

# QFX5100 Application Acceleration Switch



## Product Overview

The QFX5100-24Q-AA Application Acceleration switch speeds the performance of critical time-sensitive applications by processing them within the network fabric using the QFX-PFA-4Q Packet Flow Accelerator (PFA) expansion module, which features a high-performance 320 Gbps field-programmable gate array (FPGA) with 1 million logical elements. The unique combination of 320 Gbps PFAs and a 2.56 Tbps Packet Forwarding Engine (PFE), all powered by Juniper's robust Junos operating system, makes the QFX5100-24Q-AA the most customizable switch in the industry.

## Product Description

The Juniper Networks® QFX5100-24Q-AA Application Acceleration switch is a compact, 1 U, high-density 40GbE data center switch. The base unit features 24 quad small form-factor pluggable plus transceiver (QSFP+) ports; with the addition of an optional QFX-PFA-4Q Packet Flow Accelerator (PFA) expansion module, the switch can morph into an intelligent application acceleration system. Alternatively, the QFX5100-24Q-AA can expand to support 32 QSFP+ ports by installing two four-port 40GbE expansion modules; when scaled to 32 ports, the QFX5100-24Q-AA supports wire-speed performance with an aggregate throughput of 2.56 Tbps or 1.44 Bpps per switch.

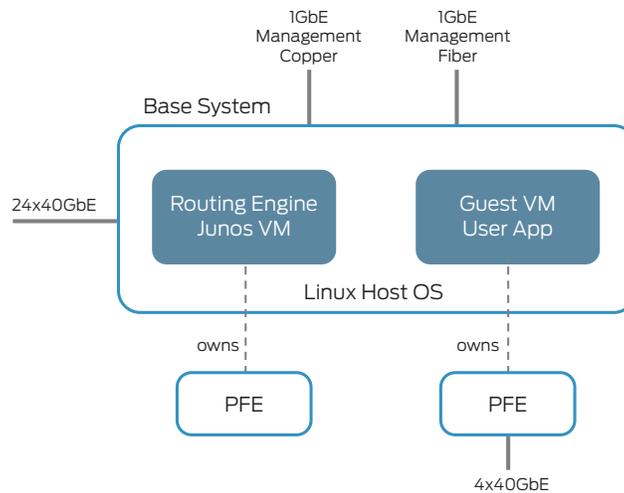


Figure 1: QFX5100-24Q-AA software architecture.

To support application processing on the QFX5100-24Q-AA, the CPU subsystem is enhanced with a quad-core Intel CPU with 32 GB DRAM and additional storage capacity through an onboard 128 GB solid-state drive (SSD). The enhanced CPU provides dedicated resources for applications running in the guest virtual machines (VMs) on the switch and also enables greater flexibility for custom programming of the PFA module.

The QFX-PFA-4Q PFA is a four-port 40GbE expansion module for QFX5100-24Q-AA featuring an Altera Stratix V 320 Gbps FPGA with 1 million logical elements. The PFA supports 160 Gbps high-speed internal connectivity to the Packet Forwarding Engine (PFE) on the QFX5100-24Q-AA platform, while four front-panel QSFP+ ports enable direct external connections to the PFA subsystem.

The QFX5100-24Q-AA CPU subsystem also includes a two-port 10GbE network interface card (NIC) device to support faster downloads of FPGA bit streams into the PFA module, as well as to route between the PFE and the Routing Engine. The PFA module supports 24 GB SDRAM (DDR3) for packet memory and 72 MB of quad data rate static RAM (SRAM) (QDR2+) for low-latency processing. The module also features a high precision oscillator with external packet-per-second interfaces for precision timing support. As an application

development module, the QFX-PFA-4Q is intended for customers requiring customized packet processing. However, Juniper does not provide or develop any packaged or customized solutions for the QFX-PFA module. Customers are encouraged to work with preferred partner Maxeler ([www.maxeler.com/contact-us/](http://www.maxeler.com/contact-us/)) for customized solutions or tools.

