

Cisco ASR 9000 400-Gbps IPoDWDM Line Card

Product Overview

The Cisco® ASR 9000 Series IP over dense wavelength-division multiplexing (DWDM) collapses network layers by tightly integrating DWDM interfaces with the routing platform, thereby helping customers to increase operational efficiency by simplifying management and accelerating service delivery. This 400-Gbps throughput capable IPoDWDM line card provides customers with a flexible solution supporting multiple combinations of coherent 100G and 10G Ethernet ports, all in a single slot of the Cisco ASR 9000 Series Aggregation Services Routers. This IPoDWDM line-card solution further reduces transport elements, while supporting advanced multilayer features such as proactive protection and control-plane interaction, dramatically reducing operating expenses and capital cost.

The Cisco ASR 9000 400-Gbps IPoDWDM line card can support customer applications including video on demand, Internet Protocol Television (IPTV), point-to-point video, Internet video, and cloud-based computing. These line cards can also be used to deliver economical, scalable, highly available, line-rate Ethernet and IP/Multiprotocol Label Switching (IP/MPLS) edge services. The Cisco ASR 9000 Series line cards and routers are designed to provide the fundamental infrastructure for scalable Carrier Ethernet and IP/MPLS networks, supporting profitable business, residential, and mobile services (Figure 1.).

Figure 1. Cisco ASR 9000 Series 400-Gbps IPoDWDM Line Card



Features and Benefits

The Cisco ASR 9000 400-Gbps IPoDWDM line card has two coherent 100G CFP2-DWDM ports and 20 ports of 10G that can support all high-powered SFP+ optics.

This IPoDWDM line card is designed to provide the following benefits:

- Transport over fiber with very high polarization mode dispersion (PMD)
- Support for 96 channels with ITU-T 50-GHz channel spacing
- Flexspectrum support for even tighter spacing between channels and continuous tuning of the transmit laser at 0.1-GHz granularity
- Software-configurable hard decision (HD) or soft decision (SD) forward error correction (FEC) algorithms for maximum optical performance and backward compatibility with existing Cisco 100-Gbps DWDM line cards

Enhanced Forward Error Correction Capability

The Cisco ASR 9000 400-Gbps IPoDWDM line card supports four types of software-configurable soft decision or hard decision FEC algorithm on the CFP2-DWDM ports for highly efficient optical performance and backward compatibility with other Cisco 100-Gbps DWDM line cards:

- SD FEC with 7 percent overhead: the default FEC mode
- SD FEC with 20 percent overhead
- HD FEC with 7 percent overhead: standards-based ITU-T G.975
- HD high-gain FEC with 7 percent overhead

The SD FEC employs an advanced differential encoding and cycle slip-aware algorithm offering excellent performance and robustness against high cycle slip rates. The client port supports the ITU-T G.975 FEC algorithm when configured as an OTU-4, which can be enabled or disabled through software configuration. The FEC performance summary is detailed in Table 2. The 10G ports would use the generic FEC (GFEC) as the FEC mode.

Advanced Modulation Scheme

- The Cisco ASR 9000 400-Gbps IPoDWDM Line Card features 100-Gbps coherent polarization-multiplexed differential quadrature phase shift keying (CP-DQPSK) modulation scheme

The main benefits of this modulation schemes is:

- Strong OSNR performance
- Outstanding CD robustness, eliminating the need for any optical chromatic dispersion compensation solution
- Extended PMD robustness (three times better than 10-Gbps units)
- Very high spectral efficiency, allowing 100-Gbps wavelengths to be transmitted across a high number of ROADMs with negligible penalty

Supported FECs, speed, and modulation formats are detailed in Table 1 and Table 2.

Table 1. Supported FEC and Modulation Formats in ASR 9000 400G IPoDWDM Line Card

EC Mode	Supported Speed	Modulation
Standard-based ITU-T G.975 HD FEC with 7% overhead	100G	CP-DQPSK
HG FEC (HD FEC) with 7% overhead FEC	100G	CP-DQPSK
SD FEC with 7% overhead	100G	CP-DQPSK
SD FEC with 20% overhead	100G	CP-DQPSK

Table 2. DWDM Receive-Side Optical Performance Summary

FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	CD Tolerance	DGD	OSNR	
						(0.5 nm RWB)	(0.1 nm RWB)
CP-DQPSK Modulation							
SD FEC (20% overhead)	<4x10E (-2)	<10E (-15)	0 to -14 dBm	0 ps/nm	–	5.1 dB	12 dB
			(-16 dBm with 0.1 dB OSNR penalty)	+/-70,000 ps/nm	180 ps	6.6 dB	13.5 dB
			(-20 dBm with 0.3 dB OSNR penalty)	+/-94,000 ps/nm	180 ps	7.6 dB	14.5 dB

FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	CD Tolerance	DGD	OSNR	
						(0.5 nm RWB)	(0.1 nm RWB)
SD FEC (7% overhead)	<1x10E (-2)	<10E (-15)	0 to -14 dBm (-16 dBm with 0.1 dB OSNR penalty)	0 ps/nm	-	-	14.2 dB
				+/-40,000 ps/nm	180 ps	-	15.2 dB
				+/-70,000 ps/nm	180 ps	-	15.7 dB
G FEC (hard decision) (7% overhead)	<1.0x10E (-5)	<10E (-15)	0 to -14 dBm (-16 dBm with 0.4 dB OSNR penalty)	0 ps/nm	-	13.5 dB	20.5 dB
				+/-40,000 ps/nm	180 ps	14.5 dB	-
HG FEC (hard decision) (7% overhead)	<4.0x10E (-3)	<10E (-15)	0 to -14 dBm (-16 dBm with 0.2 dB OSNR penalty)	0 ps/nm	-	-	14.5 dB
				+/-40,000 ps/nm	180 ps	-	15.5 dB
CP-16QAM Modulation							
SD FEC (20% overhead)	<4x10E (-2)	<10E (-15)	0 to -14 dBm (-16 dBm with 0.7 dB OSNR penalty)	0 ps/nm	-	16.5 dB	21.3 dB
				+/-20,000 ps/nm	180 ps	18.0 dB	22.8 dB
SD FEC (7% overhead)	<1x10E (-2)	<10E (-15)	0 to -14 dBm (-16 dBm with 0.7 dB OSNR penalty)	0 ps/nm	-	-	-
				+/-20,000 ps/nm	180 ps	-	-

Performance Monitoring

The Cisco ASR 9000 400-Gbps IPoDWDM module provides support for both transparent and nontransparent signal transport performance monitoring. The digital wrapper channel is monitored according to G.709 (OTN) and G.8021 standards. Performance monitoring of optical parameters on the client and DWDM line interface includes loss of signal (LOS), laser bias current, transmit optical power, and receive optical power. Calculation and accumulation of the performance monitoring data are supported in 15-minute and 24-hour intervals as per G.7710.

Physical system parameters measured at the wavelength level, such as mean PMD, accumulated CD, or received OSNR, are also included in the set of performance monitoring parameters. These can greatly simplify troubleshooting operations and enhance the set of data that can be collected directly from the equipment. The module incorporates faceplate-mounted LEDs to provide a quick visual check of the operational status of the card.

A detailed list of performance monitors is given in Table 3.

Table 3. Performance Monitoring Parameters

Area	Parameter Name		Description
OTN	OTUk SM	ODUk PM	
	BBE-SM	BBE-PM	Number of background block errors
	BBER-SM	BBER-PM	Background block error ratio
	ES-SM	ES-PM	Number of errored seconds
	ESR-SM	ESR-PM	Errored seconds ratio

Area	Parameter Name		Description
	SES-SM	SES-PM	Number of severely errored seconds
	SESR-SM	SESR-PM	Severely errored seconds ratio
	UAS-SM	UAS-PM	Number of unavailable seconds
	FC-SM	FC-PM	Number of failure counts
FEC	Bit errors		Number of corrected bit errors
	Uncorrectable words		Number of uncorrectable words
Trunk optical PM	OPT		Transmit optical power
	LBC		Transmitter laser bias current
	OPR		Receiver optical power
	RCD		Residual chromatic dispersion
	PMD		Mean polarization mode dispersion
	OSNR		Optical signal-to-noise ratio, calculated with 0.5 nm RBW

Product Specifications

Table 4 provides product specifications.

Table 4. Product Specifications for ASR 9000 400-Gbps IPoDWDM Line Card

Description	Specification
Chassis compatibility	Compatible with the Cisco ASR 9922, 9912, 9904, 9010, and 9006 systems
Port density	Two 100G CFP2-DWM ports and 20 ports 10G SFP+ ports
Ethernet	<ul style="list-style-type: none"> • 100-Gbps IEEE 802.3ba compliant • 100 Gigabit Ethernet PHY monitoring • IEEE 802.x flow control • Full-duplex operation • Per-port byte and packet counters for policy drops; oversubscription drops; cyclic redundancy check (CRC) error drops; packet sizes; and unicast, multicast, and broadcast packets
Reliability and availability	Line-card online insertion and removal (OIR) support without system impact
Network Equipment Building Standards (NEBS)	Cisco ASR 9000 Series Routers are designed to meet: <ul style="list-style-type: none"> • GR-1089-CORE: NEBS EMC and safety • GR-63-CORE: NEBS physical protection
Physical dimensions	14.5" W x 1.72" H x 22.40" L (368.3mm W, 43.7mm H, 569mm) Weight = 22.9lbs (10.4kgs)
Operating temperature (nominal)	41 to 104°F (5 to 40°C)
Operating temperature (short-term)¹	23 to 131°F (-5 to 55°C)
Operating humidity (nominal) relative humidity	10 to 85%
Storage temperature	-40 to 158°F (-40 to 70°C)
Storage relative humidity	5 to 95% Note: Not to exceed 0.024 kg of water per kg of dry air
Operating altitude	-60 to 4000m (up to 2000m conforms to IEC, EN, UL, and CSA 60950 requirements)

¹ Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year. (This number refers to a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period.)

