

# QFX10000 COHERENT DWDM LINE CARD

## Product Overview

*The QFX10000 Coherent DWDM Line Card is an extension of Juniper's flagship QFX10000 line of Switches. Installed in the modular QFX10008 and QFX100016 switching platforms, the QFX10000 Coherent DWDM Line Card helps customers achieve operational simplicity by providing a single interface for managing IP and DWDM without compromising density and security.*

## Product Description

Distributed cloud applications, video streaming, and mobile applications are causing an explosion in data center traffic growth, creating the need to interconnect geographically dispersed locations to create a single hyperscale logical resource pool.

To achieve this interconnectivity, cloud operators are deploying isolated packet and dense wavelength-division multiplexing (DWDM) equipment as separate domains with independent management tools. Integrating DWDM into Juniper Networks® QFX10000 line of Switches eliminates these operational silos by bringing packet and optical into a converged architecture, while the integration of coherent optics into the QFX10000 Switches reduces space and power consumption and eliminates the high cost of external transponder shelves.

The high availability and traffic engineering features available on the QFX10000 Switches complement integrated coherent DWDM into a single multilayer Data Center Interconnect (DCI) environment, all managed by Juniper Networks Junos® operating system. The modular QFX10000 Switches, the QFX10008 and QFX10016, offer up to 19.2 Tbps of DWDM capacity in a single system with line-rate encryption. The six-port QFX10000 Coherent DWDM Line Card is equipped with flex modulation technology, enabling 200 Gbps, 150 Gbps, or 100 Gbps line rates to support cloud data center applications such as cloud interconnect, metro connect, and enhanced disaster recovery. The line card also supports line-rate Ethernet protocols, Layer 3, MPLS, and Virtual Extensible LAN (VXLAN) features used to create Layer 2 or Layer 3 services over a DWDM network.

The QFX10000 Coherent DWDM Line Card is built on Juniper Networks Q5 silicon, which, in addition to rich L2 and L3 Ethernet features, offers the large logical scale and deep buffers required for collapsed DCI deployments. The QFX10000 Coherent DWDM Line Card will interoperate with any Ethernet client cards and any common components of the QFX10000 line's chassis.

### Integrated Coherent DWDM Line Card Capabilities on the QFX10000

- Offers leading density, performance, and economics for cloud-scale applications
- Simplifies cloud deployment by collapsing spine/DCI into a single network
- Provides a consistent management interface for both packet and optical using Junos OS
- Supports IP over DWDM for L2 or L3 applications

### Industry-Leading DWDM Density

- 19.2 Tbps per system with QFX10016
- 25.6 Tbps per fiber pair with 128 channels
- 1.2 Tbps per line card; 6x200 Gbps per line card
- 1.2 Tbps Packet Forwarding Engine (PFE) with deep buffers and large forwarding information base (FIB)

### Highly Secure Cloud Connections

- 1.2 Tbps line rate IEEE 802.1AE Media Access Control Security (MACsec) encryption across all ports
- Up to 12x100GbE, 256-bit encryption

### Superior Performance for Metro or Long-Haul Applications

- Flex modulation to support both metro or long haul on the same line card
- 120 km without amplification
- 4,000 km with amplification
- 200 Gbps DP-16QAM (approximately 1000 km)
- 150 Gbps DP-8QAM (approximately 2,000 km)
- 100 Gbps DP-QPSK (approximately 4,000 km)
- Configurable modulation

### Open and Programmable

- Alien wavelength support over third-party line system
- YANG data model
- Junos OS CLI and SNMP

## Architecture and Key Components

### Integrated DWDM Solutions

The QFX10000 Coherent DWDM Line Card integrates rich L2 and L3 packet features, scale, security, and high-density DWDM

in a single line card to dramatically simplify cloud connectivity. Today, cloud operators maintain dedicated network layers for the spine and data center edge, driving capital and operating costs higher. The feature-rich QFX10000 helps data center operators simplify their networks by collapsing multiple layers such as spine and optical DCI into a single platform. This architecture eliminates dedicated transponder shelves and removes the costs associated with 100GbE client optics between Ethernet line cards and transponder chassis, providing a common interface for managing both IP and DWDM layers.

### 200 Gbps DWDM and MACsec in the QFX10000

The QFX10000 Coherent DWDM Line Card integrates transponders into the switching platform, providing state-of-the-art compensation dispersion using soft-decision forward error correction (FEC) support. Supporting distances from 120 to 4000 km, the QFX10000 Coherent DWDM Line Card addresses a wide range of use cases spanning metro, regional, and long-haul cloud interconnect architectures. Highly configurable, the same line card will support both metro applications of less than 120 km without amplification and long-haul applications up to 4000 km with amplification.

Line-rate MACsec encryption is built into the line card, ensuring that all traffic will be securely encrypted at any distance needed over third-party optical line systems (OLS). The QFX10000 Coherent DWDM Line Card provides a YANG API, enabling easy, standards-based integration into third-party controllers for end-to-end optical provisioning.

