

Brocade CES 2000 Series



HIGHLIGHTS

- Compact 1U IP/MPLS/VRF-enabled, NEBS Level 3-certified switch that is purpose-built for advanced Carrier Ethernet, large data center applications, and Software-Defined Networking (SDN)
- Wire-speed, non-blocking performance in all configurations
- Available in 24-port and 48-port configurations in both Hybrid Fiber (HF) and RJ45 versions to suit versatile access/aggregation media with four or two 10 GbE ports
- Powered by the field-proven Brocade Multi-Service IronWare OS that also runs on the Brocade MLXe Series of high-performance routers
- Integrated support for OpenFlow 1.3 in true hybrid mode, enabling SDN for programmatic control of the network while simultaneously supporting traditional forwarding to protect existing investments
- Advanced and highly scalable IPv4/IPv6 routing and Carrier Ethernet services, including E-LINE, E-LAN, and E-TREE
- MEF 9-, MEF 14-, and MEF 21-certified, with comprehensive service OAM capabilities

Multi-Service Compact Ethernet Switch Series

Network planners today must increasingly extend the range of their service offerings to the edge of carrier networks. However, extending intelligence and high-touch processing capabilities to the network edge requires the ability to flexibly define and easily manage services in an efficient manner. As a result, Quality of Service (QoS), resiliency, and security are critical factors in the deployment of these Ethernet-based services.

Whether they are located at a central office or remote site, the availability of space often determines the feasibility of deploying new equipment and services within a service provider, campus, or data center environment. To meet these challenges, the Brocade® CES 2000 Series is purpose-built to provide flexible, resilient, secure, and advanced Ethernet and MPLS-based services in a compact form factor.

The Brocade CES 2000 Series is a family of compact 1U, multiservice edge/aggregation switches that combine powerful capabilities with high performance and availability. The switches provide a broad set of advanced Layer 2, IPv4, IPv6, MPLS, and Software-Defined Networking (SDN) capabilities in the same device. As a result, they support a diverse set of applications in metro edge, service provider, mobile backhaul wholesale, data center, and large enterprise networks.

Providing Carrier-Class Resiliency with Multi-Service IronWare

The Brocade CES 2000 Series is built on the same Brocade Multi-Service IronWare operating system that powers mission-critical Brocade MLX Series

Routers, simplifying integration with existing networks. Key capabilities include an industry-standard interface, support for robust routing protocols, MPLS VPNs, advanced Layer 2 protocols, OpenFlow, a broad range of OAM protocols, advanced security, and simplified management.

Enabling True Carrier-Grade Ethernet Services

Carrier Ethernet is a ubiquitous offering defined by five attributes—standardized services, scalability, service management, reliability, and QoS—all of which are supported by the Brocade CES 2000 Series.

A Carrier Ethernet service can be delivered over any transport technology as long as it satisfies the standards and

KEY APPLICATIONS

- Large-scale Carrier Ethernet build-outs at the global, national, and metro levels—combined with Brocade MLX® Series Routers
- High-density aggregation of access devices such as DSLAMs, GPON/EPON OLTs, or CMTS systems at the network edge
- Edge aggregation switching and routing applications in metro networks
- MPLS access and aggregation
- Multiple security zones and simplified VPNs for enterprise and campus networks using Multi-VRF
- Mobile backhaul over Carrier Ethernet infrastructure for wholesale
- Fiber To The Curb (FTTC) and Fiber To The Building (FTTB) applications with stringent Service Level Agreements (SLAs)
- Aggregation in ISP networks
- High-performance data center top-of-rack server access with high-touch processing and deep buffering

attributes associated with the service.

Examples of possible underlying transport mechanisms include native Ethernet using 802.1Q VLANs, MPLS-based Layer 2 VPNs, IEEE 802.1ad PBs, and IEEE 802.1ah PBBs.

Standardized Services

Because the Brocade CES 2000 Series is certified for MEF 9, MEF 14, and MEF 21, providers can offer E-LINE, E-LAN, and E-TREE services—the standardized service names for point-to-point, multipoint, and rooted multipoint services. These services can be offered using 802.1Q VLANs, PBs, PBBs, or MPLS Layer 2 VPNs.