Similar to other QFX5100 switches, the QFX5100-24Q-AA supports rich Layer 2, Layer 3, and MPLS features. The QFX5100 also runs the same reliable, high-performance Juniper Networks Junos operating system used by Juniper Networks QFX Series switches, EX Series Ethernet Switches, Juniper routers, and SRX Series Services Gateways, ensuring a consistent implementation and operation of control plane features across the Juniper infrastructure. With its diverse set of deployment options, including Layer 3 and spine and leaf, the QFX5100 line is the universal building block for data center switching architectures, enabling users to easily adapt as requirements change over time.

## Architecture and Key Components

The QFX5100-24Q-AA Application Acceleration switch includes the following capabilities. Please refer to the Specifications section for currently shipping features vs. those that will be available in a future software release.

### QFX5100-24Q-AA Highlights

- Supports high-density configurations—24x40GbE ports in the base 1 U platform:
  - 32x40GbE ports with four-port QSFP+ expansion modules installed in two expansion slots
  - 28x40GbE ports with a single four-port QSFP+ expansion module
- For added flexibility, the 40GbE ports on all QFX5100 switches can be used as 4x10GbE ports using QSFP+ to small form-factor pluggable plus transceiver (SFP+) direct attach copper (DAC) or QSFP+ to SFP+ fiber splitter cables and optics
- Delivers up to 2.56 Tbps L2 and L3 performance and as low as 550 ns latency<sup>1</sup>
- Includes 2.5 GHz quad-core Intel CPU with 32 GB memory and 128 GB SSD storage
- Provides dedicated CPU cores for guest VM
- Provides dedicated out-of-band management interface for guest VM
- Ensures high availability with the industry's only topology-independent in-service-software upgrade (TISSU)
- Rich automation capabilities with support for Python, Chef, Puppet, and zero touch provisioning (ZTP)
- Works with Juniper Networks Cloud Analytics Engine to monitor and report workload and application behavior across the physical and virtual infrastructure
- Includes built-in Insight Technology software capability for microburst monitoring and reporting, as well as hotspot statistics and visibility

- Supports standards-based network virtualization protocols such as Virtual Extensible LAN (VXLAN), Open vSwitch Database (OVSDB) protocol\*, and integration with Juniper Networks Contrail and VMware NSX SDN controllers
- Includes advanced Junos OS features such as BGP add-path, MPLS, L3 VPN, and IPv6 6PE

### QFX-PFA-4Q Packet Flow Accelerator Module Highlights

- Includes high-capacity 320 Gbps Altera Stratix V
- Provides 14 million gates
- Features 48 GB DDR3 DRAM
- Includes 72 MB QDR2+
- Offers four QSFP+ front panel ports
- Supports timing input and output interfaces for Precision Time Protocol (PTP) applications
- Provides 160 Gbps of wire-speed connectivity between PFE and PFA

### Other QFX5100 Switch Models

In addition to QFX5100-24Q-AA, the QFX5100 switch line includes three compact 1 U models and one 2 U model, each providing wire-speed packet performance, very low latency, and a rich set of Junos OS features. In addition to a high throughput PFE, control plane performance on all QFX5100 models is further enhanced with a powerful 1.5 GHz dual-core Intel CPU with 8 GB of memory and 32 GB SSD storage.

