IBM Storage Networking SAN192C-6 Product Guide

IBM Redbooks Product Guide

This IBM® Redbooks® Product Guide describes the IBM Storage Networking SAN192C-6. The IBM Storage Networking SAN192C-6 is a director-class SAN switch that is designed for deployment in small- to medium-sized storage networks that can support enterprise clouds and business transformation. It layers a comprehensive set of intelligent features into a high-performance, protocol-independent switch fabric.

IBM Storage Networking SAN192C-6 addresses the stringent requirements of large virtualized data center storage environments. It delivers uncompromising availability, security, scalability, ease of management, and transparent integration of new technologies for flexible data center SAN solutions. It shares the same operating system and management interface with other IBM data center switches. By using the IBM Storage Networking SAN192C-6, you can transparently deploy unified fabrics with Fibre Channel, IBM Fibre Connection (IBM FICON®), and Fibre Channel over IP (FCIP) connectivity for 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 the IBM Storage Networking SAN192C-6.

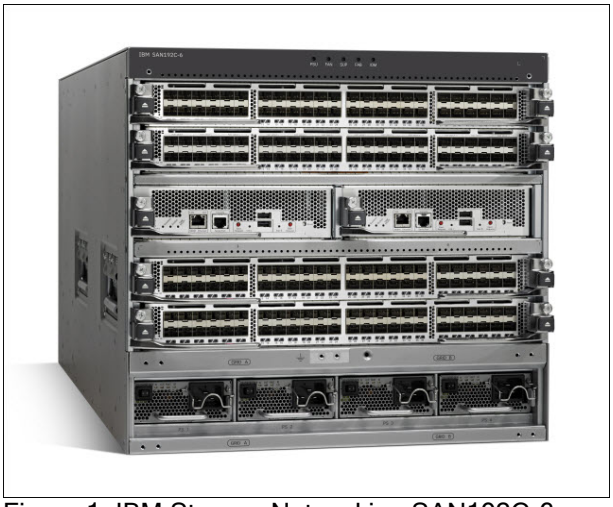

Figure 1. IBM Storage Networking SAN192C-6

Did you know?

- The IBM Storage Networking SAN192C-6 is 15.6 inches tall (9RU) and allows up to four IBM Storage Networking SAN192C-6 Directors per standard 7-foot rack (42RU).
- You can lower TCO with Fibre Channel and FICON SAN consolidation.
- The IBM Storage Networking SAN192C-6 provides up to 12 terabits per second (Tbps) front-panel, Fibre Channel, line-rate, nonblocking system-level switching capacity.

Product highlights

The IBM Storage Networking SAN192C-6 offers several important features, described in this section.

Lower TCO with SAN consolidation

Organizations need efficient, cost-effective SANs to keep up with today's exponential data growth. IBM Storage Networking SAN192C-6 lets you easily consolidate data assets into fewer, larger, and more manageable SANs to reduce hardware footprint and the associated capital and operational expenses. It offers industry-leading scalability with the following features:

- Up to 192 32-Gbps ports per chassis
- Up to 12 Tbps front-panel, Fibre Channel, line-rate, nonblocking system-level switching capacity
- Enable large and scalable deployment of SAN extension solutions with the IBM Storage Networking c-type family directors 24/10-port SAN Extension Module
- Exceptional capabilities with intelligent fabric services
- Virtual SANs (VSANs) for consolidating individual physical SAN islands while maintaining logical boundaries
- Inter-VSAN routing (IVR) for sharing resources across VSANs

Scalable expansion with outstanding investment protection

IBM Storage Networking SAN192C-6 is designed to make optimal use of valuable data center floor space. It is 15.6 inches tall (9RU) and allows up to four IBM Storage Networking SAN192C-6 directors per standard 7-foot rack (42RU). A smaller footprint makes it an excellent candidate for deployment in smaller storage networks and pod-based converged data center infrastructure solutions for the cloud.

By using IBM Storage Networking c-type family directors' switching modules, the IBM Storage Networking SAN192C-6 supports up to 192 ports in a 6-slot modular chassis, with up to 768 ports in a single rack. Fibre Channel ports can be configured and auto-negotiated at 2/4/8-Gbps, 4/8/16-Gbps, or 8/16/32-Gbps speeds. IBM Storage Networking SAN192C-6 supports the same Fibre Channel switching modules as the IBM Storage Networking SAN384C-6 and SAN768C-6 directors for a high degree of system commonality. Designed to grow with your storage environment, IBM Storage Networking SAN192C-6 provides smooth migration, common sparing, and outstanding investment protection.

