IBM Storage Networking SAN384C-6 Product Guide

IBM Redbooks Product Guide

This IBM® Redbooks® Product Guide introduces IBM Storage Networking SAN384C-6. It is a director-class storage area network (SAN) switch that is designed for deployment in large-scale storage networks to enable enterprise clouds and business transformation by adding enterprise connectivity options that support IBM Fibre Connection (IBM FICON®) connectivity.

IBM Storage Networking SAN384C-6 delivers a high performing and reliable FICON infrastructure that is designed to support fast and scalable IBM z Systems™ servers.

Layering a comprehensive set of intelligent features onto a high-performance, protocol-independent switch fabric, IBM Storage Networking SAN384C-6 addresses the stringent requirements of large virtualized data center storage environments: High availability, security, scalability, ease of management, and transparent integration of new technologies for flexible data center SAN solutions. Sharing the operating system and management interface with other data center switches, IBM Storage Networking SAN384C-6 enables seamless deployment of fabrics with high-performance Fibre Channel, IBM Fibre Connection (IBM FICON®), and Fibre Channel over IP (FCIP) connectivity to achieve low total cost of ownership (TCO).

For mission-critical enterprise storage networks that require secure, robust, cost-effective business-continuance services, the FCIP extension module is designed to deliver outstanding SAN extension performance, reducing latency for disk and tape operations with FCIP acceleration features, including FCIP write acceleration and FCIP tape write and read acceleration.

Figure 1 shows IBM Storage Networking SAN384C-6.

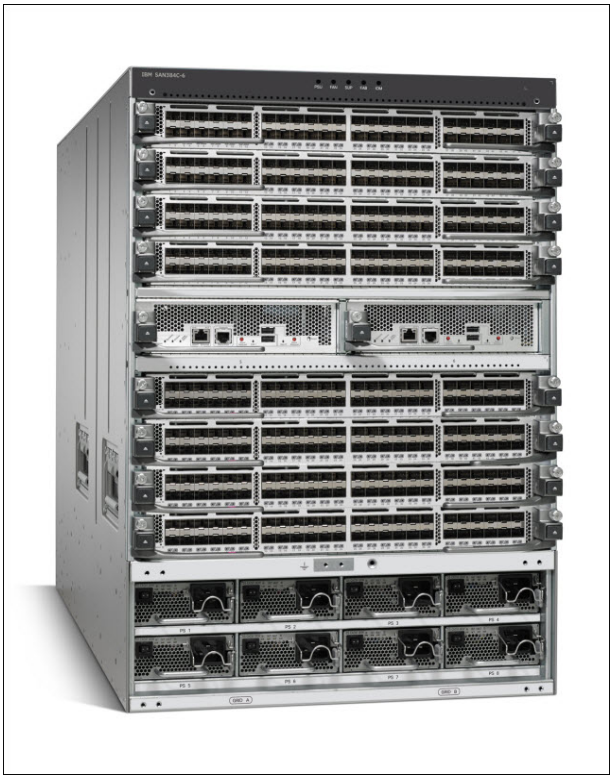

Figure 1. IBM Storage Networking SAN384C-6

Did you know?

- IBM Storage Networking SAN384C-6 director class switch enables redundancy on all major components, including the fabric card.
- The 24/10-Port SAN Extension Module supports hardware-based FCIP compression to increase the effective WAN bandwidth of SAN extension solutions. The module can deliver compression ratios in the range of 4:1 - 5:1 over a wide variety of data sources.
- The IBM Storage Networking c-type Family provides deterministic hardware performance and a comprehensive feature set that allows virtual machines to have the same SAN attributes as a physical server.
- The combination of the Supervisor-1, 32 Gbps Fibre Channel switching module and Fabric-1 Crossbar switching modules enables up to 1.5 Tbps of FC throughput between modules for each of the eight IBM Storage Networking SAN384C-6 payload slots.

Product overview

The capabilities of IBM Storage Networking SAN384C-6 can be extended with modules.

The 24/10-Port SAN Extension Module

The 24/10-Port SAN Extension Module is supported on IBM Storage Networking c-type Family Multilayer Directors. With 24 line-rate 2-, 4-, 8-, 10-, and 16-Gbps Fibre Channel ports and eight 1 and 10 Gigabit Ethernet FCIP ports, this module enables large and scalable deployment of SAN extension solutions. The SAN extension module has two independent service engines that can each be individually and incrementally enabled to scale as business requirements expand.
The SAN extension module supports the full range of services available on other IBM Storage Networking c-type Family Fibre Channel switching modules, including virtual SAN (VSAN), security, and traffic management services. The FCIP module uses IBM expertise and knowledge of IP networks to deliver outstanding SAN extension performance, reducing latency for disk and tape operations with FCIP acceleration features, including FCIP write acceleration and FCIP tape write and read acceleration.

Hardware-based encryption helps secure sensitive traffic with IP Security (IPsec), and hardware-based compression dramatically enhances performance for both high- and low-speed links, enabling immediate cost savings in expensive WAN infrastructure. Multiple FCIP interfaces within a single engine or across service engines can be grouped into a port channel of up to 16 links for high availability and increased aggregate throughput.

Figure 2 shows the 24/10-Port SAN Extension Module.

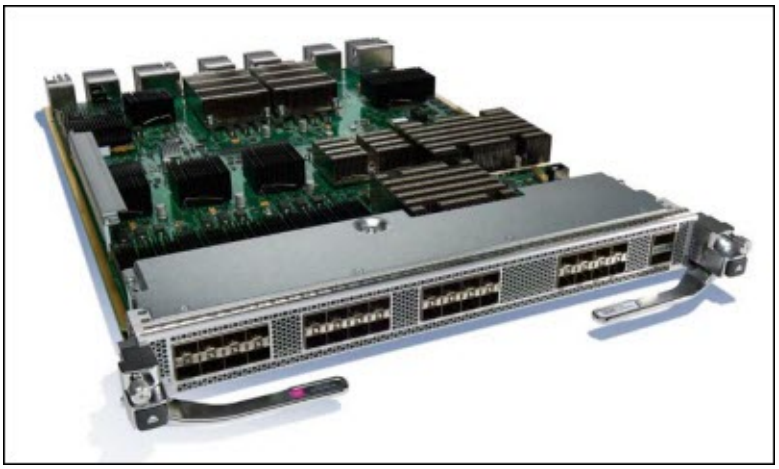

Figure 2. 24/10-Port SAN Extension Module

Main features and benefits

The 24/10-Port SAN Extension Module is designed for mission-critical enterprise storage networks that require secure, robust, cost-effective business-continuance services. The SAN extension module offers the following main features:

- **FCIP for remote SAN extension:**
  - Simplifies data-protection and business-continuance strategies by enabling backup, remote replication, and other disaster-recovery services over WAN distances using open standards FCIP tunneling.
  - Optimizes utilization of WAN resources for backup and replication by enabling hardware-based compression, hardware-based encryption, FCIP write acceleration, and tape read and write acceleration for both FCIP and FICON over IP. The SAN extension module will support four tunnels per interface and can scale up to 32 tunnels (four tunnels x eight 1/10 GbE ports).
  - Preserves IBM Storage Networking c-type Family Directors enhanced capabilities, including VSANs, advanced traffic management, and security, across remote connections.
- **Integrated IP storage services in a high-density form factor:** The module supports eight 1 and 10 Gigabit Ethernet ports. Individual ports can be configured with hot-swappable shortwave and longwave Small Form-factor Pluggable (SFP) connections.
- **Integrated hardware-based VSANs and Inter-VSAN Routing (IVR):** The module enables deployment of large-scale multisite and heterogeneous SAN topologies. Integration into port-level hardware allows any port in a system or fabric to be partitioned into any VSAN. Integrated hardware-based IVR provides line-rate routing between any ports in a system or fabric without the need for external routing appliances.
- **Intelligent network services:** The module uses VSAN technology for hardware-enforced, isolated environments in a single physical fabric; access control lists (ACLs) for hardware-based intelligent frame processing; and advanced traffic management features, such as fabric-wide quality of service (QoS), to facilitate migration from SAN islands to enterprise wide storage networks.
- **Sophisticated diagnostics:** The module provides intelligent diagnostics, protocol decoding, and network analysis tools, in addition to integrated Call Home capability, for greater reliability, faster problem resolution, and reduced service costs.
- **Comprehensive network security framework:** The module supports RADIUS and TACACS+, Fibre Channel Security Protocol (FC-SP), Secure File Transfer Protocol (SFTP), Secure Shell (SSH) Protocol, Simple Network Management Protocol Version 3 (SNMPv3) implementing the Advanced Encryption Standard (AES), VSANs, hardware-enforced zoning, ACLs, and per-VSAN role-based access control (RBAC). RBAC provides separate control over management functions and access on a per-VSAN basis, enabling separation of duties among administrators on the same physical switch. Gigabit Ethernet ports support IPsec authentication, data integrity, and hardware-assisted data encryption.
- **IP Version 6 (IPv6) support:** The module supports IPv6 as mandated by the U.S. Department of Defense (DoD), Japan, and China. IPv6 support is provided for FCIP and for management traffic routed in band and out of band.

Integrated FCIP for remote SAN and mainframe channel extension

Data-distribution, data-protection, and business-continuance services are significant components of today's information-centered businesses. The capability to efficiently replicate critical data on a global scale helps ensure a higher level of data protection for valuable corporate information, and also increases utilization of backup resources and lowers total cost of storage ownership. The 24/10-Port SAN Extension Module uses the open-standards FCIP protocol to extend the distance of current Fibre Channel and FICON solutions, enabling interconnection of SAN islands over extended distances.

Advanced SAN extension features

The 24/10-Port SAN Extension Module supports hardware-based FCIP compression to increase the effective WAN bandwidth of SAN extension solutions. The module can deliver compression ratios in the range of 4:1 - 5:1 over a wide variety of data sources.

The SAN extension module supports AES 256 IPsec encryption for secure transmission of sensitive data over extended distances. Hardware enablement of IPsec helps ensure line-rate throughput. Together, hardware-based compression and hardware-based encryption provide a high-performance, highly secure SAN extension capability.

Additionally, the SAN extension module supports FCIP write acceleration, a feature that can significantly improve application performance when storage traffic is extended across long distances. When FCIP write acceleration is enabled, WAN throughput is optimized by reducing the latency of command acknowledgments.

