EX4550 ETHERNET SWITCH

Product Overview

The Juniper Networks EX4550 line of Ethernet switches delivers scalable, high-performance platforms for supporting high-density 10 gigabit per second (Gpbs) data center top-of-rack as well as data center, campus, and service provider aggregation deployments.

Product Description

Featuring up to 48 wire-speed 1GbE or 10GbE small form-factor pluggable transceiver (SFP/SFP+) or 100M/1GBASE-T/10GBASE-T ports in a compact one rack unit (1 U) platform, the Juniper Networks® EX4550 Ethernet Switch delivers 480 Gbps of Layer 2 and Layer 3 connectivity to networked devices such as servers and other switches. Two versions of the EX4550 base switch are available: the EX4550-32F, a fiber-based version that provides 32 fixed 10GbE SFP/SFP+ pluggable ports; and the EX4550-32T, a copper-based version that supports 32 fixed 100M/1GBASE-T/10GBASE-T ports.

Both versions feature two expansion slots, one in front and one in back, that can accommodate one of four optional expansion modules, providing tremendous configuration and deployment flexibility for campus and data center access and aggregation networks. The four expansion modules include:

· A 128 Gbps Virtual Chassis module
· An 8x10GBASE-T copper expansion module
· An 8x10GBASE SFP/SFP+ fiber expansion module
· A 2x40GbE QSFP+ expansion module

Architecture and Key Components

Virtual Chassis Technology

The EX4550 supports Juniper Networks' unique Virtual Chassis technology, which enables up to 10 interconnected switches to operate as a single, logical device with a single IP address. Virtual Chassis technology enables enterprises to separate physical topology from logical groupings of endpoints and, as a result, provides efficient resource utilization. The EX4550 can participate in the same Virtual Chassis configuration with any combination of Juniper Networks EX4200 and EX4500 Ethernet Switches, delivering highly flexible and scalable configuration options for campus and data center deployments.

EX4550 switches in a Virtual Chassis configuration can be connected using dedicated 128 Gbps interconnect ports on the Virtual Chassis expansion module, or via link aggregation groups (LAGs) across 10GbE/40GbE ports, providing aggregate backplane capacity of up to 320 Gbps.

In the data center, EX4550 Virtual Chassis deployments can extend across multiple top-of-rack or end-of-row switches, providing tremendous configuration flexibility for 10GbE server connectivity by only requiring redundant links between Virtual Chassis groups rather than each physical switch to ensure high availability. In addition, mixed Virtual Chassis

configurations featuring EX4200, EX4500, and EX4550 switches provide an ideal solution for data centers with a mix of 1GbE and 10GbE servers, or for environments transitioning from 1GbE to 10GbE server connectivity.

Data Center and Campus Advantages

The EX4550 delivers a highly available, simple, and scalable 10GbE connectivity solution in a compact and power efficient platform, making it a perfect fit for both data center and campus networks. The EX4550 offers a number of other advantages for data center and campus deployments, including the following:

Simple

Virtual Chassis technology on the EX4550 dramatically simplifies the campus aggregation layer, eliminating the need for Spanning Tree Protocol (STP), Virtual Router Redundancy Protocol (VRRP), complex routing, or VLAN configurations. In addition, when deployed in a Virtual Chassis configuration, the EX4550 also reduces the number of devices to manage and can even eliminate network switching layers. A single Virtual Chassis configuration can span multiple nodes, reducing the need for larger, more expensive nodes on superior tiers. Juniper Networks Junos® operating system, which is common across the entire EX Series switch product family, accelerates the learning curve by enabling the entire architecture to be managed with a common set of instructions and from a single pane of glass.

Scalable

A single EX4550 can support up to 48 10GbE ports at line rate, providing a highly scalable solution for even the most demanding environments. In addition, Virtual Chassis technology makes it easy to scale the network while reducing management complexity. By adding switches to a Virtual Chassis configuration, it is possible to grow the number of switch ports without increasing the number of devices to manage. As more switches are added to the Virtual Chassis configuration, backplane bandwidth demands can also be scaled to maintain adequate oversubscription ratios. EX4550 Virtual Chassis bandwidth can be increased to 256 Gbps by inserting 128 Gbps Virtual Chassis expansion modules in each of the two available expansion slots. Virtual Chassis bandwidth can be further increased to 320 Gbps by inserting a 40GbE expansion module into each of the available expansion slots.

Highly Available

When EX4550 switches are deployed in a Virtual Chassis configuration, Junos OS initiates a process to assign a master (active) and backup (hot standby) switch to manage the configuration. If the master switch fails, an integrated Layer 2 and Layer 3 graceful Routing Engine switchover (GRES) feature automatically switches to the backup to maintain continuous and uninterrupted system operations. The EX4550 switch also includes a number of other high availability features, including redundant power and cooling, graceful protocol restart, equal-cost multipath (ECMP), LAG links distributed across multiple slots, and quality of service (QoS) to prioritize time-sensitive data.
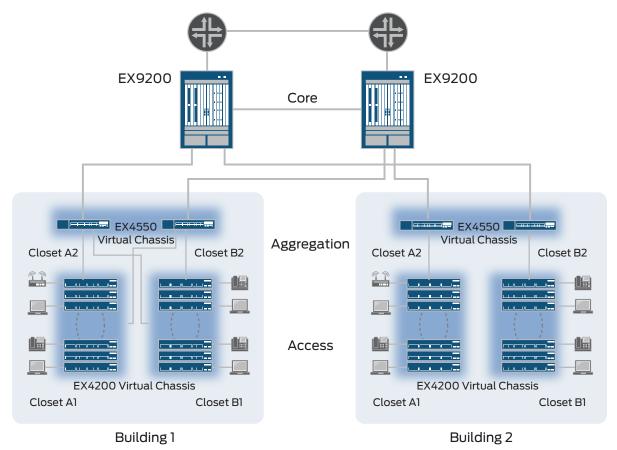