The 24/10-Port SAN Extension Module is supported on IBM Storage Networking c-type Family 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.

Enterprise-class availability

The IBM Storage Networking SAN192C-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, the IBM Storage Networking SAN192C-6 software architecture offers outstanding availability. It provides redundancy on all major hardware components, including the supervisor, fabric modules, and power supplies. The Supervisor Module automatically restarts failed processes, which makes the IBM Storage Networking SAN192C-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.

FCIP for remote SAN extension

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. It 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 (4 tunnels x 8 1/10GE ports).

Business transformation with enterprise cloud deployment

Enterprise clouds provide organizations with elastic computing and network capabilities, which enables IT to scale resources up or down as needed in a quick and cost-efficient manner. IBM Storage Networking SAN192C-6 provides industry-leading scalability and the following features for enterprise cloud deployments:

- Pay-as-you-grow flexibility to meet the scalability needs in the cloud
- Robust security for multitenant cloud applications
- Predictable performance to meet stringent service-level agreements (SLAs)
- Resilient connectivity for an always-on cloud infrastructure
- Advanced traffic management capabilities, such as quality of service (QoS), to allocate network capabilities to cloud applications rapidly and cost-efficiently

Furthermore, Data Center Network Manager (DCNM) provides resource monitoring and capacity planning on a per-virtual machine basis. You can federate up to 10 DCNM servers to easily manage large clouds. Resource use information can be delivered through Storage Management Initiative Specification (SMI-S)-based developer APIs to deliver IT as a service.

Comprehensive solution for robust security

IBM Storage Networking SAN192C-6 offers an extensive security framework to protect highly sensitive data crossing today's enterprise storage networks. It employs intelligent packet inspection at the port level, including the application of ACLs for hardware enforcement of zones, VSANs, and advanced port-security features. It also uses Fibre Channel Service Protocol (FC-SP) and TrustSec Fibre Channel link encryption mechanisms to provide comprehensive security for storage networks.

24/10-Port SAN Extension Module

The 24/10-Port SAN Extension Module is supported on IBM Storage Networking c-type family 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 directors Fibre Channel switching modules, including 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.

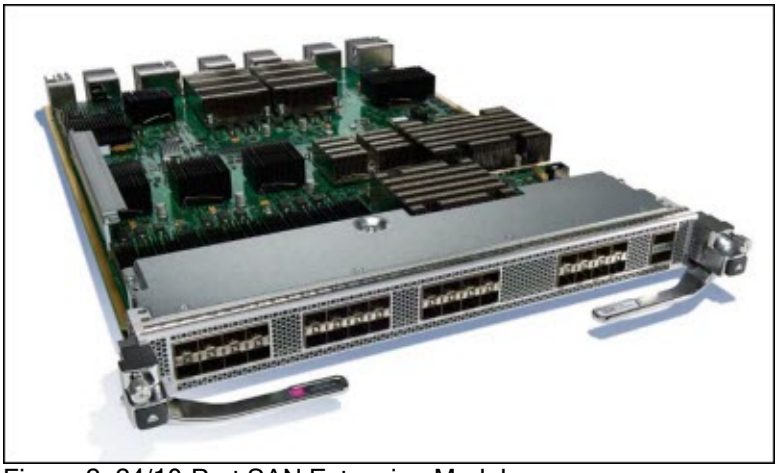

Figure 2. 24/10-Port SAN Extension Module

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 1/10GE ports).
  - Preserves IBM Storage Networking c-type family 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 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 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 as well as integrated IBM Call Home capability for greater reliability, faster problem resolution, and reduced service costs.
- **Comprehensive network security framework :** The module supports RADIUS and TACACS+, 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 US 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 to 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 Tracerout, to detail the exact path and timing of flows, and Switch 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 SLA accounting. With the IBM Storage Networking c-type family, IBM delivers a comprehensive tool set for troubleshooting and analyzing storage networks.

Comprehensive solution for robust network security

Addressing the need for fail-proof security in storage networks, the 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.

48-Port 32-Gbps Fibre Channel Switching Module

The 48-Port 32-Gbps Fibre Channel Switching Module (Figure 3) 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 NVMe arrays.