Scalability

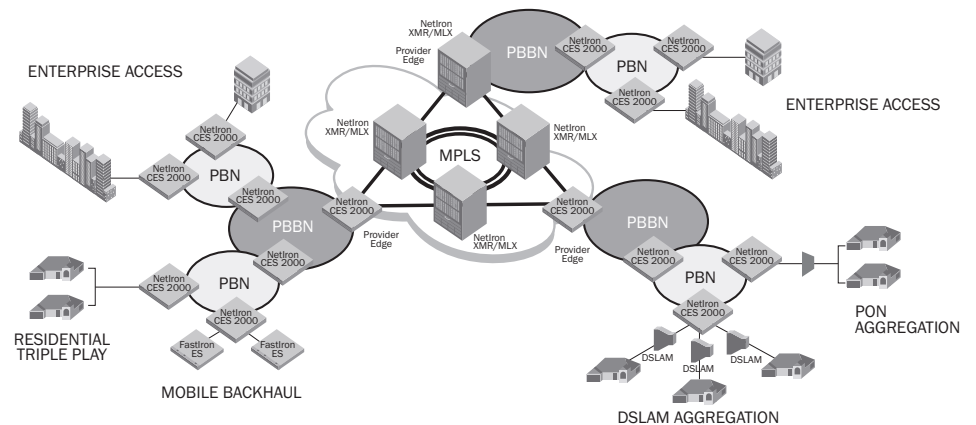
The Brocade CES 2000 Series supports up to 128,000 MAC addresses per system. Support for 100/1000 Mbps SFP ports or 10/100/1000 Mbps RJ45 ports (with wire-speed performance even at full load) helps ensure available capacity on user-facing ports to accommodate provider customers that want to upgrade to a higher-bandwidth service. In addition, the use of Link Aggregation Groups (LAGs) enables the aggregation of multiple links to provide even higher-bandwidth services at the User Network Interface (UNI).

To support highly scalable Carrier Ethernet services, Brocade has developed an innovative framework called Ethernet Service Instance (ESI). Using the ESI framework, providers can flexibly define and assign VLANs to service instances within the network—enabling them to rapidly instantiate and easily manage E-LINE, E-LAN, and E-TREE services.

Service Management

Specifications such as IEEE 802.1ag (Connectivity Fault Management) and MEF 17 (Service OAM Framework and Specifications) enable fast, proactive identification and isolation of faults in the network or service, helping to increase service uptime and the ability to meet SLAs.

The Brocade CES 2000 Series supports all the capabilities in IEEE 802.1ag, including Connectivity Check Messages, Loopback Message/Response, and LinkTrace Message/Response. It allows flexible association and definition of both Maintenance End Points (MEPs) and Maintenance Intermediate Points (MIPs) within a network. Fault management functions of MEF 17 Service OAM are also supported. Together, these tools provide the capabilities to monitor, diagnose, and centrally manage the network.



LEGEND: PB: Provider Bridge (802, 1AD). PBB: Provider Backbone Bridge (802, 1AH). PBN: Provider Bridged Network. PBBN: Provider Backbone Bridged Network.

Figure 1: A possible application of using PBB technology on Brocade CES 2000 Series Switches in a large Carrier Ethernet network.

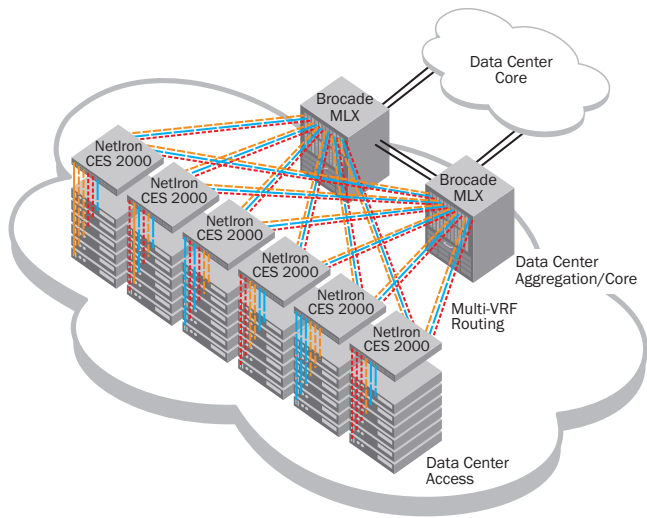


Figure 2: The Brocade CES 2000 Series supports Multi-VRF to help increase both security and ROI.

Reliability

To provide higher reliability in Carrier Ethernet services, the Brocade CES 2000 Series supports Metro Ring Protocol (MRP/MRP-II), the ring resiliency protocol of choice on many metro networks worldwide. Standard Layer 2 protocols such as MSTP, RSTP, and STP are also supported. The Brocade MRP/MRP-II implementation enables the delivery of Carrier Ethernet services over ring-based topologies, including overlapping rings that help optimize the use of fiber in metro rings and provide recovery from node/link failures in milliseconds. Brocade MRP/MRP-II can also be used within PB/PBB networks.

