BROCADE
A Broadcom Company

Product Brief

Brocade® X6 Director

Network Innovation for Virtualized, All-Flash Data Centers

Highlights

- Scale to 512 ports with industry-leading port density and consolidate infrastructure with 128 Gb/s Brocade UltraScale ICL connectivity for simpler, flatter, low-latency fabrics
- Accelerate application response time by up to 71% across 32 Gb/s links
- Seamlessly integrate next-generation NVMe into the storage fabric and optimize the performance of NVMe with real-time latency monitoring
- Simplify end-to-end management and accelerate operations of large-scale environments with Fibre Channel automation
- Provide proactive, real-time monitoring and alerting of storage I/O health and performance with integrated network sensors
- Enable Virtual Machine (VM) visibility in a storage fabric to monitor VM performance, identify VM anomalies, and optimize VM performance
- Design flexible architectures to increase agility with concurrent Fibre Channel, NVMe, FICON, or FCoE connectivity
- Extend replication over distance with a highly scalable extension solution for Fibre Channel, IP, and FICON

Overview

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 and the pressure to deliver maximum performance, business intelligence, and operational efficiency, 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 modern storage network that can keep pace with innovations in compute and storage resources, enable databases, virtual servers, desktops, and critical applications, and unlock the full capabilities of flash is required. By modernizing the storage network, organizations will be able to maximize productivity and increase the efficiency of their storage investments, even as they rapidly scale their environments. Moreover, the addition of automation technology to Gen 6 Fibre Channel will transform SAN management by simplifying operations and freeing up resources to focus on business optimization and revenue opportunities.

With the Brocade® X6 Director, organizations can seamlessly transition to an all-flash data center and build a foundation to support future innovation and operational efficiency. It provides a modular building block for increased scalability to accommodate growth for large-scale enterprise infrastructures and provides the tools to optimize NVMe storage and automate SAN management tasks. Breakthrough 32 Gb/s performance accelerates application response time by up to 71%, eliminating I/O bottlenecks, and unleashes the full performance of flash and next-generation NVMe-based storage. And with diverse deployment options and multiprotocol flexibility, organizations can adapt and optimize their businesses to meet next-generation storage and server requirements. This NVMe-ready director allows organizations to seamlessly integrate Brocade Gen 6 Fibre Channel networks with next-generation flash storage, without a disruptive rip-and-replace. In addition, the Brocade X6 Director with the Brocade FC32-64 port blade features integrated network sensors with IO Insight for advanced monitoring of NVMe workloads, helping to ensure optimal performance.

New automation capabilities enable DevOps resources to quickly automate and orchestrate SAN resources through open APIs and the Ansible automation engine. With Brocade automation, organizations can reliably perform resource-intensive tasks, such as

Gen 6 Fibre Channel

Brocade Gen 6 Fibre Channel is the modern storage 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 Gb/s performance, data center-proven availability, seamless scalability, and automated operations to ensure greater consistency, predictability, and performance while delivering greater operational efficiency.

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
- Take advantage of non-intrusive, real-time monitoring and alerting of SCSI or NVMe storage I/O health and performance with key latency and performance metrics
- Gain comprehensive visibility into the fabric using browser-accessible dashboards with drill-down capabilities

provisioning, and operationalize the continuous monitoring of the network, so that tasks can be completed in a fraction of the time, while eliminating human error.

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. 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).

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 512 32 Gb/s Fibre Channel device ports and 32 additional 128 Gb/s 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 256 32 Gb/s Fibre Channel device ports and 16 additional 128 Gb/s UltraScale ICL ports. Each blade slot can be populated with one of three blades options. For device connectivity, the Brocade FC32-48 Fibre Channel device port blade provides 48 32 Gb/s Fibre Channel ports. For device and ISL connectivity, the Brocade FC32-64 Fibre Channel device blade provides 64 32 Gb/s ports in an elegant, high-density form factor, designed with Q-Flex connections that enable administrators to simplify cabling infrastructure. Q-Flex ports can be used to aggregate edge switches into a core to form a high-density fabric with high-performance ISLs between the Brocade FC32-64 Port Blade in a Brocade X6 Director and Brocade G620 or G630 Switches. This allows organizations to effectively scale to build high-density fabrics to meet data growth demands, handle more workloads, and drive efficiency by maximizing rack space.