In addition to DWDM and MACsec support, the QFX10000 Coherent DWDM Line Card employs Q5 silicon to further enhance cloud interconnect deployments with L2 and L3 services over DWDM, including VXLAN, Ethernet VPN (EVPN), BGP, and MPLS features.

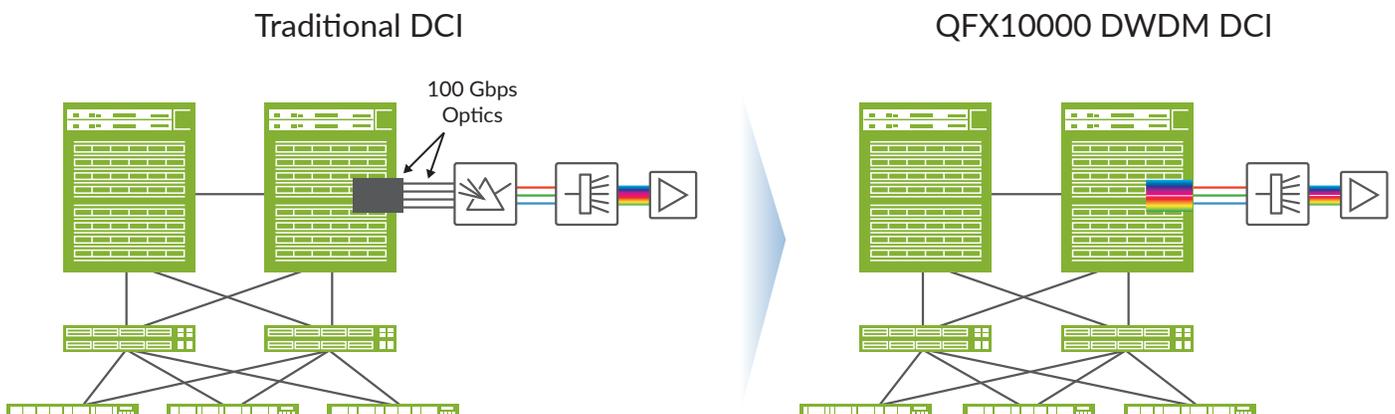


Figure 1: Simplified QFX10000 DWDM for cloud scale data center interconnects

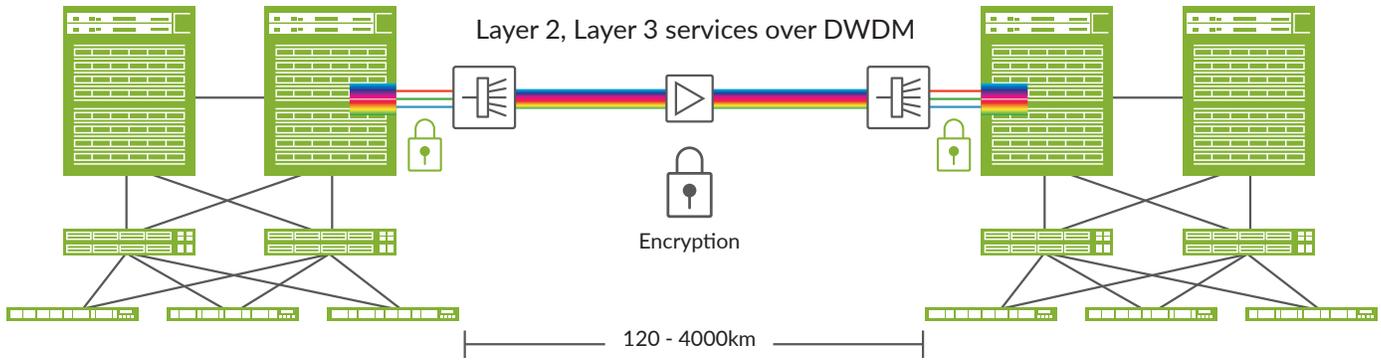


Figure 2: QFX10000 DWDM cloud-scale data center interconnect solution

## Features and Benefits

### QFX10000 Modular Switches

The QFX10000 line of industry-leading switches offers a highly scalable, high-density network foundation for spine applications, supporting today’s most demanding data center and cloud environments. With the addition of the Coherent DWDM Line Card, customers can further simplify data center operations and reduce costs by collapsing multiple network layers into a converged DCI architecture.

Each QFX10000 line card is built upon the Juniper Q5 silicon, which supports a wide range of L2 and L3 Ethernet functionality such as 802.1Q VLAN, VXLAN, link aggregation, Virtual Router Redundancy Protocol (VRRP), L2 to L3 mapping, and port monitoring. Additionally, the line cards support filtering, sampling, load balancing, rate limiting, class of service (CoS), MPLS, Fibre Channel over Ethernet (FCoE) transit functionality, and other key features needed to deploy a dependable, lossless, high-performance Ethernet infrastructure.

For more information on QFX10000 modular switches and its range of line cards, see [QFX10000 Modular Ethernet Switches](#).

