

Brocade MLX Series Routers



HIGHLIGHTS

- Scalable multiservice IP/MPLS, SDN-enabled routers in 4-, 8-, 16-, and 32-slot chassis options
- Fully distributed, non-blocking, and programmable architecture with up to 15.36 Tbps fabric capacity for maximum performance and investment protection
- 64 100 GbE, 128 40 GbE, 768 10 GbE, and 1,536 1 GbE ports in a single router
- Wire-speed forwarding performance for all software features, including Ethernet, VLAN, IPv4, IPv6, MPLS, VPLS, IPsec, MACsec, and OpenFlow capabilities
- High-availability design with redundant management modules, switch fabrics, power supplies, and fans; hitless failover; hitless software upgrades; and non-stop routing
- Delivers integrated hardware support for OpenFlow 1.3 in the industry's only true hybrid port mode, enabling SDN to seamlessly interwork with existing network forwarding
- Ideal for applications in data center core and interconnects, Wide Area Networks (WANs), and campus cores

Multiservice IP/MPLS SDN Routers

The way organizations communicate and conduct business has changed dramatically in the past decade. Services such as high-definition video streaming, cloud services, and anytime/anywhere mobile connectivity not only consume an enormous amount of network capacity, but also create a greater degree of complexity for network operations. As a result, today's network planners are seeking solutions that provide the right mix of scalability, performance, programmability, and operational simplicity.

The Brocade® MLX® Series of high-performance routers, which includes Brocade MLXe Core Routers, is designed to meet these requirements and many others. Built with a state-of-the-art, sixth-generation, network processor-based architecture and terabit-scale switch fabrics, the Brocade MLX Series provides a rich set of high-performance Layer 2/3, IPv4, IPv6, Multiprotocol Label Switching (MPLS), wire-speed encryption, and Software-Defined Networking (SDN). As a result, these routers address the diverse needs in environments that include the data centers of service provider, enterprise, and public sector organizations; service provider transit and Internet Exchange Points (IXPs); research and education networks; enterprise and public sector campuses; and mobile 4G/LTE service providers.

Scalability Without Compromising Performance

The Brocade MLX Series is highly optimized for IP Ethernet deployments, providing symmetric scaling with chassis options that include 4-, 8-, 16-, and 32-slot systems. These routers offer industry-leading wire-speed port capacity without compromising the performance of advanced software capabilities. For example, the Brocade MLXe-32 delivers

data forwarding performance of 6.4 Tbps and a switch fabric capacity of 15.36 Tbps, enough capacity to future-proof networks for years to come.

However, true router scalability is measured not only in terms of packet forwarding performance, but also in the scalability of the hardware forwarding tables and maturity of the control plane. The Brocade MLX Series offers a flexible scale-as-you-grow model with hardware

Brocade SDN Controller and Brocade MLX Series

The Brocade MLX Series operates seamlessly under the **Brocade SDN Controller**. This controller is a quality-assured edition of the OpenDaylight controller code supported by an established networking provider and its leaders within the OpenDaylight community.

Forwarding Information Base (FIB) capacity options in a wide range of interface modules supporting up to 2.4 million IPv4 routes or 1.8 million IPv6 routes. In addition, the robust control plane has been proven in thousands of mission-critical deployments around the globe.

SDN-Enabled Programmatic Control of the Network

Software-Defined Networking (SDN) is a powerful new network paradigm designed for the world's most demanding networking environments and promises breakthrough levels of customization, scale, and efficiency. The Brocade MLX Series enables SDN by supporting the OpenFlow protocol, which allows communication between an OpenFlow controller and an OpenFlow-enabled router. Using this approach, organizations can control their networks programmatically, transforming the network into a platform for innovation through new network applications and services.

The Brocade MLX Series supports OpenFlow 1.3 in its innovative hybrid port mode, allowing simultaneous deployment of traditional switching or routing with OpenFlow on a single port. This unique capability provides a pragmatic path to SDN by enabling network operators to integrate OpenFlow into existing networks, giving them the programmatic control offered by SDN for specific flows while the remaining traffic is routed as before. Brocade hardware support for OpenFlow enables organizations to apply these capabilities at scale with support for up to 128,000 flows per chassis and line-rate performance for 100 Gigabit Ethernet (GbE), 40 GbE, and 10 GbE networks.

Designed for Non-Stop Networking

Designed to enable reliable converged infrastructures and support mission-critical applications, the Brocade MLX Series features advanced redundant switch fabric architecture for very high availability. The architecture helps ensure that the system continues to operate at

peak performance even in the case of a switch fabric card failure. In the highly unlikely case of additional fabric failures, the advanced architecture allows the system to continue operating in a graceful degradation mode, where the system tunes its performance to the remaining fabric capacity.

The advanced fabric architecture is complemented by comprehensive hardware redundancy for the management modules, power supplies, and cooling system. In addition, the Brocade NetIron operating system offers hitless management failover for IPv4 and IPv6 with Open Shortest Path First (OSPF), IS-IS and IP multicast Non-Stop Routing, and Border Gateway Protocol (BGP) Graceful Restart capabilities—as well as hitless (in-service) software upgrades to further enhance both system availability and overall network availability. With LDP Graceful Restart, MPLS traffic loss is minimized if there is an interruption on the network. To maintain continuous operations in data centers and metro networks, the innovative Brocade Multi-Chassis Trunking (MCT) feature provides fast link and node failover protection while simultaneously maximizing network utilization. For example, MCT supports active/standby redundancy for VPLS and VLL pseudowires, providing flexible options for redundancy in network designs that interconnect multiple data centers. For increased redundancy and functionality, dynamic Layer 3 routing over MCT is also supported.

Advanced Capabilities for a Broad Range of Applications

The Brocade MLX Series provides a wide range of capabilities to support advanced applications and services in the most demanding network environments, including Wide Area Network (WAN), data center, and campus.