To enhance multivendor interoperability, the Brocade CES 2000 Series supports Ethernet Ring Protection (ERP), a non-proprietary protocol described in ITU-T G.8032 (version 1 and 2), and integrates an Automatic Protection Switching (APS) protocol and protection switching mechanisms to provide Layer 2 loop avoidance and fast reconvergence in Layer 2 ring topologies. By integrating with mature Ethernet Operations, Administration, and Maintenance (OAM) functions such as IEEE 802.1ag and a simple APS protocol to achieve fast

protection switching in Ethernet ring networks, ERP supports multi-ring and ladder topologies to reduce OpEx and CapEx for service providers.

Advanced QoS Capabilities

The Brocade CES 2000 Series supports up to eight queues per port, each with a distinct priority level. Providers can apply advanced QoS capabilities (such as the use of two-rate, three-color traffic policers, egress shaping, and priority remarking) to offer guaranteed service levels to customers. In addition, the Brocade CES 2000 Series can be configured with ingress and egress bandwidth profiles per UNI that comply with the rigid traffic management specifications of MEF 10/MEF 14.

Using VPLS and PBB to Scale Carrier Ethernet Services

Most network cores today are based on MPLS. By using VPLS, providers can easily leverage an existing MPLS network to offer Carrier Ethernet services. In a VPLS network, participating Provider Edge (PE) devices establish a full mesh of pseudowires among all nodes in a VPLS instance. To ensure scalability of the VPLS service, providers can utilize hierarchical VPLS to limit the number of PE devices that participate in the full mesh.

In addition, they can use PBB technology to implement hierarchical VPLS by cross-connecting VPLS at the PE router (the hub device) to PBB spokes at the network edge. Implementing hierarchical VPLS with PBB spokes provides an extremely simple way to scale the VPLS service while reducing signaling overhead within the MPLS network.

More importantly, it significantly increases the scalability of the overall solution, because the MPLS PE router is completely insulated from customer MAC addresses—it maps frames based on the backbone MAC header to a VPLS instance. Figure 1 shows an example of using PBB technology on the Brocade CES 2000 Series with VPLS on the Brocade MLX Series to achieve unparalleled scalability in service delivery.

High-Performance Top-of-Rack Switch for Data Centers

In the data center, cost reduction, virtualization, security, and consolidation continue to be the top priorities. Growth in data traffic and rising application demands require higher levels of performance and the ability to scale with more storage and network bandwidth.

The Brocade CES 2000 Series is designed to meet the challenges of campus and large data center networks by providing a broad set of capabilities, including wire-speed performance, deep packet buffers, and low latency in a compact 1U form factor. Comprehensive support for IPv4 and IPv6 routing protocols, when complemented with VRRP and VRRP-E, is well suited for these environments. In addition, the Brocade CES 2000 Series supports advanced services such as MPLS (VLL, VPLS), QoS, and Layer 3 Virtualization (VRF)—making it an ideal top-of-rack switch in high-end data centers or an edge router in campus networks.

Figure 2 shows an example of using Multi-VRF on the Brocade CES 2000 Series. Multi-VRF enables a single device

to host multiple routing tables and allows application traffic separation at Layer 3 for SLA assurance, regulatory compliance, and security. An additional benefit of Multi-VRF is reduced maintenance and capital costs as well as better bandwidth utilization to increase ROI.

Multicast Support

Multicast transport is a key enabler of next-generation services such as IPTV as well as the use of video, financial, and other one-to-many applications. To meet this challenge, the Brocade CES 2000 Series provides comprehensive support for multicast switching and routing through a variety of protocols, including PIM-SM, PIM-DM, PIM-SSM, IGMP v2/v3, and other platform-independent capabilities. Egress interface-based replication optimizes switch performance and buffer usage within the system to help maximize network performance for multicast traffic.

Routing Capabilities

The Brocade CES 2000 Series offers routing capabilities that are commonly required in edge aggregation and other applications within a provider's domain. These capabilities include advanced hardware-based routing technology, which ensures secure and robust wire-speed routing performance.

The Brocade CES 2000 Series supports IPv4 and IPv6 unicast protocols—RIP/RIPng, OSPF/OSPFv3, IS-IS/IS-IS for IPv6, and BGP/BGP-MP for IPv6. To increase overall service availability, it also supports Graceful Restart helper mode for both OSPF and BGP, enabling hitless management failover and hitless OS upgrades on adjacent modular routers with these functions.

Security Capabilities

Multi-Service IronWare contains security capabilities that are available on the Brocade CES 2000 Series. These capabilities support inbound and outbound ACLs, ACL logging, advanced Layer 2 controls, limits for broadcast/unknown unicast/multicast, Multi-VRF, Layer 2 VPNs, and more.

