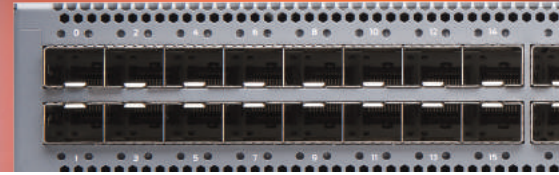# EX4650 Ethernet Switch

Product Overview

The EX4650 line of Ethernet switches delivers high scale, high availability, and high performance for campus distribution deployments. The EX4650 offers fixed 1GbE/10GbE/25GbE ports with 40GbE/100GbE uplinks that support advanced campus environments, allowing them to provide the onramp to multicloud, to deploy cutting edge cloud applications, and to embrace IoT technology. It is also flexible enough for use in enterprise on-premises top-of-rack and service provider aggregation deployments.

Product Description

The Juniper Networks® EX4650 Ethernet Switch delivers 2 Tbps of Layer 2 and Layer 3 connectivity to networked devices such as secure routers, servers, and other switches. Featuring 48 wire-speed 10GbE/25GbE small form-factor pluggable and pluggable plus transceiver (SFP/SFP+/SFP28) ports and 8 wire-speed 40GbE/100GbE quad SFP+ transceiver (QSFP+/QSP28) ports in a compact 1 U platform, the EX4650 provides the flexibility to support mixed 1GbE, 10GbE, 25GbE, 40GbE, and 100GbE environments. Four models are available: two featuring AC power supplies with front-to-back or back-to-front airflow, and two featuring DC power supplies with front-to-back or back-to-front airflow. All models include dual power supplies.

Key Components

The EX4650 switch includes native 25GbE (fiber only) and either 40GbE or 100GbE fixed-configuration options with rich L2, L3, Ethernet VPN (EVPN), and MPLS features. The EX4650 switches run the same reliable, high-performance Juniper Networks Junos® operating system used by Juniper Networks EX Series and QFX Series Ethernet Switches, SRX Series Services Gateways,and Juniper routers, ensuring a consistent control plane feature implementation and user experience across the entire Juniper infrastructure.

EX4650 Switch Models

The EX4650 switch is a compact, 1 U platform that provides high throughput, very low latency, and a rich set of Junos OS features. The performance of the EX4650's control plane is further enhanced with a powerful 2.3 GHz quad-core Intel CPU with 16 GB of memory and 64 GB SSD storage.

The EX4650-48Y is a 25GbE/100GbE campus distribution switch offering 48 SFP28 transceiver ports and eight QSFP28 ports that can be configured as 8x40GbE or 8x100GbE ports, with an aggregate throughput of 2 Tbps or 1.49 Bpps per switch. For added flexibility, each QSFP28 port can also be configured as 4x25GbE ports using breakout cables, increasing the total number of supported 25GbE ports to 80 per switch.

EX4650-48Y Highlights

The EX4650-48Y switch features the following:

- Support for high-density, multispeed 1GbE/10GbE/25GbE downlinks and 40GbE/100GbE uplinks for access and aggregation configurations, with up to 48 25GbE ports and up to eight 100GbE uplink ports in a 1 U platform
- Throughput of up to 2 Tbps L2 and L3 performance, with latency as low as 550 nanoseconds
- A 2.3 GHz quad-core Intel CPU with 16 GB memory and 64 GB SSD storage
- Feature-rich automation capabilities with support for Python and Zero Touch Provisioning (ZTP)

- Support for virtualization protocols such as Virtual Extensible LAN (VXLAN)
- Advanced Junos OS features such as EVPN, BGP add-path, MPLS, L3 VPN, and IPv6 6PE

Architecture and Key Components

EVPN-VXLAN Technology

The EX4650 embraces open standards and extends the industry-standard EVPN-VXLAN technology already supported in both the data center and campus. With enterprise applications moving to the cloud, it has become necessary to deploy IP fabrics as enterprise fabrics with L2 extensions using VXLAN. The EX4650 is capable of both L2 and L3 VXLAN gateway services, allowing customers to deploy networks that provide L2 adjacencies for applications over L3 fabrics. EVPN-VXLAN offers a scalable way to build and interconnect multiple campuses, data centers, and public clouds, delivering the following benefits:

- Greater network efficiency
- Based on industry standards
- Scalable at all network layers
- Faster convergence
- Flexible and secure architecture

Junos OS

The high-performance EX4650 runs Junos OS, Juniper's powerful and robust network operating system that powers all Juniper switches, routers, and firewalls. Key Junos OS features that enhance the functionality and capabilities of the EX4650 include:

- Software modularity, with process modules running independently in their own protected memory space and with the ability to do process restarts

- Commit and rollback functionality that ensures error-free network configurations
- A powerful set of scripts for on-box problem detection, reporting, and resolution

Junos OS Software License

The software features supported on the EX4650-48Y switch are categorized in three tiers: Base, Premium, and Advanced.

- Base software features include basic L2 switching, basic L3 routing, multicast, automation, programmability, ZTP, and basic monitoring. A Base software feature license comes with the purchase of the hardware and does not require any explicit license keys.

- Premium software features include all Base license functionality, plus BGP, IS-IS, and EVPN-VXLAN to explicitly address the needs of enterprise customers. To enable these features, customers must purchase the EX4650-PFL license, generate unique license keys, and install them on the switch. The license is not portable across devices.

- Advanced software features include all Premium license functionality plus MPLS to explicitly address the needs of enterprise interconnect and edge use cases. To enable these features, customers must purchase the EX4650-AFL license, generate unique license keys, and install them on the switch. The license is not portable across devices.