The routers enable scalable and resilient Layer 2 Metro Ethernet services that comply with the Metro Ethernet Forum (MEF) specifications for Ethernet Private Line (EPL), Ethernet Virtual Private Line (EVPL), and Ethernet LAN (E-LAN).

Complementing Layer 2 Metro Ethernet capabilities is a powerful suite of MPLS capabilities and services, including MPLS-TE, Fast ReRoute (FRR), MPLS Virtual Leased Line (VLL), Virtual Private LAN Service (VPLS), BGP/MPLS VPNs (MPLS Layer 3 VPNs), and Dynamic Inter-VRF. Routing over VPLS provides Layer 3 forwarding functionality on the VPLS endpoints, thus simplifying management and operations by allowing a single access point for both switching and routing applications. This is ideal for inter-data center connectivity and Virtual Machine (VM) migration in the cloud.

The combination of Layer 2/3 features and advanced MPLS capabilities enables the routers to function in the data center core and connect geographically distributed data centers using standards-based technology such as VPLS. Within the data center, advanced network resiliency features, such as MCT, eliminate the need for spanning tree while enabling efficient usage of network resources through active-active load balancing.

Data Privacy Without Compromising Network Performance

The Brocade MLX 4-port 10 GbE IPsec module for Brocade MLXe Core Routers provides inline IPsec encryption capabilities at wire speed, ensuring data privacy without compromising performance or complicating deployment models. With support for four additional ports of 10 GbE/1 GbE (combo) and four ports of 1 GbE, it supports an industry-leading capacity of more than 44 Gbps encrypted traffic per half-slot module and up to 128 IPsec ports of 10 GbE in a single Brocade MLXe system. The inline ports for IPsec deliver unmatched performance by requiring no service module to be used, freeing up slots in the chassis to be used for other routing applications. This programmability enables one of the strongest cryptographic suites for IPsec—Suite B— available in hardware of the Brocade MLXe Series. For additional security, the module supports IEEE 802.1AE (MACsec), which provides 128-bit Layer 2 hop-by-hop encryption for Local Area Network (LAN) use cases.

The Brocade MLX 20-port 10/1 GbE module for the Brocade MLXe Core Router provides inline IEEE 802.1AE (MACsec), which provides 128-bit MAC layer hop-by-hop encryption for LAN use cases, with up to 640 10 GbE/1 GbE MACsec ports per chassis.

Scalable and Intelligent Network Visibility

The Brocade MLXe Core Router provides visibility capabilities to non-disruptively and transparently tap into a production network with no loss in performance. It filters and extracts relevant network traffic based on the rules configured statically or dynamically on it. Industry-leading port density, low latency, high throughput, and scalability make the Brocade MLXe router a powerful solution for carrier-class environments. By implementing network visibility with Brocade MLXe routers, network operators can increase analytics into network data and traffic, process captured data to evaluate network and application conditions, and generate actionable metrics and reports used for network planning.

Simplified Service Management

Delivering effective MPLS services on Carrier Ethernet infrastructure requires fast fault identification and isolation. The Brocade MLX Series supports MPLS Labeled Switch Path (LSP) ping and trace route features to isolate any MPLS-related connectivity issues. In addition, it supports all the capabilities of IEEE 802.1ag (Connectivity Fault Management), including Connectivity Check Messages, Loopback Message/Response, and LinkTrace Message/Response.

IEEE 802.1ag, in conjunction with the MPLS OAM features, provides the capabilities to monitor, isolate, and identify connectivity problems and reduce the time to repair business VPN services. For performance management on Carrier Ethernet infrastructure, the Brocade MLX Series supports Y.1731 to measure round-trip delay and jitter characteristics between two points in the network. To diagnose link layer connectivity issues, the routers also support the IEEE 802.3ah Link

OAM feature.

In addition, the Brocade MLX Series supports standards-based sFlow traffic monitoring technology, which provides unprecedented visibility into network usage. Integrated into the line module hardware, the sFlow technology enables the monitoring of high-speed links without impacting performance.

To simplify the manageability of Ethernet services, the Brocade MLX Series leverages Brocade Network Advisor, an application that unifies network management for all Brocade products. Brocade Network Advisor provides the easy-to-use MPLS Manager, which can help configure, monitor, and manage VPLS and Virtual Leased Line (VLL) services across networks that are based on Brocade routers. In addition, the sFlow-based technology utilized by Brocade Network Advisor reduces network downtime with proactive monitoring, traffic analysis, and reporting.

Enabling Green Operations

Although adding routers to address bandwidth shortage might initially solve the capacity problem, it does so at the expense of the environment and the opportunity to reduce energy and space costs. Any new solution that fails to reduce energy consumption is only a partial answer to the problem. Each new generation of line modules in the Brocade MLX Series consumes less energy per bit than the previous generation while significantly increasing throughput per module. In addition, the routers provide industry-leading port densities for 1 GbE, 10 GbE, 40 GbE, and 100 GbE interfaces, efficiently consolidating more services and collapsing network layers.

Brocade MLX Series Interface Modules

The Brocade MLX Series provides a wide range of leading-edge Ethernet modules for 1 GbE, 10 GbE, 40 GbE, and 100 GbE that enable organizations to use a single platform for many applications. For more information about these modules, see Tables 1 and 2.

Brocade Global Services

Brocade Global Services has the expertise to help organizations build scalable, efficient cloud infrastructures. Leveraging 15 years of expertise in storage, networking, and virtualization, Brocade Global Services delivers world-class professional services, technical support, and education services, enabling organizations to maximize their Brocade investments, accelerate new technology deployments, and optimize the performance of networking infrastructures.

Affordable Acquisition Options

Brocade Capital Solutions helps organizations easily address their IT requirements by offering flexible network acquisition and support alternatives. Organizations can select from purchase, lease, Brocade Network Subscription, and Brocade Subscription Plus options to align network acquisition with their unique capital requirements and risk profiles. To learn more, visit www.Brocade.com/CapitalSolutions.