VSANs

Well suited for efficient, secure SAN consolidation, ANSI T11-standard VSANs enable more efficient storage network utilization by creating hardware-based isolated environments with a single physical SAN fabric or switch. Each VSAN can be zoned as a typical SAN and maintained with its own fabric services for greater scalability and resilience. VSANs allow the cost of SAN infrastructure to be shared among more users, while helping ensure segregation of traffic and retaining independent control of configuration on a VSAN-by-VSAN basis.

Integrated SAN routing

In another step toward deployment of efficient, cost-effective, consolidated storage networks, the 24/10-Port SAN Extension Module supports IVR, the industry's first and most efficient routing function for Fibre Channel. IVR allows selective transfer of data between specific initiators and targets on different VSANs while maintaining isolation of control traffic within each VSAN. With IVR, data can transit VSAN boundaries while maintaining control-plane isolation, thereby maintaining fabric stability and availability. IVR eliminates the need for external routing appliances, greatly increasing routing scalability while delivering line-rate routing performance, simplifying management, and eliminating the challenges associated with maintaining separate systems. IVR reduces the total cost of SAN ownership.

Advanced traffic management

The advanced traffic management capabilities integrated into the 24/10-Port SAN Extension Module simplify deployment and optimization of large-scale fabrics:

- **Virtual output queuing:** Helps ensure line-rate performance on each port, independent of traffic pattern, by eliminating head-of-line blocking.
- **Port channels**: Allow users to aggregate up to 16 FCIP ISLs into a single logical bundle, providing optimized bandwidth utilization across all links. The bundle can consist of any speed-matched ports from any module in the chassis, helping ensure that the bundle can remain active even in the event of a module failure.
- **Fabric Shortest Path First (FSPF)-based multipathing:** Provides the intelligence to load-balance traffic across up to 16 equal-cost paths and, in the event of a switch failure, dynamically reroute traffic.
- **QoS:** Can be used to manage bandwidth and control latency to prioritize critical traffic.
- **Shaper:** Rate limits the WAN bandwidth according to the maximum bandwidth configured for the FCIP tunnel.

Advanced diagnostics and troubleshooting tools

Management of large-scale storage networks requires proactive diagnostics, tools to verify connectivity and route latency, and mechanisms for capturing and analyzing traffic. The IBM Storage Networking c-type Family integrates the industry's most advanced analysis and diagnostic tools. Power-on self-test (POST) and online diagnostics provide proactive health monitoring.

The 24/10-Port SAN Extension Module implements diagnostic capabilities, such as Fibre Channel Traceroute to detail the exact path and timing of flows, and Switched Port Analyzer (SPAN) to intelligently capture network traffic. The module also supports the SAN Extension Tuner (SET) tool, which helps you optimize FCIP performance by generating either direct-access (for magnetic disks) or sequential-access (for magnetic tape) Small Computer System Interface (SCSI) I/O commands and directing this traffic to a specific virtual target.

You can specify the size of the test I/O transfers and the number of concurrent or serial I/O operations to generate while testing. The SET tool reports the resulting I/O operations per second (IOPS) and I/O latency, which helps you determine the number of concurrent I/O operations needed to get the best FCIP throughput.

After traffic has been captured, it can be analyzed with the Fabric Analyzer, an embedded Fibre Channel analyzer. Comprehensive port-based and flow-based statistics facilitate sophisticated performance analysis and service-level agreement (SLA) accounting.

Comprehensive solution for robust network security

Addressing the need for fail-proof security in storage networks, the MDS 9000 24/10-Port SAN Extension Module offers an extensive security framework to protect highly sensitive data moving in today's enterprise networks. The module employs intelligent frame inspection at the port level, including the application of ACLs for hardware enforcement of zones, VSANs, and advanced port security features:

- Extended zoning capabilities restrict broadcasts to only the selected zones (broadcast zones).
- VSANs are used to achieve greater security and stability by providing complete isolation among devices that are connected to the same physical SAN.
- FC-SP provides switch-to-switch and host-to-switch Diffie-Hellman Challenge Handshake Authentication Protocol (DH-CHAP) authentication supporting RADIUS and TACACS+, to help ensure that only authorized devices can access protected storage networks.

The Supervisor-1 Module

The Supervisor-1 Module delivers the latest advanced switching technology with NX-OS software to power a new generation of scalable and intelligent multilayer switching solutions for SANs.

Designed to integrate multiprotocol switching and routing, intelligent SAN services, and storage applications onto highly scalable SAN switching platforms, the Supervisor-1 Module enables intelligent, resilient, scalable, and secure high performance multilayer SAN switching solutions when combined with the IBM Storage Networking c-type Family switching modules.

The IBM Storage Networking c-type Family lowers the TCO for storage networking by combining a robust and flexible hardware architecture, multiple layers of network and storage intelligence, and compatibility with all IBM Storage Networking c-type Family switching modules. It offers advanced management tools for overall lowest TCO. It supports VSAN technology for hardware-enforced, isolated environments within a single physical fabric for secure sharing of physical infrastructure, which further decreases TCO.

This powerful combination helps organizations to build highly available, scalable storage networks with comprehensive security and unified management. The Supervisor-1 Module is supported in the IBM Storage Networking SAN384C-6.

Figure 3 shows the Supervisor-1 Module.

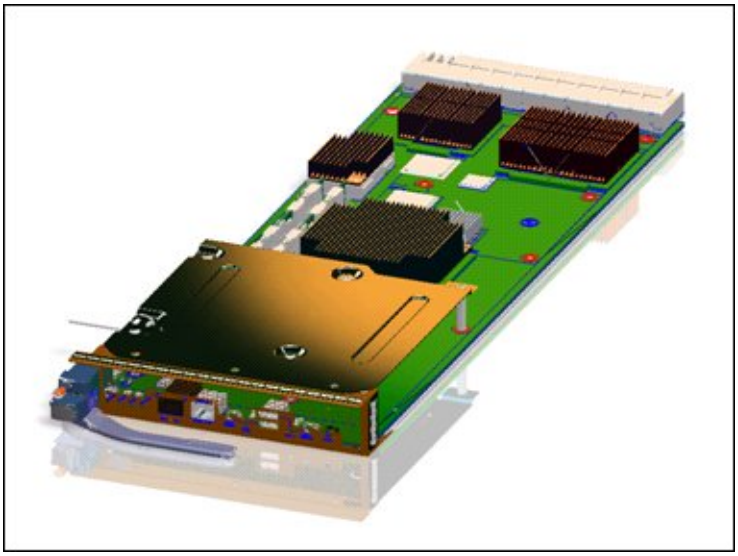

Figure 3. Supervisor-1 Module

48-Port 32-Gbps Fibre Channel Switching Module

The 48-Port 32-Gbps Fibre Channel Switching Module (Figure 4) delivers predictable performance, scalability, and innovative features to support private and virtualized data centers. With industry-leading 768 line-rate 32-Gbps Fibre Channel ports per director, the 32-Gbps 48-port Fibre Channel switching module meets the high-performance needs for flash-memory and Non-Volatile Memory Express (NVMe) over Fibre Channel workloads. It offers innovative services, including virtual machine awareness, on-board Fibre Channel analytics engine, E-port and F-port diagnostics, integrated VSANs, IVR, and port channels. It delivers full-duplex aggregate performance of 1536 Gbps, making it well suited for high-speed 32-Gbps storage subsystems, 32-Gbps Inter-Switch Links (ISLs), high-performance virtualized servers, and all-flash and NMVe arrays.

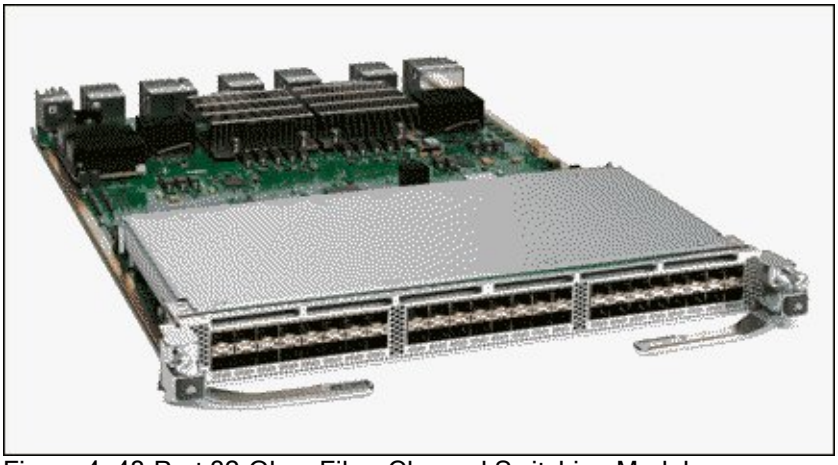

Figure 4. 48-Port 32-Gbps Fibre Channel Switching Module

The 48-Port 32-Gbps Fibre Channel Switching Module enables administrators to scale and consolidate SAN deployments with fewer hardware components. Your SAN administrators can consolidate workloads from hundreds of high-performance virtual machines and scale them with incremental updates as your SAN grows while protecting your existing investment.

This switching module ships with a built-in analytics engine. The engine can analyze real-time Fibre Channel exchanges and report on various metrics in detail, enabling comprehensive and timely monitoring of any potential performance problems among SAN edge devices. The on-board network processing unit (NPU) in the module allows I/O-level metrics to be computed at every switch.

The NPU can monitor all flows on all ports at line rate. The NPU examines every exchange passing through the 32-Gbps application-specific integrated circuit (ASIC) to capture flow metrics such as exchange completion time, maximum number of outstanding exchanges, data access latency, read and write IOPS, throughput, logical unit number (LUN) access pattern (sequential or random), and I/O block sizes.

The switching module is hot swappable and compatible with 4-, 8-, 16-, and 32-Gbps Fibre Channel interfaces. This module also supports hot-swappable Enhanced Small Form-Factor Pluggable (SFP+) transceivers. Individual ports can be configured with 32-, 16-, and 8-Gbps SFP+ transceivers. Each port supports 500 buffer credits for exceptional extensibility without the need for additional licenses. With the Enterprise Package license, up to 8191 buffer credits can be allocated to an individual port, enabling full link bandwidth over long distances with no degradation in link utilization.

The 32-Gbps Fibre Channel switching module also provides existing features, such as predictable performance, high availability, advanced traffic management capabilities, integrated VSAN and IVR, resilient high-performance ISLs, hardware-assisted slow-drain support, comprehensive security frameworks, fault detection and isolation of errored packets, and sophisticated diagnostics.