The QFX5100 line of switches includes the following:

- **QFX5100-48S:** Compact 1 U 10GbE data center access switch with 48 small form-factor pluggable and pluggable plus (SFP/SFP+) transceiver ports and six quad SFP+ (QSFP+) ports with an aggregate throughput of 1.44 Tbps or 1.08 Bpps per switch.
- **QFX5100-48T:** Compact 1 U 10GbE data center access switch with 48 tri-speed (10GbE/1GbE/100 Mbps) RJ-45 ports and six QSFP+ ports with an aggregate throughput of 1.44 Tbps or 1.08 Bpps per switch.
- **QFX5100-24Q:** Compact 1 U high-density 40GbE data center access and aggregation switch starting with a base density of 24 QSFP+ ports with the option to scale to 32 QSFP+ ports with two four-port expansion modules. All 32 ports support wire-speed performance with an aggregate throughput of 2.56 Tbps or 1.44 Bpps per switch.
- **QFX5100-96S:** Compact 2 U high-density 10GbE aggregation switch with 96 SFP+/SFP and eight QSFP+ ports with an aggregate throughput of 2.56 Tbps or 1.44 Bpps per switch.

### Switch Deployments

Today's data centers are built with high-performance, small form-factor, multicore blade and rack servers. The greater compute capacity and server densities enabled by these devices are increasing traffic levels, creating the need for high-speed,

<sup>1</sup>550 ns is for 40GbE to 40GbE mode only

\*Roadmap

low-latency, storage- and I/O-converged networking solutions that can maximize performance for physical servers, virtual servers, and storage in the data center.

An immense amount of compute power is required to process these applications, which often need to interact with other applications on different servers to complete a single task. Switching between different compute resources leads to higher application latency—intolerable in use cases such as high frequency trading and Hadoop clusters. The QFX5100-24Q-AA with PFA module accelerates application processing by performing certain compute tasks on a hardware acceleration platform, lowering latency, improving performance, and lowering the cost of procuring additional compute resources.

The greatest benefit of an FPGA is its ability to perform customized processing, as well as the flexibility to change and reprogram logic as needs change. Fixed pipeline ASICs such as the PFE on the QFX5100 are designed for fast switching and routing of packets based on L2 and L3 headers. Functions that typically occur at L4 or above—such as Network Address Translation (NAT), packet encryptions, and load balancing—can easily be implemented on the QFX-PFA-4Q expansion module.

## Junos OS

All QFX5100 switches run Junos OS, Juniper's powerful and robust network operating system.

The Junos operating system features the most advanced and robust routing capabilities in the industry. All QFX5100 switches include support for RIP and OSPF for both IPv4 and IPv6 in the base software. Advanced capabilities such as IS-IS, BGP, LDP, RSVP, and BGP-LU are also supported. With additional capabilities like 64-way equal-cost multipath (ECMP) and BGP add path, QFX5100 is an ideal building block for deploying the most robust L3 underlay for software-defined networks (SDN)

In addition to advanced features, Junos OS has the following additional attributes:

- Software modularity with process modules running independently in their own protected memory space and with the ability to do process restarts
- Uninterrupted routing and forwarding with features such as nonstop routing (NSR) and nonstop bridging (NSB)
- Commit and rollback functionality that ensures error free network configurations
- A powerful set of scripts for on-box problem detection, reporting, and resolution

## Junos Space Network Director

The QFX5100 switches can be managed through Junos Space Network Director, a next-generation network management solution that allows users to visualize, analyze, and control the entire enterprise network—data center and campus, physical

and virtual, wired and wireless—through a single pane of glass. Network Director incorporates sophisticated analytics for real-time intelligence, trended monitoring, and automation to increase agility as well as enabling faster rollout and activation of services.

For cloud deployments, Network Director provides a set of REST APIs that enable on-demand and dynamic network services by simplifying the consumption of services for multitenant environments. With third-party cloud orchestration tool integration, the Network Director API enables automation and provisioning of L2, L3, and security services in the data center without the need for manual operator intervention.

## Features and Benefits

### Topology-Independent In-Service-Software Upgrade (TISSU)

With its Intel core processor, the QFX5100-24Q-AA Application Acceleration switch allows Junos OS to run within a VM on Linux. Junos OS runs in two separate VMs in active and standby pairs; during software upgrade cycles, the switches seamlessly move to the newer software version while maintaining intact data plane traffic. This true topology-independent ISSU, an industry-first software upgrade feature for a fixed-configuration top-of-rack switch, is supported across all L2 and L3 protocols and doesn't need the support of any other switches to perform an image upgrade.