To support disaster recovery and data protection storage solutions over long distances, the Brocade SX6 Extension Blade provides flexible Fibre Channel and IP storage replication deployment options with 16 32 Gb/s Fibre Channel ports, 16 1/10-Gigabit Ethernet (GbE) ports, and two 40GbE ports. This blade allows organizations to seamlessly integrate extension capabilities within the Brocade X6 Director to provide extension services for large-scale, multisite data center environments implementing block, file, and tape data protection solutions. The Brocade SX6 blade can be deployed with the Brocade 7840 Extension Switch in a data center-to-edge architecture as a cost-effective option for connecting primary data centers with remote data centers and offices.

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

Extending Brocade Fabric Vision Technology between Data Centers (cont.)

Increase operational stability:

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

Dramatically reduce costs:

- Eliminate nearly 50% 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 I/O metrics to optimize storage performance and increase ROI

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, a Broadcom company, builds on more than 20 years of mainframe leadership that includes designing the FICON standard and authoring many FICON patents.

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.

Increase Productivity with Simple and Open 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 20 years of storage networking experience, Brocade, a Broadcom company, understands the nuances that go into infrastructure management and the tasks that can benefit from automation. By introducing REST APIs directly into its switch and management products, Broadcom offers a broad range of choices to enable any SAN management solution. IT organizations that couple Broadcom'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.

Brocade automation solutions are based on these pillars:

- Make standard REST APIs available directly from the switch in order to automate repetitive daily tasks, such as fabric inventory, provisioning, and operational state monitoring.
- Leverage Ansible to easily scale automation and orchestration across the entire 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 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. With the Brocade FC32-64 Port Blade, the Brocade X6 Director can optimize performance with enhanced IO Insight monitoring for NVMe over Fibre Channel with integrated, non-intrusive, real-time monitoring and alerts for network performance. This proactive monitoring of NVMe over Fibre Channel traffic and VMs provides deep diagnostics and visibility to maintain optimal network health and performance.

IO Insight monitors I/O 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 I/O 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 I/O 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 I/O 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:

- Monitoring and Alerting Policy Suite (MAPS): Provides an easy-to-use solution for policy-based threshold monitoring and alerting. MAPS proactively monitors the health and performance of any SCSI or NVMe storage infrastructure to ensure application uptime and availability. By leveraging prebuilt 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. 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, automatic learning, and non-disruptive monitoring of a flow's performance. Administrators can monitor all flows from a specific host to multiple targets or volumes, from multiple hosts to a specific target/volume, or across a specific ISL. Additionally, they can perform volume-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 I/O response time, I/O completion time, the number of pending I/Os, and IOPS metrics for a flow from a specific host to a target or volume running SCSI or NVMe over Fibre Channel traffic. With VM Insight, administrators can monitor network throughput and I/O 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 SANnav™: Next-Generation SAN Management

Brocade SANnav™ Management Portal and SANnav Global View empower IT administrators by providing comprehensive visibility across the entire SAN, from a global view down to local environments. These tools streamline management workflows to accelerate the deployment of new applications, switches, hosts, and targets. They also increase operational efficiencies with a modernized graphical user interface (GUI) that enables enhanced monitoring, faster troubleshooting, and advanced analytics.

Brocade Gen 6 Fibre Channel hardware includes integrated network sensors that non-disruptively gather millions of real-time metrics that SANnav Management Portal uses to identify, monitor, and analyze the overall health and performance of the SAN. SANnav Management Portal contextualizes this data into visual dashboards, enabling administrators to quickly detect and isolate points of interest for both troubleshooting and performance optimization.