Main features

The 48-Port 32-Gbps Fibre Channel Switching Module offers the following main features:

- **Outstanding SAN performance:** The combination of the 32-Gbps Fibre Channel switching module and Fabric-1 crossbar switching modules enables up to 1.5 terabits per second (Tbps) of Fibre Channel throughput between the modules in each direction for each payload slot in the Multilayer Directors. The IBM Storage Networking c-type Family architecture, which is based on central arbitration and a crossbar fabric, provides 32-Gbps line-rate, nonblocking, predictable performance across all traffic conditions for every port in the chassis.
- **High availability:** The IBM Storage Networking c-type Family directors provide outstanding availability and reliability. They are the industry's first director-class switches considered to support mission-critical workloads because they enable redundancy on all major components, including the fabric card. They also provide grid redundancy on the power supply and 1+1 redundant supervisors. Users can add a fabric card to enable N+1 fabric redundancy at 16-Gbps Fibre Channel speeds. The suggested number of modules per chassis is 6 if there are 32-Gbps line linecards with 32-Gbps transceivers. If you do not want to upgrade, or you want to partially upgrade, review Table 1.

Table 1. Number of Fabric Modules needed according to ports running at 32 Gbps performance in a 48-port 32-Gbps linecard

# of ports	Running at (Performance)	# of fabric modules needed	Restrictions
24	32 Gbps	3	Other 24 ports shut down
32	32 Gbps	4	Other 16 ports shut down
40	32 Gbps	5	Other 8 ports shut down
48	32 Gbps	6	No restrictions

- **Industry-leading scalability:** The IBM Storage Networking c-type Family directors combine industry-leading scalability with performance to meet the needs of even the largest data center storage environments. IBM Storage Networking SAN768C-6 supports up to 48 Tbps of Fibre Channel system bandwidth and 768 2-, 4-, 8-, 16-, and 32-Gbps full line-rate autosensing Fibre Channel ports in a single chassis. IBM Storage Networking SAN384C-6 Multilayer Director supports up to 24 Tbps of Fibre Channel system bandwidth and up to 384 2-, 4-, 8-, 16-, and 32-Gbps full line-rate autosensing Fibre Channel ports in a single chassis.

  The smaller IBM Storage Networking SAN192C-6 supports up to 12 Tbps of Fibre Channel system bandwidth and 192 2-, 4-, 8-, 16-, and 32-Gbps full line-rate autosensing Fibre Channel ports in a single chassis.
- **Intelligent network services:** VSAN technology, ACLs for hardware-based intelligent frame processing, and fabricwide QoS enable migration from SAN islands to enterprise wide storage networks.
- **Fibre Channel Redirect (FC-Redirect):** FC-Redirect infrastructure provides the capability to redirect a flow to a specific service engine in the fabric to provide intelligent services such as Data Mobility Manager and I/O Accelerator.
- **Integrated hardware-based VSANs and IVR:** VSANs are integrated into port-level hardware so that any port in a system or fabric can be assigned to any VSAN. The IVR provides line-rate routing between any ports in a system or fabric without the need for external routing appliances.
- **Intelligent storage services:** The IBM Storage Networking c-type Family directors support intelligent service capabilities on other switches to provide services, such as acceleration of storage applications for data replication and backup.
- **Smart Zoning:** When the Smart Zoning feature is enabled, IBM Storage Networking c-type Family fabrics provision the hardware ACL entries, specified by the zone set, more efficiently. This feature helps prevent superfluous entries that might allow servers (initiators) to talk to other servers or allow storage devices (targets) to talk to other storage devices. This feature makes feasible larger zones with multiple initiators and multiple targets without excessive consumption of hardware resources. Smart Zones can correspond to applications, application clusters, hypervisor clusters, and other data center entities, saving the time that administrators previously spent creating many small zones and enabling automation of zoning tasks.
- **Virtual machine transparency:** The IBM Storage Networking c-type Family provides deterministic hardware performance and a comprehensive feature set that allows virtual machines to have the same SAN attributes as a physical server. On a per-virtual machine basis, NX-OS Software offers VSANs, QoS policies, access control, performance monitoring, and data protection to promote the scalability and mobility of virtual machines. Data Center Network Manager (DCNM) enables rapid troubleshooting in mission-critical virtualized environments by providing end-to-end visibility from the virtual machine to storage with resource allocation, performance measurements, and predictions available on a per-virtual machine basis.

- **Comprehensive security:** The IBM Storage Networking c-type Family devices supports services including VSANs, hardware-enforced zoning, ACLs, per-VSAN role-based access control (RBAC), and TrustSec Fibre Channel link encryption. The comprehensive security framework consists of RADIUS and TACACS+, FC-SP, SFTP, SSH Protocol, and SNMPv3. The TrustSec Fibre Channel link encryption delivers transparent, hardware-based 32-Gbps line-rate AES 128-bit encryption of Fibre Channel data on 32-Gbps Fibre Channel switching modules.
- **Resilient high-performance ISLs:** The IBM Storage Networking c-type Family 32-Gbps Fibre Channel switching modules support high-performance ISLs consisting of 32-Gbps secure Fibre Channel. Fibre Channel switching modules also support port-channel technology for additional scalability and resilience. Administrators can group up to 16 links spanning any port on any module in a chassis into a logical link.

  Administrators can also allocate up to 8191 buffer-to-buffer credits to a single Fibre Channel port, providing industry-leading extension of storage networks to up to 4,000 kilometers at 4 Gbps, 2,000 kilometers at 8 Gbps, 1,000 kilometers at 16 Gbps, and 500 kilometers at 32 Gbps, while maintaining full link utilization. The IBM Storage Networking c-type Family switch architecture helps ensure that frames are never reordered within a switch, leading to optimal application performance because end devices never have to use resources to reorder the frames.
- **Sophisticated diagnostics:** The 48-Port 32-Gbps Fibre Channel Switching Module provides intelligent diagnostics, protocol decoding, E-port diagnostics, and network analysis tools along with an integrated Call Home capability for greater reliability, faster problem resolution, and reduced service costs.
- **Compatibility:** The 48-Port 32-Gbps Fibre Channel Switching Module can co-exist with previous-generation supported modules on the IBM Storage Networking c-type Family director.
- **Investment protection:** The 48-Port 32-Gbps Fibre Channel Switching Module can easily be inserted into existing IBM Storage Networking c-type Family directors without any impact on operations.

Main benefits

The 48-Port 32-Gbps Fibre Channel Switching Module offers the following benefits:

- Lower TCO with SAN consolidation: With the exponential growth of data in today's business environment, organizations need to deploy large-scale SANs in the most efficient and cost-effective ways. To meet scalability requirements while managing TCO, the IBM Storage Networking c-type Family directors offer the following features:
  - Industry-leading port density of line-rate 32-Gbps Fibre Channel ports per chassis
  - 1.5-Tbps Fibre Channel performance per slot
  - Up to 48-Tbps front-panel Fibre Channel line-rate, non-blocking, system-level switching
  - Exceptional capabilities with intelligent fabric services
  - VSANs for consolidating individual physical SAN islands while maintaining logical boundaries
  - IVR for sharing resources across VSANs
  - Built-in network processing unit for inline analytics

These features enable the consolidation of an organization's data assets into fewer, larger, and more manageable SANs, thus reducing the hardware footprint and associated capital and operating expenses:

- **Enterprise-class availability:** The IBM Storage Networking c-type Family was specifically designed from the beginning for high-availability and mission-critical environments. Beyond meeting the basic requirements of nondisruptive software upgrades and redundancy of all critical hardware components, the IBM Storage Networking c-type Family software architecture offers outstanding greater than five-nines availability.
- **Virtual machine-aware SAN deployment:** The growing adoption of server virtualization in data centers increases the number of hosts attached to the SAN, places higher workloads on the SAN, and requires more storage, thereby increasing the need for SAN services. The VMpath technology, part of DCNM, provides end-to-end visibility from the virtual machines to the storage devices. Resource allocation, performance measurements, and predictions are available on a per-virtual machine basis to enable rapid troubleshooting in mission-critical virtualized environments.
- **Advanced traffic management:** The following advanced traffic management capabilities, integrated into every 48-Port 32-Gbps Fibre Channel Switching Module, simplify deployment and optimization of large-scale fabrics:
  - The virtual output queue (VOQ) helps ensure line-rate performance on each port, independent of traffic pattern, by eliminating head-of-line blocking.
  - Up to 8191 buffer-to-buffer credits can be assigned to any individual port for optimal bandwidth utilization across distances.
  - Port channels allow up to 16 physical ISLs to be aggregated into a single logical bundle, providing optimized bandwidth utilization across all links. The bundle can be a mix of any port from any module in the chassis. This approach helps ensure that the bundle can remain active even if a module fails.
  - Fabric Shortest Path First (FSPF)-based multipathing provides the intelligence to load-balance across up to 16 equal-cost paths and dynamically reroute traffic if a switch fails.
  - QoS helps manage bandwidth and control latency to prioritize critical traffic and is available on every port.
  - The lossless network-wide in-order delivery guarantee helps ensure that frames are never reordered within a switch. This guarantee extends across the entire multiswitch fabric, assuming that the fabric is stable and no topology changes are made.
  - Advanced diagnostics and troubleshooting tools: The IBM Storage Networking c-type Family integrates proactive diagnostics, tools to verify connectivity and route latency and to capture and analyze traffic, thereby simplifying the management of large-scale storage networks. The POST and online diagnostics provide proactive health monitoring. Starting with NX-OS Software Release 8.1(1b), the powerful Generic Online Diagnostics (GOLD) framework replaces the Online Health Management System (OHMS) diagnostic framework on the new IBM Storage Networking c-type Family Multilayer Director chassis.

    GOLD is a suite of diagnostic facilities that verify whether the hardware and internal data paths are operating as designed. Boot-time diagnostics, continuous monitoring, standby fabric loopback tests, and on-demand and scheduled tests are part of the GOLD feature set. This industry-leading diagnostics subsystem enables rapid fault isolation and continuous system monitoring, which are critical features in today's continuously operating environments.
  - Integrated hardware functions support diagnostic capabilities, such as Fibre Channel traceroute, to identify the exact path and timing of flows, and SPAN and Remote SPAN (RSPAN) to intelligently capture network traffic. The captured Fibre Channel traffic can be analyzed with the embedded Fabric Analyzer. Comprehensive port-based and flow-based statistics enable sophisticated performance analysis and SLA accounting.