The Premium and Advanced software licenses are offered as perpetual licenses. Please see the Ordering Information section for license SKU descriptions.
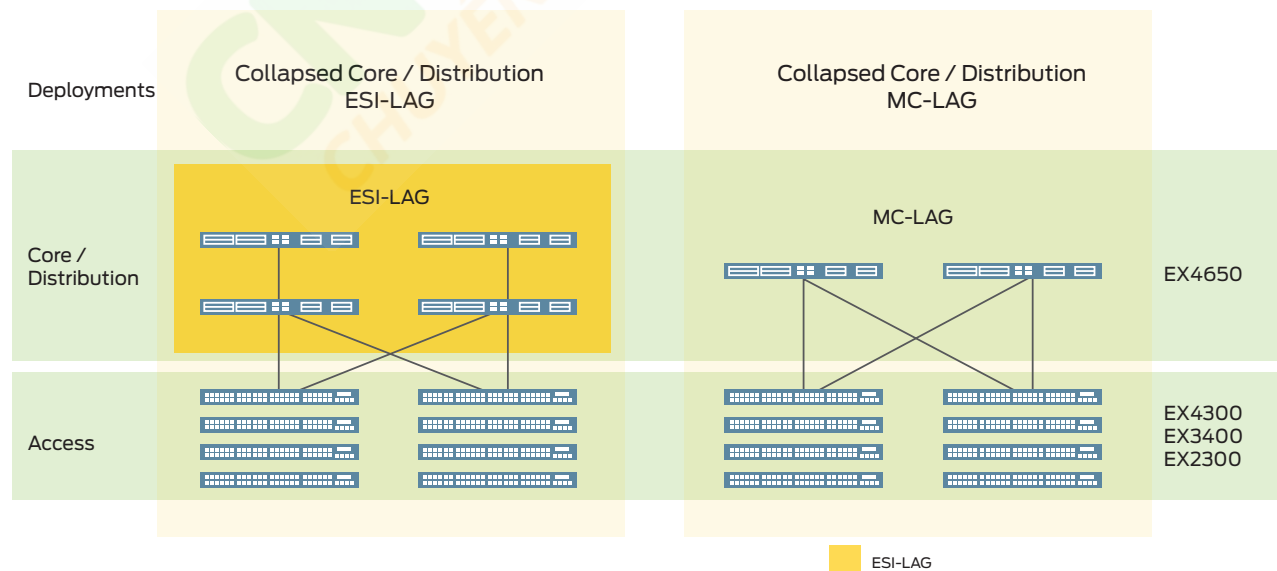

Figure 1: EX4650 as campus collapsed core/distribution switch with EVPN multihoming (ESI-LAG) and MC-LAG support

EX4650 Campus Deployment Options

The EX4650 switch is designed primarily for the following use cases:

1. **Collapsed Campus Core/Distribution:** A pair of interconnected EX4650 switches can be deployed to provide EVPN multihoming (ESI-LAG) or multichassis link aggregation (MC-LAG) in a collapsed core/distribution configuration. This eliminates the need for Spanning Tree Protocol (STP) across the campus network by providing multihoming capabilities from the access to the distribution layer, while distribution to core is an L3 IP fabric. ESI-LAG also supports horizontal scaling with more than two devices in the distribution layer and can extend EVPN to the core.

2. **Campus Distribution or Core Switch Supporting IP Clos:** A pair of interconnected EX4650 switches can provide EVPN L2 and L3 VXLAN gateway support. This eliminates the need for STP across the campus network by providing a multihoming capability from the access to the distribution layer, while distribution to the core is an L3 IP fabric using EVPN technology. The IP fabric can also extend to connect multiple enterprise buildings, while VXLAN allows stretching L2 across buildings. An IP Clos network between the distribution and the core layers can exist in two modes, both of which are supported by the EX4650:

   · Centrally routed bridging overlay: Integrated Routing and Bridging (IRB) interface placed at a central location in the fabric (in this case, a core device)

   · Edge routed bridging overlay: IRB interface placed at the edge of the fabric (in this case, a distribution device)

3. **Enterprise On-Premises Server Connectivity:** Data centers are demanding more high-speed, low-latency, storage- and I/O-converged networking solutions to maximize the performance of their physical servers, virtual servers, and storage. The EX4650 addresses these needs with low-latency, lossless, high-density 10GbE and 25GbE interfaces, as well as 100GbE uplinks to the core network. Furthermore, the EX4650 offers EVPN-VXLAN L2 and L3 gateway support, making it an ideal solution for overlay deployments in the enterprise on-premises data center.

The EX4650 also offers flexible airflow options, enabling them to support back-to-front and front-to-back cooling to ensure consistency with server designs for hot-aisle or cold-aisle deployments. Support for tri-speed 1GbE/10GbE/25GbE make the EX4650 ideal for enterprise server access; 48 ports of native 10GbE/25GbE for server connectivity and up to eight 40GbE or 100GbE ports for uplink connectivity provide very low oversubscription of 1.5:1 from access to aggregation. Each 40GbE port can be broken out into four 10GbE ports, providing additional options for server connectivity.