Receive ACLs assist in placing controls on unwanted traffic targeted toward the control plane. Through tools such as ACL-based traffic policers, ACL-based sFlow, and ACL-based mirroring, malicious traffic can be easily identified and preventive measures taken in the network. In addition, Multi-VRF can help segment the network into different zones for security and isolation.

Software-Defined Networking

Software-Defined Networking (SDN) is a powerful new network paradigm that provides increased agility and programmatic control of network infrastructure, enabling a new class of IT applications to meet critical business needs. The Brocade CES 2000 enables SDN by supporting the OpenFlow protocol in hardware, which allows communication between an OpenFlow controller and the OpenFlow-enabled Brocade CES 2000 Switch. The Brocade CES 2000 delivers OpenFlow 1.3 in hybrid switch mode, meaning organizations can simultaneously deploy traditional Layer 2 and Layer 3 forwarding with OpenFlow on the same system. This unique capability enables network operators to integrate OpenFlow into existing networks, giving them the benefits offered by SDN for specific flows while the remaining traffic is handled the same way as before. OpenFlow 1.3 delivers a richer feature set required for commercial and enterprise networks to

address complex network behavior and optimize performance for dynamic SDN applications. These features include Quality of Service (QoS), Q-in-Q, Group Tables, Active-Standby Controller, and IPv6. The Brocade CES 2000 is ideal for service delivery at the network edge and for data center top-of-rack deployments in a software-defined network.

Simplified Service Management

To simplify the manageability and provisioning of Ethernet services, the Brocade CES 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.

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, network monitoring services, and education, 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/Capital.

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.

KEY FEATURES

Advanced Carrier-grade Ethernet services

- Up to 128,000 MAC addresses
- 4000 VLANs/S-VLANs/B-VLANs
- Ability to reuse VLAN-ID on each port using the Brocade Ethernet Service Instance (ESI) framework
- MPLS services: IP over MPLS, Virtual Leased Line (VLL), and Virtual Private LAN Service (VPLS)
- IEEE 802.1ad Provider Bridges
- IEEE 802.1ah Provider Backbone Bridges
- IEEE 802.1ag Connectivity Fault Management
- Comprehensive set of Layer 2 control protocols: Brocade MRP/MRP-II, VSRP, RSTP, MSTP, ITU-T G.8032 Ethernet Ring Protection (ERP version 1 and 2)
- Multi-Chassis Trunking (MCT) with support for up to 256 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 customer BPDUs
- ITU Y.1731 OAM functions and mechanisms for Ethernet-based networks
- MEF 9, MEF 14, MEF 21 certification

Comprehensive IPv4/IPv6 unicast 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 to support Virtual Routing applications over non-MPLS backbones
- Support for VRRP and VRRP-E
- 8-path Equal Cost Multi-Path (ECMP)
- Up to 32,000 IPv4 unicast routes in FIB
- Up to 8000 IPv6 unicast routes in FIB
- Connecting IPv6 islands over IPv4 MPLS using IPv6 Provider Edge routers (6PE)
- Connecting IPv6 VPNs over an IPv4 MPLS backbone (6VPE)
- BFD Holdover for OSPFv2/3 and IS-IS

- BFD for Static Routes
- BFD for OSPFv3
- ND6 IPv6 Prefix Suppress
- IS-IS Graceful Restart Helper Mode, IS-IS

Software-Defined Networking (SDN)

- OpenFlow 1.3: QoS (for metering and enqueue), Group Table (select and fast failover), Q-in-Q (TAG type auto-recognition), Active-Standby Controller, IPv6, Transport Layer Security (TLS) 1.2 (controller interface)
- Brocade OpenFlow hybrid switch mode for OpenFlow capabilities on the same system as traditional routing or switching features
- Supports up to 4,000 OpenFlow flows

Support for trunks (link aggregation groups) using either IEEE 802.3ad LACP or static trunks

- Up to 12 links per trunk
- Support for single-link trunks

Rich multicast support

- Supported IPv4 multicast protocols, including PIM-DM, PIM-SM, and PIM-SSM
- IGMP v2/v3 routing and snooping support
- IGMP static groups support
- Multicast boundaries to facilitate admission control
- PIM and MLD snooping for IPv6
- Up to 4000 multicast groups in hardware
- Multicast traffic distribution over LAGs
- Efficient egress interface-based replication to maximize performance and conserve buffers

Deep egress buffering for transient bursts in traffic

- 64 MB to 192 MB of buffering, based on configuration

Advanced QoS

- Inbound and outbound two-rate, three-color traffic policers with accounting
- Eight queues per port, each with a distinct priority level
- Multiple queue servicing disciplines: Strict Priority, Weighted Fair Queuing, and hybrid
- Advanced remarking capabilities based on port, VLAN, PCP, DSCP, or IPv4 flow