Figure 1: The EX4550 offers an economical, power-efficient, compact solution for campus aggregation deployments.

Adaptable and Modular

As business grows, the network needs to evolve. With its compact 1 U form factor and complete switch features, the EX4550 can be easily redeployed in different environments and physical layouts. Customers can also easily transition from 1GbE to 10GbE using the dual-speed interfaces on the EX4550-32T or by replacing 1GbE optics with 10GbE optics on the EX4550-32F. EX4550 switch capacity can be expanded without increasing the number of managed devices by simply adding more switches to the Virtual Chassis configuration.

MACsec on the EX4550

A MACsec feature enables the EX4550 to support 480 Gbps of near line-rate hardware-based traffic encryption on all fiber ports, including the base unit and optional expansion modules.

Defined by IEEE 802.1AE, MACsec provides secure, encrypted communication at the link layer that is capable of identifying and preventing threats from denial of service (DoS) and intrusion attacks, as well as man-in-the-middle, masquerading, passive wiretapping and playback attacks launched from behind the firewall. When MACsec is deployed on switch ports, all traffic is encrypted on the wire but traffic inside the switch is not. This allows the switch to apply all network policies such as Quality of Service (QoS), deep packet inspection and sFlow to each packet without compromising the security of packets on the wire.

Hop-by-hop encryption enables MACsec to secure communications while maintaining network intelligence. In addition, Ethernet-based WAN networks can use MACsec to provide link security over long-haul connections. MACsec is transparent to Layer 3 and higher-layer protocols and is not limited to IP traffic; it works with any type of traffic carried over Ethernet links.

Campus Deployments

The EX4550 offers an economical, power efficient and compact solution for aggregating 10GbE expansions from access devices in building and campus deployments (see Figure 1). The switch's dual-speed interfaces also support environments transitioning from 1GbE to 10GbE.

The EX4550 easily meets enterprise core switch requirements, delivering wire-speed performance on every port, full device redundancy, support for Layer 3 dynamic routing protocols such as RIP and OSPF, L2 and L3 MPLS VPNs, and a comprehensive security and QoS feature set.

Data Center Deployments

The EX4550 Ethernet Switch is designed for demanding data center applications where high performance, high availability, and energy efficiency are key requirements (see Figure 2). Operating at wire speed, the EX4550 switches deliver 714 Mpps throughput and a data rate of 960 Gbps (full duplex) for both Layer 2 and Layer 3 protocols. EX4550 switches can be interconnected in a Virtual Chassis configuration that also includes EX4200 and EX4500 switches, creating a single logical device that offers a variety of port and density options for mixed server environments.

Flexible deployment options enable the EX4550 to support back-to-front and front-to-back cooling, which ensures consistency with server designs for hot and cold aisle deployments. Front and rear facing configuration options ensure closer proximity to server ports, optimizing performance and keeping cable lengths short and manageable.

The EX4550-32T switch ports can operate at 100 Mbps, 1 Gbps and 10 Gbps using the same cable infrastructure, offering a simple and cost-effective way to migrate to higher-speed servers at the
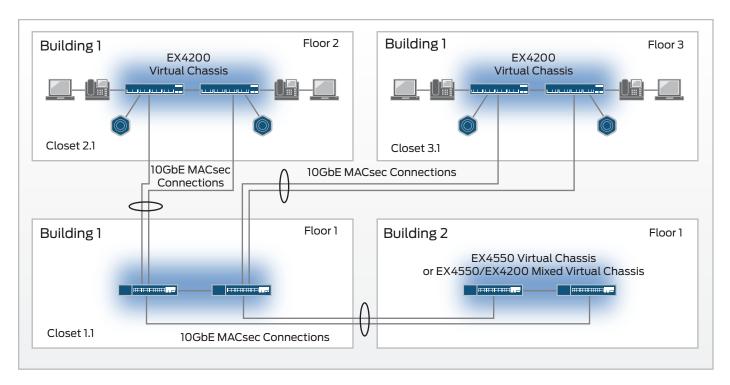
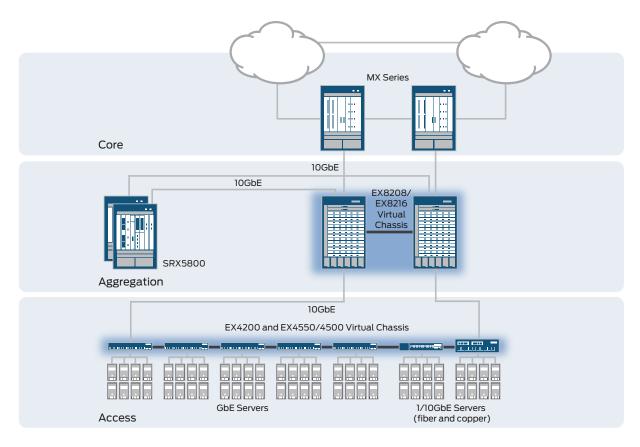Figure 2: MACsec deployment with EX4200 and EX4550 switches.