Maximizing Investments

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

Table 1. Brocade MLX Series interface modules.

Interface Module	Versions Supported			
	-DM	-M	-X	-X2
24x1 GbE RJ45		•	•	
24x1 GbE Fiber		•	•	
48x1 GbE MRJ21		•		
4x10 GbE		•	•	
8x10 GbE		•	•	
24x10 GbE	•			
20x10 GbE		•		•
20x1 GbE (upgradable to 10 GbE)		•		•
4x10 GbE IPsec		•		
4x40 GbE		•		
2x100 GbE CFP2		•		•
2x100 GbE CFP*			•	
1x100 GbE CFP*			•	

*Denotes full-slot module, all other interface modules are half-slot.

Table 2. Supported route table scalability for Brocade MLX interface modules.

Interface Module Version	Supported Route Table Scalability
-DM	Up to 256,000 IPv4 routes Up to 64,000 IPv6 routes
-M	Up to 512,000 IPv4 routes Up to 256,000 IPv6 routes
-X	Up to 1 million IPv4 routes Up to 240,000 IPv6 routes
-X2	Up to 2.4 million IPv4 routes Up to 1.8 million IPv6 routes

Key Features

4-, 8-, 16-, and 32-slot systems for maximum deployment versatility

Up to 9.5 billion packets per second routing performance with non-blocking 15.36 Tbps data capacity

Ideal for demanding, high-density environments with up to:

- 64 100 GbE ports per system
- 128 40 GbE ports per system
- 768 10 GbE ports per system
- 1,536 1 GbE ports per system

Comprehensive, wire-speed, dual-stack IPv4/IPv6 routing support based on the Brocade Multi-Service IronWare OS:

- High-performance, robust routing using Forwarding Information Base (FIB) programming in hardware
- RIP/RIPng, OSPF/OSPFv3, IS-IS/IS-IS for IPv6, and BGP-4/BGP-MP for IPv6
- Secure Multi-VRF routing for supporting virtual routing applications over non-MPLS backbones
- VRRP and VRRP-E
- Connecting IPv6 islands over IPv4 MPLS using IPv6 Provider Edge (6PE) routers
- 6VPE enabling IPv6 multitenancy to the edge of the cloud

- 127-bit IPv6 interface addresses

Industry-leading scalability up to*:

- 10 million BGP routes
- 2.4 million IPv4 routes in hardware (FIB)
- 1.8 million IPv6 routes in hardware (FIB)
- 153,600 multicast routes
- 2,000 BGP peers per system
- 2,000 BGP/MPLS VPNs and up to 1 million VPN routes
- 48,000 VLLs per system
- 16,000 VPLS instances and up to 1 million VPLS MAC addresses and 64,000 RSVP-TE LSPs
- 4,094 VLANs and up to 2 million MAC addresses
- Large-scale Equal Cost Multi-Path (ECMP): up to 32 paths for unicast and multicast

Software-Defined Networking (SDN):

- OpenFlow 1.3: QoS (for metering and enqueue), Group Table (select and fast failover), QinQ (TAG type auto-recognition), Active-Standby Controller, IPv6, Transport Layer Security (TLS) 1.2 (controller interface)
- Brocade OpenFlow in hybrid port mode with support for sFlow, IP, and MPLS/VPLS (uplinks) with protected VLAN for additional flexibility

- Up to 128,000 flows supported
- True 12-tuple (Layer 2 and Layer 3) matching for a diverse set of applications

Industry-leading performance for MPLS services, providing several service choices:

- IP over MPLS, IPv6 over MPLS (6PE), IPv6 Layer 3 VPNs (6VPE), MPLS over GRE, Virtual Leased Line (VLL), Virtual Private LAN Service (VPLS), BGP/MPLS VPN, Multi-VRF, routing over VPLS, Max VPLS LSP Load Balance Scale for LER, RSVP TE Link Metric for CSPF Computation, RSVP Auto-Bandwidth with Absolute Threshold

Comprehensive MPLS signaling and path calculation algorithms for both traffic-engineered and non-traffic-engineered applications:

- LDP, OSPF-TE, IS-IS-TE, RSVP-TE, CSPF, LDP over RSVP, Point-to-Multipoint (P2MP) RSVP-TE LSP
- MPLS FRR (detour, bypass) and hot standby paths for traffic protection

Superior high-availability design:

- Redundant management modules
- Redundant switch fabrics
- Redundant power supplies and cooling system
- Hitless Layer 2/3 failover with stateful OSPF IS-IS and BGP Graceful Restart
- Hitless (in-service) software upgrades with Graceful Restart

Advanced QoS:

- Hierarchical Quality of Service (H-QoS): Supports up to four levels of hierarchy—port, logical port (optional), customer (optional), and service
- Inbound and outbound two-rate three-color traffic policers with accounting
- Eight distinct priority levels
- WRED support for congestion management and precedence dropping (tunable via configuration)
- Support for hybrid queue servicing disciplines: Mixed, Strict Priority, and Weighted Fair Queuing

Comprehensive hardware-based security and policies:

- Layer 2/3 ACLs (both inbound and outbound)
- Granular ACL accounting (both inbound and outbound)
- Hardware-based packet filtering
- Hardware-based Policy-Based Routing (PBR)
- Unicast Reverse Path Forwarding (uRPF)

- IPv4/IPv6 Receive ACLs
- Extensive sFlow Layer 2-7 traffic monitoring for IPv4, IPv6, and MPLS services
- IPv6 ACL-Based Rate Limiting
- ACL Editing
- Port-based network access control using 802.1x or MAC port security
- Root guard and BPDU guard
- Broadcast, multicast, and unknown unicast rate limits
- ARP inspection for static entries
- Multi-port Static ARP and Static MAC
- 256-bit Suite B Algorithm IP-layer encryption
- 128-bit MAC-layer encryption

Advanced Carrier-grade Ethernet services:

- Ability to reuse VLAN-ID on each port using the Brocade Ethernet Service Instance (ESI) framework
 - MPLS Layer 2 VPN services
 - IEEE 802.1ad Provider Bridges
 - IEEE 802.1ah Provider Backbone Bridges
 - IEEE 802.1ag Connectivity Fault Management
 - ITU Y.1731 OAM functions and mechanisms for Ethernet-based networks
 - Comprehensive set of Layer 2 control protocols: Brocade MRP/MRP-II, VSRP, RSTP, MSTP, and ITU G.8032 Ethernet Ring Protection (ERP version 1 and 2)
 - Multi-Chassis Trunking with support for up to 512 clients (Active/Active mode or Active/Standby mode for Active/Passive access for client ports)
 - E-LINE (EPL and EVPL), E-LAN, and E-TREE support
 - Protocol tunneling of Bridge Protocol Data Units (BPDUs)
 - MEF 9, MEF 14, and MEF 21 certification
- Full suite of unicast and multicast IPv4 and IPv6 routing protocols:
- Supported IPv4 protocols include RIP, OSPF, BGP-4, IS-IS, PIM-DM, PIM-SM/SSM, IGMP, BGP-MP for multicast, MSDP, Anycast RP, PIM Multicast ECMP, and RPF Shortcut
 - Supported IPv6 protocols include RIPng, OSPFv3, IS-IS for IPv6, BGP-MP for IPv6 (BGP4+), PIM-SM/SSM, MLD, VRRPv6, IPv6 Non-Stop Routing (NSR), VRRP-E, PIM Multicast ECMP, and RPF Shortcut

* Scalability limits depend on configured system parameters, -DM/-X/-X2 module types, licenses, system profile selected, and routing database complexity.

Brocade MLX Series at a Glance

Features	MLXe-4	MLXe-8	MLXe-16	MLXe-32
Interface slots	4	8	16	32
Switch fabric capacity	1.92 Tbps	3.84 Tbps	7.68 Tbps	15.36 Tbps
Data forwarding capacity	1.6 Tbps	3.2 Tbps	6.4 Tbps	12.8 Tbps
Packet routing performance	1.19 billion pps	2.38 billion pps	4.75 billion pps	9.5 billion pps
Maximum 100 GbE ports	8	16	32	64
Maximum 40 GbE ports	16	32	64	128
Maximum 10 GbE ports	96	192	384	768
Maximum 1 GbE ports	192	384	768	1,536
Height (inches/rack units)	8.71 in./5RU	12.21 in./7RU	24.50 in./14RU	57.75 in./33RU
Management module redundancy	1:1	1:1	1:1	1:1
Switch fabric redundancy	N+1	N+1	N+1	N+1
Power supply redundancy	1+1	1+1	1+1	1+1
Airflow	Side to back	Side to back	Front to back	Front to back

Brocade MLX Series Power Specifications

	MLXe-4	MLXe-8	MLXe-16	MLXe-32
Maximum DC power consumption (W)	2,083	4,060	7,107	14,232
Maximum AC power consumption (W) (100-240 VAC)	2,083	4,060	7,107	14,232
Maximum thermal output (BTU/HR)	7,108	13,858	24,255	48,575

Brocade MLX Series Physical Specifications

Mode	Dimensions	Weight
Brocade MLXe-4	17.20 in. W × 8.71 in. H × 23.0 in. D (43.69 cm × 22.12 cm × 58.42 cm)	117 lb (53 kg)
Brocade MLXe-8	17.20 in. W × 12.21 in. H × 24.0 in. D (43.69 cm × 31.01 cm × 60.96 cm)	171 lb (78 kg)
Brocade MLXe-16	17.20 in. W × 24.47 in. H × 24.18 in. D (43.69 cm × 62.15 cm × 61.42 cm)	351 lb (159 kg)
Brocade MLXe-32	17.45 in. W × 57.75 in. H × 26.88 in. D (44.32 cm × 146.69 cm × 68.28 cm)	505 lb (229 kg)

Brocade MLX Series Specifications

IEEE Compliance

- 802.3-2005 CSMA/CD Access Method and Physical Layer Specifications
- 802.3ab 1000BASE-T
- 802.3ae 10 Gigabit Ethernet
- 802.3u 100BASE-TX, 100BASE-T4, 100BASE-FX Fast Ethernet at 100 Mbps with Auto-Negotiation
- 802.3x Flow Control
- 802.3z 1000BASE-X Gigabit Ethernet over fiber optic at 1 Gbps
- 802.3ad Link Aggregation
- 802.3ah Ethernet in the First Mile
- 802.1Q Virtual Bridged LANs
- 802.1D MAC Bridges
- 802.1w Rapid STP
- 802.1s Multiple Spanning Trees
- 802.1ad Provider Bridges; partial support: port-based and S-tagged service interface
- 802.1ag Connectivity Fault Management (CFM)
- 802.3.ba 100 Gigabit Ethernet
- 802.1ab Link Layer Discovery Protocol
- 802.1ah Provider Backbone Bridging
- 802.1ae MAC Security standard

ITU Compliance

- Y.1731 OAM functions and mechanisms for Ethernet-based networks
- G.8032 Ethernet Ring Protection (ERP version 1 and 2)

RFC Compliance

- | | |
|-------|---|
| BGPv4 | <ul style="list-style-type: none">• RFC 1745 OSPF Interactions• RFC 1772 Application of BGP in the Internet• RFC 1997 Communities and Attributes• RFC 2385 BGP Session Protection via TCP MD5• RFC 2439 Route Flap Dampening• RFC 2918 Route Refresh Capability• RFC 3392 Capability Advertisement• RFC 3682 Generalized TTL Security Mechanism, for eBGP Session Protection• RFC 4271 BGPv4• RFC 4273 BGP-4 MIB• RFC 4456 Route Reflection• RFC 4486 Sub Codes for BGP Cease Notification Message• RFC 4724 Graceful Restart Mechanism for BGP• RFC 4893 BGP Support for Four-octet AS Number Space• RFC 5065 BGP4 Confederations• RFC 5291 Outbound Route Filtering Capability for BGP-4• RFC 5396 Textual Representation of Autonomous System (AS) Numbers• RFC 5668 4-Octet AS specific BGP Extended Community |
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OSPF