- Comprehensive solution for robust security: Addressing the need for stringent security in storage networks, the 32-Gbps Fibre Channel line card offers an extensive security framework to protect the highly sensitive data crossing today's enterprise networks. The IBM Storage Networking c-type Family employs intelligent packet inspection at the port level, including the application of ACLs for hardware enforcement of zones, VSANs, and advanced port security features. VSANs are used to achieve greater security and stability by providing complete isolation of devices that are connected to the same physical SAN. IVR enables controlled sharing of resources between VSANs.
- In addition, FC-SP1 provides switch-to-switch and host-to-switch DH CHAP authentication supporting RADIUS or TACACS+ to help ensure that only authorized devices access protected storage networks. TrustSec1 Fibre Channel link encryption, available on the 32-Gbps modules, enables you to transparently encrypt ISLs at up to line-rate speeds, providing an additional layer of protection for traffic within and between data centers. The IBM Storage Networking c-type Family supports a fabric binding feature that helps ensure that ISLs are enabled only between specified switches in the fabric binding configuration.
- Integrated mainframe support: The IBM Storage Networking c-type Family is mainframe ready, with full support for FICON for IBM z Systems and Linux environments. The IBM Storage Networking c-type Family supports transport of the FICON protocol in both cascaded and noncascaded fabrics. It also supports a mix of FICON and open-systems Fibre Channel Protocol (FCP) traffic on the same switch.

Product highlights

IBM Storage Networking SAN384C-6 and its components offer the following main features:

- **Outstanding SAN performance :** The combination of the 32 Gbps Fibre Channel switching modules and Fabric-1 Crossbar switching modules enables up to 1.5 Tbps of front-panel FC throughput between modules in each direction for each of the eight IBM Storage Networking SAN384C-6 payload slots. This per-slot bandwidth is double the bandwidth that is needed to support a 48-port 32 Gbps FC module at full line rate. Based on central arbitration and a crossbar fabric, the SAN384C-6 architecture provides 32 Gbps line-rate, non-blocking, predictable performance across all traffic conditions for every chassis port.
- **High availability:** The SAN384C-6 director class switch enables redundancy on all major components, including the fabric card. It provides Grid Redundancy on Power Supply and 1+1 redundant Supervisors. Users can include a fourth fabric card to enable N+1 Fabric Redundancy at 768 Gbps slot bandwidth. The SAN384C-6 combines nondisruptive software upgrades, stateful process restart and failover, and full redundancy of major components for higher availability.
- **Business continuity:** The SAN384C-6 director enables large and scalable deployment of SAN extension solutions through the SAN Extension module.
- **Outstanding scalability:** The SAN384C-6 director provides up to 24 Tbps of FC backplane bandwidth. A single chassis delivers 384 4/8 Gbps, 2/4/8 Gbps, 4/8/16 Gbps, or 8/16/32 Gbps full line-rate autosensing Fibre Channel ports. A single rack supports up to 1152 Fibre Channel ports. The IBM Storage Networking c-type Family directors are designed to meet the requirements of even the largest data center storage environments.
- **Deployment of SAN extension solutions :** Enable large and scalable with the 24/10-port SAN Extension Module.

- **Intelligent network services:** VSAN technology, ACLs for hardware-based intelligent frame processing, and fabric-wide QoS enable migration from SAN islands to enterprise-wide storage networks and include the following features:
  - Integrated hardware-based VSANs and IVR: Integration of VSANs into port-level hardware allows any port in a system or fabric to be partitioned to any VSAN. Integrated hardware-based IVR provides line-rate routing between any ports in a system or fabric without the need for external routing appliances.
  - Intelligent storage services: SAN384C-6 operates with intelligent service capabilities on other IBM Storage Networking c-type Family platforms to provide services, such as acceleration of storage applications for data replication and backup, and data migration to hosts and targets that are attached to SAN384C-6.
  - SmartZoning: When the SmartZoning feature is enabled, IBM Storage Networking c-type Family fabrics provision the hardware access control entries that are specified by the zone set more efficiently, which avoids the superfluous entries that allow servers (initiators) to talk to other servers, or allow storage devices (targets) to talk to other storage devices. This feature makes larger zones with multiple initiators and multiple targets feasible without excessive consumption of hardware resources.

    Thus, smart zones can correspond to applications, application clusters, hypervisor clusters, or other data center entities, which saves the time that administrators previously spent creating many small zones, and enables the automation of zoning tasks.
- **Virtual machine transparency:** The IBM Storage Networking c-type Family provides deterministic hardware performance and a comprehensive feature set that allows virtual machines to have the same SAN attributes as a physical server. On a per-virtual machine basis, the NX-OS Software offers VSANs, QoS policies, access control, performance monitoring, and data protection to promote the scalability and mobility of virtual machines.

  Data Center Network Manager for SAN (DCNM-SAN) provides end-to-end visibility all the way from the virtual machine down to storage, with resource allocation, performance measurements, and predictions that are available on a per-virtual machine basis to enable rapid troubleshooting in mission-critical, virtualized environments.
- **Comprehensive security:** The IBM Storage Networking c-type Family supports a comprehensive security framework. It consists of RADIUS and TACACS+, FC-SP, SFTP, SSH Protocol, and SNMPv3 implementing VSANs, hardware-enforced zoning, ACLs, and per-VSAN role-based access control.
- **Unified SAN management:** The IBM Storage Networking c-type Family includes built-in storage network management with all features available through a command-line interface (CLI) or DCNM, a centralized management tool that simplifies managing unified fabrics. DCNM supports the federation of up to 10 DCNM servers to manage up to 150,000 devices by using a single management pane.
- **Sophisticated diagnostic tests:** The SAN384C-6 provides intelligent diagnostic tests, protocol decoding, network analysis tools, and integrated Call Home capability for greater reliability, faster problem resolution, and reduced service costs.
- **Multiprotocol intelligence:** The multilayer architecture of the IBM Storage Networking SAN384C-6 enables the following consistent feature set over a protocol-independent switch fabric. IBM Storage Networking SAN192C-6 transparently integrates Fibre Channel, and FICON. Consider the following points:
  - IBM Storage Networking SAN384C-6 supports 2/4/8/16/32 Gbps ports on the 48-Port 32 Gbps Fibre Channel Switching Module for deployment in open systems and FICON environments.
  - IBM Storage Networking SAN384C-6 is mainframe-ready, with full support for IBM z Systems FICON and Linux environments.

Main benefits

IBM Storage Networking SAN384C-6 features the benefits that are described in this section.

Reduce TCO with SAN Consolidation

With data growing exponentially, organizations need efficient, cost-effective, large-scale SANs. You can scale while managing TCO with industry-leading port densities of up to 384 32 Gbps Fibre Channel ports per chassis. You can deploy 1.5-Tbps front-panel Fibre Channel performance per slot and up to 24-Tbps front-panel Fibre Channel line-rate nonblocking system-level switching.

Intelligent fabric services, VSANs for consolidating physical SAN islands while maintaining logical boundaries, and IVR for sharing resources across VSANs can be deployed. You can consolidate your data into fewer, larger, and more manageable SANs, which reduces the hardware footprint and associated capital and operating expenses.

Enterprise-class availability

IBM Storage Networking SAN384C-6 is designed from the beginning for high availability. In addition to meeting the basic requirements of nondisruptive software upgrades and redundancy of all critical hardware components, IBM Storage Networking SAN384C-6 software architecture offers outstanding availability. The Supervisor Modules automatically restart failed processes, which makes IBM Storage Networking SAN384C-6 exceptionally robust. In the rare event that a supervisor module is reset, complete synchronization between the active and standby supervisor modules helps ensure stateful failover with no disruption of traffic.

IBM Storage Networking SAN384C-6 director provides redundancy on all major active hardware components. Table 2 lists the redundancy that is available across all components.

Table 2. Redundancy details for IBM Storage Networking SAN384C-6

Item	Redundancy
Supervisors	1+1
Power supplies	Grid redundancy
Fabrics	N+1 redundancy

High availability is implemented at the fabric level by using robust and high-performance ISLs. PortChannel allows users to aggregate up to 16 physical links into one logical bundle. The bundle can consist of any speed-matched ports in the chassis, which helps ensure that the bundle can remain active if a port, ASIC, or module fails. ISLs in a PortChannel can have significantly different lengths.

This capability is valuable in campus and metropolitan area network (MAN) environments because logical links can now be spread over multiple physical paths, which helps ensure uninterrupted connectivity even if one of the physical paths is disrupted. IBM Storage Networking SAN384C-6 provides outstanding high availability, which helps ensure that solutions exceed the 99.999% uptime requirements of today's most demanding environments.

Business Transformation with Enterprise Cloud Deployment

With industry-leading scalability and pay-as-you-grow flexibility, IBM Storage Networking SAN384C-6 enables you to quickly scale enterprise clouds up or down as needed. You also receive the following benefits:

- Robust security protects multitenancy cloud applications
- Predictable high performance meets stringent SLAs

- Resilient connectivity helps ensure always-on cloud infrastructure
- Advanced traffic management capabilities (such as QoS) quickly and cost-efficiently allocate elastic network capabilities to cloud applications

DCNM also provides resource monitoring and capacity planning on a per-virtual machine basis. You can efficiently complete the following tasks:

- Consolidate enterprise cloud deployments
- Federate up to 10 DCNM servers to easily manage large-scale clouds
- Use information through Storage Management Initiative Specification (SMI-S)-based developer APIs to deliver IT as a service

Advanced traffic management

Deploy and optimize large-scale fabrics more easily by using the following features:

- Virtual Output Queuing: Helps ensure line-rate performance on each port (independent of traffic patterns) by eliminating head-of-line blocking.
- Up to 4095 Buffer-to-Buffer Credits: By using extended credits, allows up to 4095 buffer credits from a pool of more than 6000 buffer credits for a module to be allocated to ports as needed to greatly extend the distance for Fibre Channel SANs. Alternatively, 4095 buffer credits can be assigned to an individual port for optimal bandwidth utilization across distance.
- PortChannels: Allows users to aggregate up to 16 physical ISLs into a single logical bundle, which provides optimized bandwidth usage across all links. The bundle can consist of any speed-matched ports from any module in the chassis, which helps ensure that the bundle can remain active even if there is a module failure.
- FSPF-Based Multipathing: Provides the intelligence to load balance across up to 16 equal cost paths and dynamically reroute traffic if there is a switch failure.
- QoS: Helps manage bandwidth and control latency to prioritize critical traffic.

Ease of management

IBM Storage Networking SAN384C-6 presents the user with a consistent and logical CLI. By using the CLI, customers can enable debugging modes for each switch feature and view a real-time updated activity log of control protocol exchanges. Each log entry is timestamped and listed in chronological order.

DCNM (formerly Fabric Manager) is an easy-to-use application that simplifies management across multiple switches and converged fabrics. Its intuitive GUI simplifies day-to-day operations of unified fabrics in virtualized data center environments.