The EX4650 operates in both cut-through and store-and-forward modes, delivering sustained wire-speed switching with sub-microsecond latency and low jitter for any packet size (including jumbo frames) in both modes. With features such as EVPN multihoming (ESI-LAG) and MC-LAG, the EX4650 supports active/active server dual homing and can utilize full bisectional bandwidth from server to switch.
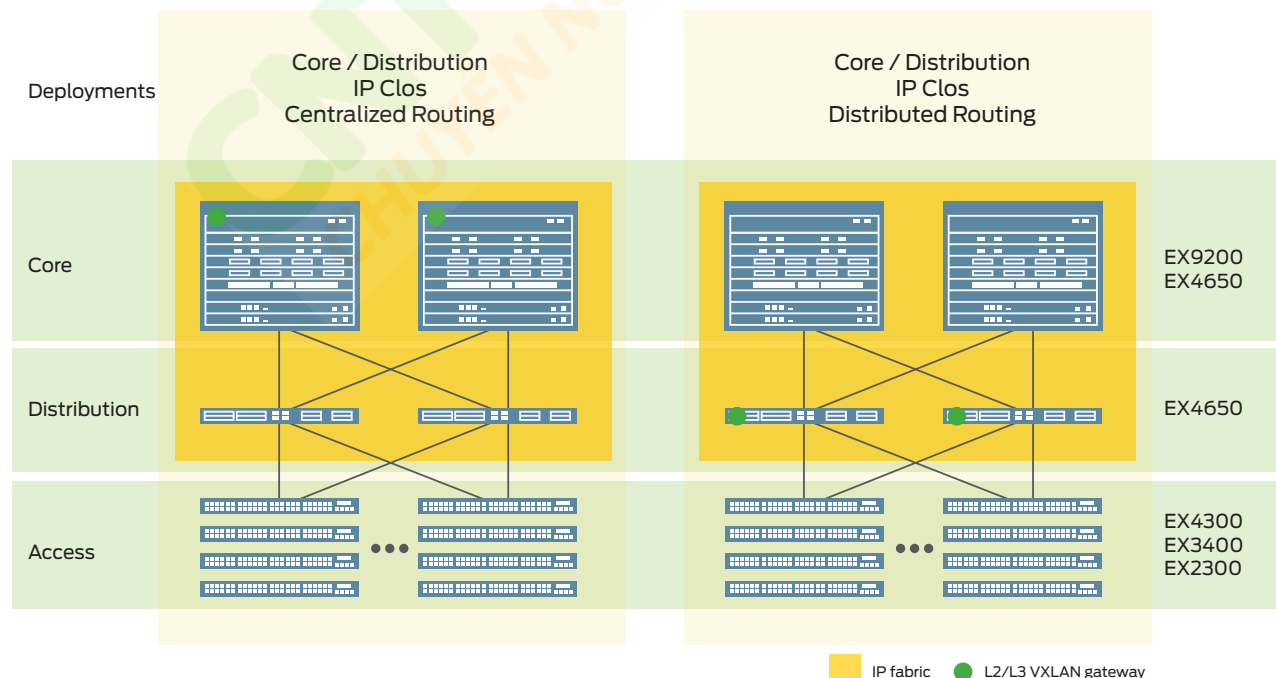

Figure 2: EX4650 as a campus distribution switch supporting IP Clos with EVPN-VXLAN L2/L3 gateway support
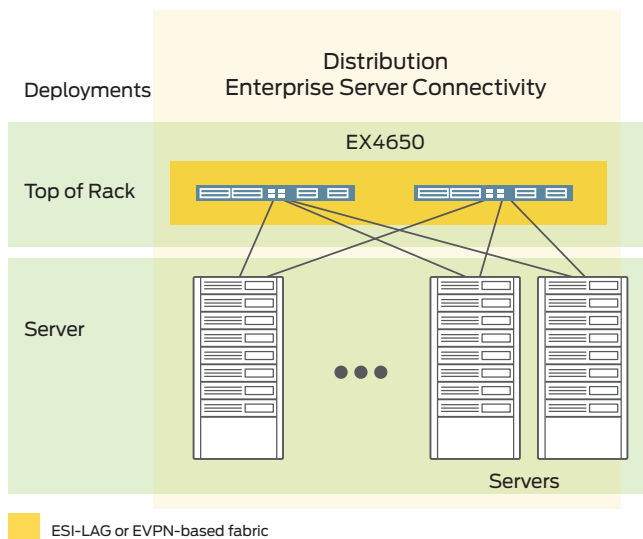
Figure 3: EX4650 for enterprise on-premises server connectivity

Features and Benefits

Automation

The EX4650 supports a number of network automation and plug-and-play features, including ZTP and event scripts, automatic rollback, and Python scripting.

Flexible Forwarding Table

The EX4650 includes a Unified Forwarding Table (UFT), which allows the hardware table to be divided into configurable partitions of L2 media access control (MAC), L3 host, and longest prefix match (LPM) tables. In a pure L2 environment, the EX4650 supports up to 288,000 MAC addresses; in L3 mode, the table can support up to 168,000 host entries; in LPM mode, the table can support up to 360,000 prefixes. Junos OS provides configurable options through a CLI to optimize the EX4650 for various deployment scenarios.

Intelligent Buffer Management

The EX4650 features a total of 32 MB of shared buffers. While 25% of the total buffer space is dedicated, the rest is shared among all ports and is user configurable. The intelligent buffer mechanism in the EX4650 effectively absorbs traffic bursts while providing deterministic performance, significantly increasing performance over static allocation.

MPLS

A broad set of MPLS features, including L3 VPN, IPv6 provider edge router (6PE), RSVP traffic engineering, and LDP, support standards-based network segmentation and virtualization, allowing the EX4650 to be deployed as a low-latency MPLS label-switching router (LSR).

VXLAN Overlays

The EX4650 is capable of both L2 and L3 VXLAN gateway services. Customers can deploy overlay networks to provide L2 adjacencies for applications over L3 fabrics. The overlay networks utilize VXLAN in the data plane and EVPN or OVSDB for programming the overlays, which can operate without a controller or be orchestrated with an SDN controller like OpenContrail.

Junos OS

Running Junos OS, which features the most advanced and robust routing capabilities in the industry, the EX4650 supports RIP and OSPF for both IPv4 and IPv6, as well as advanced routing capabilities such as IS-IS and BGP. With additional capabilities such as 64-way equal-cost multipath (ECMP) and BGP add path, the EX4650 is an ideal building block for deploying the most robust L3 underlay for SDN.