Figure 3: The EX4550 provides 10GbE server access in the data center.

access layer. In addition, the expansion slots on the EX4550-32T can support 10GbE SFP+ and 40GbE QSFP+ modules, which can be used as fiber uplinks or to extend connections beyond 100m.

Customers introducing 10GbE into their server racks can use the EX4550 to add 10GbE-attached servers, iSCSI, and network-attached storage (NAS) with minimal impact to the current switching infrastructure.

10GbE Data Center Bridging and I/O Convergence Deployments

The EX4550 is a full IEEE DCB- and T11 FC-BB-5-based Fibre Channel over Ethernet (FCoE) transit switch, delivering a high-performance solution for converged server edge access environments. As an FCoE transit switch, the EX4550 provides a pure IEEE DCB converged access layer between FCoE-enabled servers and an FCoE-enabled Fibre Channel storage area network (SAN) (see Figure 4).

The EX4550 also supports FC Initiation Protocol (FIP) snooping, which provides perimeter protection to ensure that the presence of an Ethernet layer does not impact existing SAN security policies. The FCoE transit switch functionality, along with priority-based flow control (PFC) and Data Center Bridging Capability Exchange protocol (DCBX), are included as part of the default software; no additional licenses are required.

Junos Operating System

The EX4550 runs the same Juniper Networks Junos operating system that is used by other EX Series Ethernet Switches, as well as all Juniper Networks routers and Juniper Networks SRX Series Services Gateways. By utilizing a common operating system, Juniper delivers a consistent implementation and operation of control plane features across all products. To maintain that consistency,

Junos OS adheres to a highly disciplined development process that uses a single source code, follows a single quarterly release train, and employs a highly available modular architecture that prevents isolated failures from bringing down an entire system.

These attributes are fundamental to the core value of the software, enabling all Junos OS-powered products to be updated simultaneously with the same software release. All features are fully regression tested, making each new release a true superset of the previous version. Customers can deploy the software with complete confidence that all existing capabilities will be maintained and operate in the same way.

Management Options

Four different system management options are available for the EX4550 Ethernet Switch.

- The standard Junos OS command-line interface (CLI) offers the same granular management capabilities and scripting parameters found in any router powered by the Junos operating system.
- The EX4550 also includes the integrated Juniper Networks Junos Web Software, an embedded web-based device manager that allows users to configure, monitor, troubleshoot, and perform system maintenance on individual switches via a browser-based graphical interface.
- EX4550 performance, configuration, and fault data can also be exported to leading third-party management systems such as HP OpenView, IBM Tivoli, and Computer Associates Unicenter software, providing a complete, consolidated view of network operations.
- The EX4550 is also supported by Juniper Networks Junos Space, an open, programmable application platform for hosting a comprehensive suite of network operational application tools that provide a smart, simple, and open approach for automating the
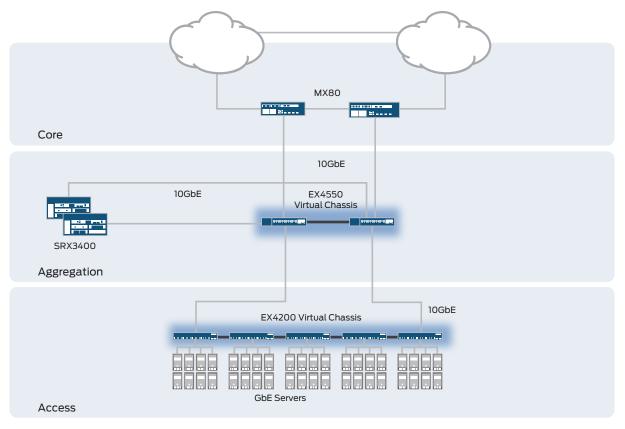
Figure 4: The EX4500 10GbE switch is ideal for small data center core deployments.

deployment and operation of a Juniper infrastructure. Junos Space provides multiple management and infrastructure applications for managing Juniper resources and assets, including inventory management, device and interface configuration, automated software management and deployment, and event-driven fault management. These Junos Space applications offer predefined automation schemes and best practice templates to enable rapid and accurate deployments.

Features and Benefits

EX4550 Ethernet switches include the following key features and benefits.

- **High performance:** Each EX4550 supports 480 Gbps of bandwidth with 48 line-rate 10 Gbps ports at all packet sizes, or 14.88 Mpps per port at the minimum Ethernet frame size.
- **Security:** A MACsec software license enables near line-rate hardware-based IEEE 802.1AE encryption on all fiber ports, including base unit and optional expansion modules.
- **High availability:** EX4550 switches offer dual internal load-sharing AC power supplies and redundant variable-speed fans as standard features, protecting the switch from a single power supply or fan failure. DC power options are also available.
- **Energy efficient:** Consuming less than five watts (fiber) and nine watts (copper) per 10GbE interface, the EX4550 offers a low power solution for 10GbE top-of-rack, end-of-row, and aggregation deployments. The EX4550 switches also improve cooling efficiency with redundant variable-speed fans that automatically adjust their speed based on existing conditions to reduce power consumption.
- **Small footprint:** The EX4550 supports up to 48 wire-speed 10GbE ports in a single 1 U platform.