- RFC 2328 OSPF v2
- RFC 3101 OSPF NSSA
- RFC 1745 OSPF Interactions
- RFC 1765 OSPF Database Overflow
- RFC 1850 OSPF v2 MIB
- RFC 2154 OSPF w/Digital Signature(Password, MD-5)
- RFC 2370 OSPF Opaque LSA Option
- RFC 3137 OSPF Stub Router Advertisement
- RFC 3630 TE Extensions to OSPF v2
- RFC 3623 Graceful OSPF Restart (helper mode)
- RFC 4222 Prioritized Treatment of Specific OSPF Version 2
- RFC 5250 OSPF Opaque LSA option

IS-IS

- RFC 1195 Routing in TCP/IP and Dual Environments
- RFC 1142 OSI IS-IS Intra-domain Routing Protocol
- RFC 3277 IS-IS Blackhole Avoidance
- RFC 5120 IS-IS Multi-Topology Support
- RFC 5301 Dynamic Host Name Exchange
- RFC 5302 Domain-wide Prefix Distribution
- RFC 5303 Three-Way Handshake for IS-IS Point-to-Point
- RFC 5304 IS-IS Cryptographic Authentication(MD-5)
- RFC 5306 Restart Signaling for ISIS (helper mode)

RIP

- RFC 1058 RIP v1
- RFC 2453 RIP v2
- RFC 1812 RIP Requirements

IPv4 Multicast

- RFC 1122 Host Extensions
 - RFC 1112 IGMP v1
 - RFC 2236 IGMP v2
 - RFC 2362 PIM-SM
 - RFC 3376 IGMP v3
 - RFC 3569 Overview of SSM
 - RFC 3618 MSDP
 - RFC 3973 PIM-DM
 - RFC 4610 Anycast RP using PIM
 - RFC 4611 MSDP Deployment Scenarios
 - RFC 4760 BGP-MP
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General Protocols	<ul style="list-style-type: none"> • RFC 768 UDP • RFC 791 IP • RFC 792 ICMP • RFC 793 TCP • RFC 826 ARP • RFC 854 TELNET • RFC 894 IP over Ethernet • RFC 903 RARP • RFC 906 TFTP Bootstrap • RFC 950 Subnet • RFC951 BootP • RFC 1027 Proxy ARP • RFC 1042 Standard for The Transmission of IP • RFC 1166 Internet Numbers • RFC 1122 Host Extensions for IP Multicasting • RFC 1191 Path MTU Discovery • RFC 1256 IRDP • RFC 1340 Assigned Numbers • RFC 1519 CIDR • RFC 1542 BootP Extensions • RFC 1591 DNS (client) • RFC 1812 Requirements for IPv4 Routers • RFC 1858 Security Considerations for IP Fragment Filtering • RFC 2131 BootP/DHCP Helper • RFC 2578 Structure of Management Information Version 2 • RFC 2784 Generic Routing Encapsulation • RFC 3021 Using 31-Bit Prefixes on IPv4 Point-to-Point Links • RFC 3768 VRRP • RFC 4001 Textual Conventions for Internet Network Addresses • RFC 4950 ICMP Extensions for MPLS • RFC 4459 MTU and Fragmentation 	Other	<ul style="list-style-type: none"> • RFC 2474 DiffServ Definition • RFC 2475 An Architecture for Differentiated Services • RFC 2597 Assured Forwarding PHB Group • RFC 2697 Single Rate Three Color Marker • RFC 2698 A Two-Rate Three-Color Marker • RFC 3246 An Expedited Forwarding PHB • RFC 1354 IP Forwarding MIB • RFC 1757 RMON Groups 1, 2, 3, 9 • RFC 2068 HTTP • RFC 2665 Ethernet Interface MIB • RFC 2784 Generic Routing Encapsulation (GRE) • RFC 2865 RADIUS • RFC 2863 Interfaces Group MIB • RFC 3176 sFlow • RFC 4087 IP Tunnel MIB • RFC 4133 Entity MIB • RFC 4293 - IP MIB • RFC 5905 NTP Version 4 • RFC 4741 NETCONF (Partial) • RFC 5961 TCP Security • RFC 5880 Bidirectional Forwarding Detection (BFD)
QoS	<ul style="list-style-type: none"> • RFC 2474 DiffServ Definition • RFC 2475 An Architecture for Differentiated Services • RFC 2597 Assured Forwarding PHB Group • RFC 2697 Single Rate Three Color Marker • RFC 2698 A Two-Rate Three-Color Marker • RFC 3246 An Expedited Forwarding PHB 	IPv6 Core	<ul style="list-style-type: none"> • RFC 1887 IPv6 unicast address allocation architecture • RFC 1981 IPv6 Path MTU Discovery • RFC 2375 IPv6 Multicast Address Assignments • RFC 2450 Proposed TLA and NLA Assignment Rules • RFC 2460 IPv6 Specification • RFC 2462 IPv6 Stateless Address—Auto-Configuration • RFC 2464 Transmission of IPv6 over Ethernet Networks • RFC 2471 IPv6 Testing Address allocation • RFC 2711 IPv6 Router Alert Option • RFC 3587 IPv6 Global Unicast—Address Format • RFC 4193 Unique Local IPv6 Unicast Addresses • RFC 4291 IPv6 Addressing Architecture • RFC 4301 IP Security Architecture • RFC 4303 Encapsulation Security Payload • RFC 4305 ESP and AH cryptography • RFC 4443 ICMPv6 • RFC 4552 Auth for OSPFv3 using AH/ESP • RFC 4835 Cryptographic Alg. Req. for ESP • RFC 4816 Neighbor Discovery for IP version 6 (IPv6)