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 Gb/s line-speed links and up to 16.2 Tb/s 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 512 ports (equivalent to 640 with UltraScale ICLs) at 32 Gb/s
  - 20 Tb/s aggregate chassis bandwidth (port bandwidth + UltraScale ICL bandwidth)
  - 16 Tb/s Fibre Channel port bandwidth
  - 4 Tb/s UltraScale ICL bandwidth
- 1.5 Tb/s bandwidth per slot

Brocade X6-4: Non-blocking architecture

- Up to 256 ports (equivalent to 320 with UltraScale ICLs) at 32 Gb/s
  - 10 Tb/s aggregate chassis bandwidth (port bandwidth + UltraScale ICL bandwidth)
  - 8 Tb/s Fibre Channel port bandwidth
  - 2 Tb/s UltraScale ICL bandwidth
- 1.5 Tb/s bandwidth per slot

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 Gb/s 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% and free up to 25% 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 Gb/s ports (4.096 Tb/s), and the Brocade X6-4 supports 16 UltraScale ICL ports, providing the equivalent of 64 32 Gb/s ports (2.048 Tb/s). 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 Gb/s (4×16).

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 Gb/s Fibre Channel connectivity is available on the Brocade FC32-48 Port Blade with in-flight encryption and compression as well as optional support for 10 Gb/s 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 Gb/s Fibre Channel/FICON ports, 16 1GbE/10GbE ports, and two 40GbE 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.

The Brocade X6 Director increases flexibility with multiprotocol connectivity, allowing administrators to seamlessly adapt to next-gen requirements and design architectures with concurrent Fibre Channel, NVMe, or FCoE connectivity options. 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. Using the Brocade FC32-64 Port Blade, the Brocade X6 Director provides FCoE host connectivity support to design flexible architectures for increased agility.

For investment protection, Brocade X6 Directors offer three generations of backward-compatibility support for connectivity to 4, 8, and 16 Gb/s 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 modules to be added within the chassis.

Brocade Global Support

Brocade Global Support has the expertise to help organizations build resilient, efficient SAN infrastructures. Leveraging 20+ 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 overall performance of their network.

Maximizing Investments

To help optimize technology investments, Brocade, a Broadcom company, 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.broadcom.com/brocade

Brocade X6 Director Specifications

System Architecture	
Chassis	Single chassis: The Brocade X6-8 provides up to 512 32 Gb/s ports or a 640-port equivalent with 128 Gb/s (4×32 Gb/s) UltraScale ICL ports (32 QSFP ports). The Brocade X6-4 provides up to 256 32 Gb/s ports or a 320-port equivalent with 16 UltraScale ICL ports (16 QSFP ports). Each provides support for (E, F, D, M, SIM, AE, and EX) Fibre Channel ports using 48- and 64-port 32 Gb/s Fibre Channel blades.
Control processor	Redundant (active/standby) control processor modules.
Scalability	Full-fabric architecture of 239 switches.
Certified maximum	6000 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 Gb/s Gen 6 Fibre Channel Brocade FC32-64 Port Blade provides 64 ports of 32 Gb/s Gen 6 Fibre Channel
Extension blades	Brocade SX6 Extension Blade provides Fibre Channel extension (16×32 Gb/s Fibre Channel ports) and IP extension over IP networks (16×1GbE/10GbE and 2×40GbE ports).
Performance	Fibre Channel: 4.25 Gb/s line speed, full duplex; 8.5 Gb/s line speed, full duplex; 10.53 Gb/s line speed, full duplex; 14.025 Gb/s line speed, full duplex; 28.05 Gb/s, full duplex. Autosensing of 4, 8, 16, and 32 Gb/s port speeds depending on SFPs used. Speed matching between 4, 8, 16, and 32 Gb/s port speeds. 10 Gb/s port speeds with dedicated SFPs. FCoE: 10GbE, 25GbE, or 40GbE FCoE speeds. Support for 10GbE, 25GbE, and 40GbE speeds requires the use of the appropriate QSFP transceiver.
ISL trunking	Frame-based trunking with up to eight 32 Gb/s ports per ISL trunk; up to 256 Gb/s per ISL trunk Exchange-based load balancing across ISLs with DPS included in Brocade FOS.
UltraScale ICL trunking	Chassis-to-chassis linkage through connectors on the Core Routing (CR) blade. Can configure the following maximum QSFPs per trunk depending on blade type, connecting: • Up to four 4×32 Gb/s QSFP ports in a trunk group to form a 512 Gb/s 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 Gb/s QSFP ports in a trunk group to form a 512 Gb/s 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. A minimum of two QSFP connections are required for a trunk, and up to four 4×16 Gb/s QSFP trunks between pairs of Brocade CR32-8 (CR32-4) and CR16-8 (CR16-4).
Multichassis with UltraScale ICL ports	Up to 6144 non-blocking 32 Gb/s 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	Brocade X6-8: 4.096 Tb/s; 32 UltraScale ICL ports provide the equivalent of 128 32 Gb/s ports. Each UltraScale ICL port provides 128 Gb/s bandwidth over a QSFP (32 Gb/s×4) link. Brocade X6-4: 2.048 Tb/s; 16 UltraScale ICL ports provide the equivalent of 64 32 Gb/s ports. Each UltraScale ICL port provides 128 Gb/s bandwidth over a QSFP (32 Gb/s×4) link. Both models: Frame-based trunking is enabled between four UltraScale ICLs. DPS distributes exchanges across all frame trunks.