The DCNM offers the following functionality:

- Monitoring of events and performance historically and at scale
- Wizard- and template-based provisioning of NX-OS technologies and services
- VMpath analytics, with dynamic topology views for extended visibility into virtual infrastructure
- Resource management through trend analysis of inventory and performance
- Rule-based event notification and filtering
- Role-based access control to provide separation between network and storage teams

You can scale to large deployments through scale-out server architecture with automated failover capability. DCNM provides a resilient management system that centralizes infrastructure and path monitoring across geographically dispersed data centers. The DCNM base management function is available at no charge, and advanced features are unlocked with a license.

Comprehensive solution for robust security

The extensive security framework of IBM Storage Networking SAN384C-6 protects sensitive data that is crossing enterprise networks. It features intelligent, port-level packet inspection, including the use of ACLs for hardware enforcement of zones, VSANs, and advanced port security features. VSANs are used to achieve greater security and stability by providing complete isolation of devices that are connected to the same physical SAN. IVR enables controlled sharing of resources between VSANs.

In addition, FC-SP provides switch-to-switch and host-to-switch DH-CHAP that supports RADIUS or TACACS+. This feature ensures that only authorized devices access protected storage networks.

Advanced diagnostic and troubleshooting tools

Managing large-scale storage networks requires proactive diagnostics, tools to verify connectivity and route latency, and traffic analysis. A comprehensive tool set is delivered for analyzing, troubleshooting, and debugging storage networks. POST and online diagnostics proactively monitor system health. The exact path and timing of flows can be identified with capabilities, such as Fibre Channel traceroute. Network traffic can be captured by using SPAN and RSPAN. Then, traffic can be analyzed by using the Fabric Analyzer, which is an embedded Fibre Channel analyzer. You gain sophisticated performance analysis and SLA accounting by collecting port-based and flow-based statistics.

Consolidation, reduced complexity, and lower power consumption

With the ongoing increase in server workloads, converged networks reduce complexity and provide lower overall data center power consumption, which extends the lifecycle of assets. Moreover, a converged network improves SAN attachment rates, which simplifies virtual machine mobility.

Integrated mainframe support

IBM Storage Networking SAN384C-6 is mainframe-ready, with full support for IBM z Systems FICON and Linux environments. IBM Storage Networking SAN384C-6 supports transporting the FICON protocol in cascaded and non-cascaded fabrics, and an intermix of FICON and open systems Fibre Channel Protocol traffic on the same switch.

IBM Storage Networking SAN384C-6 product specifications

The product specifications for IBM Storage Networking SAN384C-6 are described in this section. IBM Storage Networking SAN384C-6 supports FC connectivity for servers and storage. The IBM Storage Networking SAN384C-6 model supports all the FICON features and functions that are listed in this section, and requires NX-OS 8.1(1b) or later.

Table 3 lists the product specifications for IBM Storage Networking SAN384C-6.

Table 3. Product specifications for IBM Storage Networking SAN384C-6 (part 1 of 3)

Feature	Description
Product compatibility	IBM Storage Networking c-type Family
Operating systems	For the most current and complete information, see the IBM System Storage Interoperation Center (SSIC): http://ibm.co/1Pmc6de
Optional features	• 24/10-port SAN Extension Module (AJL5) • 48-Port 32-Gbps Fibre Channel Switching Module (AJL4) • 48-Port 32-Gbps Fibre Channel Switching Module Bundle (AJL2) • Supervisor-1 Module (AJKE) • Enterprise Package (AJJ9) • DCNM for SAN Advanced Edition (AJJA) • Mainframe Package (AJJB) • SAN Insights • 3000 W AC power supply (5960) • Small form-factor pluggables (SFPs) • Fans
Software compatibility	NX-OS Software Release 8.1(1b) or later is required for FICON support. The 48-port 32 Gbps Fibre Channel switching module requires NX-OS Release 8.1(1b) or later.
Chassis slot configuration	• Line-card slots: 8 • Supervisor slots: 2 • Crossbar switching fabric slots: 6* • Fan trays: Three fan trays at the back of the chassis • Power supply bays: 8
Performance/Scalability	• Up to 24-Tbps front-panel Fibre Channel switching bandwidth • Supported Fibre Channel port speeds: o 4/8-Gbps autosensing, optionally configurable o 4/8/16 Gbps autosensing, optionally configurable o 8/16/32-Gbps autosensing, optionally configurable • Buffer credits: 48-port line-rate 32-Gbps Fibre Channel module: o Default credits per port: 500 o With Enterprise license, 8300 shared among a single port group of 16 ports • Ports per chassis: Up to 384 4/8/10/16/32 Gbps Fibre Channel ports • PortChannel: Up to 16 ports (the channel can span any speed-matched port on any module in the chassis)

*A minimum of three fabrics are required to support fully populated chassis with 8 x 48 Port 32 Gbps FC cards. Four fabrics are required to provide N + 1 protection.

Table 3. Product specifications for IBM Storage Networking SAN384C-6 (part 2 of 3)

Feature	Description
Fabric services	• Name server • Registered State Change Notification (RSCN) • Login services • Fabric Configuration Server (FCS) • Broadcast • In-order delivery
Advanced functions	• VSAN • IVR • PortChannel with multipath load balancing • QoS-flow-based, zone-based • N_Port ID virtualization
Diagnostic tests and troubleshooting tools	• POST diagnostic tests • Online diagnostic tests • Internal port loopbacks • SPAN and RSPAN • Fibre Channel Traceroute • Fibre Channel Ping • Fibre Channel Debug • Fabric Analyzer • Syslog • Online system health • Port-level statistics • Real-Time Protocol Debug

Network security	• VSANs
	• ACLs
	• Per-VSAN RBAC
	• Fibre Channel zoning:
	  o N_Port WWN
	  o N_Port FC-ID
	  o Fx_Port WWN
	  o Fx_Port WWN and interface index
	  o Fx_Port domain ID and interface index
	  o Fx_Port domain ID and port number
	• FC-SP:
	  o DH-CHAP switch-switch authentication
	  o DH-CHAP host-switch authentication
	• Port security and fabric binding
	• Management access:
	  o SSHv2 implementing AES
	  o SNMPv3 implementing AES
	  o SFTP

FICON	• FC-SB-3 compliant • Cascaded FICON fabrics • Intermix of FICON and Fibre Channel FCP traffic • CUP management interface

Table 3. Product specifications for IBM Storage Networking SAN384C-6 (part 3 of 3)

Feature	Description
Serviceability	● Configuration file management ● Nondisruptive software upgrades for Fibre Channel interfaces ● Call Home ● Power-management LEDs ● Port beaconing ● System LED ● SNMP traps for alerts ● Network boot
Reliability and availability	● Online, nondisruptive software upgrades ● Stateful nondisruptive supervisor module failover ● Hot-swappable redundant supervisor modules ● Hot-swappable redundant crossbar modules ● Hot-swappable 2N redundant power ● Hot-swappable fan trays with integrated temperature and power management ● Hot swappable Enhanced SFP (SFP+) optics (8/16/32 Gbps) ● Hot-swappable switching modules ● Stateful process restart ● Any module, any port configuration for PortChannels ● Fabric-based multipathing ● Per-VSAN fabric services ● Online diagnostic tests ● Port tracking ● Virtual Routing Redundancy Protocol (VRRP) for management
Network management	● Access methods through Supervisor-1 Module: o Out-of-band 10/100/1000 Ethernet port o RS-232 serial console port o In-band IP over Fibre Channel ● Access methods through IBM Storage Networking SAN384C-6 Family Fibre Channel switching module: In-band FICON CUP over Fibre Channel ● Access protocols: o CLI-using console and Ethernet ports o SNMPv3-using Ethernet port and in-band IP over Fibre Channel access o FICON CUP ● Distributed Device Alias service ● Network security: o Per-VSAN role-based access control by using RADIUS- and TACACS+-based authentication, authorization, and accounting (AAA) functions o SFTP o SSHv2 implementing AES o SNMPv3 implementing AES ● Management applications: o CLI o Data Center Network Manager
Programming interface	● Scriptable CLI ● Data Center Network Manager web services API ● DCNM GUI
Physical dimensions	● Dimensions (H x W x D): 61.9 x 43.9 x 86.4 cm (24.35 in. x 17.3 in. x 34.0 in.) ● 14 RU
Weight	● Chassis (includes fans): 84.2 kg (185.5 lbs) ● Power supply (3000W AC): 2.7 kg (6 lbs) ● Fabric module: 5.0 kg (11 lbs) ● Supervisor-1 module: 3.2 kg (7 lbs)

*Four fabrics are required to provide N + 1 protection.

Table 4 lists the switching capabilities per fabric.

Table 4. Switching capabilities per fabric

Switching capability per fabric	Number of fabric cards	Front panel Fibre Channel bandwidth per slot
	1	256 Gbps
	2	512 Gbps
	3	768 Gbps
	4	1024 Gbps
	5	1280 Gbps
	6	1536 Gbps

Table 5 lists the supported protocols for IBM Storage Networking SAN384C-6 and its components.