IPv6 Routing	<ul style="list-style-type: none"> • RFC 2080 RIPng for IPv6 • RFC 2740 OSPFv3 for IPv6 • RFC 5308 Routing IPv6 with IS-IS • RFC 2545 Use of BGP-MP for IPv6 • RFC 6106 Support for IPv6 Router Advertisements with DNS Attributes • RFC 6164 Using 127-Bit IPv6 Prefixes on Inter-Router Links 	Layer 3 VPN	<ul style="list-style-type: none"> • RFC 3107 Carrying Label Information in BGP-4 • RFC 4360 BGP Extended Communities Attribute • RFC 4364 BGP/MPLS IP VPNs • RFC 4365 Applicability Statement for BGP/MPLS IP VPNs • RFC 4382 MPLS/BGP Layer 3 VPN MIB • RFC 4576 Using LSA Options Bit to Prevent Looping in BGP/MPLS IP VPNs (DN Bit) • RFC 4577 OSPF as the PE/CE Protocol in BGP/MPLS IP VPNs • RFC 4760 Multiprotocol Extensions for BGP-4
IPv6 Multicast	<ul style="list-style-type: none"> • RFC 2710 Multicast Listener Discovery (MLD) for IPv6 • RFC 3810 Multicast Listener Discovery Version 2 for IPv6 • RFC 4601 PIM-SM • RFC 4604 IGMPv3 and MLDv2 for SSM • RFC 4607 Source-Specific Multicast for IP 	Layer 2 VPN and PWE3	<ul style="list-style-type: none"> • RFC 3343 TTL Processing in MPLS networks • RFC 4664 Framework for Layer 2 Virtual Private Networks • RFC 4665 Service Requirements for Layer 2 Provider-Provisioned Virtual Private Networks • RFC 4762 VPLS using LDP Signaling • RFC3985 Pseudowire Emulation Edge to Edge (PWE3) Architecture • RFC 4447 Pseudowire Setup and Maintenance using LDP • RFC 4448 Encapsulation Methods for Transport of Ethernet over MPLS Networks • RFC 5542 Definitions of Textual Conventions for Pseudowire (PW) Management • RFC 5601 Pseudowire (PW) Management Information Base
IPv6 Transitioning	<ul style="list-style-type: none"> • RFC 3056 Connection of IPv6 Domains via IPv4 Clouds • RFC 4213 Transition Mechanisms for IPv6 Hosts and Routers • RFC 4798 Connecting IPv6 Islands over IPv4 MPLS Using IPv6 Provider Edge Routers • RFC 4659 BGP-MPLS IP Virtual Private Network (VPN) Extension for IPv6 VPN 	Encryption	<ul style="list-style-type: none"> • RFC 5996 Internet Key Exchange Protocol Version 2 (IKEv2) • RFC 4303 IP Encapsulating Security Payload (ESP) • RFC 6379 Suite B Cryptographic Suites for IPsec • RFC 5903 Elliptic Curve Groups modulo a Prime (ECP Groups) for IKE and IKEv2 • RFC 4868 Using HMAC-SHA-256, HMAC-SHA-384, and HMAC-SHA-512 with IPsec • RFC 4754 IKE and IKEv2 Authentication Using the Elliptic Curve Digital Signature Algorithm(ECDSA) • RFC 4106 The Use of Galois/Counter Mode (GCM) in IPsec Encapsulating Security Payload (ESP) • RFC 3602 AES with 128-bit keys in CBC mode • RFC 4806 Online Certificate Status Protocol (OCSP) Extensions to IKEv2 • FIPS PUB 186-4 Digital Signature Standard (DSS) • SP800-56A Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography
MPLS	<ul style="list-style-type: none"> • RFC 2205 RSVP v1 Functional Specification • RFC 2209 RSVP v1 Message Processing Rules • RFC 2702 TE over MPLS • RFC 2961 RSVP Refresh Overhead Reduction Extensions • RFC 3031 MPLS Architecture • RFC 3032 MPLS Label Stack Encoding • RFC 3037 LDP Applicability • RFC 3097 RSVP Cryptographic Authentication • RFC 3209 RSVP-TE • RFC 3270 MPLS Support of Differentiated Services • RFC 3813 MPLS LSR MIB • RFC 3815 Definition of Managed Objects for the MPLS, LDP • RFC 4090 Fast Reroute Extensions to RSVP-TE for LSP Tunnels; partial support • RFC 4379 OAM • RFC 4448 Encapsulation methods for transport of Ethernet over MPLS networks • RFC 4461 Signaling Requirements for Point-to-Multipoint Traffic-Engineered MPLS Label Switched Path(LSR) • RFC 4875 Extensions to RSVP-TE for P2MP TE LSPs • RFC 5036 LDP Specification • RFC 5305 ISIS-TE • RFC 5443 LDP IGP Synchronization • RFC 5561 LDP Capabilities • RFC 5712 MPLS Traffic Engineering Soft Preemption • RFC 5918 LDP "Typed Wildcard" FEC • RFC 5919 Signaling LDP Label Advertisement Completion 		

Federal Certification

FIPS: FIPS 140-2 Level 2 with Design Assurance for Level 3
Common Criteria: Network Device Protection Profile version 1.1
USGv6: UNH-IOL USGv6 accreditation as Switch and Router
JITC: 1. DoD UC APL for Assured Services LAN (ASLAN) Layer 2/3 switch with MPLS
2. DoD UC APL for Customer Edge Router

MEF Certification

- MEF 9 Certified—Abstract Test Suite for Ethernet Services at the UNI
 - MEF 14 Certified—Abstract Test Suite for Traffic Management Phase 1
-

Network Management

- Brocade Network Advisor Web-based Graphical User Interface (GUI)
 - Integrated industry-standard Command Line Interface (CLI)
 - sFlow (RFC 3176)
 - Telnet
 - SNMP v1, v2c, v3
 - SNMP MIB II
 - RMON
 - Support for automated configuration management using NETCONF
 - Entity MIB (Version 3)
-

