Port, EX_Port, M_Port, D_Port, SIM Port, FICON)
Classes of service	Class 2, Class 3, Class F (inter-switch frames)
ANSI Fibre Channel protocol	FC-PH (Fibre Channel Physical and Signaling Interface standard)
Fabric initialization	Complies with FC-SW 5.0
Port to port latency	Local switching: ≤ 900 ns (including FEC) Blade to blade: 2.7 μs
Switching capacity	An aggregate switching capacity of 13.5 billion frames per second (for Class 2, Class 3, and Class F frames for a 384-port chassis)

Brocade X6 Director Specifications *(continued)*

High Availability

Architecture	Non-blocking shared memory; passive backplane; redundant active/passive control processor; redundant active/active core switching blades; redundant WWN cards
Chassis power	Brocade X6-8: <ul style="list-style-type: none">• Four power supplies required for AC low-line (100 VAC to 120 VAC).• Two power supplies required for AC high-line (200 VAC to 240 VAC).• Two power supplies required for High Voltage AC (200 VAC to 277 VAC) or High Voltage DC (240 VDC to 380 VDC).• Device ships with three PSUs or empty (3 for 2+1 redundancy). Two provide system power, but four must be installed to provide power efficiency and 2+2 redundancy. Brocade X6-4: <ul style="list-style-type: none">• Two power supplies required for AC low-line (100 VAC to 120 VAC).• One power supply required for AC high-line (200 VAC to 240 VAC).• One power supply required for High Voltage AC (200 VAC to 277 VAC) or High Voltage DC (240 VDC to 380 VDC).• The device ships with two power supplies. One provides system power, but both must be installed to provide power efficiency and 1+1 redundancy.
Cooling	Brocade X6-8: <ul style="list-style-type: none">• Requires three fan tray assemblies. A failure condition is one failed fan from any fan tray.• Each assembly contains two fans for a total of six. The system requires five of six functioning fans for operation in the Brocade X6-8. One fan tray assembly can be hot-swapped and should be replaced immediately in the event of a failure. Brocade X6-4: <ul style="list-style-type: none">• Requires two fan tray assemblies. A failure condition is one failed fan from any fan tray.• Each assembly contains two fans for a total of four. The system requires three of four functioning fans for operation in the Brocade X6-4. One fan assembly can be hot-swapped and should be replaced immediately in the event of a failure.
Airflow	Non-port-side intake to port-side exhaust or port-side intake to non-port-side exhaust options are available.
Solution availability	Designed to provide 99.999 percent uptime capabilities; hot-pluggable redundant power supplies, fans, WWN cards, processors, core switching, port blades, and optics; online diagnostics; non-disruptive firmware download and activation
Management	
Management	HTTP, SNMP v1/v3 (FE MIB, FC Management MIB), SSH; Auditing, Syslog; Brocade Advanced Web Tools, Brocade Network Advisor SAN Enterprise or Brocade Network Advisor SAN Professional Plus; Command Line Interface (CLI); SMI-S compliant; RESTful API; trial licenses for add-on capabilities
Security	DH-CHAP (between switches and end devices), FCAP switch authentication, FIPS 140-2 L2-compliant, HTTPS, IPsec, IP filtering, LDAP with IPv6, OpenLDAP, Port Binding, RADIUS, user-defined Role-Based Access Control (RBAC), Secure Copy (SCP), Secure RPC, SFTP, SSH v2, SSL/TLS, Switch Binding, TACACS+, Trusted Switch
Management access	10/100/1000 Ethernet (RJ-45) per control processor, in-band over Fibre Channel; serial port (RJ-45) and one USB per control processor module; DHCP/DHCPv6; call-home integration enabled through Brocade Network Advisor
Diagnostics	IO Insight for IO monitoring; ClearLink optics and cable diagnostics, including electrical/optical loopback, link traffic/latency/distance; built-in flow generator; POST and embedded online/offline diagnostics, including environmental monitoring, FCping and Pathinfo (FC traceroute), flow mirroring, frame viewer, non-disruptive daemon restart, optics health monitoring, power monitoring, RAStrace logging, and Rolling Reboot Detection (RRD)