Additional Features

- System status LEDs
- LCD status display
- Versatile two- and four-post rack mounting options
- Front-to-back and back-to-front airflow options
- AC and DC power supply options
- Support for jumbo frames (9,000)
- Quality of service (IEEE 802.1p marking)
- Multicast (Internet Group Management Protocol v1/v2/v3 snooping)
- Layer 2 features including support for 4,096 VLAN IDs, Spanning Tree (802.1s and 802.1w), bridge protocol data unit (BPDU) guard, 802.3as Link Aggregation
- Management features including Telnet and SSH v1/v2, SNMP v1-v3, RADIUS, TACACS+, and RMON

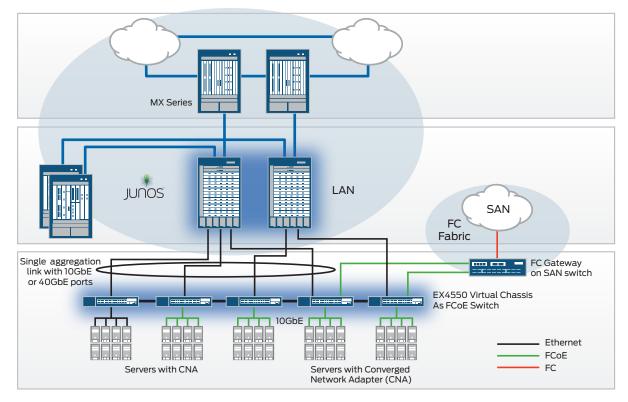| Configuration	Power Consumption
EX4550-32F with no expansion modules installed; 32 SFP+ USR ports in base, all ports forwarding (line rate)	175 Watts
EX4550-32F with one expansion module (8 x 10GbE SFP+ ports) installed; 32 USR ports in base, all ports forwarding (line rate)	195 Watts
EX4550-32F with two expansion modules (8 x 10GbE SFP+ ports) installed; 32 USR ports in base, all ports forwarding (line rate)	215 Watts
EX4550-32T with no expansion modules installed; 32 RJ-45 ports in base, all ports forwarding (line rate), <10m	330 Watts
EX4550-32T with two expansion modules (8 x 10GT copper ports) installed; 32 RJ-45 ports in base, all ports forwarding (line rate), <10m	413 Watts

Figure 5: The EX4550 deployed as a data center FCoE transit switch in a top-of-rack Virtual Chassis configuration.

EX4550-32T

EX4550-32F

Specifications

Hardware

Interface Options

- 32 GbE/10GbE (MACsec 802.1AE capable) SFP/SFP+ fiber connectors
- 32 100M/1GBASE-T/10GBASE-T RJ-45 auto-negotiating ports
- 16 10GbE SFP/SFP+ (MACsec 802.1AE capable) ports (via two optional 8-port expansion modules)
- 16 100M/1GBASE-T/10GBASE-T ports (via two optional 8-port expansion modules)
- 4 40GbE QSFP+ ports (via two optional 2-port expansion modules)
- 128 Gbps Virtual Chassis module with 2 x 64 Gbps ports
- 1 x 10/100/1000 Ethernet RJ-45 ports for management
- Console port for management

Supported Optics

- SFP+ 10GBASE-LR
- SFP+ 10GBASE-LRM
- SFP+ 10GBASE-SR
- SFP+ 10GBASE-ER
- SFP 1GBASE-LX
- SFP 1GBASE-SX
- SFP 1GBASE-T
- SFP 10GE ZR
- SFP+ 10GBASE-USR
- SFP+ DAC 1 m
- SFP+ DAC 3 m
- SFP+ DAC 5 m
- SFP+ DAC 7 m
- QFX-QSFP-40G-SR4
- QFX-QSFP-DAC-1M
- QFX-QSFP-DAC-3M

Dimensions

- Height: 1.72 in (4.37 cm); 1 U
- Width:
  - 17.35 in (44.07 cm) without front-mounting brackets
  - 19 in (48.3 cm) with front-mounting brackets
- Depth: 18.5 in (46.99 cm)
- Weight:
  - EX4550 switch with 1 AC or DC power supply: 19.4 lb (8.8 kg)
  - AC power supply: 2.4 lb (1.1 kg)
  - DC power supply: 2.4 lb (1.1 kg)

Rack Installation Kit

- Versatile two- and four-post mounting options for 19-in server rack or datacom rack

Specifications (continued)

LEDs
- System LEDs that indicate status

Airflow
- Airflow out (AFO) power supply unit (PSU)-side air exhaust or front-to-back cooling, or airflow in (AFI) PSU-side air intake or back-to-front cooling
- Redundant variable-speed fans that reduce power draw