EVPN-VXLAN

Many proprietary campus architectures are built on traditional L2 Ethernet-based architectures that address the desire to eliminate Spanning Tree Protocol (STP). With the increase of IoT devices in the enterprise, these networks will be expected to scale rapidly without adding complexity and resources. Some of these IoT devices, however, have limited networking capabilities and require L2 adjacency across buildings or campuses. To address this problem, traditional solutions extend VLANs across buildings and campuses using data plane flood-and-learn. Unfortunately, this solution is inefficient and difficult to manage. The increasing number of network endpoints, coupled with rapidly changing business needs, demands an open, standards-based network that is simple, scalable, and programmable across both the campus and the data center.

Modern enterprise networks need a campus architecture that decouples the overlay network from the underlay network with technologies such as VXLAN, which enables network administrators to create logical L2 networks across different L3 networks. The EX4650 satisfies these requirements by supporting EVPN-VXLAN L2 and L3 gateway capabilities, providing the following benefits:

- Improved network and host mobility efficiency
  - Control plane MAC learning to reduce unknown-unicast flooding
  - Reduced Address Resolution Protocol (ARP) flooding due to MAC-to-IP binding in control plane
  - Multipath traffic over multiple core switches (VXLAN entropy)
  - Multipath traffic to active/active dual-homed access layer switches

- Fast convergence
  - Faster reconvergence when linked to dual-homed access switches fail (aliasing)
  - Faster reconvergence when endpoints move
- Scalability
  - Scalable BGP-based control plane
  - Seamless expansion of the core, distribution, and access layers as business needs grow
  - Seamless expansion of campuses as business needs grow
- Flexibility
  - Easy integration with L3 and L2 VPNs
  - BGP-based control plane functionality that allows application of fine-grained policies
- Nonproprietary
  - Standards-based protocols that support multivendor core, distribution, and access layers

Junos Telemetry Interface

The EX4650 supports Junos Telemetry Interface (JTI), a modern telemetry streaming tool designed for performance monitoring in enterprise networks. Streaming data to a performance management system enables network administrators to measure trends in link and node utilization, and troubleshoot such issues as network congestion in real time. JTI delivers the following features:

- Application visibility and performance management by provisioning sensors to collect and stream data and analyze application and workload flow paths through the network
- Capacity planning and optimization by proactively detecting hotspots and monitoring latency and microbursts
- Troubleshooting and root cause analysis via high-frequency monitoring
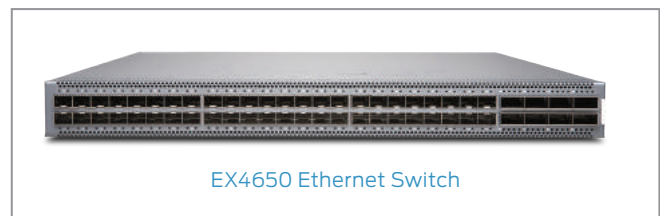
Monitoring and Analytics with Juniper AppFormix

Juniper AppFormix®, a network and device monitoring platform, provides comprehensive visualization and smart analytics for the EX4650 switch. Powered by machine learning and artificial intelligence, AppFormix automatically learns network and device performance profiles, detects faults, and facilitates preventative remediation in real time at scale, thus bringing DevOps style automation benefits from cloud to enterprise.

Based on a distributed policy and analytics architecture, AppFormix seamlessly collects and analyzes telemetry in real-time from the EX4650 platform via JTI, generating events and alert notifications and providing the operator with actionable insights.

AppFormix delivers the following features and benefits:

- **Real-time metrics and alarms**—AppFormix collects and analyzes comprehensive metrics in real time for monitored networks and devices, displaying them in the AppFormix dashboard as real-time charts and graphs. With AppFormix, an operator can also configure alarms for individual or groups of metrics that are triggered when specific values or conditions are met, or when anomalies occur, notifying the operator in real time. AppFormix software also plots these alarms on both real-time and historical charts, giving the operator a holistic view of current status as well as prevailing trends.
- **SLA Monitor**—The AppFormix dashboard includes an SLA Monitor pane that provides operators with an overview showing the current state of the network and devices. The SLA status indicates whether the network and the device are currently operating outside a user-defined performance threshold, while risk predicts whether the device may be unhealthy in the future based on historical trends.
- **Notifications**—AppFormix can be configured to notify external systems when events and alarms are triggered. For each event or alarm, AppFormix can post a structured description of the event as a JavaScript Object Notation (JSON) payload to an external HTTP endpoint. These notifications can initiate an action or workflow, whether corrective, preventive, or otherwise, to keep the network and devices operating in an optimal state. For operator convenience, AppFormix comes preconfigured with some of the industry's most popular incident management and collaboration platforms, including PagerDuty, ServiceNow, and Slack.
- **Reports**—AppFormix reports allow users to analyze how networks and devices are being consumed over time. The dashboard displays reports in both graphical and tabular formats. Users may also download the data as an HTML-formatted report, raw comma-separated value (CSV) file, or JSON-formatted statistics for further analysis.