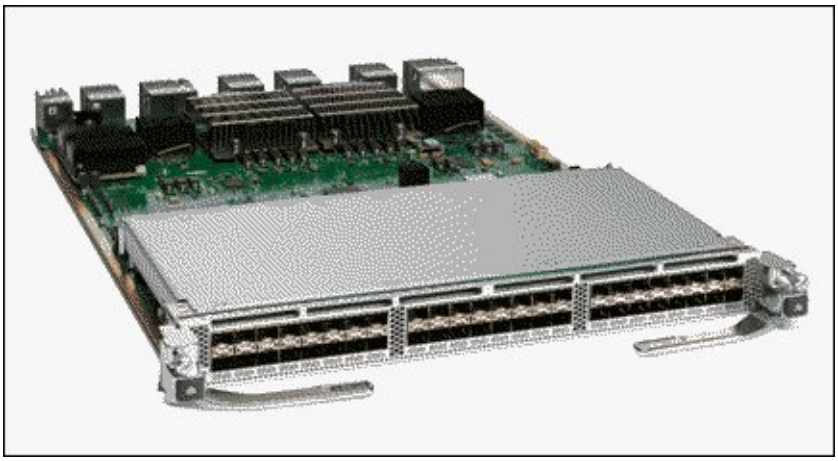

Figure 3. 48-Port 32-Gbps Fibre Channel Switching Module

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 48-port 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 Tbps of Fibre Channel throughput between the modules in each direction for each payload slot in the IBM Storage Networking c-type directors. The IBM Storage Networking c-type family directors' 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 six 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. The 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. The IBM Storage Networking SAN384C-6 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 IBM 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 IBM Storage Networking c-type family 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 may 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:** 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. 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:** IBM Storage Networking c-type family devices support services including VSANs, hardware-enforced zoning, ACLs, per-VSAN RBAC, and TrustSec Fibre Channel link encryption. The comprehensive security framework consists of RADIUS and TACACS+, FC-SP, SFTP, SSH Protocol, and SNMPv3. 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:** IBM Storage Networking c-type family 48-port 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 4000 kilometers at 4 Gbps, 2000 kilometers at 8 Gbps, 1000 kilometers at 16 Gbps, and 500 kilometers at 32 Gbps, while maintaining full link utilization. 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:** IBM Storage Networking c-type family 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.
- **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 main 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, 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 nonblocking 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:** 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. 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 ensures 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: 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. Generic Online Diagnostics (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 Switched Port Analyzer (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 SAN192C-6 and SAN384C-6 are mainframe ready, with full support for FICON for IBM z Systems and Linux environments. They support transport of the FICON protocol in both cascaded and noncascaded fabrics. They also support a mix of FICON and open-systems Fibre Channel Protocol (FCP) traffic on the same switch.

Key features

Table 2 summarizes the main features and benefits of the IBM Storage Networking SAN192C-6.

Table 2. Main features and benefits of the IBM Storage Networking SAN192C-6 (part 1 of 4)

Feature	Benefit
Performance and scalability	
Outstanding SAN performance	The combination of the 32 Gbps Fibre Channel switch module and the Fabric-1 crossbar switching modules enables up to 1.5 Tbps of front-panel Fibre Channel throughput between modules in each direction for each of the four IBM Storage Networking SAN192C-6 payload slots. At 32 Gbps, all linecards operate at full line rate with six fabric modules installed. Based on central arbitration and crossbar fabric, the IBM Storage Networking SAN192C-6 architecture provides 32-Gbps line-rate nonblocking, predictable performance across all traffic conditions for every port in the chassis.
Industry-leading scalability	IBM Storage Networking SAN192C-6 provides up to 12 Tbps of Fibre Channel system bandwidth and 192 full line-rate autosensing Fibre Channel (2/4/8 Gbps, 4/8/16 Gbps, 8/16/32 Gbps) ports in a single chassis. It is designed to meet the requirements of large data center storage environments.
Reliability and availability	
High availability	IBM Storage Networking SAN192C-6 combines nondisruptive software upgrades, stateful process restart and failover, and full redundancy of all major components for best-in-class availability. Redundancy is enabled on all major components, including the fabric card. It provides grid redundancy on the power supply and 1+1 redundant supervisors. When you are using 32 Gbps transceivers in the 32 Gbps switching modules, see Table 1 on page 8 to determine the number of the fabric modules that are necessary to support availability.
Multiprotocol connectivity	
Multiprotocol architecture	The multilayer architecture of the IBM Storage Networking c-type family enables a consistent feature set over a protocol-independent switch fabric. The IBM Storage Networking SAN192C-6 transparently integrates Fibre Channel and FICON. Consider the following points: ● IBM Storage Networking SAN192C-6 supports full line-rate Fibre Channel (4/8/16 Gbps or 8/16/32 Gbps) ports on the 48-Port 32 Gbps Fibre Channel Switching Module for deployment in open systems. ● The IBM Storage Networking SAN192C-6 supports IBM System z® FICON and Linux environments.
Integrated mainframe support	IBM Storage Networking SAN192C-6 supports FICON protocol in cascaded and noncascaded fabrics, and an intermix of FICON and open systems Fibre Channel Protocol traffic on the same switch. IBM Control Unit Port (CUP) support enables in-band management of IBM Storage Networking c-type family switches from mainframe management applications. It also supports a fabric-binding feature that helps ensure that inter-switch links (ISLs) are enabled only between specified switches in the fabric-binding configuration.