CPU
- 1.2 GHz

Memory
- 2 GB DRAM, 2 GB flash

Power
- Dual hot-swappable load sharing AC and DC power supplies

Software

Security
- RADIUS
- TACACS+
- Access control lists (ACLs): Allow and deny
- SSH v1, v2
- Secure interface login and password
- Local proxy Address Resolution Protocol (ARP)
- Static ARP support

Layer 2 Switching
- Maximum number of media access control (MAC) addresses in hardware: 32,000*
- Jumbo frames: 9,216 bytes
- Number of VLANs: 4,096
- Port-based VLAN
- 4,096 VLAN IDs supported
- Routed VLAN interface (RVI)

Link Aggregation
- 802.3ad support
  - Number of LAGs supported: 64
  - Maximum number of ports per LAG: 8
- LAG load-sharing algorithm—bridged or routed (unicast or multicast) traffic:
  - IP: S/D IP
  - TCP/UDP: S/D IP, S/D Port
  - Non-IP: S/D MAC
  - Tagged ports support in LAG

Spanning Tree
- Rapid Spanning Tree Protocol (RSTP) and VLAN Spanning Tree Protocol (VSTP) running concurrently
- Spanning Tree Protocol (802.1D)
- Multiple Spanning Tree Protocol (MSTP) (802.1s)
- RSTP (802.1w)
- VSTP - VLAN Spanning Tree
- BPDU protect
- Loop protect
- Root protect

Quality of Service
- EZQoS
- Class of service (CoS) on L3 VLAN
- Per interface rewrite

- Per interface classification
- Policer mark down action
- Remarking of bridged packets
- Layer 2 QoS
- Layer 3 QoS
- Rate Limiting:
  - Ingress policing: 1 rate 2 color
  - Egress shaping: Per queue, per port
  - 8 hardware queues per port
  - Scheduling methods (egress): Strict priority (SP), shaped-deficit weighted round-robin (SDWRR)
  - 802.1p remarking
  - L2-L4 classification criteria: Interface, MAC address, Ethertype, 802.1p, VLAN, IP address, DiffServ code point (DSCP)/IP precedence, TCP/UDP port numbers, etc.
  - Congestion avoidance capabilities: Weighted tail drop eight queues

Layer 3 Features: IPv4
- VRF-lite (IS-IS, RIP, OSPF, BGP)
- IP directed broadcast traffic forwarding
- Routing protocols: RIPv1/v2, OSPF, BGP, IS-IS
- Maximum number of IPv4 unicast routes in hardware: 14,000*
- Maximum number of IPv4 multicast routes in hardware: 4,000
- Static routing
- Routing policy
- Virtual Router Redundancy Protocol (VRRP)
- Bidirectional Forwarding Detection (BFD) protocol

Layer 3 Features: IPv6
- Maximum number of Neighbor Discovery Protocol (NDP) entries: 1,000
- Maximum number of IPv6 unicast routes in hardware: 3,400*
- Maximum number of IPv6 multicast routes in hardware: 1,000
- Routing protocols: RIPng, OSPFv3, IPv6, BGP, MLDv2
- Static routing

Multicast
- VRF-lite (PIM, IGMP)
- IGMP static
- IGMP v1, v2, v3
- IGMP snooping
- Protocol Independent Multicast—Sparse Mode (PIM-SM), and PIM source-specific multicast (PIM-SSM)
- Multicast Source Discovery Protocol (MSDP)

Access control lists (ACLs) (Junos OS firewall filters)
- Port-based ACL (PACL): Ingress and egress
- VLAN-based ACL (VACL): Ingress and egress
- Router-based ACL (RACL): Ingress and egress
- ACL entries (ACE) in hardware per system: 1,500
- ACL counter for denied packets
- ACL counter for permitted packets
- Ability to add/remove/change ACL entries in middle of list (ACL editing)
- L2-L4 ACL
- Trusted Network Connect (TNC) certified
- MAC authentication (RADIUS)
- Control plane denial-of-service (DoS) protection

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* MAC address table uses a hash-based scheme to program entries; therefore, some entries may not be programmed due to hash index collision.

*Uni-dimensional scale (shared table between v4 and v6)

Specifications (continued)

Virtual Chassis Capabilities

- Maximum number of members: 10
- Virtual Chassis ports (VCPs):
  - Two dedicated 64 Gbps ports with 128 Gbps Virtual Chassis module
  - Any base or expansion port can act as a VCP
- Maximum Virtual Chassis interconnect capacity:
  - 128 Gbps with Virtual Chassis module
  - 256 Gbps with two Virtual Chassis modules
  - 320 Gbps with two 40GbE expansion modules
  - Up to 48 x 10 Gbps using base or expansion ports (subject to a maximum of 8 members per LAG group per destination, 64 LAG groups per system or 110 LAG groups per Virtual Chassis configuration)
- Maximum Virtual Chassis distance:
  - Virtual Chassis module ports: Up to 5 m with VCP cable
  - Base or expansion ports: Up to maximum distance supported by optics

Data Center Bridging (DCB)

- Priority-based flow control (PFC): IEEE 802.1Qbb
- Data Center Bridging Capability Exchange protocol (DCBX)

Fibre Channel over Ethernet (FCoE)