- Egress port and priority-based shaping
- QoS for management protocols (SSH and Telnet)

Comprehensive hardware-based security and policies

- Hardware-based Layer 3 and Layer 2 ACLs (both inbound and outbound) with logging
- Ability to bind multiple ACLs to the same port

Hardware-based receive ACLs

- Hardware-based Policy-Based Routing (PBR)
- Additional security capabilities
- 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

Advanced monitoring capabilities

- Port- and ACL-based mirroring that enables traffic mirroring based on incoming port, VLAN-ID, or IPv4/TCP/UDP flow
- Hardware-based sFlow sampling that allows extensive Layer 2 through Layer 7 traffic monitoring for IPv4 and Carrier Ethernet services
- ACL-based sFlow support
- sFlow support for MPLS LSR and LER interfaces

Interface capabilities

- Jumbo frame support up to 9216 bytes
- Optical monitoring of SFP and XFP optics for fast detection of fiber faults
- UDLD and LFS/RFN support

Intuitive, comprehensive status indication via LEDs

- Per-port UP/DOWN/ACTIVITY indicators
- FAN tray status
- Power supply status

Redundancy

- Redundant, hot-swappable AC/DC power supplies at the rear
- Removable fan tray with fan redundancy

Brocade CES 2000 Series by the Numbers

Features	Brocade CES 2048FX	Brocade CES 2024C-4X	Brocade CES 2024F-4X
Port Density	48 100/1000 Hybrid Fiber SFP ports with 2x10 GbE	24 10/100/1000 RJ45 ports with 4x10 GbE ports	24 100/1000 Hybrid Fiber SFP ports with 4x10 GbE ports
10 GbE Uplinks	Yes (built in)	Yes (built in)	Yes (built in)
Combination Ports	No	Yes (4 100/1000 SFP ports)	Yes (4 10/100/1000 RJ45 ports)
Forwarding Performance	136 Gbps	128 Gbps	128 Gbps
Packet Forwarding Performance	101 Mpps	101 Mpps	101 Mpps
Buffering	192 MB	192 MB	192 MB
Power Supply Options	Internal AC or DC	Internal AC or DC	Internal AC or DC
Power Supply Redundancy	1+1	1+1	1+1
Fan Redundancy	M+N	M+N	M+N
Airflow	Front to back	Front to back	Front to back

Software Options

Premium License

Content

BASE

Fundamental Layer 2 and Layer 3 functions:

- All Classic Layer 2 capabilities
 - Base Layer 3 (RIP and static routes)
 - QoS and ACLs
 - Management via SNMP/CLI
 - Bundled with base hardware
 - Connectivity Fault Management (IEEE 802.1ag) and Y.1731 Service OAM
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ME_PREM (Metro Edge Premium License)

All functions in BASE plus:

- Provider Bridges (IEEE 802.1ad)
 - Provider Backbone Bridges (IEEE 802.1ah)
 - In-band management for PB/PBB network
 - IPv4 routing: OSPF and IS-IS
 - IPv6 routing: RIPng, OSPFv3, and IS-IS for IPv6
 - Ethernet Service Instance (ESI) framework
 - Multi-VRF
 - MPLS (IPoverMPLS, VPLS, VLL)
 - 802.3ah Link OAM
 - Y.1731 Service OAM
-

L3_PREM (Layer 3 Premium License)

All functions in BASE plus:

- IPv4 routing: OSPF, IS-IS, and BGP
 - IPv6 routing: RIPng, OSPFv3, IS-IS for IPv6, and BGP-MP for IPv6
 - Multi-VRF
 - OpenFlow scalability and operational enhancements
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Brocade CES 2000 Series by the Numbers

Configuration	Maximum AC Power Consumption (Watts) (100 to 240 V AC)	Maximum DC Power Consumption (Watts)	Maximum Thermal Output (BTU/hour)
Brocade CES 2024C with 4x10 GbE uplink installed	256	217	875
Netron CES 2024F with 4x10 GbE uplink installed	268	222	915
Netron CES 2048FX	295	295	1007

Brocade CES 2000 Series Physical Specifications

Configuration	Dimensions
Brocade CES 2024C with 4x10 GbE uplink installed	17.4 in. W x 1.7 in. H x 17.6 in. D (44.3 cm x 4.4 cm x 44.8 cm)
Brocade CES 2024F with 4x10 GbE uplink installed	17.4 in. W x 1.7 in. H x 17.6 in. D (44.3 cm x 4.4 cm x 44.8 cm)
Brocade CES 2048FX	17.4 in. W x 1.7 in. H x 17.3 in. D (44.3 cm x 4.4 cm x 43.9 cm)