Table 2. The main features and benefits of the IBM Storage Networking SAN192C-6 (part 2 of 4)

Feature	Benefit
Software features	
Advanced traffic management	The following advanced traffic management capabilities in IBM Storage Networking SAN192C-6 simplify deployment and optimization of large-scale fabrics: ● Virtual output queue (VOQ): Helps ensure line-rate performance on each port (independent of traffic pattern) by eliminating head-of-line blocking. ● Up to 4095 buffer-to-buffer credits: The use of 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: Allow users to aggregate up to 16 physical ISLs into a single logical bundle, which optimizes bandwidth utilization 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 a module fails. The IBM Storage Networking c-type family switch architecture helps ensure that frames can never be reordered within a switch. ● Fabric Shortest Path First (FSPF)-based multipathing: Provides the intelligence to load balance across up to 16 Fibre Channel equal-cost paths and dynamically reroutes traffic if there is a switch failure. ● QoS: Can prioritize critical traffic to manage bandwidth and control latency.
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 includes the following features: ● Integrated hardware-based VSANs and Inter-VSAN Routing (IVR): Integrating 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: IBM Storage Networking SAN192C-6 interoperates with intelligent service capabilities on other IBM Storage Networking c-type family platforms and the intelligent services switch. You can accelerate storage applications for data replication, backup, and data migration to hosts and targets that are attached to the IBM Storage Networking SAN192C-6. ● Smart zoning: By using this feature, IBM Storage Networking c-type family director fabrics can provision hardware access control entries that are specified by the zone set more efficiently and avoid superfluous entries that allow servers (initiators) to talk to other servers or storage devices (targets) to talk to other storage devices. Large zones with multiple initiators and multiple targets are now possible without consuming excessive hardware resources. Smart zones can correspond to applications, application clusters, hypervisor clusters, or other data center entities. Zoning tasks are automated and the time previously spent creating many small zones is avoided.
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 virtual machine scalability and mobility. DCNM provides end-to-end visibility from the virtual machine to storage, with resource allocation, performance measurements, and predictions available on a per-virtual machine basis.

Table 2. The main features and benefits of the IBM Storage Networking SAN192C-6 (part 3 of 4)

Feature	Benefit
Security	
Comprehensive security	Comprehensive security services include VSANs, hardware-enforced zoning, ACLs, per-VSAN role-based access control (RBAC), and TrustSec Fibre Channel link encryption. The IBM Storage Networking c-type family also supports a comprehensive security framework with RADIUS and TACACS+, FC-SP, Secure File Transfer Protocol (SFTP), Secure Shell (SSH) Protocol, and Simple Network Management Protocol Version 3 (SNMPv3). FC-SP provides switch-to-switch and host-to-switch Diffie-Hellman Challenge Handshake Authentication Protocol (DH-CHAP) supporting RADIUS or TACACS+ to help ensure that only authorized devices access protected storage networks. TrustSec Fibre Channel link encryption, which is available in the IBM Storage Networking c-type family 32-Gbps modules, allows you to transparently encrypt ISLs at up to line-rate speeds, which providing another layer of protection for traffic within and between data centers.
Diagnostics and troubleshooting	
Sophisticated diagnostic tests	IBM Storage Networking SAN192C-6 provides intelligent diagnostic tests, protocol decoding, and network analysis tools; and integrated Call Home capability for added reliability, faster problem resolution, and reduced service costs. Consider the following points: ● For diagnostic tests, IBM Storage Networking SAN192C-6 supports the powerful Generic Online Diagnostics (GOLD) framework. GOLD is a suite of diagnostic facilities to verify that hardware and internal data paths are operating as designed. Boot-time diagnostic tests, 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 the rapid fault isolation and continuous system monitoring that are critical in today's continuously operating environments. ● IBM Storage Networking SAN192C-6 provides the integrated functions that are required to implement diagnostic capabilities. These capabilities include Fibre Channel traceroute for identifying the exact path and timing of flows, and Switched Port Analyzer (SPAN) and Remote SPAN (RSPAN) to capture intelligently network traffic. After traffic is captured, it can be analyzed with the Fabric Analyzer, which is an embedded Fibre Channel analyzer. Comprehensive port-based and flow-based statistics enable sophisticated performance analysis and SLA accounting. With IBM Storage Networking SAN192C-6, IBM delivers a comprehensive tool set for troubleshooting and analysis of storage networks.