EX4650 Ethernet Switch

EX4650 Switch Specifications

Hardware

Switching Capacity

- 2 Tbps/1.49 Bpps

Weight

- 23.7 lb (10.75 kg)

Dimensions (HxWxD)

- 1.72 x 17.36 x 20.48 in (4.37 x 44.09 x 52.02 cm)
- Switching mode: Cut-through and store-and-forward
- Front-to-back (airflow out) for hot aisle deployment
- Back-to-front (airflow in) for cold aisle deployment
- Management and console port connections

Power Consumption

- Max load 450 W; typical load 260 W; idle load 160 W

Interface Options

- 1GbE SFP: 48 (24 copper 1GbE)
- 10GbE SFP+: 48/80 (with breakout cable)
- 25GbE SFP28: 48/80 (with breakout cable)
- 40GbE QSFP+: 8
- 100GbE QSFP28: 8
- Each QSFP+ port can be configured as a 4 x 10GbE interface or as a 40 Gbps port
- Each QSFP28 port can be configured as a 4 x 25GbE interface or as a 100 Gbps port
- 1 USB 2.0 port
- 1 RS-232 console port
- 2 management ports: 2 x RJ-45 ports
- Supported transceiver and direct attach cable (DAC)
- SFP 1GbE optical and copper module
- SFP+ 10GbE optical modules
- SFP+ DAC cables: 1/3 m twinax copper and 1/3/5/7 m active twinax copper
- SFP28 DAC cables: 1 m twinax copper
- SFP28 optics: SR, LR
- QSFP+ DAC cables: 1/3 m twinax copper
- QSFP+ optics: SR4, LX4, ESR4, ER4, LR4
- QSFP+ to SFP+ 10GbE direct attach breakout copper (1/3 m twinax copper cable)
- QSFP28 to SFP28 25GbE direct attach breakout copper (1 m twinax copper cable)
- QSFP28 optics: SR4, ER4, PSM4, CWDM4, LR4

Rack Installation Kit

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

Airflow

- Redundant (N+1) and hot-pluggable fan modules for front-to-back and back-to-front airflow
- Redundant variable-speed fans to reduce power draw

Power Supply and Fan Modules

- Dual redundant (1+1) and hot-pluggable 650 W AC/DC power supplies
- 110-240 V single phase AC power
- -44 to -72 V DC power supply
- Redundant (4+1) and hot-pluggable fan modules for front-to-back or back-to-front airflow

Performance Scale (Unidimensional)

- Layer 2
  - MAC addresses per system: 288,000
  - VLAN IDs: 4093
  - Number of link aggregation groups (LAGs): 80
  - Number of ports per LAG: 64
  - Multiple Spanning Tree Protocol (MSTP) instances: 64
  - VLAN Spanning Tree Protocol (VSTP) instances: 509
  - Jumbo frame: 9216 bytes
- Firewall filters
  - Ingress filters: 1500
  - Egress filters: 512
- Layer 3
  - IPv4 unicast prefixes: 360,000
  - IPv4 unicast routes: 208,000
  - IPv4 multicast routes: 104,000
  - ECMP paths: 64
  - IPv6 unicast prefixes: 170,000
  - Ipv6 unicast routes: 104,000
  - IPv6 multicast routes: 52,000
  - ARP entries: 64,000
- Traffic mirroring
  - Mirroring destination ports per switch: 4
  - Maximum number of mirroring sessions: 4
  - Mirroring destination VLANs per switch: 4

Software Features Supported

Layer 2 Features

- STP—IEEE 802.1D (802.1D-2004)
- Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1w); MSTP (IEEE 802.1s)
- Bridge protocol data unit (BPDU) protect
- Loop protect
- Root protect
- RSTP and VSTP running concurrently
- VLAN—IEEE 802.1Q VLAN trunking

- The Routed VLAN Interface (RVI)
- Port-based VLAN
- Private VLAN (PVLAN)
- VLAN translation
- Static MAC address assignment for interface
- Per VLAN MAC learning (limit)
- MAC learning disable
- Link Aggregation and Link Aggregation Control Protocol (LACP) (IEEE 802.3ad)

Link Aggregation

- Multichassis link aggregation (MC-LAG)
- EVPN Multihoming (ESI-LAG)
- LAG load-sharing algorithm—bridged or routed (unicast or multicast) traffic:
  - IP: SIP, Dynamic Internet Protocol (DIP), TCP/UDP source port, TCP/UDP destination port
  - L2 and non-IP: MAC SA, MAC DA, Ethertype, VLAN ID, source port

Layer 3 Features (IPv4)

- Static routing
- Routing protocols (RIP, OSPF, IS-IS, BGP)
- Virtual Router Redundancy Protocol (VRRP)
- Bidirectional Forwarding Detection (BFD) protocol
- Virtual router
- Dynamic Host Configuration Protocol (DHCP) relay
- Proxy Address Resolution Protocol (ARP)

Multicast Features

- Internet Group Management Protocol (IGMP): v1, v2, v3
- IGMP snooping: v1, v2, and v3 (L2 only)
- IGMP Filter
- PIM-SM, PIM-SSM, PIM-DM
- Multicast Source Discovery Protocol (MSDP)

Security and Filters

- Secure interface login and password
- RADIUS
- TACACS+
- Ingress and egress filters: Allow and deny, port filters, VLAN filters, and routed filters, including management port filters
- Filter actions: Logging, system logging, reject, mirror to an interface, counters, assign forwarding class, permit, drop, police, mark
- SSH v1, v2
- Static ARP support
- Storm control, port error disable, and autorecovery
- Sticky MAC address
- DHCP snooping

Quality of Service (QoS)

- L2 and L3 QoS: Classification, rewrite, queuing
- Rate limiting:
  - Ingress policing: Single-rate two-color policer, two-rate three-color policer
  - Egress policing: Policer, policer mark down action
  - Egress shaping: Per queue on each port
- 10 hardware queues per port (8 unicast and 2 multicast)
- Strict-priority queuing (PQ), shaped-deficit weighted round-robin (SDWRR), weighted random early detection (WRED), weighted tail drop
- 802.1p remarking
- L2 classification criteria: Interface, MAC address, Ethertype, 802.1p, VLAN
- Congestion avoidance capabilities: WRED
- Trust IEEE 802.1p (ingress)
- Remarking of bridged packets

Data Center Bridging (DCB)

- Priority-based flow control (PFC)—IEEE 802.1Qbb
- Data Center Bridging Capability Exchange (DCBX), DCBx FCoE, and iSCSI type, length, and value (TLVs)