### Automation

The QFX5100-24Q-AA Application Acceleration switch supports a number of features for network automation and plug-and-play operations. Features include zero touch provisioning, operations and event scripts, automatic rollback, and Python scripting. The switch also offers support for integration with VMware NSX Layer 2 Gateway Services, Puppet, and OpenStack.

### Flexible Forwarding Table

The QFX5100-24Q-AA Application Acceleration switch's Flexible Forwarding Table (FFT) allows the hardware table to be carved into configurable partitions of L2 media access control (MAC), L3 host, and longest prefix match (LPM) tables. In a pure L2 environment, the switch supports 288,000 MAC addresses. In L3 mode, the table can support 128,000 host entries, and in LPM mode, it can support 128,000 prefixes. Junos OS provides configurable options through a CLI so that each QFX5100 can be optimized for different deployment scenarios.

### Intelligent Buffer Management

The QFX5100-24Q-AA Application Acceleration switch has a total of 12 MB 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 QFX5100 effectively absorbs traffic bursts while providing deterministic performance, significantly increasing performance over static allocation.

### Cloud Analytics Engine

The QFX5100-24Q-AA Application Acceleration switch supports the Juniper Networks Cloud Analytics Engine, providing critical network performance data to improve application performance and availability. Cloud Analytics Engine performs data collection, correlation, and visualization to help customers better understand workload and application behavior across the physical and virtual infrastructure.

### Insight Technology for Analytics

The QFX5100-24Q-AA Application Acceleration switch provides dynamic buffer utilization monitoring and reporting, with an interval of 10 milliseconds to provide microburst and latency insight. It calculates both queue depth and latency, and logs messages when configured thresholds are crossed. Interface traffic statistics can be monitored at two-second granularity. The data can be viewed via CLI, system log, or streamed to external servers for more analysis. Supported reporting formats include Java Script Object Notification (JSON), comma-separated values (CSV), and tab-separated values (TSV). These files can be consumed by orchestration systems, SDN controllers, or network management applications (such as Junos Space Network Director) to make better network design decisions and identify network hotspots.

### MPLS

The QFX5100-24Q-AA Application Acceleration switch supports a broad set of MPLS features, including L3 VPN, IPv6 provider edge router (6PE), RSVP traffic engineering, and LDP to allow standards-based network segmentation and virtualization. The

QFX5100 can be deployed as a low-latency MPLS label-switching router (LSR) or MPLS PE router in smaller scale environments. The QFX5100 is the industry's only compact, low-latency, high-density, low power switch to offer an MPLS feature set.

### IP Clos Fabric

The QFX5100-24Q-AA switches can be used either as a leaf or as a spine and a leaf, depending on the topology (see Figures 2 and 3, respectively).

### FCoE

As a Fibre Channel over Ethernet (FCoE) transit switch, the QFX5100-24Q-AA Application Acceleration switch provides an IEEE data center bridging (DCB) converged network between FCoE-enabled servers and an FCoE-enabled Fibre Channel storage area network (SAN). The QFX5100 offers a full-featured DCB implementation that provides strong monitoring capabilities on the top-of-rack switch for SAN and LAN administration teams to maintain clear separation of management. In addition, FCoE Initiation Protocol (FIP) snooping provides perimeter protection, ensuring that the presence of an Ethernet layer does not impact existing SAN security policies. FCoE link aggregation group (LAG) active/active support is available to achieve resilient (dual-rail) FCoE connectivity.

The FCoE transit switch functionality, including priority-based flow control (PFC), Enhanced Transmission Selection (ETS), and Data Center Bridging Capability Exchange (DCBX), are included as part of the default software.