Table 2. The main features and benefits of the IBM Storage Networking SAN192C-6 (part 4 of 4)

Feature	Benefit
Management	
Ease of 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, which is a centralized management tool that simplifies the management of unified fabrics. DCNM supports integration with third-party storage management applications to allow transparent interaction with existing management tools. Adhering to the syntax of the widely known IOS Software CLI, the IBM Storage Networking c-type family CLI is easy to learn and delivers broad management capabilities. This highly efficient direct interface optimizes management. You 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. Through the use of the intuitive GUI, DCNM simplifies day-to-day operations of unified fabrics in highly virtualized data center environments. DCNM SAN Advanced Edition supports the following features: ● Event and performance monitoring 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 ● RBAC to provide separation between the network and storage teams DCNM can federate up to 10 DCNM servers to manage up to 150,000 devices by using a single management window. The solution can scale to large enterprise deployments through a scale-out server architecture with automated failover capability. You gain 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. DCNM can be installed on Linux and Microsoft Windows operating systems and supports PostgreSQL and Oracle databases.

Licensing

Table 3 summarizes the optional licenses that can be purchased to enable the extra features and capabilities of the IBM Storage Networking SAN192C-6.

Table 3. Optional licenses

License	Description
Enterprise Package (FC AJJ9)	Includes advanced traffic-engineering and network security features, such as IVR, QoS, and zone-based QoS, FC-SP, port security, VSAN-based access control, and fabric binding for open systems. Licensed per switch for all the ports on the switch.
DCNM SAN Advanced Edition (FC AJJA)	Includes advanced management capabilities, such as VMware vCenter integration, performance trending, advanced provisioning, backup, and dashboards. Licensed per switch for all the ports on the switch.
Mainframe Package (FC AJJB)	Includes FICON protocol support and allows IBM CUP management for in-band management from IBM S/390® and z/900 processors. Licensed per switch for all the ports on the switch.
SAN Insights (FC AJKV)	This feature provides SAN Insights for DCNM. It enables the director to provide on-board and outbound access to the telemetry data provided by the 32 Gbps modules with the added functions of DCNM visualization.

Specifications

This section lists the specifications and supported protocols for the IBM Storage Networking SAN192C-6.

Table 4 summarizes the IBM Storage Networking SAN192C-6 specifications.

Table 4. Product specifications (part 1 of 7)

Feature	Description
Product compatibility	IBM Storage Networking c-type
Software compatibility	NX-OS Software Release 8.1(1b) or later
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 (AJL2) • 48-Port 32-Gbps Fibre Channel Switching Module Bundle (AJL4) • Fabric-1 Switching Module (AJK9) • Enterprise Package (AJJ9) • DCNM SAN Advanced Edition (AJJA) • Mainframe Package (AJJB) • SAN Insights (AKJV) • Small form-factor pluggables (SFPs) • Fans
Indicators	• Power supply LED • FAN LED • Supervisor LED • Fabric LED • Line-card module LED
Fibre Channel standards (protocols)	• 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)

Table 4. Product specifications (part 2 of 7)

Feature	Description
Fibre Channel standards (protocols) (cont.)	• 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) • 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 • IEEE 802.1Qbb-2011: Priority-based flow control (PFC) • IEEE 802.3db-2011: MAC address control frame for priority-based flow control • IEEE 802.1Qaz-2011: Enhanced transmission selection for bandwidth sharing between traffic classes (ETS and DCBX) • 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