- FCoE transit switch (FIP snooping)
- iSCI SAN
- iSCI TLV support

High Availability

- Nonstop active routing (NSR): OSPF v2, RIP v1/v2, BGP, IS-IS, IGMP v1, v2, v3
- Redundant, hot-swappable power supplies
- Redundant, field-replaceable, hot-swappable fans
- GRES for Layer 2 hitless forwarding and Layer 3 protocols on Routing Engine failover
- Graceful restart: OSPF, BGP, IGMP v1/v2/v3 snooping
- Nonstop bridging for xSTP, Link Aggregation Control Protocol (LACP), Link Layer Discovery Protocol–Media Endpoint Discovery (LLDP/LLDP-MED)
- Nonstop software upgrade (NSSU) for EX4550 with Virtual Chassis or EX4200/EX4550/EX4500 with Virtual Chassis
- Virtual Chassis fast convergence (as low as sub-50 ms)

MPLS

- The following MPLS functionality is supported on EX4550 switches:
  - Label-switching router (LSR) and label edge router (LER) functionality
  - RSVP and LDP for label assignment and distribution (LSP setup), and BGP for advertising label-switched paths (LSPs)
  - Traffic protection through standby secondary paths
  - Traffic-engineering capabilities provided by OSPF, IS-IS, Constrained Shortest Path First (CSPF), and RSVP-TE
  - Static LSPs
  - IPv4 over MPLS, IPv6 tunneling
  - BGP-based L2 VPNs
  - LDP-based L2 circuits
  - L3 VPNs for IPv4 and IPv6 unicast traffic
  - Circuit cross-connect (CCC)

Supported RFCs

- RFC 768 UDP
- RFC 783 Trivial File Transfer Protocol (TFTP)
- RFC 791 IP
- RFC 792 ICMP
- RFC 793 TCP
- RFC 826 ARP
- RFC 854 Telnet client and server
- RFC 894 IP over Ethernet
- RFC 903 RARP
- RFC 906 TFTP Bootstrap
- RFC 951, 1542 BootP
- RFC 1027 Proxy ARP
- RFC 1058 RIP v1
- RFC 1112 IGMP v1
- RFC 1122 Host Requirements
- RFC 1256 IPv4 ICMP Router Discovery (IRDP)
- RFC 1492 TACACS+
- RFC 1519 Classless Interdomain Routing (CIDR)
- RFC 1587 OSPF not-so-stubby area (NSSA) Option
- RFC 1591 Domain Name System (DNS)
- RFC 1812 Requirements for IP Version 4 Routers
- RFC 1981: Path maximum transmission unit (MTU) Discovery for IPv6
- RFC 2030 SNTP, Simple Network Time Protocol
- RFC 2068 HTTP server
- RFC 2131 BOOTP/DHCP relay agent and Dynamic Host Configuration Protocol (DHCP) server
- RFC 2138 RADIUS Authentication
- RFC 2139 RADIUS Accounting
- RFC 2154 OSPF w/Digital Signatures (Password, MD-5)
- RFC 2236 IGMP v2
- RFC 2267 Network Ingress Filtering
- RFC 2328 OSPF v2 (edge mode)
- RFC 2338 VRRP
- RFC 2362 PIM-SM (edge mode)
- RFC 2370 OSPF Opaque link-state advertisement (LSA) Option
- RFC 2453 RIP v2
- RFC 2460: Internet Protocol, v6 (IPv6) specification
- RFC 2464: Transmission of IPv6 Packets over Ethernet Networks
- RFC 2474 DiffServ Precedence, including 8 queues/port
- RFC 2475 DiffServ Core and Edge Router Functions
- RFC 2597 DiffServ Assured Forwarding (AF)
- RFC 2598 DiffServ Expedited Forwarding (EF)
- RFC 2925 MIB for Remote Ping, Trace
- RFC 3376 IGMP v3
- RFC 3484 Default Address Selection for IPv6
- RFC 3569 draft-ietf-ssm-arch-06.txt PIM-SSM PIM Source Specific Multicast
- RFC 3579 RADIUS EAP support for 802.1x
- RFC 3618 MSDP
- RFC 3623 OSPF Graceful Restart
- RFC 4213: Basic Transition Mechanisms for IPv6 Hosts and Routers
- RFC 4291: IPv6 Addressing Architecture
- RFC 4364 BGP/MPLS IP Virtual Private Networks
- RFC 4443: ICMPv6 for the IPv6 specification
- RFC 4861: Neighbor Discovery for IPv6

Specifications (continued)

Supported RFCs (continued)

- RFC 4862: IPv6 Stateless Address Autoconfiguration
- RFC 4915 MT-OSPF
- RFC 5176 Dynamic Authorization Extensions to RADIUS
- Draft-ietf-bfd-base-05.txt Bidirectional Forwarding Detection
- Draft-kompella-ppvpn-l2vpn-03.txt
- Draft-martini-l2circuit-trans-mpls-19.txt
- LLDP Media Endpoint Discovery (LLDP-MED), ANSI/TIA-1057, draft 08
- PIM-DM Draft IETF PIM Dense Mode draft-ietf-idmr-pim-dm-05. txt, draft-ietf-pim-dm-new-v2-04.txt