Brocade X6 Director Specifications *(continued)*

Mechanical Specifications

Enclosure	Brocade X6-8 12-blade slots: 14U rack-mountable chassis; 27 in. to 31 in. and 22 in. rail kits for the four-post rack; mid-mount kit for the two-post rack Brocade X6-4 8-blade slots: 8U rack-mountable chassis; 27 in. to 31 in. rail, 18 in. to 24 in. rail, and airflow diversion rack mount kits for the four-post rack; mid-mount kit for the two-post rack
Mounting	Rack-mountable in a standard 19-inch EIA cabinet
Size	Brocade X6-8 Height: 61.23 cm (24.11 in., 14U) Width: 43.74 cm (17.23 in.) Depth: 61.04 cm (24.04 in.) Brocade X6-4 Height: 34.45 cm (13.56 in., 8U) Width: 43.74 cm (17.23 in.) Depth: 61.04 cm (24.04 in.) Brocade X6-4 with airflow diversion rack-mount kit Height: 40.00 cm (15.75 in., 9U) Width: 43.74 cm (17.23 in.) Depth: 61.29 cm (24.09 in.)
System weight	Brocade X6-8 35.61 kg (78.5 lb) for chassis 145.8 kg (321.5 lb) for 384-port configuration, fully populated Brocade X6-4 24.5 kg (54 lb) for chassis 68.95 kg (152.0 lb) for 192-port configuration, fully populated
Environment	
Temperature	Operating: 0°C to 40°C (32°F to 104°F) Non-operating: -25°C to 70°C (-13°F to 158°F)
Humidity	Operating humidity: 5% to 93% RH non-condensing at 40°C (104°F) with a maximum gradient of 10% per hour Non-operating humidity: 10% to 93% RH non-condensing at 70°C (158°F)
Altitude	Up to 3,000 meters (9,842 feet)
Shock	Operating: 10 g, 11 ms, half sine wave Non-operating: 20 g, 11 ms, half sine wave
Vibration	Operating: 5 Hz to 10 Hz @ +5 db/Oct; 10 Hz to 200 Hz @ 0.0005 Grms; 200 Hz to 500 Hz @ -5 db/Oct; scale 0.05 Grms Non-operating: 3 Hz to 10 Hz @ +5 db/Oct; 10 Hz to 200 Hz @ 0.0065 Grms; 200 Hz to 500 Hz @ -5db/Oct; scale 1.12 Grms
Heat dissipation	Brocade X6-8 384-port configuration: Typical: 8,836 BTU/hr; Max: 14,485 BTU/hr Power consumed: Typical: 2,589 W; Max: 4,244 W Note: Input power is at 200 VAC with full PSU redundancy. Brocade X6-4 192-port configuration: Typical: 4,696 BTU/hr; Max: 8,139 BTU/hr Power consumed: Typical: 1,376 W; Max: 2,385 W Note: Input power is at 200 VAC with full PSU redundancy.

Brocade X6 Director Specifications *(continued)*

Power

Supported power range	Standard AC Power Supplies	High Voltage (HV) Power Supplies
	<i>Input Voltage</i> Standard AC input: Range: 85 VAC to 264 VAC auto-volt Nominal: 100 VAC to 240 VAC <i>Power</i> 85 VAC to 132 VAC: 1,450 W 180 VAC to 264 VAC: 2,870 W	<i>Input Voltage</i> Range: 90 VAC to 132 VAC Nominal: 100 VAC to 120 VAC Range: 180 VAC to 305 VAC Nominal: 200 VAC to 277 VAC Range: 192 VDC to 400 VDC Nominal: 240 VDC to 380 VDC <i>Power</i> 90 VAC to 132 VAC: 1,450 W 180 VAC to 305 VAC: 2,870 W 192 VDC to 400 VDC: 2,870 W
In-rush current	35 Amps maximum, peak	
Frequency	50 Hz to 60 Hz (Nominal: 50 Hz to 60 Hz)	

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