Brocade CES 2000 Series Specifications

IEEE Compliance

- IEEE 802.3 10Base-T
- IEEE 802.3u 100Base-TX, 100Base-FX, 100Base-LX
- IEEE 802.3z 1000Base-SX/LX
- IEEE 802.3ab 1000Base-T
- 802.3 CSMA/CD Access Method and Physical Layer Specifications
- 802.3ae 10 Gigabit Ethernet
- 802.3x Flow Control
- 802.3ad Link Aggregation
- 802.1Q Virtual Bridged LANs
- 802.1D MAC Bridges
- 802.1w Rapid STP
- 802.1s Multiple Spanning Trees
- 802.1x Port-based Network Access Control
- 802.1ad Provider Bridges
- 802.1ah Provider Backbone Bridges
- 802.1ag Connectivity Fault Management (CFM)
- 802.1ab Link Layer Discovery Protocol
- 802.1ah Provider Backbone Bridging

ITU Compliance

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

MEF Specifications

- MEF 2 Requirements and Framework for Ethernet Service Protection
- MEF 4 Metro Ethernet Network Architecture Framework Part 1: Generic Framework
- MEF 6.1 Metro Ethernet Services Definitions Phase 2
- MEF 9 Abstract Test Suite for Ethernet Services at the UNI
- MEF 10.1 Ethernet Services Attributes Phase 2
- MEF 11 User Network Interface (UNI) Requirements and Framework
- MEF 12 Metro Ethernet Network Architecture Framework Part 2: Ethernet Services Layer
- MEF 13 User Network Interface (UNI) Type 1 Implementation Agreement
- MEF 14 Abstract Test Suite for Traffic Management Phase 1
- MEF 15 Requirements for Management of Metro Ethernet Phase 1 Network Elements
- MEF 17 Service OAM Framework and Requirements (partial)
- MEF 19 Abstract Test Suite for UNI Type 1
- MEF 21 Abstract Test Suite for UNI Type 2 Part 1 Link OAM

Brocade CES 2000 Series Specifications (Continued)

RFC Compliance	
BGPv4	<ul style="list-style-type: none"> • RFC 4271 BGPv4 • RFC 1745 OSPF Interactions • RFC 1997 Communities and Attributes • RFC 2439 Route Flap Dampening • RFC 2796 Route Reflection • RFC 1965 BGP4 Confederations • RFC 2842 Capability Advertisement • RFC 2918 Route Refresh Capability • RFC 1269 Managed Objects for BGP • RFC 2385 BGP Session Protection via TCP MD5 • RFC 3682 Generalized TTL Security Mechanism, for eBGP Session Protection • RFC 4273 BGP-4 MIB • RFC 4893 BGP Support for Four-octet AS Number Space • RFC 5396 Textual Representation of Autonomous System (AS) Numbers • RFC 4724 Graceful Restart Mechanism for BGP (helper mode)
OSPF	<ul style="list-style-type: none"> • RFC 2328 OSPF v2 • RFC 3101 OSPF NSSA • RFC 1745 OSPF Interactions • RFC 1765 OSPF Database Overflow • RFC 1850 OSPF v2 MIB • RFC 2370 OSPF Opaque LSA Option • RFC 3630 TE Extensions to OSPF v2 • RFC 3623 Graceful OSPF Restart (helper mode)
MPLS	<ul style="list-style-type: none"> • RFC 3031 MPLS Architecture • RFC 3032 MPLS Label Stack Encoding • RFC 3036 LDP Specification • RFC 2205 RSVP v1 Functional Specification • RFC 2209 RSVP v1 Message Processing Rules • RFC 3209 RSVP-TE • RFC 3270 MPLS Support of Differentiated Services • RFC 3812 MPLS MIB • RFC 4090 Fast Reroute Extensions to RSVP-TE for LSP Tunnels; partial support • RFC 4875 Extensions to RSVP-TE for P2MP TE LSPs • RFC 5443 LDP IGP Synchronization • RFC 5712 MPLS Traffic Engineering Soft Preemption
Layer 2 VPN and PWE3	<ul style="list-style-type: none"> • RFC 4664 Framework for Layer 2 Virtual Private Networks • RFC 4664 Service Requirements for Layer 2 Provider-Provisioned Virtual Private Networks • RFC 4762 VPLS using LDP Signaling • draft-ietf-pwe3 PWE3 Architecture • RFC 4447 Pseudowire Setup and Maintenance using LDP • RFC 4448 Encapsulation Methods for Transport of Ethernet over MPLS Networks • RFC 5542 Definitions for Textual Conventions for Pseudo-Wires Management • RFC 5601 Pseudowire (PW) Management Information Base
Layer 3 VPN	<ul style="list-style-type: none"> • RFC 2858 Multiprotocol Extensions for BGP-4 • RFC 3107 Carrying Label Information in BGP-4 • RFC 4364 BGP/MPLS IP VPNs • draft-ietf-idr-bgp-ext-communities BGP Extended Communities Attribute • 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 • draft-ietf-idr-route-filter Cooperative Route Filtering Capability for BGP-4 • RFC 4382 MPLS/BGP Layer 3 VPN MIB
IS-IS	<ul style="list-style-type: none"> • RFC 1195 Routing in TCP/IP and Dual Environments • RFC 1142 OSI IS-IS Intra-domain Routing Protocol • RFC 2763 Dynamic Host Name Exchange • RFC 2966 Domain-wide Prefix Distribution • RFC 5120 IS-IS Multi-Topology Support • RFC 5306 Restart Signaling for IS-IS
RIP	<ul style="list-style-type: none"> • RFC 1058 RIP v1 • RFC 2453 RIP v2 • RFC 1812 RIP Requirements
IPv4 multicast	<ul style="list-style-type: none"> • RFC 1122 Host Extensions • RFC 1112 IGMP • RFC 2236 IGMP v2 • RFC 3376 IGMP v3 • RFC 3973 PIM-DM • RFC 2362 PIM-SM • RFC 4610 Anycast RP using PIM