Table 4. Product specifications (part 3 of 7)

Feature	Description
Chassis slot configuration	● Line-card slots: 4 ● Supervisor slots: 2 ● Crossbar switching fabric slots: 6* ● Fan trays: 3 fan trays at the back of the chassis ● Power supply bays: 4
Performance and scalability	● Up to 12-Tbps front-panel Fibre Channel switching bandwidth ● Supported Fibre Channel port speeds: o 2/4/8-Gbps autosensing, optionally configurable 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 ● 8191 maximum credits per port Port channel: Up to 16 ports ● Ports per chassis: Up to 192 ports, which can be Fibre Channel (2/4/8-Gbps, 4/8/16/32-Gbps) ● Ports per rack: Up to 768 Fibre Channel (2/4/8-Gbps, 4/8/16-Gbps, 8/16/32-Gbps) ● PortChannel: Up to 16 ports (the channel can span any speed-matched port on any module in the chassis)
Features and functions	
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 and zone-based ● N-Port ID virtualization

*Four fabrics are needed to provide N+1 redundancy.

Table 4. Product specifications (part 4 of 7)

Feature	Description
Features and functions (cont.)	
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 • IBM Fabric Analyzer • Syslog • Online system health • Port-level statistics • Real-Time Protocol Debug
Network security	• VSANs • ACLs • Per-VSAN RBAC • Fibre Channel zoning • N-Port Worldwide Name (WWN) • N-port FC-ID • Fx-port WWN • Fx-port WWN and interface index • Fx-port domain ID and interface index • Fx-port domain ID and port number • FC-SP • DH-CHAP switch-switch authentication • DH-CHAP host-switch authentication • Port security and fabric binding • Management access • SSHv2 implementing Advanced Encryption Standard (AES) • SNMPv3 implementing AES • SFTP • TrustSec Fibre Channel Link Encryption
IBM FICON	• FC-SB-3 compliant • Cascaded FICON fabrics • Intermix of FICON and Fibre Channel FCP traffic • FICON CUP management interface • Exchange-based-routing ready

Table 4. Product specifications (part 5 of 7)

Feature	Description
Features and functions (cont.)	
Serviceability	• Configuration file management • Nondisruptive software upgrades for Fibre Channel interfaces • IBM Call Home • Power-management LEDs • Port beaconing • System LEDs • 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 fabric modules* • Hot-swappable 2N redundant power • Hot-swappable fan trays with integrated temperature and power management • Hot-swappable Enhanced Small Form-Factor Pluggable (SFP+) optics (8/16/32-Gbps Fibre Channel and 10 Gigabit Ethernet) • 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

*Four fabrics are needed to provide N+1 redundancy.

Table 4. Product specifications (part 6 of 7)

Feature	Description
Features and functions (cont.)	
Network management	• Access methods through the Supervisor-1 Module • Out-of-band 10/100/1000 Ethernet port • RS-232 serial console port • In-band IP over Fibre Channel • Access methods through the Fibre Channel switching module • In-band FICON CUP over Fibre Channel • Access protocols • CLI using console and Ethernet ports • SNMPv3 that uses Ethernet port and in-band IP over Fibre Channel access • FICON CUP • Distributed Device Alias service • Network security • Per-VSAN role-based access control that uses RADIUS-based and TACACS+-based authentication, authorization, and accounting (AAA) functions • SFTP • SSHv2 implementing AES • SNMPv3 implementing AES • Management applications • CLI • DCNM
Programming interface	• Scriptable CLI • DCNM web services API • DCNM GUI

Table 4. Product specifications (part 7 of 7)

Feature	Description
Features and functions (cont.)	
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 • FIPS certified • FIPS 140-2 Level 2

Table 5 lists the switching capability per fabric.

Table 5. 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

Physical specifications

Table 6 lists the physical, electrical, and environmental specifications.