Element Security Options

- TLS 1.1 and 1.2
 - AAA
 - RADIUS
 - Secure Shell (SSH v2)
 - Secure Copy (SCP v2)
 - HTTPs
 - TACACS/TACACS+
 - Username/Password (Challenge and Response)
 - Bi-level Access Mode (Standard and EXEC Level)
 - Protection against Denial of Service (DoS) attacks, such as TCP SYN or Smurf Attacks
-

Environmental

- Operating temperature: 0°C to 40°C (32°F to 104°F)
- Storage temperature: -25°C to 70°C (-13°F to 158°F)
- Relative humidity: 5% to 90%, at 40°C (104°F), non-condensing
- Storage humidity: 95% maximum relative humidity, non-condensing
- Operating altitude: 6,600 ft (2,012 m)
- Storage altitude: 15,000 ft (4,500 m) maximum

Safety Agency Approvals

- CAN/CSA-C22.2 No. 60950-1-3
 - UL 60950-1
 - IEC 60950-1
 - EN 60950-1 Safety of Information Technology Equipment
 - EN 60825-1 Safety of Laser Products—Part 1: Equipment Classification, Requirements and User's Guide
 - EN 60825-2 Safety of Laser Product—Part 2: Safety of Optical Fibre Communication Systems
-

Electromagnetic Emission

- ICES-003 Electromagnetic Emission
 - FCC Class A
 - EN 55022/CISPR-22 Class A/VCCI Class A
 - AS/NZS 55022
 - EN 61000-3-2 Power Line Harmonics
 - EN 61000-3-3 Voltage Fluctuation and Flicker
 - EN 61000-6-3 Emission Standard (supersedes EN 50081-1)
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Immunity

- EN 61000-6-1 Generic Immunity and Susceptibility (supersedes EN 50082-1)
 - EN 55024 Immunity Characteristics. Supersedes:
 - EN 61000-4-2 ESD
 - EN 61000-4-3 Radiated, radio frequency, electromagnetic field
 - EN 61000-4-4 Electrical fast transient
 - EN 61000-4-5 Surge
 - EN 61000-4-6 Conducted disturbances induced by radio-frequency fields
 - EN 61000-4-8 Power frequency magnetic field
 - EN 61000-4-11 Voltage dips and sags
-

TELCO NEBS/ETSI

Designed to meet the following specifications (formal testing under way):

- Telcordia GR-63-CORE NEBS Requirements: Physical Protection
- Telcordia GR-1089-CORE EMC and Electrical Safety
- Telcordia SR-3580 Level 3
- ETSI ETS 300-019 Physical Protection
- Part 1-1, Class 1.1, Partly Temperature Controlled Storage Locations
- Part 1-2, Class 2.3, Public Transportation
- Part 1-3, Class 3.1, Temperature Controlled Locations (Operational)
- ETSI ETS 300-386 EMI/EMC

Power and Grounding

- ETS 300 132-1 Equipment Requirements for AC Power Equipment Derived from DC Sources
 - ETS 300 132-2 Equipment Requirements for DC Powered Equipment
 - ETS 300 253 Facility Requirements
-

Physical Design and Mounting

- | | |
|------------|--|
| Rack mount | 19-inch rack mount supporting racks compliant with: <ul style="list-style-type: none">• ANSI/EIA-310-D• ETS 300 119• GR-63-CORE Seismic Zone 4 |
|------------|--|
-

Tabletop

Environmental Regulatory Compliance

- EU 2002/95/EC RoHS (with lead exemption)
 - EU 2002/96/EC WEEE
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Network Equipment Building Standards (NEBS)

- GR-1089-CORE NEBS EMC and Safety
 - GR-63 CORE: NEBS Physical Protection
 - SR-3580: NEBS Criteria Levels (Level 3)
-

Brocade MLX Series Ordering Information

Part Number	Description
BR-MLXE-4-MR2-M-AC	Brocade MLXe-4 AC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-4-MR2-M-DC	Brocade MLXe-4 DC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-4-MR2-X-AC	Brocade MLXe-4 AC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-4-MR2-X-DC	Brocade MLXe-4 DC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W DC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-8-MR2-M-AC	Brocade MLXe-8 AC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-8-MR2-M-DC	Brocade MLXe-8 DC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W DC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-8-MR2-X-AC	Brocade MLXe-8 AC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-8-MR2-X-DC	Brocade MLXe-8 DC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W DC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-16-MR2-M-AC	Brocade MLXe-16 AC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-16-MR2-M-DC	Brocade MLXe-16 DC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W DC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-16-MR2-X-AC	Brocade MLXe-16 AC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-16-MR2-X-DC	Brocade MLXe-16 DC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W DC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-32-MR2-M-AC	Brocade MLXe-32 AC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-32-MR2-M-DC	Brocade MLXe-32 DC system with one MR2 (M) management module, two high-speed switch fabric modules, one 1,800 W DC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-32-MR2-X-AC	Brocade MLXe-32 AC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W AC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLXE-32-MR2-X-DC	Brocade MLXe-32 DC system with one MR2 (X) management module, two high-speed switch fabric modules, one 1,800 W DC power supply, four exhaust fan assembly kits, and air filter. Power cord not included.
BR-MLX-MR2-M	Brocade MLX system management module, 4 GB SDRAM, 2 GB internal compact flash, external compact flash slot, EIA/TIA-232 and 10/100/1,000 Ethernet ports for out-of-band management
BR-MLX-MR2-X	Brocade MLXe system management module, 4 GB SDRAM, 2 GB internal compact flash, external compact flash slot, EIA/TIA-232 and 10/100/1,000 Ethernet ports for out-of-band management
BR-MLX-32-MR2-M	Brocade MLX 32-slot system management module, 4 GB SDRAM, 2 GB internal compact flash, external compact flash slot, EIA/TIA-232 and 10/100/1,000 Ethernet ports for out-of-band management
BR-MLX-32-MR2-X	Brocade MLXe 32-slot system management module, 4 GB SDRAM, 2 GB internal compact flash, external compact flash slot, EIA/TIA-232 and 10/100/1,000 Ethernet ports for out-of-band management
NI-X-4-HSF	Brocade MLX 4-slot system high-speed switch fabric module
NI-X-16-8-HSF	Brocade MLX 8/16-slot system high-speed switch fabric module
NI-X-32-HSF	Brocade MLX 32-slot system high-speed switch fabric module
BR-MLX-10GX4-IPSEC-M	Brocade MLX 4-port 10 GbE/1 GbE combo and 4-port 1 GbE (-M) IPsec module with 512,000 IPv4 routes or 240,000 IPv6 routes in hardware