Brocade NetIron CES 2000 Series Specifications (Continued)

IPv6 core	<ul style="list-style-type: none"> • RFC 2460 IPv6 Specification • RFC 2461 IPv6 Neighbor Discovery • RFC 2462 IPv6 Stateless Address—Auto-Configuration • RFC 4443 ICMPv6 • RFC 4291 IPv6 Addressing Architecture • RFC 3587 IPv6 Global Unicast—Address Format • RFC 2375 IPv6 Multicast Address Assignments • RFC 2464 Transmission of IPv6 over Ethernet Networks • RFC 2711 IPv6 Router Alert Option • RFC 3315 Dynamic Host Configuration Protocol (DHCP) for IPv6 	QoS	<ul style="list-style-type: none"> • RFC 2475 An Architecture for Differentiated Services • RFC 3246 An Expedited Forwarding PHB • RFC 2597 Assured Forwarding PHB Group • RFC 2698 A Two Rate Three Color Marker
IPv6 routing	<ul style="list-style-type: none"> • RFC 2080 RIPng for IPv6 • RFC 2740 OSPFv3 for IPv6 • draft-ietf-isis-ipv6 Routing IPv6 with IS-IS • RFC 2545 Use of BGP-MP for IPv6 • RFC 6106 Support for IPv6 Router Advertisements with DNS Attributes • RFC 4659 BGP-MPLS IP Virtual Private Network (VPN) Extension for IPv6 • RFC 6164 Using 127-Bit IPv6 Prefixes on Inter-Router Links 	Other	<ul style="list-style-type: none"> • RFC 1354 IP Forwarding MIB • RFC 2665 Ethernet Interface MIB • RFC 1757 RMON Groups 1, 2, 3, 9 • RFC 2068 HTTP • RFC 4330 SNMP • RFC 2865 RADIUS • RFC 3176 sFlow • RFC 2863 Interfaces Group MIB • Draft-ietf-tcpm-tcpsecure TCP Security • draft-ietf-bfd-base Bidirectional Forwarding Detection (BFD) • RFC 2784 Generic Routing Encapsulation (GRE) • RFC 4741 NETCONF (Partial) • RFC 4087 IP Tunnel MIB • RFC 4133 Entity MIB • RFC 5676 Definitions of Managed Objects for Mapping SYSLOG Messages to SNMP Notification
IPv6 transitioning	<ul style="list-style-type: none"> • RFC 4798 Connecting IPv6 Islands over IPv4 MPLS Using IPv6 Provider Edge Routers (6PE) • RFC 4659 Transporting IPv6 Layer 3 VRFs across IPv4/MPLS Backbones (6VPE) 	<hr/> <h3>Network Management</h3> <ul style="list-style-type: none"> • 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 • NETCONF • Entity MIB (Version 3) 	
General protocols	<ul style="list-style-type: none"> • RFC 791 IP • RFC 792 ICMP • RFC 793 TCP • RFC 1350 TFTP • RFC 826 ARP • RFC 768 UDP • RFC 894 IP over Ethernet • RFC 903 RARP • RFC 906 TFTP Bootstrap • RFC 1027 Proxy ARP • RFC 951 BootP • RFC 1122 Host Extensions for IP Multicasting • RFC 1256 IRDP • RFC 1519 CIDR • RFC 1542 BootP Extensions • RFC 1812 Requirements for IPv4 Routers • RFC 1541 and 1542 DHCP • RFC 2131 BootP/DHCP Helper • RFC 3768 VRRP • RFC 854 TELNET • RFC 1591 DNS (client) 	<hr/> <h3>Element Security Options</h3> <ul style="list-style-type: none"> • 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 attacks, such as TCP SYN or Smurf Attacks 	