Table 5. Supported protocols for IBM Storage Networking SAN384C-6 (part 1 of 3)

Supported standards	
Fibre Channel protocols	● Fibre Channel standards (part 1): o FC-PH, Revision 4.3 (ANSI INCITS 230-1994) o FC-PH, Amendment 1 (ANSI INCITS 230-1994/AM1-1996) o FC-PH, Amendment 2 (ANSI INCITS 230-1994/AM2-1999) o FC-PH-2, Revision 7.4 (ANSI INCITS 297-1997) o FC-PH-3, Revision 9.4 (ANSI INCITS 303-1998) o FC-PI, Revision 13 (ANSI INCITS 352-2002) o FC-PI-2, Revision 10 (ANSI INCITS 404-2006) o FC-PI-3, Revision 4 (ANSI INCITS 460-2011) o FC-PI-4, Revision 8 (ANSI INCITS 450-2008) o FC-PI-5, Revision 6 (ANSI INCITS 479-2011) o FC-FS, Revision 1.9 (ANSI INCITS 373-2003) o FC-FS-2, Revision 1.01 (ANSI INCITS 424-2007) o FC-FS-2, Amendment 1 (ANSI INCITS 424-2007/AM1-2007) o FC-FS-3, Revision 1.11 (ANSI INCITS 470-2011) o FC-LS, Revision 1.62 (ANSI INCITS 433-2007) o FC-LS-2, Revision 2.21 (ANSI INCITS 477-2011) o FC-SB-4, Revision 3.0 (ANSI INCITS 466-2011) o FC-SB-3, Revision 1.6 (ANSI INCITS 374-2003) o FC-SB-3, Amendment 1 (ANSI INCITS 374-2003/AM1-2007) o FC-SW-2, Revision 5.3 (ANSI INCITS 355-2001) o FC-SW-3, Revision 6.6 (ANSI INCITS 384-2004) o FC-SW-4, Revision 7.5 (ANSI INCITS 418-2006) o FC-SW-5, Revision 8.5 (ANSI INCITS 461-2010) o FC-GS-3, Revision 7.01 (ANSI INCITS 348-2001) o FC-GS-4, Revision 7.91 (ANSI INCITS 387-2004) o FC-GS-5, Revision 8.51 (ANSI INCITS 427-2007) o FC-GS-6, Revision 9.4 (ANSI INCITS 463-2010) o FCP, Revision 12 (ANSI INCITS 269-1996) o FCP-2, Revision 8 (ANSI INCITS 350-2003) o FCP-3, Revision 4 (ANSI INCITS 416-2006) o FCP-4, Revision 2 o FCP-4, Revision 2b (ANSI INCITS 481-2011) o FC-SB-2, Revision 2.1 (ANSI INCITS 349-2001) o FC-SB-3, Revision 1.6 (ANSI INCITS 374-2003)

Table 5. Supported protocols for IBM Storage Networking SAN384C-6 (part 2 of 3)

Supported standards	
Protocols	● Fibre Channel standards (part 2): o FC-BB-2, Revision 6.0 (ANSI INCITS 372-2003) o FC-BB-3, Revision 6.8 (ANSI INCITS 414-2006) o FC-BB-4, Revision 2.7 (ANSI INCITS 419-2008) o FC-BB-5, Revision 2.0 (ANSI INCITS 462-2010) o FC-VI, Revision 1.84 (ANSI INCITS 357-2002) o FC-SP, Revision 1.8 (ANSI INCITS 426-2007) o FC-SP-2, Revision 2.71 (ANSI INCITS 496-2012) o FAIS, Revision 1.03 (ANSI INCITS 432-2007) o FAIS-2, Revision 2.23 (ANSI INCITS 449-2008) o FC-IFR, Revision 1.06 (ANSI INCITS 475-2011) o FC-FLA, Revision 2.7 (INCITS TR-20-1998) o FC-PLDA, Revision 2.1 (INCITS TR-19-1998) o FC-Tape, Revision 1.17 (INCITS TR-24-1999) o FC-MI, Revision 1.92 (INCITS TR-30-2002) o FC-MI-2, Revision 2.6 (INCITS TR-39-2005) o FC-MI-3, Revision 1.03 (INCITS TR-48-2012) o FC-DA, Revision 3.1 (INCITS TR-36-2004) o FC-DA-2, Revision 1.06 (INCITS TR-49-2012) o FC-MSQS, Revision 3.2 (INCITS TR-46-2011) ● FC-Tape, Revision 1.17 (INCITS TR-24-1999) ● FC-MI, Revision 1.92 (INCITS TR-30-2002) ● FC-MI-2, Revision 2.6 (INCITS TR-39-2005) ● FC-DA, Revision 3.1 (INCITS TR-36-2004) ● Class of service: Class 2, Class 3, and Class F ● Fibre Channel features: o Fibre Channel standard port types: E, F, FL, and B o Fibre Channel enhanced port types: SD, ST, and TE o T11 standards-compliant FC-BB-5 Revision 2.0 o T11 standards-compliant FCoE o Fibre Channel forwarding (FCF) o Converged Enhanced Ethernet (CEE) interoperability o Direct attachment of FCoE targets o Fibre Channel enhanced port types: VE, TE, and VF o F-port trunking o F-port channeling o VSANs o Fibre Channel PortChannel o VSAN trunking o Fabric Device Management Interface (FDMI) o Fibre Channel ID (FCID) persistence o Distributed device alias services o In-order delivery

Table 5. Supported protocols for IBM Storage Networking SAN384C-6 (part 3 of 3)

Supported standards	
Protocols (continued)	● Fibre Channel features (continued): o Port tracking o IPv6, IPv4, and ARP over Fibre Channel (RFC 4338) o Extensive IETF-standards-based TCP/IP, SNMPv3, and remote monitoring (RMON) MIBs o CEE DCB: ● Priority flow control (PFC) ● Data Center Bridging Exchange (DCBX) o Enhanced transmission selection (ETS) o N-port virtualization (NPV) o N-port ID virtualization (NPIV) o Fabric services: Name server, registered state change notification (RSCN), login services, and name server zoning o Per-VSAN fabric services o Fabric Services o Fabric Shortest Path First (FSPF) o Diffie-Hellman Challenge Handshake Authentication o Protocol (DH-CHAP) and Fibre Channel Security o Protocol (FC-SP) o Host-to-switch and switch-to-switch FC-SP authentication o Fabric binding for Fibre Channel o Port security o Standard zoning o Domain and port zoning o Enhanced zoning o Fabric Analyzer o Fibre Channel traceroute o Fibre Channel ping o Fibre Channel debugging o Fabric Manager support o Storage Management Initiative Specification (SMI-S)

24/10-Port SAN Extension Module specifications

Table 6 lists the specifications for the 24/10-Port SAN Extension Module.

Table 6. Product specifications for the 24/10-Port SAN Extension Module (part 1 of 5)

Feature	Description
Product compatibility	IBM Storage Networking c-type Family
Software compatibility	NX-OS Software 8.1(1b)
Protocols	Fibre Channel standards: ● FC-PH, Revision 4.3 (ANSI INCITS 230-1994) ● FC-PH, Amendment 1 (ANSI INCITS 230-1994/AM1-1996) ● FC-PH, Amendment 2 (ANSI INCITS 230-1994/AM2-1999) ● FC-PH-2, Revision 7.4 (ANSI INCITS 297-1997) ● FC-PH-3, Revision 9.4 (ANSI INCITS 303-1998) ● FC-PI, Revision 13 (ANSI INCITS 352-2002) ● FC-PI-2, Revision 10 (ANSI INCITS 404-2006) ● FC-PI-3, Revision 4 (ANSI INCITS 460-2011) ● FC-PI-4, Revision 8 (ANSI INCITS 450-2008) ● FC-PI-5, Revision 6 (ANSI INCITS 479-2011) ● FC-FS, Revision 1.9 (ANSI INCITS 373-2003) ● FC-FS-2, Revision 1.01 (ANSI INCITS 424-2007) ● FC-FS-2, Amendment 1 (ANSI INCITS 424-2007/AM1-2007) ● FC-FS-3, Revision 1.11 (ANSI INCITS 470-2011) ● FC-LS, Revision 1.62 (ANSI INCITS 433-2007) ● FC-LS-2, Revision 2.21 (ANSI INCITS 477-2011) ● FC-SW-2, Revision 5.3 (ANSI INCITS 355-2001) ● FC-SW-3, Revision 6.6 (ANSI INCITS 384-2004) ● FC-SW-4, Revision 7.5 (ANSI INCITS 418-2006) ● FC-SW-5, Revision 8.5 (ANSI INCITS 461-2010) ● FC-GS-3, Revision 7.01 (ANSI INCITS 348-2001) ● FC-GS-4, Revision 7.91 (ANSI INCITS 387-2004) ● FC-GS-5, Revision 8.51 (ANSI INCITS 427-2007) ● FC-GS-6, Revision 9.4 (ANSI INCITS 463-2010) ● FCP, Revision 12 (ANSI INCITS 269-1996) ● FCP-2, Revision 8 (ANSI INCITS 350-2003) ● FCP-3, Revision 4 (ANSI INCITS 416-2006) ● FCP-4, Revision 2b (ANSI INCITS 481-2011) ● FC-SB-2, Revision 2.1 (ANSI INCITS 349-2001) ● FC-SB-3, Revision 1.6 (ANSI INCITS 374-2003) ● FC-SB-3, Amendment 1 (ANSI INCITS 374-2003/AM1-2007) ● FC-SB-4, Revision 3.0 (ANSI INCITS 466-2011) ● FC-SB-5, Revision 2.00 (ANSI INCITS 485-2014) ● FC-BB-6, Revision 2.00 (ANSI INCITS 509-2014) ● FC-BB-2, Revision 6.0 (ANSI INCITS 372-2003) ● FC-BB-3, Revision 6.8 (ANSI INCITS 414-2006) ● FC-BB-4, Revision 2.7 (ANSI INCITS 419-2008) ● FC-BB-5, Revision 2.0 (ANSI INCITS 462-2010) ● FC-VI, Revision 1.84 (ANSI INCITS 357-2002) ● FC-SP, Revision 1.8 (ANSI INCITS 426-2007) ● FC-SP-2, Revision 2.71 (ANSI INCITS 496-2012) ● FAIS, Revision 1.03 (ANSI INCITS 432-2007) ● FAIS-2, Revision 2.23 (ANSI INCITS 449-2008) ● FC-IFR, Revision 1.06 (ANSI INCITS 475-2011) ● FC-FLA, Revision 2.7 (INCITS TR-20-1998) ● FC-PLDA, Revision 2.1 (INCITS TR-19-1998) ● FC-Tape, Revision 1.17 (INCITS TR-24-1999) ● FC-MI, Revision 1.92 (INCITS TR-30-2002) ● FC-MI-2, Revision 2.6 (INCITS TR-39-2005)

Table 6. Product specifications for the 24/10-Port SAN Extension Module (part 2 of 5)