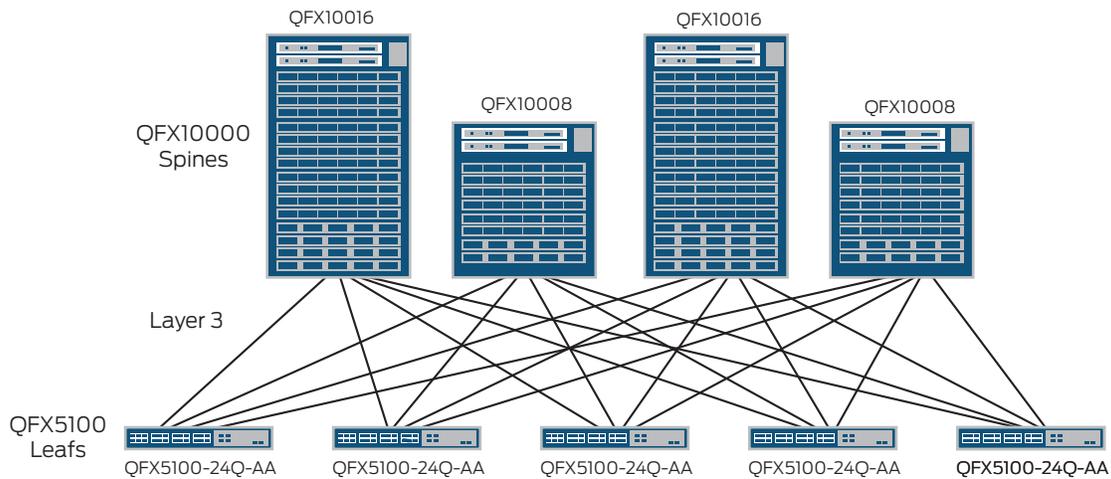


Figure 2: IP Clos Layer 3 fabric using QFX5100-24Q-AA switches as leaves.

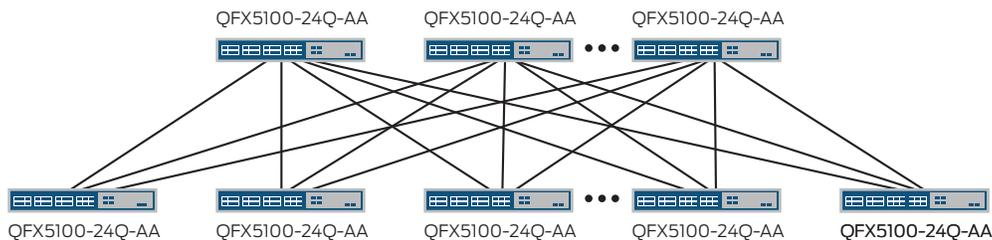
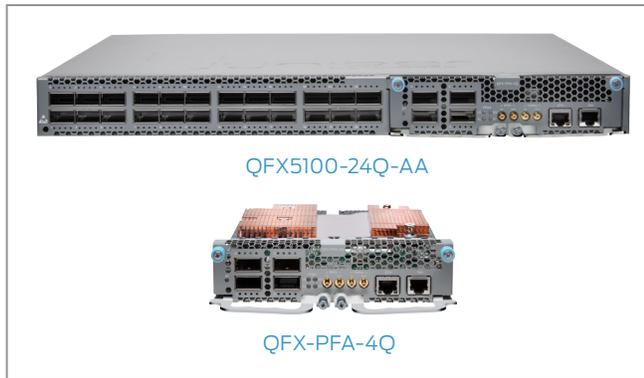


Figure 3: IP Layer 3 fabric using QFX5100-24Q-AA switches as spine and leafs.