Brocade NetIron CES 2000 Series Specifications (Continued)

Environmental

- Operating temperature: 0°C to 40°C (32°F to 104°F)
 - Relative humidity: 5% to 90%, at 40°C (104°F), non-condensing
 - Operating altitude: 10,000 ft (3048 m)
 - Storage temperature: -25°C to 70°C (-13°F to 158°F)
 - Storage humidity: 95% maximum relative humidity, non-condensing
 - Storage altitude: 15,000 ft (4500 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 Products—Part 2: Safety of Optical Fibre Communication Systems
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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 & Flicker
 - EN 61000-6-3 Emission Standard (Supersedes: EN 50081-1)
-

Immunity

- EN 61000-6-1 Generic Immunity and Susceptibility; this supersedes EN 50082-1
 - EN 55024 Immunity Characteristics. This 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

- 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 Powered 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 |
|------------|--|
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Environmental Regulatory Compliance

- EU 2002/95/EC RoHS
 - EU 2002/96/EC WEEE
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Ordering Information

Part Number	Description
BR-CES-2024C-4X-AC	Brocade CES 2024C-4X includes 24 RJ45 ports of 10/100/1000 Mbps Ethernet with four combination RJ45/SFP Gigabit Ethernet, four fixed ports of 10 GbE SFP+, 500 W AC power supply (RPS9), and base software. Needs XNI-CE-2000-FAN.
BR-CES-2024C-4X-DC	Brocade CES 2024C-4X includes 24 RJ45 ports of 10/100/1000 Mbps Ethernet with four combination RJ45/SFP Gigabit Ethernet, four fixed ports of 10 GbE SFP+, 500 W DC power supply (RPS9DC), and base software. Needs XNI-CE-2000-FAN.
BR-CES-2024F-4X-AC	Brocade CES 2024F-4X includes 24 SFP ports of 100/1000 Mbps Ethernet with four combination RJ45/SFP Gigabit Ethernet, four fixed ports of 10 GbE SFP+, 500 W AC power supply (RPS9), and base software. Needs XNI-CE-2000-FAN.
BR-CES-2024F-4X-DC	Brocade CES 2024F-4X includes 24 SFP ports of 100/1000 Mbps Ethernet with four combination RJ45/SFP Gigabit Ethernet, four fixed ports of 10 GbE SFP+, 500 W DC power supply (RPS9DC), and base software. Needs XNI-CE-2000-FAN.
NI-CES-2024C-AC	Brocade CES 2024C, 24x1 GbE copper (RJ45) configuration with four combination 100/1000 SFP ports, one optional slot, and one 500 W AC power supply
NI-CES-2024F-AC	Brocade CES 2024F, 24x1 GbE Hybrid Fiber (HF) SFP configuration with four combination 10/100/1000 RJ45 ports, one optional slot, and one 500 W AC power supply
NI-CES-2024-2x10G	Brocade CES 2000 Series 2x10 GbE XFP uplink for 24-port Brocade CES 2000 Series Switches (both AC and DC models)
NI-CES-2048CX-AC	Brocade CES 2048CX, 48x1 GbE copper (RJ45) with 2x10 GbE XFP uplinks configuration and one 500 W AC power supply
NI-CES-2048FX-AC	Brocade CES 2048FX, 48x1 GbE Hybrid Fiber (HF) with one 500 W AC power supply and 2x10 GbE XFP uplinks configuration
NI-CES-2048FX-DC	Brocade CES 2048FX, 48x1 GbE Hybrid Fiber (HF) with one 500 W DC power supply and 2x10 GbE XFP uplinks configuration
NI-CES-2024-MEU	Metro Edge Premium upgrade for Brocade CES 2000 Series 24-port models
NI-CES-2024-L3U	Layer 3 Premium upgrade for Brocade CES 2000 Series 24-port models
NI-CES-2048-MEU	Metro Edge Premium upgrade for Brocade CES 2000 Series 48-port models
NI-CES-2048-L3U	Layer 3 Premium upgrade for Brocade CES 2000 Series 48-port models

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