Feature	Description
Protocols (cont.)	• FC-MI-3, Revision 1.03 (INCITS TR-48-2012) • FC-DA, Revision 3.1 (INCITS TR-36-2004) • FC-DA-2, Revision 1.06 (INCITS TR-49-2012) • FC-MSQS, Revision 3.2 (INCITS TR-46-2011) • Fibre Channel classes of service: Class 2, Class 3, and Class F • Fibre Channel standard port types: E, F, FL, and B • Fibre Channel enhanced port types: SD, ST, and TE • IP over Fibre Channel (RFC 2625) • IPv6, IPv4, and Address Resolution Protocol (ARP) over Fibre Channel (RFC 4338) • Extensive IETF-standards based TCP/IP, SNMPv3, and remote monitoring (RMON) MIBs IP standards: • RFC 791 IPv4 • RFC 793 and 1323 TCP • RFC 894 IP/Ethernet • RFC 1041 IP/802 • RFC 792, 950, and 1256 Internet Control Message Protocol (ICMP) • RFC 1323 TCP performance enhancements • RFC 2338 Virtual Router Redundancy Protocol (VRRP) • RFC 2460 and 4291 IPv6 • RFC 2463 ICMPv6 • RFC 2461 and 2462 IPv6 neighbor discovery and stateless autoconfiguration • RFC 2464 IPv6/Ethernet • RFC 3643 and 3821 FCIP Ethernet standards: • IEEE 802.3z Gigabit Ethernet • IEEE 802.1Q VLAN IPsec standards • RFC 2401 Security Architecture for IP • RFC 2403 and 2404 Hash Message Authentication Code (HMAC) • RFC 2405, 2406, and 2451 IP Encapsulating Security Payload (ESP) • RFC 2407 and 2408 Internet Security Association and Key Management Protocol (ISAKMP) • RFC 2412 OAKLEY Key Determination Protocol • RFC 3566, 3602, and 3686 AES Internet Key Exchange (IKE) standards: • RFC 2409 IKEv1 • IKEv2, draft
Cards, ports, and slots	24 x fixed 2/4/8/10/16-Gbps Fibre Channel ports, 8 x 1/10 Gigabit Ethernet ports
Features and Functions	
Fabric services	• Name server • Registered state change notification (RSCN) • Login services • Fabric Configuration Server (FCS) • Private loop • Public loop • Translative loop • Broadcast • In-order delivery

Table 6. Product specifications for the 24/10-Port SAN Extension Module (part 3 of 5)

Feature	Description
Cards, ports, and slots	24 x fixed 2/4/8/10/16-Gbps Fibre Channel ports, 8 x 1/10 Gigabit Ethernet ports
Fabric services	• Name server • Registered state change notification (RSCN) • Login services • Fabric Configuration Server (FCS) • Private loop • Public loop • Translative loop • Broadcast • In-order delivery
Advanced functions	• VSAN • IVR • Port channel with multipath load balancing • Flow-based and zone-based QoS • Hardware-based compression for MAN and WAN data • Hardware-based encryption • Hardware-based data integrity • FCIP disk write acceleration • FCIP tape read and write acceleration
Diagnostics and troubleshooting tools	• POST diagnostics • Online diagnostics • Internal port loopbacks • SPAN and remote SPAN • Fibre Channel Traceroute • Fibre Channel Ping • Fibre Channel Debug • Fabric Analyzer • Syslog • Online system health • Port-level statistics • Real-Time Protocol (RTP) debug
Network security	• VSANs • ACLs • Per-VSAN RBAC • Fibre Channel zoning: o N-port worldwide name (WWN) o N-port FC-ID o Fx-port WWN o Fx-port WWN and interface index o Fx-port domain ID and interface index o Fx-port domain ID and port number o Logical unit number (LUN) o Read-only o Broadcast • FC-SP: o DH-CHAP switch-to-switch authentication o DH-CHAP host-to-switch authentication • Port security and fabric binding • IPsec for FCIP • IKEv1 and v2 • Management access: o SSH v2 implementing AES o SNMPv3 implementing AES o SFTP

Table 6. Product specifications for the 24/10-Port SAN Extension Module (part 4 of 5)

Feature	Description
Serviceability	• Configuration file management • Nondisruptive software upgrades for Fibre Channel interfaces • Call Home • Power-management LEDs • Port beaconing • System LED • SNMP traps for alerts • Network boot
Performance	• Port speed: Fibre Channel 2/4/8/10/16 Gbps, FCIP 1/10/40 Gigabit Ethernet • Port channels: Up to 16 FCIP links • FCIP tunnels: Up to 4 per port
Reliability and availability	• Hot-swappable module • Hot-swappable SFP optics • Online diagnostics • Stateful process restart • Nondisruptive supervisor failover • Any module, any port configuration for port channels • Fabric-based multipathing • Per-VSAN fabric services • Port tracking • VRRP for management and FCIP
Network management	• Access methods through the Supervisor Module: o Out-of-band 10/100/1000 Ethernet port (Supervisor-1 Module) o Out-of-band 10/100/1000 Ethernet port (Supervisor-2 Module) o RS-232 serial console port (RJ45 form factor) o In-band IP-over-Fibre Channel • Access protocols: o Command-line interface (CLI) through console and Ethernet ports o SNMPv3 through Ethernet port and in-band IP-over-Fibre Channel access o Storage Networking Industry Association (SNIA) Storage Management Initiative Specification (SMI-S) • Distributed device alias service • Network security: o Per-VSAN RBAC using RADIUS- and TACACS+-based authentication, authorization, and accounting (AAA) functions o SFTP o SSHv2 implementing AES o SNMPv3 implementing AES • Management applications: o CLI o Data Center Network Manager o Device Manager
Programming interfaces	• Fabric Manager GUI • Device Manager GUI
Environmental	• Temperature, ambient operating: 32 - 104°F (0 - 40°C) • Temperature, ambient nonoperating and storage: -40 - 158°F (-40 - 70°C) • Relative humidity, ambient (noncondensing) operating: 5 - 90% • Relative humidity, ambient (noncondensing) nonoperating and storage: 5 - 95% • Altitude, operating: -197 - 6500 ft (-60 - 2000m)
Physical dimensions	• Dimensions (H x W x D): 4.4 x 40.39 x 55.37 cm (1.75 x 15.9 x 21.8 in.). Occupies one slot in the chassis. • Weight: 7.71 kg (17 lb).

Table 6. Product specifications for the 24/10-Port SAN Extension Module (part 5 of 5)

Feature	Description
Approvals and compliance	Safety compliance: ● CE Marking ● UL 60950 ● CAN/CSA-C22.2 No. 60950 ● EN 60950 ● IEC 60950 ● TS 001 ● AS/NZS 3260 ● IEC60825 ● EN60825 ● 21 CFR 1040 EMC compliance: ● FCC Part 15 (CFR 47) Class A ● ICES-003 Class A ● EN 55022 Class A ● CISPR 22 Class A ● AS/NZS 3548 Class A ● VCCI Class A ● EN 55024 ● EN 50082-1 ● EN 61000-6-1 ● EN 61000-3-2 ● EN 61000-3-3

Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module

Table 7 lists the specifications for the 48-Port 32-Gbps Fibre Channel Switching Modules.

Table 7. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (Part 1 of 5)

Item	Description
Product compatibility	IBM Storage Networking c-type Family Multilayer Directors
Software compatibility	NX-OS Software Release NX-OS 8.1(1b)
Protocols	● Fibre Channel standards: o FC-PH, Revision 4.3 (ANSI INCITS 230-1994) o FC-PH, Amendment 1 (ANSI INCITS o 230-1994/AM1-1996) o FC-PH, Amendment 2 (ANSI INCITS o 230-1994/AM2-1999) o FC-PH-2, Revision 7.4 (ANSI INCITS 297-1997) o FC-PH-3, Revision 9.4 (ANSI INCITS 303-1998) o FC-PI, Revision 13 (ANSI INCITS 352-2002) o FC-PI-2, Revision 10 (ANSI INCITS 404-2006) o FC-PI-3, Revision 4 (ANSI INCITS 460-2011) o FC-PI-4, Revision 8 (ANSI INCITS 450-2008) o FC-PI-5, Revision 6 (ANSI INCITS 479-2011) o FC-FS, Revision 1.9 (ANSI INCITS 373-2003) o FC-FS-2, Revision 1.01 (ANSI INCITS 424-2007) o FC-FS-2, Amendment 1 (ANSI INCITS o 424-2007/AM1-2007) o FC-FS-3, Revision 1.11 (ANSI INCITS 470-2011) o FC-LS, Revision 1.62 (ANSI INCITS 433-2007)

Table 7. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (Part 2 of 5)

Item	Description
Protocols (continued)	● Fibre Channel standards (continued): o FC-LS-2, Revision 2.21 (ANSI INCITS 477-2011) o FC-SW-2, Revision 5.3 (ANSI INCITS 355-2001) o FC-SW-3, Revision 6.6 (ANSI INCITS 384-2004) o FC-SW-4, Revision 7.5 (ANSI INCITS 418-2006) o FC-SW-5, Revision 8.5 (ANSI INCITS 461-2010) o FC-GS-3, Revision 7.01 (ANSI INCITS 348-2001) o FC-GS-4, Revision 7.91 (ANSI INCITS 387-2004) o FC-GS-5, Revision 8.51 (ANSI INCITS 427-2007) o FC-GS-6, Revision 9.4 (ANSI INCITS 463-2010) o FCP, Revision 12 (ANSI INCITS 269-1996) o FCP-2, Revision 8 (ANSI INCITS 350-2003) o FCP-3, Revision 4 (ANSI INCITS 416-2006) o FCP-4, Revision 2b (ANSI INCITS 481-2011) o FC-SB-2, Revision 2.1 (ANSI INCITS 349-2001) o FC-SB-3, Revision 1.6 (ANSI INCITS 374-2003) o FC-SB-3, Amendment 1 (ANSI INCITS 374-2003/AM1-2007) o FC-SB-4, Revision 3.0 (ANSI INCITS 466-2011) o FC-SB-5, Revision 2.00 (ANSI INCITS 485-2014) o FC-BB-6, Revision 2.00 (ANSI INCITS 509-2014) o FC-BB-2, Revision 6.0 (ANSI INCITS 372-2003) o FC-BB-3, Revision 6.8 (ANSI INCITS 414-2006) o FC-BB-4, Revision 2.7 (ANSI INCITS 419-2008) o FC-BB-5, Revision 2.0 (ANSI INCITS 462-2010) o FC-VI, Revision 1.84 (ANSI INCITS 357-2002) o FC-SP, Revision 1.8 (ANSI INCITS 426-2007) o FC-SP-2, Revision 2.71 (ANSI INCITS 496-2012) o FAIS, Revision 1.03 (ANSI INCITS 432-2007) o FAIS-2, Revision 2.23 (ANSI INCITS 449-2008) o FC-IFR, Revision 1.06 (ANSI INCITS 475-2011) o FC-FLA, Revision 2.7 (INCITS TR-20-1998) o FC-PLDA, Revision 2.1 (INCITS TR-19-1998) o FC-Tape, Revision 1.17 (INCITS TR-24-1999) o FC-MI, Revision 1.92 (INCITS TR-30-2002) o FC-MI-2, Revision 2.6 (INCITS TR-39-2005) o FC-MI-3, Revision 1.03 (INCITS TR-48-2012) o FC-DA, Revision 3.1 (INCITS TR-36-2004) o FC-DA-2, Revision 1.06 (INCITS TR-49-2012) o FC-MSQS, Revision 3.2 (INCITS TR-46-2011) ● Fibre Channel classes of service: Class 2, Class 3, and Class F ● Fibre Channel standard port types: E, F, FL, and B ● Fibre Channel enhanced port types: SD, ST, and TE
Cards, ports, and slots	● 48 autosensing 4/8-Gbps or 4/8/16-Gbps or 8/16/32-Gbps Fibre Channel ports ● Can be used on any payload slot of the IBM Storage Networking c-type Family directors
Features and functions	
Fabric services	Name server: ● Registered state-change notification (RSCN) ● Login services ● Fabric configuration server (FCS) ● Public loop ● Broadcast ● In-order delivery