Supported MIBs

- RFC 1155 SMI
- RFC 1157 SNMPv1
- RFC 1212, RFC 1213, RFC 1215 MIB-II, Ethernet-like MIB, and TRAPs
- RFC 1493 Bridge MIB
- RFC 1643 Ethernet MIB
- RFC 1724 RIPv2 MIB
- RFC 1850 OSPFv2 MIB
- RFC 1905 RFC 1907 SNMP v2c, SMIv2, and Revised MIB-II
- RFC 2011 SNMPv2 for Internet protocol using SMIv2
- RFC 2012 SNMPv2 for transmission control protocol using SMIv2
- RFC 2013 SNMPv2 for user datagram protocol using SMIv2
- RFC 2096 IPv4 Forwarding Table MIB
- RFC 2287 System Application Packages MIB
- RFC 2570 – 2575 SNMPv3, user based security, encryption, and authentication
- RFC 2576 Coexistence between SNMP Version 1, Version 2, and Version 3
- RFC 2578 SNMP Structure of Management Information MIB
- RFC 2579 SNMP Textual Conventions for SMIv2
- RFC 2665 Ethernet-like interface MIB
- RFC 2787 VRRP MIB
- RFC 2819 RMON MIB
- RFC 2863 Interface Group MIB
- RFC 2863 Interface MIB
- RFC 2922 LLDP MIB
- RFC 2925 Ping/Traceroute MIB
- RFC 2932 IPv4 Multicast MIB
- RFC 3413 SNMP Application MIB
- RFC 3414 User-based Security Model for SNMPv3
- RFC 3415 View-based Access Control Model for SNMP
- RFC 4188 STP and Extensions MIB
- RFC 4363 Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and VLAN extensions
- Draft – blumenthal – aes – usm - 08
- Draft – ietf-bfd-mib-02.txt
- Draft – ietf-idmr-igmp-mib-13
- Draft – ietf-idmr-pim-mib-09
- Draft – reeder - snmpv3 – usm - 3desede -00

Troubleshooting

- Debugging: CLI via console, Telnet, or SSH
- Diagnostics: Show and debug command, statistics
- Traffic monitoring/mirroring (port, VLAN)
- IP tools: Extended ping and trace
- Junos OS commit and rollback

Traffic Mirroring

- Static LSPs
- Port-based
- VLAN-based
- ACL-based mirroring
- Mirroring destination ports per system: 1
- LAG port monitoring
- Multiple destination ports monitored to 1 mirror (N:1)
- Maximum number of mirroring sessions: 1
- Mirroring to remote destination (over L2): 1 destination VLAN

Safety and Compliance

Safety Certifications

- UL-UL60950-1 (First Edition)
- C-UL to CAN/CSA 22.2 No.60950-1 (First Edition)
- TUV/GS to EN 60950-1, Amendment A1-A4, A11
- CB-IEC60950-1, all country deviations

Electromagnetic Compatibility Certifications

- FCC 47CFR Part 15 Class A
- EN 55022 Class A
- ICES-003 Class A
- VCCI Class A
- AS/NZS CISPR 22 Class A
- CISPR 22 Class A
- EN 55024
- EN 300386
- CE

Environmental

- Reduction of Hazardous Substances (ROHS) 5
- Telco
- Common Language Equipment Identifier (CLEI) code

Environmental Ranges

- Operating temperature: 32º to 104º F (0º to 40º C)
- Storage temperature: -40º to 158º F (-40º to 70º C)
- Operating altitude: Up to 10,000 ft (3,048 m)
- Nonoperating altitude: Up to 16,000 ft (4,877 m)
- Relative humidity operating: 10% to 85% (noncondensing)
- Relative humidity nonoperating: 0% to 95% (noncondensing)

Telecom Quality Management

- TL9000

Mean Time Between Failures (MTBF)

Part Number	Description	Predicted MTBF (khrs)	FIT Rate
EX4550-32F-AFO/AFI	EX4550, 32-port 1/10GbE SFP+, converged switch, 650 W AC PS, port side to PSU side airflow or PSU side to port side airflow	166	6,016
EX4550-32T-AFO/AFI	EX4550, 32-port 100M/1G/10GBASE-T converged switch, 650 W AC PS, port side to PSU side airflow or PSU side to port side airflow	146	6,858
EX4550-VC1-128G	EX4550, 128 Gbps Virtual Chassis module (Virtual Chassis cables sold separately)	6,296	144
EX4550-EM-8XSFP	EX4550 8-port 10GbE SFP+ expansion module (optics sold separately)	1,273	786
EX4550-EM-8XT	EX4550 8-port 100M/1G/10GBASE-T expansion module (optics sold separately)	999	1,001
EX4550-EM-2QSFP	EX4550 2-port 40GbE expansion module (optics sold separately)	1,403	713

Juniper Networks Services and Support

Juniper Networks is the leader in performance-enabling services that are designed to accelerate, extend, and optimize your high-performance network. Our services allow you to maximize operational efficiency while reducing costs and minimizing risk, achieving a faster time to value for your network. Juniper Networks ensures operational excellence by optimizing the network to maintain required levels of performance, reliability, and availability. For more details, please visit **www.juniper.net/us/en/products-services**.