Brocade MLX Series Ordering Information (Continued)

Part Number	Description
BR-MLX-100GX2-CFP2-X2	Brocade MLX 2-port 100 GbE (X2) CFP2 module with extended route table support for up to 2.4 million IPv4 or 1.8 million IPv6 routes in hardware
BR-MLX-100GX2-CFP2-M	Brocade MLX 2-port 100 GbE (M) CFP2 module. Supports 512,000 IPv4 routes in FIB.
BR-MLX-100Gx2-X	Brocade MLX Series 2-port 100 GbE module with IPv4/IPv6/MPLS hardware support—requires high-speed switch fabric modules and CFP optics
BR-MLX-100Gx1-X	Brocade MLX Series 1-port 100 GbE module with IPv4/IPv6/MPLS hardware support—requires high-speed switch fabric modules and CFP optics
BR-MLX-100Gx1-2PUPG	Brocade MLX Series 100 GbE second port license—requires CFP optics
BR-MLX-40Gx4-M	Brocade MLX Series 4-port 40 GbE (M) module with IPv4/IPv6/MPLS hardware support and support for QSFP+ optics, including both LR and SR versions. Supports up to 512,000 IPv4 routes or 128,000 IPv6 routes. Requires high-speed switch fabric modules.
BR-MLX-10GX20-X2	Brocade MLX 20-port 10 GbE/1 GbE (X2) SFP+ and SFP combo module with extended route table support for up to 2.4 million IPv4 or 1.8 million IPv6 routes in hardware. Integrated hardware-enabled MACsec.
BR-MLX-10GX20-M	Brocade MLX 20-port 10 GbE/1 GbE (M) combo module. Supports SFP+ and SFP with up to 512,000 IPv4 routes or 240,000 IPv6 routes in FIB. Integrated hardware-enabled MACsec.
BR-MLX-10GX24-DM	Brocade MLXe 24-port 10 GbE module with IPv4/IPv6/MPLS hardware support—requires SFP optics. Supports 256,000 IPv4 routes in FIB.
BR-MLX-10Gx8-X	Brocade MLX Series 8-port 10 GbE (X) module with IPv4/IPv6/MPLS hardware support—requires SFP optics. Supports up to 1 million IPv4 routes in FIB. Requires high-speed switch fabric modules.
NI-MLX-10Gx8-M	Brocade MLX Series 8-port 10 GbE (M) module with IPv4/IPv6/MPLS hardware support and up to 512,000 IPv4 routes—requires SFP+ optics and high-speed switch fabric modules
BR-MLX-10Gx4-X	Brocade MLX Series 4-port 10 GbE (X) module with IPv4/IPv6/MPLS hardware support—requires XFP optics. Supports 1 million IPv4 routes in hardware.
BR-MLX-10Gx4-X-ML	Brocade MLX/MLXe 4-port 10 GbE (ML) module with IPv4/IPv6/MPLS hardware support—requires XFP optics. Supports 512,000 IPv4 routes in FIB. License upgradable to "X" scalability (1 million IPv4 routes in hardware).
NI-MLX-48-T-A	Brocade MLX Series 48-port 10/100/1000BASE-T, MRJ21 module with IPv4/IPv6/MPLS hardware support
BR-MLX-1GFX24-X	Brocade MLX Series 24-port FE/GbE (SFP) module, with IPv4/IPv6/MPLS hardware support. Supports 1 million IPv4 routes in hardware.
BR-MLX-1GFX24-X-ML	Brocade MLX Series 24-port FE/GbE (SFP) module, with IPv4/IPv6/MPLS hardware support. Supports 512,000 IPv4 routes in FIB. License upgradable to "X" scalability (1 million IPv4 routes in hardware).
BR-MLX-1GCX24-X	Brocade MLX 24-port (X) 10/100/1,000 copper (RJ-45) module with IPv4/IPv6/MPLS hardware support. Supports 1 million IPv4 routes in hardware.
BR-MLX-1GCX24-X-ML	Brocade MLX 24-port (X) 10/100/1,000 copper (RJ-45) module with IPv4/IPv6/MPLS hardware support. Supports 512,000 IPv4 routes in FIB. License upgradable to "X" scalability (1 million IPv4 routes in hardware).
BR-MLX-1GX20-U10G-M	Brocade MLX 20-port 1 GbE (M) module. Upgradable to 10 GbE using additional software license. Supports SFP with up to 512,000 IPv4 routes or 240,000 IPv6 routes in hardware.
BR-MLX-1GX20-U10G-MUPG	Brocade MLX 20-port license to upgrade from 1 GbE to 10 GbE (M).
BR-MLX-1GX20-U10G-X2	Brocade MLX 20-port 1 GbE (X2) module. Upgradable to 10 GbE using additional software license. Supports SFP with up to 2 million IPv4 routes or 800,000 IPv6 routes in hardware. Integrated hardware-enabled MACsec.
BR-MLX-1GX20-U10G-X2UPG	Brocade MLX 20-port license to upgrade from 1 GbE to 10 GbE (X2).

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