QFX5100-24Q-AA

QFX-PFA-4Q

## Specifications

### Hardware

- Switching capacity: 2.56 Tbps/1.44 Bpps

### Weight:

- QFX5100-24Q-AA: 21.6 lb (9.8 kg)
- QFX-PFA-4Q: 3 lb (1.4 kg)

### Dimensions (HxWxD):

- QFX5100-24Q-AA: 1.72 x 17.36 x 20.48 in (4.37 x 44.09 x 52.02 cm)
- QFX-PFA-4Q: 6.69 x 7.48 in (1.7 x 1.9 cm)
- Switching mode: Cut-through and store-and-forward
- Front-to-back or back-to-front airflow (for hot aisle/cold aisle deployment)
- Management and rear console port connections
- Power consumption:<sup>2</sup>
  - QFX5100-24Q-AFO/AFI: 175 W
  - QFX-PFA-4Q: 120 W

### Interface Options

- QFX5100-24Q-AA-AFO/AFI:
  - 1GbE SFP: N/A
  - 10GbE SFP+: 96/104 (with breakout cable)
  - 40GbE QSFP+: 24/32 (with 2 x QFX-EM-4Q)
- Each QSFP+ port can be configured as a 4x10GbE interface
- Each QSFP+ port can be configured as a 40 Gbps port
- USB port
- Console port
- 2 management ports: 1 RJ-45 and 1 SFP
- Supported transceiver and direct attach cable
- QSFP+ 40GbE optical modules
- QSFP+ DAC cables: 1/3/5 m twinax copper
- QSFP+ to SFP+ 10GbE direct attach breakout copper (1/3 m twinax copper cable)

### Rack Installation Kit

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

### Airflow

- Front-to-back and back-to-front cooling
- Redundant variable-speed fans to reduce power draw

### Power Supply and Fan Modules

- Dual redundant (1+1) and hot-pluggable power supplies
- 110-240 V single phase AC power
- 36 to -72 V DC power
- Redundant (N+1) and hot-pluggable fan modules for front-to-back and back-to-front airflow

### Performance Scale (Unidimensional)

- MAC addresses per system: 288,000<sup>3</sup>
- VLAN IDs: 4,091
- Number of link aggregation groups (LAGs): 128
- Number of ports per LAG: 32
- Number of FCoE VLANs/FC Virtual Fabrics: 4,095
- Firewall filters: 4,000
- IPv4 unicast routes: 128,000 prefixes; 208,000 host routes; 64 ECMP paths
- IPv4 multicast routes: 104,000
- IPv6 multicast routes: 52,000
- IPv6 unicast routes: 64,000 prefixes
- ARP entries: 48,000
- Jumbo frame: 9,216 bytes
- Spanning Tree Protocol (STP):
  - Multiple Spanning Tree Protocol (MSTP) instances: 64
  - VLAN Spanning Tree Protocol (VSTP) instances: 253
- Traffic mirroring:
  - Mirroring destination ports per switch: 4
  - Maximum number of mirroring sessions: 4
  - Mirroring destination VLANs per switch: 4

### 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
- Routed VLAN Interface (RVI)
- Port-based VLAN
- MAC address filtering
- Private VLAN (PVLAN)
- QinQ
- 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)
- IEEE 802.1AB Link Layer Discovery Protocol (LLDP)
- Link Aggregation

<sup>2</sup> Measured with 10GbE passive DAC and QSFP passive DAC

<sup>3</sup> One-dimensional scale

- Multichassis link aggregation (MC-LAG)
- Redundant Trunk Group (RTG)
- 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
  - Layer 2 and non-IP: MAC SA, MAC DA, Ethertype, VLAN ID, source port
  - FCoE packet: Source ID (SID), Destination ID (DID), Originator exchange ID (OXID), source port

### Layer 3 Features (IPv4)

- Static routing
- Routing policy
- 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, v3
- IGMP Filter
- PIM-SM
- 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
- Control plane denial-of-service (DoS) protection
- IP Source Guard
- Dynamic ARP Inspection (DAI)
- Sticky MAC address
- DHCP snooping