Brocade X6 Director Specifications (cont.)

System Architecture (cont.)	
Chassis bandwidth	Brocade X6-8: 20.5 Tb/s per chassis: 16.384 Tb/s port bandwidth (512 ports×32 Gb/s) data rate + 4.096 Tb/s UltraScale ICL bandwidth (32×128 Gb/s) Brocade X6-4: 10.2 Tb/s per chassis: 8.192 Tb/s port bandwidth (192 ports×32 Gb/s) data rate + 2.048 Tb/s UltraScale ICL bandwidth (16×128 Gb/s)
Slot bandwidth	1536 Gb/s (line rate) providing line-rate performance for the Brocade FC32-48 blade and 1.33:1 over-subscription performance for the Brocade FC32-64 blade
Switch latency	Brocade FC32-48 and FC32-64 blades at Gen 6 32 Gb/s speeds: <780 ns (including FEC); any-port-to-any-port local switching and 2.6 µs blade to blade at 32 Gb/s, cut-through routing Brocade SX6 blade, Fibre Channel to Fibre Channel: <780 ns (including FEC) and 2.6 µs any-port-to-any-port at 32 Gb/s, cut-through routing
Maximum frame size	2112-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 and FC32-64 Port Blades: 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 Gb/s SWL/LWL and SFP+ at 16 Gb/s SWL/LWL/ELWL, 10 Gb/s SWL/LWL SFP. **Brocade FC32-64 Port Blade:** Supports hot-pluggable QSFP connector; 4×32 Gb/s SWL (supports 16/32 Gb/s) and 4×16 Gb/s SWL (supports 4/8/16 Gb/s), MPO 1×12 ribbon cable connector (66 m OM3, 100m OM4); 4×32 Gb/s 2 km QSFP (fixed 4×32 Gb/s speed and SMF LC); Brocade FC32-64 QSFPs support only 4/8/16/32 Gb/s (no 10 Gb/s Fibre Channel); 10GbE, 25GbE, or 40GbE FCoE QSFP. **Brocade SX6 Extension Blade:** Supports hot-pluggable Brocade Fibre Channel SFP28 at 32 Gb/s SWL/LWL; SFP+ at 16 Gb/s SWL/LWL/ELWL; SFP at 10 Gb/s FC SWL/LWL and Ethernet SFP+ at 1 GbE copper, 1GbE 1000BASE-SX/LX/CWDM, SFP+ at 10GbE SR/LR; SFP+ at 10GbE tunable DWDM 80 km, and QSFP at 40GbE SR4/LR4/ER4. **Core Routing (CR) blades, Brocade CR32-4 and CR32-8:** Support hot-pluggable Brocade Fibre Channel QSFPs at 4×32 Gb/s SWL, 4x32 Gb/s 2 km, 4×16 Gb/s SWL, and 4×16 Gb/s 2 km 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 512 32 Gb/s ports, universal (E_Port, F_Port, EX_Port, M_Port, D_Port, SIM Port, FICON) Brocade X6-4: Up to 256 32 Gb/s 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: <780 ns (including FEC) Blade to blade: 2.6 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 512-port chassis)

Brocade X6 Director Specifications (cont.)