High Availability

- Bidirectional Forwarding Detection (BFD)
- Uplink failure detection

MPLS

- Static label-switched paths (LSPs)
- RSVP-based signaling of LSPs
- LDP-based signaling of LSPs
- LDP tunneling (LDP over RSVP)
- MPLS class of service (CoS)
- MPLS LSR support
- IPv6 tunneling (6PE) (via IPv4 MPLS backbone)
- IPv4 L3 VPN (RFC 2547, RFC 4364)

Server Virtualization Management and SDN-Related Protocols

- VXLAN OVSDB
- EVPN-VXLAN

Management and Operations

- Role-based CLI management and access
- CLI via console, telnet, or SSH
- Extended ping and traceroute
- Junos OS configuration rescue and rollback
- Image rollback
- SNMP v1/v2/v3
- Junos XML management protocol
- sFlow v5
- Beacon LED for port and system
- Zero Touch Provisioning (ZTP)

- OpenStack Neutron Plug-in
- Python
- Junos OS event, commit, and OP scripts
- Junos Telemetry Interface (JTI)

Traffic Mirroring

- Port-based
- LAG port
- VLAN-based
- Filter-based
- Mirror to local
- Mirror to remote destinations (L2 over VLAN)

Standards Compliance

IEEE Standard

- IEEE standard
- IEEE 802.1D
- IEEE 802.1w
- IEEE 802.1
- IEEE 802.1Q
- IEEE 802.1p
- IEEE 802.1ad
- IEEE 802.3ad
- IEEE 802.1AB
- IEEE 802.3x
- IEEE 802.1Qbb
- IEEE 802.1Qaz

T11 Standards

- INCITS T11 FC-BB-5

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 1058 Routing Information Protocol
- RFC 1112 IGMP v1
- RFC 1122 Host requirements
- RFC 1142 OSI IS-IS Intra-domain Routing Protocol
- RFC 1256 IPv4 ICMP Router Discovery Protocol (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 1745 BGP4/IDRP for IP—OSPF Interaction
- RFC 1772 Application of the Border Gateway Protocol in the Internet
- RFC 1812 Requirements for IP Version 4 Routers
- RFC 1997 BGP Communities Attribute
- RFC 2030 SNTP, Simple Network Time Protocol
- RFC 2068 HTTP server
- RFC 2131 BOOTP/DHCP relay agent and Dynamic Host
- RFC 2138 RADIUS Authentication
- RFC 2139 RADIUS Accounting
- RFC 2154 OSPF with 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 LSA Option
- RFC 2385 Protection of BGP Sessions via the TCP MD5 Signature Option
- RFC 2439 BGP Route Flap Damping
- RFC 2453 RIP v2
- RFC 2474 Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers
- RFC 2597 Assured Forwarding PHB (per-hop behavior) Group
- RFC 2598 An Expedited Forwarding PHB
- RFC 2697 A Single Rate Three Color Marker
- RFC 2698 A Two Rate Three Color Marker
- RFC 2796 BGP Route Reflection—An Alternative to Full Mesh IBGP
- RFC 2918 Route Refresh Capability for BGP-4
- RFC 3065 Autonomous System Confederations for BGP
- RFC 3376 IGMP v3 (source-specific multicast include mode only)
- RFC 3392 Capabilities Advertisement with BGP-4
- RFC 3446 Anycast RP
- RFC 3569 SSM
- RFC 3618 MSDP
- RFC 3623 Graceful OSPF Restart
- RFC 4271 Border Gateway Protocol 4 (BGP-4)
- RFC 4360 BGP Extended Communities Attribute
- RFC 4456 BGP Route Reflection: An Alternative to Full Mesh Internal BGP (IBGP)
- RFC 4486 Subcodes for BGP Cease Notification Message
- RFC 4724 Graceful Restart Mechanism for BGP
- RFC 4812 OSPF Restart Signaling
- RFC 4893 BGP Support for Four-octet AS Number Space

- RFC 5176 Dynamic Authorization Extensions to RADIUS
- RFC 5396 Textual Representation of Autonomous System (AS) Numbers
- RFC 5668 4-Octet AS Specific BGP Extended Community
- RFC 5880 Bidirectional Forwarding Detection (BFD) Dynamic Host Configuration Protocol (DHCP) server

Supported MIBs
- RFC 1155 SMI
- RFC 1157 SNMPv1
- RFC 1212, RFC 1213, RFC 1215 MIB-II, Ethernet-Like MIB and traps
- RFC 1850 OSPFv2 MIB
- RFC 1901 Introduction to Community-based SNMPv2
- RFC 2011 SNMPv2 for Internet Protocol using SMIv2
- RFC 2012 SNMPv2 for the Transmission Control Protocol using SMIv2
- RFC 2013 SNMPv2 for the User Datagram Protocol using SMIv2
- RFC 2233 The Interfaces Group MIB using SMIv2
- RFC 2287 System Application Packages MIB
- RFC 2570 Introduction to Version 3 of the Internet-standard Network Management Framework
- RFC 2571 An Architecture for describing SNMP Management Frameworks (read-only access)
- RFC 2572 Message Processing and Dispatching for the SNMP (read-only access)
- 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 2580 Conformance Statements for SMIv2
- RFC 2665 Ethernet-like Interface MIB
- RFC 2787 VRRP MIB
- RFC 2790 Host Resources MIB
- RFC 2819 RMON MIB
- RFC 2863 Interface Group MIB
- RFC 2932 IPv4 Multicast MIB
- RFC 3410 Introduction and Applicability Statements for Internet Standard Management Framework
- RFC 3411 An Architecture for Describing SNMP Management Frameworks
- RFC 3412 Message Processing and Dispatching for the SNMP
- RFC 3413 Simple Network Management Protocol (SNMP) Applications—(all MIBs are supported except the proxy MIB)
- RFC 3414 User-based Security Model (USM) for version 3 of SNMPv3
- RFC 3415 View-based Access Control Model (VACM) for the SNMP
- RFC 3416 Version 2 of the Protocol Operations for the SNMP