Table 7. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (Part 3 of 5)

Item	Description
Advanced functions	• VSAN • IVR • Port channel with multipath load balancing • Flow-based and zone-based QoS • N-port ID virtualization (NPIV) • Inline analytics
Diagnostics and troubleshooting tools	• POST diagnostics • Online diagnostics • Internal port loopbacks • SPAN and RSPAN • Fibre Channel traceroute • Fibre Channel ping • Fibre Channel debug • Fabric Analyzer • Syslog • Online system health • Port-level statistics • Real-rime protocol debug • E-port and F-port diagnostics

Network security	• VSANs
	• ACLs
	• Per-VSAN RBAC
	• Fibre Channel zoning:
	  o N-port Worldwide Name (WWN)
	  o N-port Fibre Channel ID (FC-ID)
	  o Fx-port WWN
	  o Fx-port WWN and interface index
	  o Fx-port domain ID and interface index
	  o Fx-port domain ID and port number
	  o LUN
	• FC-SP:[a]
	  o DH-CHAP switch-to-switch authentication
	  o DH-CHAP host-to-switch authentication
	• Port security and fabric binding
	• Management access:
	  o SSHv2 implementing AES
	  o SNMPv3 implementing AES
	  o SFTP
	• TrustSec1Fibre Channel link-level encryption:
	  o SSHv2 implementing AES

Serviceability	• Configuration file management • Nondisruptive software upgrades for Fibre Channel interfaces • Call Home • Power-management LEDs • Port beaconing • System LED • SNMP traps for alerts • Network boot

a. Supported only for 4- and 8-Gbps speeds. 2 Gbps is not supported.

Table 7. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (Part 4 of 5)

Item	Description
Performance	• Port speed: 4/8-Gbps, 4/8/16-Gbps, and 8/16/32-Gbps autosensing Fibre Channel • Buffer credits: o Default credits per port: 500 o With Enterprise license: • 8300 shared among a single port group of 16 ports • 8191 maximum credits per port Port channel: Up to 16 ports • Port channel: Up to 16 ports
Reliability and availability	• Hot-swappable module • Hot-swappable SFP+ transceivers • Online diagnostics • Stateful process restart • Nondisruptive supervisor failover • Any-module, any-port configuration for port channels • Fabric-based multipathing • Per-VSAN fabric services • Port tracking • Virtual Routing Redundancy Protocol (VRRP) for management
Network management	• Access methods through the Supervisor-1 Module: o Out-of-band 10/100/1000 Ethernet port (Supervisor-1) o RS-232 serial console port o In-band IP over Fibre Channel • Access methods through the Fibre Channel switching module: o In-band FICON Control Unit Port (CUP) over any IBM System Z FICON channel • Access protocols: o Command-line interface (CLI) through console and Ethernet ports o SNMPv3 through Ethernet port and in-band IP over Fibre Channel access o FICON CUP • Distributed Device Alias service • Network security: o Per-VSAN RBAC using RADIUS- and TACACS+-based authentication, authorization, and accounting (AAA) functions o SFTP o SSHv2 implementing AES o SNMPv3 implementing AES • Management applications: o CLI o Fabric Manager o Device Manager
Programming interfaces	• Scriptable CLI • Prime DCNM web services API • Prime DCNM GUI • Representational state transfer (REST) API
Environmental	• Temperature, ambient operating: 0 - 40°C (32 - 104°F) • Temperature, ambient nonoperating and storage: -40 - 70°C (-40 - 158°F) • Relative humidity, ambient (noncondensing) operating: 10 - 90% • Relative humidity, ambient (noncondensing) nonoperating and storage: 10 - 95% • Altitude, operating: -60 - 2000m (-197 - 6500 ft)
Physical dimensions	• Dimensions (H x W x D): 4.4 x 40.39 x 55.37 cm (1.75 x 15.9 x 21.8 in.) • Weight: 7.94 kg (17.5 lb)

Table 7. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (Part 5 of 5)

Item	Description
Approvals and compliance	● Regulatory compliance: o CE Markings per directives 2004/108/EC and 2006/95/EC ● Safety compliance: o UL 60950-1 Second Edition o CAN/CSA-C22.2 No. 60950-1 Second Edition o EN 60950-1 Second Edition o IEC 60950-1 Second Edition o AS/NZS 60950-1 o GB4943 2001 ● EMC compliance: o 47CFR Part 15 (CFR 47) Class A o AS/NZS CISPR22 Class A o CISPR22 Class A o EN55022 Class A o ICES003 Class A o VCCI Class A o EN61000-3-2 o EN61000-3-3 o KN22 Class A o CNS13438 Class A o EN55024 o CISPR24 o EN300386 o KN24

a. Supported only for 4- and 8-Gbps speeds. 2 Gbps is not supported.

Table 8 lists supported optics, media, and transmission distances.

Table 8. Supported optics, media, and transmission distances.

Speed	Media	Distance
● 32-Gbps shortwave LC, SFP+ ● 32-Gbps longwave, LC, SFP+ ● 16-Gbps shortwave, LC, SFP+ ● 16-Gbps longwave, LC, SFP+ ● 8-Gbps shortwave, LC, SFP+ ● 8-Gbps longwave, LC, SFP+	● 50/125-micron multimode ● 9/125-micron single mode ● 50/125-micron multimode ● 9/125-micron single mode ● 50/125-micron multimode ● 9/125-micron single mode	● 70 m OM3 and 100 m OM4 ● 10 km ● 100 m OM3 and 125 m OM4 ● 10 km ● 150m OM3 and 190 m ● OM4 10 km

Product specifications for the Supervisor-1 Module

Table 9 lists the specifications for the Supervisor-1 Module.

Table 9. Specifications for the Supervisor-1 Module (part 1 of 3)

Feature	Description
Product compatibility	IBM Storage Networking c-type Family
Software compatibility	NX-OS Software Release 8.1(1b) or later.
Interfaces	• (1) RS-232 RJ-45 console port • (1) 10/100/1000 Ethernet management port • (2) USB 2.0 ports
Indicators	• Status LED • System LED • Power management LED • Active/standby LED
Backplane bandwidth	• Up to 24 Tbps of FC backplane bandwidth • Up to 384 2/4/8/16 Gbps Full Line Rate autosensing Fibre Channel fixed speed ports in a single chassis
Chassis slot configuration	Two Supervisor-1 modules are required per system.

Table 9. Specifications for the Supervisor-1 Module (part 2 of 3)

Feature	Description
Fabric services	• Name server • Registered State Change Notification (RSCN) • Login services • Fabric Configuration Server (FCS) • Broadcast • In-order delivery
Advanced functions	• VSAN • IVR • PortChannel with multipath load balancing • QoS-flow-based, zone-based • FCC • N_Port ID virtualization
Diagnostic and troubleshooting tools	• POST diagnostic tests • Online diagnostic tests • Internal port loopbacks • SPAN and RSPAN • Fibre Channel Traceroute • Fibre Channel Ping • Fibre Channel Debug • Fabric Analyzer • Syslog • Online system health • Port-level statistics • Real-Time Protocol Debug

Network security	• VSANs
	• ACLs
	• Per-VSAN RBAC
	• Fibre Channel zoning:
	  o N_Port WWN
	  o N_Port FC-ID
	  o Fx_Port WWN
	  o Fx_Port WWN and interface index
	  o Fx_Port domain ID and interface index
	  o Fx_Port domain ID and port number
	  o LUN
	  o Read-only
	  o Broadcast
	• FC-SP:
	  o DH-CHAP switch-switch authentication
	  o DH-CHAP host-switch authentication
	• Port security and fabric binding
	• Management access:
	  o SSHv2 implementing AES
	  o SNMPv3 implementing AES
	  o SFTP

Serviceability	• Configuration file management • Nondisruptive software upgrades for Fibre Channel interfaces • Call Home • Power-management LEDs • Port beaconing • System LED • SNMP traps for alerts • Network boot

Table 9. Specifications for the Supervisor-1 Module (part 3 of 3)

Feature	Description
Reliability and availability	• Hot-swappable module • Active-active redundancy • Stateful Process Restart • Stateful, nondisruptive supervisor failover • Online, nondisruptive software upgrades • Virtual Routing Redundancy Protocol (VRRP) for management • Per-VSAN fabric services • Power management • Thermal management • Fabric-based multipathing
Network management	• Access methods through Supervisor-1 Module: o Out-of-band 10/100/1000 Ethernet port o RS-232 serial console port o In-band IP over Fibre Channel • Access protocols: o CLI-using console and Ethernet ports o SNMPv3-using Ethernet port and in-band IP over Fibre Channel access • Distributed Device Alias service • Network security: o Per-VSAN role-based access control by using RADIUS-based and TACACS+-based authentication, authorization, and accounting (AAA) functions o SFTP o SSHv2 implementing AES o SNMPv3 implementing AES • Management applications: o CLI o Data Center Network Manager
Programming interface	• Scriptable CLI • Data Center Network Manager web services API • DCNM GUI
Physical dimensions	• Dimensions (H x W x D): 5.18 x 19.05 x 55.37 cm (2.04 x 7.5 x 21.8 in.) • Weight: 3.2 kg (7 lb)

Table 10 lists the feature codes for licensed software.

Table 10. Licensed software

Feature Code	Description
AJJ9	Enterprise Package
AJJA	DCNM SAN Advanced Edition
AJJB	Mainframe Package
AJKV	SAN Insights

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Related information

For more information, see the following documents:

- IBM Storage Networking SAN50C-R Product Guide, TIPS1359
  http://www.redbooks.ibm.com/abstracts/tips1359.html
- IBM Storage Networking SAN384C-6 Product Guide, TIPS1360
  http://www.redbooks.ibm.com/abstracts/tips1360.html
- IBM Storage Networking SAN32C-6 Product Guide, TIPS1361
  http://www.redbooks.ibm.com/abstracts/tips1361.html
- IBM Storage Networking SAN192C-6 Product Guide, TIPS1362
  http://www.redbooks.ibm.com/abstracts/tips1362.html
- IBM Storage Networking SAN768C-6 Product Guide, REDP5513
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