Description	Specification
ETSI standards	Cisco ASR 9000 Series Routers are designed to meet: <ul style="list-style-type: none"> • EN300 386: Telecommunications Network Equipment (EMC) • ETSI 300 019 Storage Class 1.1 • ETSI 300 019 Transportation Class 2.3 • ETSI 300 019 Stationary Use Class 3.1 • EN55022: Information Technology Equipment (Emissions) • EN55024: Information Technology Equipment (Immunity) • EN50082-1/EN-61000-6-1: Generic Immunity Standard
EMC standards	Cisco ASR 9000 Series Routers are designed to meet: <ul style="list-style-type: none"> • FCC Class A • ICES 003 Class A • AS/NZS 3548 Class A • CISPR 22 (EN55022) Class A • VCCI Class A • BSMI Class A • IEC/EN 61000-3-2: Power Line Harmonics • IEC/EN 61000-3-3: Voltage Fluctuations and Flicker
Immunity	Cisco ASR 9000 Series Routers are designed to meet: <ul style="list-style-type: none"> • IEC/EN-61000-4-2: Electrostatic Discharge Immunity (8kV Contact, 15kV Air) • IEC/EN-61000-4-3: Radiated Immunity (10V/m) • IEC/EN-61000-4-4: Electrical Fast Transient Immunity (2kV Power, 1kV Signal) • IEC/EN-61000-4-5: Surge AC Port (4kV CM, 2kV DM) • IEC/EN-61000-4-5: Signal Ports (1kV) • IEC/EN-61000-4-5: Surge DC Port (1kV) • IEC/EN-61000-4-6: Immunity to Conducted Disturbances (10Vrms) • IEC/EN-61000-4-8: Power Frequency Magnetic Field Immunity (30A/m) • IEC/EN-61000-4-11: Voltage DIPS, Short Interruptions, and Voltage Variations
Safety	Cisco ASR 9000 Series Routers are designed to meet: <ul style="list-style-type: none"> • UL/CSA/IEC/EN 60950-1 • IEC/EN 60825 Laser Safety • ACA TS001 • AS/NZS 60950 • FDA: Code of Federal Regulations Laser Safety

Pluggable Interfaces

The Cisco ASR 9000 Series 400-Gbps IPoDWDM supports coherent CFP2- DWDM optics (100G ports) and SFP+ optics (10G ports). Table 5 lists the optics type, supported modes, and minimum software release required for the supporting various modes.

Table 5. Supported Pluggables and Interface Modes

Optic Type	Supported Modes	Software Release Support
ONS-CFP2-WDM	100G	Cisco IOS XR 5.3.2
SFP+ (SR/LR/ER/ZR/Tunable-DWDM)	10G	Cisco IOS XR 5.3.3

Ordering Information

The Cisco ASR 9000 Series 400-Gbps IPoDWDM line card may be deployed in the 20-slot, 10-slot, 8-slot, 4-slot, and 2-slot chassis, with Cisco IOS XR Software Release 5.3.2 or later. Table 6 shows the hardware part number and the minimum system software requirements.

Table 6. System Software Requirements

Hardware Part Number	Minimum Software Release Support
A9K-400G-DWDM-TR	Cisco IOS XR 5.3.2

Software Licensing

Line-Card Feature Licenses

Optional per-line-card feature licenses can be used to turn on advanced features on the line cards. Table 7 lists the associated license and the minimum software release version required to activate the licenses.

Table 7. Feature Licenses for Cisco ASR 9000 400-Gbps IPoDWDM Line Card

License Part Number	Feature Description	Minimum SW release
A9K-400G-AIP-TR	Advanced IP license to activate full-scale VRF instances	Cisco IOS XR 5.3.2
A9K-400G-IVRF	Infrastructure VRF license to activate up to 8 VRF instances	Cisco IOS XR 5.3.2
A9K-WDM-ADV-OPT	Advanced optical license to activate G.709, pre-FEC FRR, GFEC, SD FEC per 100G	Cisco IOS XR 5.3.2
A9K-WDM-ADV-FEC	Advance FEC license to activate high-gain staircase FEC per CFP2 port	Cisco IOS XR 5.3.2

Downloading the Software

Visit the [Cisco Software Center](#) to download Cisco IOS Software.

Cisco Services for the Cisco ASR 9000 Series

Through a lifecycle services approach, Cisco delivers comprehensive support to service providers to help them successfully deploy, operate, and optimize their IP next-generation networks (IP NGNs). Cisco Services for the Cisco ASR 9000 Series Aggregation Services Routers provide the services and proven methodologies that help assure service deployment with substantial return on investment, operational excellence, optimal performance, and high availability. These services are delivered using leading practices, tools, processes, and lab environments developed specifically for Cisco ASR 9000 Series deployments and postimplementation support. The Cisco Services team addresses your specific requirements, mitigates risk to existing revenue-generating services, and helps accelerate time to market for new network services.

For more information about Cisco Services, contact your local Cisco account representative or visit <http://www.cisco.com/go/spservices>.

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