- RFC 3417 Transport Mappings for the SNMP
- RFC 3418 Management Information Base (MIB) for the SNMP
- RFC 3584 Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework
- RFC 3826 The Advanced Encryption Standard (AES) Cipher Algorithm in the SNMP User-based Security Model
- RFC 4188 Definitions of Managed Objects for Bridges
- RFC 4318 Definitions of Managed Objects for Bridges with Rapid Spanning Tree Protocol
- RFC 4363b Q-Bridge VLAN MIB

Approvals

Safety
- CAN/CSA-C22.2 No. 60950-1 Information Technology Equipment - Safety
- UL 60950-1 (2nd Edition) Information Technology Equipment – Safety
- EN 60950-1: 2006/A2:2013 Information Technology Equipment – Safety
- IEC 60950-1: 2005/A2:2013 Information Technology Equipment - Safety (All country deviations): CB Scheme
- EN 60825-1 Safety of Laser Products - Part 1: Equipment classification and requirements

EMC
- EN 300 386 V1.6.1 (2012-09) Electromagnetic compatibility and Radio spectrum Matters (ERM) Telecommunication network equipment
- EN 300 386 V2.1.1 (2016-07) Telecommunication network equipment; EMC requirements; Harmonized Standard covering the essential requirements of the Directive 2014/30/EU
- EN 55032:2012 (CISPR 32:2012) Electromagnetic compatibility of multimedia equipment—Emission requirements
- EN 55024:2010 (CISPR 24:2010) Information technology equipment—Immunity characteristics—Limits and methods of measurement
- IEC/EN 61000 Immunity Test
- AS/NZS CISPR 32:2015 Australia/New Zealand Radiated and Conducted Emissions
- FCC 47 CFR Part 15 USA Radiated and Conducted Emissions
- ICES-003 Canada Radiated and Conducted Emissions
- VCCI-CISPR 32:2016 Japanese Radiated and Conducted Emissions
- BSMI CNS 13438 Taiwan Radiated and Conducted Emissions (at 10 Meters)
- KN32/KN35 Korea Radiated Emission and Immunity Characteristics (at 10 Meters)
- KN61000 Korea Immunity Test
- TEC/SD/DD/EMC-221/05/OCT-16 India EMC standard

Environmental Compliance

Restriction of Hazardous Substances (ROHS) 6/6

China Restriction of Hazardous Substances (ROHS)

Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

Waste Electronics and Electrical Equipment (WEEE)

Recycled material

80 Plus Silver PSU Efficiency

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 6000 ft (1829 m)
- Relative humidity operating: 5% to 90% (noncondensing)
- Relative humidity nonoperating: 0% to 95% (noncondensing)

Juniper Networks Services and Support

Juniper Networks leads the market in performance-enabling services designed to accelerate, extend, and optimize your deployments. Our services enable you to maximize operational efficiency, reduce costs, and minimize risk while achieving a faster time-to-value for your network.

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Juniper Professional Services offers an Enterprise Switching QuickStart program to ensure that your solution is operational and you have a complete understanding of areas such as configuration and ongoing operations. The QuickStart service provides an onsite consultant who works with your team to quickly develop the initial configuration and deployment of a small Juniper Networks data center switching environment. A knowledge transfer session, which is intended as a review of local implementation and configuration options, is also included, but is not intended as a substitute for formalized training.

Ordering Information

Product	Description
Switch Hardware	
EX4650-48Y-AFI	48 25GbE/10GbE/GbE SFP28/SFP+/SFP ports, 8 100GbE/40GbE QSFP28/QSFP+ ports, redundant fans, 2 AC power supplies, 2 power cords, 4-post rack mount kit, and back to front airflow
EX4650-48Y-AFO	48 25GbE/10GbE/GbE SFP28/SFP+/SFP ports, 8 100GbE/40GbE QSFP28/QSFP+ ports, redundant fans, 2 AC power supplies, 2 power cords, 4-post rack mount kit, and front to back airflow
EX4650-48Y-DC-AFI	48 25GbE/10GbE/GbE SFP28/SFP+/SFP ports, 8 100GbE/40GbE QSFP28/QSFP+ ports, redundant fans, 2 DC power supplies, 2 power cords, 4-post rack mount kit, and back to front airflow
EX4650-48Y-DC-AFO	48 25GbE/10GbE/GbE SFP28/SFP+/SFP ports, 8 100GbE/40GbE QSFP28/QSFP+ ports, redundant fans, 2 DC power supplies, 2 power cords, 4-post rack mount kit, and front to back airflow
JPSU-650W-AC-AFO	Juniper 650 W AC power supply (port-side to FRU-side airflow)
JPSU-650W-AC-AFI	Juniper 650 W AC power supply (FRU-side to port-side airflow)
JPSU-650W-DC-AFO	Juniper 650 W DC power supply (port-side to FRU-side airflow)
JPSU-650W-DC-AFI	Juniper 650 W DC power supply (FRU-side to port-side airflow)
QFX5110-FANAFI	FANAFI fan model, back-to-front airflow
QFX5110-FANAFO	FANAFO fan model, front-to-back airflow
EX-4PST-RMK	4 post rack mount kit
Optics and Transceivers	
EX-SFP-1GE-T	SFP 1000BASE-T copper transceiver module for up to 100 m transmission on Category 5
EX-SFP-1GE-SX	SFP 1000BASE-SX GbE optics, 850 nm for up to 550 m transmission on multimode fiber
EX-SFP-1GE-LX	SFP 1000BASE-LX GbE optics, 1310 nm for 10 km transmission on single-mode fiber
EX-SFP-10GE-USR	SFP+ 10GbE ultra short reach optics, 850 nm for 10 m on OM1, 20 m on OM2, 100 m on OM3 multimode fiber
EX-SFP-10GE-SR	SFP+ 10GBASE-SR 10GbE optics, 850 nm for up to 300 m transmission on multimode fiber
EX-SFP-10GE-LR	SFP+ 10GBASE-LR 10GbE optics, 1310 nm for 10 km transmission on single-mode fiber
EX-SFP-10GE-ER	SFP+ 10GBASE-ER 10GbE optics, 1550 nm for 40 km transmission on single-mode fiber
EX-SFP-10GE-ZR	SFP+ 10GBASE-ZR 10GbE optics, 1550 nm for 80 km transmission on single-mode fiber
EX-SFP-DAC-1M	SFP+ 10GbE Direct Attach Copper (twinax copper cable), 1 m
EX-SFP-DAC-3M	SFP+ 10GbE Direct Attach Copper (twinax copper cable), 3 m
QFX-SFP-DAC-1MA	SFP+ 10GbE Direct Attach Copper (active twinax copper cable), 1 m