### Quality of Service (QoS)

- L2 and L3 QoS: Classification, rewrite, queuing
- Rate limiting:
  - Ingress policing: 1 rate 2 color, 2 rate 3 color
  - Egress policing: Policier, policier mark down action
  - Egress shaping: Per queue on each port
- 12 hardware queues per port (8 unicast and 4 multicast)
- Strict priority queuing (LLQ), shaped-deficit weighted round-robin (SDWRR), weighted random early detection (WRED), weighted tail drop
- 802.1p remarking
- Layer 2 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
- Enhanced Transmission Selection (ETS)—IEEE 802.1Qaz
- Data Center Bridging Exchange Protocol (DCBX), DCBx FCoE, and iSCSI type, length, and value (TLVs)

### Fibre Channel over Ethernet (FCoE)

- FCoE transit switch (FIP snooping ACL installation)
- FCoE session path learning
- FCoE session health monitoring
- Graceful restart for FIP snooping
- FC-BB-6 VN2VN snooping

### High Availability

- Topology-independent in-service-software upgrade (TISSU)
- Bidirectional Forwarding Detection (BFD)
- Uplink failure detection (UFD)

### 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 access control list (ACL)/policers
- MPLS LSR support
- IPv6 tunneling (6PE) (via IPv4 MPLS backbone)
- MPLS Operation, Administration, and Maintenance (OAM)—LSP ping
- IPv4 L3 VPN (RFC 2547, 4364)

### Server Virtualization Management

- Junos Space Virtual Control:
  - IEEE 802.1Qbg (VEPA hairpin forwarding)
  - VMware NSX VXLAN L2 Gateway\*
  - VXLAN OVSDB\*

\*Roadmap

## Management and Operations

- Junos Space Network Director\*
- 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
- High frequency statistics collection
- Beacon LED for port and system
- Automation and orchestration
- Zero touch provisioning (ZTP)
- OpenStack Neutron Plug-in
- Puppet
- Chef
- Python
- Junos OS event, commit, and OP scripts

## 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 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
- IEEE 802.1Qau\*
- IEEE 802.1Qbg\*

### 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 (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 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 2385 Protection of BGP Sessions via the TCP Message Digest 5 (MD5) Signature Option
- RFC 2439 BGP Route Flap Damping
- RFC 2453 RIP v2
- RFC 2474 Definition of the Differentiated Services 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

\*Roadmap

- 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)
- Configuration Protocol (DHCP) server
- 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)—(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

## 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 transmission control protocol using SMIv2
- RFC 2013 SNMPv2 for 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

## Approvals

### Safety

- CAN/CSA-C22.2 No. 60950-1 (2007) Information Technology Equipment—Safety
- UL 60950-1 (2nd Ed.) Information Technology Equipment—Safety
- EN 60950-1 (2005) Information Technology Equipment—Safety
- IEC 60950-1 (2005) Information Technology Equipment—Safety (All country deviations): CB Scheme report.
- EN 60825-1 +A1+A2 (1994) Safety of Laser Products—Part 1: Equipment Classification
- GR-63-Core (2006) Network Equipment, Building Systems (NEBS) Physical Protection
- GR-1089-Core (2006) EMC and Electrical Safety for Network Telecommunications Equipment
- SR-3580 (1995) NEBS Criteria Levels (Level 3)

### EMC

- FCC 47CFR, Part 15 Class A (2009) USA Radiated Emissions
- EN 55022 Class A (2006)+ A1 2007 European Radiated Emissions
- VCCI Class A (2007) Japanese Radiated Emissions
- BSMI CNS 13438 and NCC C6357 Taiwan Radiated Emissions
- AS/NZS CISPR22:2009

## 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: 32° to 104° F (0° to 40° C)
- Storage temperature: -40° to 158° F (-40° to 70° C)
- Operating altitude: up to 2,000 ft (610 m)
- Relative humidity operating: 5% to 90% (noncondensing)
- Relative humidity nonoperating: 0% to 95% (noncondensing)