Ordering Information

Model Number	Description
Base Unit*	
EX4550-32F-AFO	EX4550, 32-port 1/10GbE SFP+ converged switch, 650 W AC PS, port side to PSU side airflow (optics sold separately)
EX4550-32F-AFI	EX4550, 32-port 1/10GbE SFP+ converged switch, 650 W AC PS, PSU side to port side airflow (optics sold separately)
EX4550-32F-DC-AFO	EX4550, 32-port 1/10GbE SFP+ converged switch, 650 W DC PS, port side to PSU side airflow (optics sold separately)
EX4550-32F-DC-AFI	EX4550, 32-port 1/10GbE SFP+ converged switch, 650 W DC PS, PSU side to port side airflow (optics sold separately)
EX4550-32T-AFI	EX4550, 32-port 100/1G/10GBASE-T converged switch, 650 W AC PS, PSU side to built-in port side airflow
EX4550-32T-AFO	EX4550, 32-port 100/1G/10GBASE-T converged switch, 650 W AC PS, built-in port side to PSU side airflow
EX4550-32T-DC-AFI	EX4550, 32-port 100/1G/10GBASE-T converged switch, 650 W DC PS, PSU side to built-in port side airflow
EX4550-32T-DC-AFO	EX4550, 32-port 100/1G/10GBASE-T converged switch, 650 W DC PS, built-in port side to PSU side airflow
Accessories	
EX4550-VC1-128G	EX4550, 128 Gbps Virtual Chassis module (Virtual Chassis cables sold separately)
EX4550-EM-8XSFP	EX4550 8-port 10GbE SFP+ expansion module (optics sold separately)
EX4550-EM-8XT	EX4550 8-port 100/1G/10GBASE-T expansion module
EX4550-EM-2QSFP	EX4550 2-port 40GbE expansion module (optics sold separately)
JPSU-650W-DC-AFO	Juniper 650 W DC power supply for EX4550 (PSU-side airflow exhaust)
JPSU-650W-DC-AFI	Juniper 650 W DC power supply for EX4550 (PSU-side airflow intake)

Model Number	Description
JPSU-650W-AC-AFO	Juniper 650 W AC power supply for EX4550 (PSU-side airflow exhaust)
JPSU-650W-AC-AFI	Juniper 650 W AC power supply for EX4550 (PSU-side airflow intake)
EX4550-FANMODULE-AFO	Fan module (port side to PSU side airflow) for EX4550 (spare)
EX4550-FANMODULE-AFI	Fan module (PSU side to port side airflow) for EX4550 (spare)
EX4550 Feature Licenses	
EX4550-AFL	EX4550 advanced feature license for IS-IS, BGP, and MPLS
EX-QFX-MACSEC-ACC	MACsec Software License for EX4550 access switches
EX-QFX-MACSEC-AGG*	MACsec Software License for EX4550 aggregation switches
Pluggable Optics	
EX-SFP-1GE-T	SFP 1000BASE-T copper; RJ-45 connector; 100 m reach on UTP
EX-SFP-1GE-SX	SFP 1000BASE-SX; LC connector; 850 nm; 550 m reach on multimode fiber
EX-SFP-1GE-LX	SFP 1000BASE-LX; LC connector; 1,310 nm; 10 km reach on single mode fiber
EX-SFP-10GE-SR	SFP+ 10GBASE-SR; LC connector; 850 nm; 300 m reach on 50 microns multimode fiber; 33 m on 62.5 microns multimode fiber
EX-SFP-10GE-LR	SFP+ 10GBASE-LR; LC connector; 1,310 nm; 10 km reach on single mode fiber
EX-SFP-10GE-LRM	SFP+ 10GBASE-LRM; LC connector; 1,310 nm; 220 m reach on multimode fiber
EX-SFP-10GE-ER	SFP+ 10GBASE-ER 10GbE optics, 1,550 nm for 40 km transmission on single mode fiber

*Not available in Russia and CIS countries.

Ordering Information (continued)

Model Number	Description
Pluggable Optics (continued)	
EX-SFP-10GE-ZR	SFP+ 10GBASE-ZR 10GbE optics, 1,550 nm for 80 km transmission on single mode fiber
EX-SFP-10GE-DAC-1M	SFP+ 10GbE direct attach copper (twinax copper cable) 1 m
EX-SFP-10GE-DAC-3M	SFP+ 10GbE direct attach copper (twinax copper cable) 3 m
EX-SFP-10GE-DAC-5M	SFP+ 10GbE direct attach copper (twinax copper cable) 5 m
EX-SFP-10GE-DAC-7M	SFP+ 10GbE (twinax copper cable) 7 m
EX-SFP-10GE-USR	10GbE ultra short reach; 850 nm; 10 m on OM1, 30 m on OM2, 100 m on OM3 multimode fiber
QFX-QSFP-40G-SR4	QSFP+ 40GBASE-SR4 40GbE optics, 850 nm for up to 150 m transmission on MMF
QFX-QSFP-DAC-1M	QSFP+ to QSFP+ Ethernet direct attach copper (twinax copper cable) 1m passive
QFX-QSFP-DAC-3M	QSFP+ to QSFP+ Ethernet direct attach copper (twinax copper cable) 3m passive

* EX4550 base unit includes chassis, fan tray, single AC or DC power supply, power cord, power supply cover panel, and two expansion module cover panels.

About Juniper Networks

Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at **www.juniper.net**.

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