Product	Description
QFX-SFP-DAC-3MA	SFP+ 10GbE Direct Attach Copper (active twinax copper cable), 3 m
QFX-SFP-DAC-5MA	SFP+ 10GbE Direct Attach Copper (active twinax copper cable), 5 m
QFX-SFP-DAC-7MA	SFP+ 10GbE Direct Attach Copper (active twinax copper cable), 7 m
JNP-25G-SR	SFP28 25GBASE-SR optics for up to 100 m transmission over serial multimode fiber-optic (MMF) OM4 fiber
JNP-25G-LR	SFP28 25GBASE-SR optics for up to 10 km transmission over serial single-mode fiber-optic (SMF)
JNP-25G-DAC-1M	25GbE SFP28 to SFP28 copper cable, 1 m
JNP-25G-DAC-3M	25GbE SFP28 to SFP28 copper cable, 3 m
EX-QSFP-40G-LX4	40GbE QSFP+ LX4 optics
EX-QSFP-40G-SR4	QSFP+ 40GBASE-SR4 40GbE optics, 850 nm for up to 150 m transmission on multimode fiber
QFX-QSFP-40G-ESR4	QSFP+ 40GBASE-SR4 40GbE optics, 850 nm for up to 300 m transmission on multimode fiber
QSFPP-40GBASE-ER4	40GBASE-ER4 QSFP+ pluggable transceiver
EX-QSFP-40G-LR4	40GbE QSFP+ LR4
QFX-QSFP-DAC-1M	QSFP+ to QSFP+ Ethernet Direct Attach Copper (twinax copper cable), 1 m passive
QFX-QSFP-DAC-3M	QSFP+ to QSFP+ Ethernet Direct Attach Copper (twinax copper cable), 3 m passive
QFX-QSFP-DACBO-1M	QSFP+ to SFP+ 10GbE Direct Attach Breakout Copper (twinax copper cable), 1 m
QFX-QSFP-DACBO-3M	QSFP+ to SFP+ 10GbE Direct Attach Breakout Copper (twinax copper cable), 3 m
EX-QSFP-100G-SR4	QSFP28 100GbE, SR4, 100 m
JNP-QSFP-100G-PSM4	QSFP28 100GBASE-PSM4 optics for up to 500 m transmission over parallel SMF
JNP-QSFP-100G-CWDM	QSFP28 100GbE, CWDM4, 2 km
EX-QSFP-100G-LR4	QSFP28 100GbE, LR4, 10 km
JNP-100G-DAC-1M	QSFP28 to QSFP28 Ethernet Direct Attach Copper (twinax copper cable) 1 m
JNP-100G-DAC-3M	QSFP28 to QSFP28 Ethernet Direct Attach Copper (twinax copper cable) 3 m

Product	Description
JNP-100G-4X25G-1M	QSFP28 to SFP+ 25GbE Direct Attach Breakout Copper (twinax copper cable) 1 m
JNP-100G-4X25G-3M	QSFP28 to SFP+ 25 GbE Direct Attach Breakout Copper (twinax copper cable) 3 m
EX-SFP-GE80KCW1470	SFP, Gigabit Ethernet CWDM optics, 1470 nm for 80 km transmission on SMF
EX-SFP-GE80KCW1490	SFP, Gigabit Ethernet CWDM optics, 1490 nm for 80 km transmission on SMF
EX-SFP-GE80KCW1530	SFP, Gigabit Ethernet CWDM optics, 1530 nm for 80 km transmission on SMF
EX-SFP-GE80KCW1550	SFP, Gigabit Ethernet CWDM optics, 1550 nm for 80 km transmission on SMF
EX-SFP-GE80KCW1570	SFP, Gigabit Ethernet CWDM optics, 1570 nm for 80 km transmission on SMF
EX-SFP-GE80KCW1590	SFP, Gigabit Ethernet CWDM optics, 1590 nm for 80 km transmission on SMF
EX-SFP-GE80KCW1610	SFP, Gigabit Ethernet CWDM optics, 1610 nm for 80 km transmission on SMF

Software Feature Licenses

EX4650-PFL	EX4650 Premium Feature License
EX4650-AFL	EX4650 Advanced Feature License

About Juniper Networks

Juniper Networks brings simplicity to networking with products, solutions and services that connect the world. Through engineering innovation, we remove the constraints and complexities of networking in the cloud era to solve the toughest challenges our customers and partners face daily. At Juniper Networks, we believe that the network is a resource for sharing knowledge and human advancement that changes the world. We are committed to imagining groundbreaking ways to deliver automated, scalable and secure networks to move at the speed of business.

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