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:** • Four power supplies required for AC low-line (100V AC to 120V AC). • Two power supplies required for AC high-line (200V AC to 240V AC). • Two power supplies required for high-voltage AC (200V AC to 277V AC) or high-voltage DC (240V DC to 380V DC). • 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:** • Two power supplies required for AC low-line (100V AC to 120V AC). • One power supply required for AC high-line (200V AC to 240V AC). • One power supply required for high-voltage AC (200V AC to 277V AC) or high-voltage DC (240V DC to 380V DC). • 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:** • 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:** • 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% 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 SANnav Management Portal and SANnav Global View; Command Line Interface (CLI); SMI-S compliant; RESTful API; trial licenses for add-on capabilities.
Security	AES-GCM-256 encryption on FC ISLs (E_Port); DH-CHAP (between switches and end devices), FCAP switch authentication, FIPS 140-2 L2-compliant, HTTPS, IP filtering, LDAP with IPv6, OpenLDAP, Port Binding, RADIUS, user-defined Role-Based Access Control (RBAC), Secure Copy (SCP), 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 SANnav Management Portal.
Diagnostics	IO Insight for I/O monitoring (IO Insight for NVMe requires the Brocade FC32-64 Port Blade); 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 (cont.)

Mechanical	
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) maximum fully populated configuration **Brocade X6-4** 24.5 kg (54 lb) for chassis 68.95 kg (152.0 lb) maximum fully populated configuration
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 3000 meters (9842 feet)
Shock	Operating: 10g, 11 ms, half sine wave Non-operating: 20g, 11 ms, half sine wave
Vibration	Operating: 5 Hz to 10 Hz at +5 db/Oct; 10 Hz to 200 Hz at 0.0005 G^2/Hz; 200 Hz to 500 Hz at –5 db/Oct; scale 0.5 grms Non-operating: 3 Hz to 10 Hz at +5 db/Oct; 10 Hz to 200 Hz at 0.0065 G^2/Hz; 200 Hz to 500 Hz at –5 db/Oct; scale 1.12 grms
Heat dissipation	**Brocade X6-8** 512-port configuration: Typical: 10,010 BTU/hr; Max: 18,362 BTU/hr Power consumed: Typical: 2933W; Max: 5380W Note: Input power is at 200V AC with full PSU redundancy. **Brocade X6-4** 256-port configuration: Typical: 5283 BTU/hr; Max: 10,049 BTU/hr Power consumed: Typical: 1548W; Max: 2953W Note: Input power is at 200V AC with full PSU redundancy.

Brocade X6 Director Specifications (cont.)

Power		
Supported power range	**Standard AC Power Supplies** *Input Voltage* Standard AC input: Range: 90V AC to 264V AC auto-volt Nominal: 100V AC to 240V AC *Power* 85V AC to 132V AC: 1450W 180V AC to 264V AC: 2870W *80 PLUS Platinum certified*	**High Voltage (HV) Power Supplies** *Input Voltage* Range: 90V AC to 132V AC Nominal: 100V AC to 120V AC Range: 180V AC to 305V AC Nominal: 200V AC to 277V AC Range: 192V DC to 400V DC Nominal: 240V DC to 380V DC *Power* 90V AC to 132V AC: 1,450W 180V AC to 305V AC: 2,870W 192V DC to 400V DC: 2,870W
In-rush current	35A maximum, peak	
Frequency	50 Hz to 60 Hz (Nominal: 50 Hz to 60 Hz)	

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