Table 6. Physical, electrical, and environmental specifications

Item	Description	
Power and cooling	• Power supplies (3000 W AC) • Input: 100 - 240 V ac nominal (±10% for full range), 16 A nominal; 50 - 60 Hz nominal (±3 Hz for full range) • Output: 1451 W 50 V ±4%/28 A, 3.4 V ±4%/15 A (100 - 120 V AC input), 3051 W 50 V ±4%/60 A, and 3.4 V ±-4%/15 A (200 - 240 V AC input) • Airflow: Front-to-back	
Power consumption (typical)	**IBM Storage Networking SAN 192C-6 with 3 fabrics (Watts [W])**	
	Ports	**Watts**
	96	1465
	192	2425
Environmental	• Temperature, ambient operating: 0 t- 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 - 2000 m (-197 - 6500 ft.)	
Physical dimensions (H x W x D)	• Chassis dimensions (9RU): 39.62 x 43.9 x 81.3 cm (15.6 x 17.3 x 32 in.) • Chassis depth including cable management and chassis doors is 96.52 cm (38 in.) • Unit is rack mountable in a standard 48.26-cm (19-inch) EIA rack, Unit is also 2-post rack mountable	
Weight	• Chassis only: 65.8 kg (145 lb) • Fully configured: 147.42 kg (325 lb.)	

24/10-Port SAN Extension Module specifications

Table 7 lists the specifications for the 24/10-Port SAN Extension Module.

Table 7. Product specifications for the 24/10-Port SAN Extension Module (part 1 of 5)

Feature	Description
Product compatibility	IBM Storage Networking c-type Family Directors
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)

Table 7. Product specifications for the 24/10-Port SAN Extension Module (part 2 of 5)

Feature	Description
Protocols (cont.)	• FC-MI, Revision 1.92 (INCITS TR-30-2002) • FC-MI-2, Revision 2.6 (INCITS TR-39-2005) • 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 7. Product specifications for the 24/10-Port SAN Extension Module (part 3 of 5)

Feature	Description
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 • N-port worldwide name (WWN) • N-port FC-ID • Fx-port WWN • Fx-port WWN and interface index • Fx-port domain ID and interface index • Fx-port domain ID and port number • Logical unit number (LUN) • Read-only • Broadcast • FC-SP • DH-CHAP switch-to-switch authentication • DH-CHAP host-to-switch authentication • Port security and fabric binding • IPsec for FCIP • IKEv1 and v2 • Management access • SSH v2 implementing AES • SNMPv3 implementing AES • 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
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

Table 7. Product specifications for the 24/10-Port SAN Extension Module (part 4 of 5)

Feature	Description
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: • Out-of-band 10/100/1000 Ethernet port (Supervisor-1 Module) • Out-of-band 10/100/1000 Ethernet port (Supervisor-2 Module) • RS-232 serial console port (RJ45 form factor) • In-band IP-over-Fibre Channel Access protocols: • Command-line interface (CLI) through console and Ethernet ports • SNMPv3 through Ethernet port and in-band IP-over-Fibre Channel access • Storage Networking Industry Association (SNIA) Storage Management Initiative Specification (SMI-S) • Distributed device alias service Network security: • Per-VSAN RBAC using RADIUS- and TACACS+-based authentication, authorization, and accounting (AAA) functions • SFTP • SSHv2 implementing AES • SNMPv3 implementing AES Management applications: • CLI • Data Center Network Manager • 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 - 2000 m)
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 7. 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 8 lists the specifications for the 48-Port 32-Gbps Fibre Channel Switching Modules.

Table 8. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (1 of 5)

Item	Description
Product compatibility	IBM System Storage c-type Family 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 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)

Table 8. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (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 8. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (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
	• TrustSec1 Fibre 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 8. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (4 of 5)

Performance	• 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 8. Specifications for the 48-Port 32-Gbps Fibre Channel Switching Module (5 of 5)

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 9 lists supported IBM optics, media, and transmission distances.

Table 9. Supported IBM 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 • 150 m OM3 and 190 m • OM4 10 km

Product specifications for the Supervisor-1 Module

Table 10 lists the specifications for the Supervisor-1 Module.

Table 10. Specifications for the Supervisor-1 Module (part 1 of 3)

Feature	Description
Product compatibility	IBM Storage Networking c-type Family Directors
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 and 10-Gbps fixed speed ports in a single chassis
Chassis slot configuration	Two Supervisor-1 modules are required per system.

Table 10. 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 • IBM 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 10. 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 the 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)

Related publications and links

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
  http://www.redbooks.ibm.com/abstracts/redp5513.html
- IBM Support Fix Central support site (select a product from drop-down menus)
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- IBM System Storage Interoperation Center (SSIC)
  http://www.ibm.com/systems/support/storage/ssic/interoperability.wss
- IBM Storage Networking SAN192C-6
  http://www.ibm.com/systems/storage/san/ctype/9706

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