

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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