### Secure DWDM Transport

The QFX10000 Coherent DWDM Line Card supports line-rate 100GbE MACsec encryption on all ports up to 1.2 Tbps, with a built in advanced Layer 2 encryption engine based on standard IEEE 802.1AE, 256-bit, and 128-bit Advanced Encryption Standard (AES) algorithms to offer end-to-end security over the DWDM transport network. The MACsec integration on the QFX10000 Coherent DWDM Line Card eliminates the need for dedicated appliances and provides privacy and confidentiality with replay protection for sensitive tenant data traffic before leaving the cloud data center premises. MACsec support also includes both static connectivity association key (CAK) and dynamic CAK authentication.

The MACsec feature is available on all ports to provide maximum security for cloud interconnects. No additional licenses are required to enable this feature.



QFX10K-12C-DWDM Coherent DWDM Line Card

## Specifications

The QFX10000 Coherent DWDM Line Card is built with Juniper’s Q5 PFE ASIC, a high-performance coherent digital signal processor (DSP), and a 100GbE MACsec module to deliver 1.2 Tbps of secure DWDM bandwidth. Each port has a fixed LC connector and supports flex modulation to configure 200 Gbps, 150 Gbps, or 100 Gbps.

The Coherent DWDM Line Card delivers 10 million packets per second with 12 GB buffers and up to 2M-route scale. Its virtual output queue (VOQ)-based architecture is designed to scale to very large deployments with no head-of-line blocking, and includes a single-tier low-latency switch fabric, efficient multicast replication handling, and deep buffering to ensure performance at scale.

Table 1. QFX10000 Coherent DWDM Line Card Specifications

	QFX10000-6C-DWDM
Total PFE/DWDM/MACsec capacity	1.2 Tbps
MACsec	IEEE 802.1AE 256 bit, 128-bit AES encryption
Data rate/port	200 Gbps, 150 Gbps, or 100 Gbps
Maximum 200 Gbps ports	6
Maximum 150 Gbps ports	6
Maximum 100 Gbps ports	6
Packet buffer	12 GB
Weight	32 lb (14.5 kg)
Typical power	900 W
Dimensions	17.2 x 1.89 x 20.54 in (43.7 x 4.8 x 52.2 cm)
Chassis support	QFX10008, QFX10016

Table 2. QFX10000 Coherent DWDM Optical Module Specification

Optical Module	Integrated, On-board		
Fiber type	Single-mode fiber-optic (SMF, ITU-T G.652)		
Connector type	Duplex LC/UPC connector		
Wavelength range	Extended C-band, 1528.773 nm (196.10 THz) to 1568.362 nm (191.35 THz)		
Wavelength grid	12.5 GHz or 50 GHz		
Number of DWDM channels	96 (50-GHz spacing) or 128 (37.5-GHz spacing)		
Tx output power (on)	-12 to 1.5 dBm, 0.1 dB steps, +/- 1 dB accuracy		
Tx output power (off)	≤ -40 dBm		
Wavelength accuracy	+/- 1.8 GHz		
Tx output optical signal-to-noise ratio (OSNR)	≥ 36 dB		
Tx channel tuning time	≤ 90 seconds across C-band		
Laser safety	IEC 60825-1 Class 1		
Modulation	16 QAM, 8 QAM, quadrature phase shift keying (QPSK)		
Forward error correction (FEC)	SD-FEC		
Modulation formats	100 Gbps QPSK	150 Gbps 8 QAM	200 Gbps 16 QAM
Optical carriers	Single-Carrier		
Line rate	136.66 Gbps	205 Gbps	273.33 Gbps
Baud rate	34.17 Gbaud		
Payload	1 x 100GBASE-R Ethernet	½ [3 x 100]GBASE-R]	2 x 100GBASE-R Ethernet
FEC code	Turbo Product Code (TPC) with soft-decision, 25% OH		
Pre-FEC BER threshold	~3.4e-2 pre-FEC BER for 1e-15 post-FEC BER		
Net coding gain (NCG)	11.6 dB	~12 dB	12.3 dB
Periodical training sequence	Yes		
Differential coding	Configurable		
Rx input power range	-18 dBm to 0 dBm		
Rx input power range (unamplified/dark-fiber applications)	-32 dBm to 0 dBm	-27 dBm to 0 dBm	-25 dBm to 0 dBm
Rx overload power	+17 dBm		
Minimum OSNR (typical)	10.5 dB	15.0 dB	18 dB
Minimum OSNR (worse-case, EOL)	11.5 dB	16.0 dB	19.5 dB
Chromatic Dispersion (CD) tolerance	+/- 70,000 ps/nm	+/- 45,000 ps/nm	+/- 30,000 ps/nm
Polarization Mode Dispersion (PMD) tolerance	30 ps mean DGD	20 ps mean DGD	15 ps mean DGD
Polarization tracking speed	100 krad/s	50 krad/s	50 krad/s

## Ordering Information

Product Number	Description
QFX10K-12C-DWDM	1.2 Tbps 6-port 200GbE line rate Coherent DWDM line card with MACsec for QFX10000 modular switches

## 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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