## 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](http://www.juniper.net/us/en/products-services).

## Ordering Information

Model Number	Description
<b>Switch Hardware</b>	
QFX5100-24Q-AA-AFI	24 port QSFP+ application acceleration switch, redundant fans, redundant power supplies, back-to-front AC
QFX5100-24Q-AA-AFO	24 port QSFP+ application acceleration switch, redundant fans, redundant power supplies, front-to-back AC
QFX-PFA-4Q	4 QSFP+ Packet Flow Accelerator expansion module for QFX5100-24Q-AA
QFX-EM-4Q	4 port QSFP+ expansion module for QFX5100-24Q and QFX5100-24Q-AA
EX4600-EM-8F	8 port SFP+/SFP expansion module for EX4600, QFX5100-24Q, and QFX5100-24Q-AA
JPSU-650W-AC-AFO	AC 650 W PSU, front-to-back airflow for QFX5100-48S, QFX5100-48T, QFX5100-24Q, QFX5100-24Q-AA

Model Number	Description
JPSU-650W-AC-AFI	AC 650 W PSU, back-to-front airflow for QFX5100-48S, QFX5100-48T, QFX5100-24Q, QFX5100-24Q-AA
QFX5100-FAN-AFI	Back-to-front airflow fan module for QFX5100
QFX5100-FAN-AFO	Front-to-back airflow fan module for QFX5100
QFX5100-EM-BLANK	Blank module for QFX5100

## Optics and Transceivers (QFX5100-24Q-AA)

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
JNP-QSFP-DAC-5M	QSFP+ to QSFP+ Ethernet Direct Attach Copper (twinax copper cable) 5 m passive
QFX-QSFP-DACBO-1M	QSFP+ to SFP+ 10-Gigabit Ethernet Direct Attach Breakout Copper (twinax copper cable) 1 m
QFX-QSFP-DACBO-3M	QSFP+ to SFP+ 10-Gigabit Ethernet Direct Attach Breakout Copper (twinax copper cable) 3 m
QFX-QSFP-40G-SR4	QSFP+ 40GBASE-SR4 40-Gigabit Optics, 850 nm for up to 150 m transmission on multimode fiber-optic (MMF)
QFX-QSFP-40G-ESR4	QSFP+ 40GBASE-ESR4 40-Gigabit Optics, 300 m (400 m) with OM3 (OM4) MMF
JNP-QSFP-40G-LR4	QSFP+ 40GBASE-LR4 40-Gigabit Optics, 1,310 nm for up to 10 km transmission on single-mode fiber-optic (SMF)
QFX-QSFP-DACBO-1M	QSFP+ to SFP+ 10-Gigabit Ethernet Direct Attach Breakout Copper (twinax copper cable) 1 m
QFX-QSFP-DACBO-3M	QSFP+ to SFP+ 10-Gigabit Ethernet Direct Attach Breakout Copper (twinax copper cable) 3 m
JNP-QSFP-40G-LX4	QSFP+ 40GBASE-LX4 40-Gigabit Optics, 100 m (150 m) with OM3 (OM4) duplex MMF

## Optics and Transceivers (QFX-PFA-4Q)

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
JNP-QSFP-DAC-5M	QSFP+ to QSFP+ Ethernet Direct Attach Copper (twinax copper cable) 5 m passive
QFX-QSFP-DACBO-1M	QSFP+ to SFP+ 10-Gigabit Ethernet Direct Attach Breakout Copper (twinax copper cable) 1 m
QFX-QSFP-40G-SR4	QSFP+ 40GBASE-SR4 40-Gigabit Optics, 850 nm for up to 150 m transmission on MMF

## Advanced Feature Licenses

QFX5100-HDNSE-LIC	QFX5100-24Q and QFX5100-96S Advanced Feature License for IS-IS, BGP, and MPLS
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## 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](http://www.juniper.net).

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