Cisco Network Convergence System 1014 EDFA2 Line Card

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With the ushering of the AI era, there is rapid capacity growth in the data center and between data centers. This has driven the need for cloud-scale networking solutions that allow for quick and simple turn-up with enhanced monitoring, deliver performance optimization for capacity scale through modulation and baud-rate innovations, and effectively support multiple vendors' transponder solutions. The new Cisco® Network Convergence System 1014 (NCS 1014) Metro Open Line System (MOLS) delivers all this and more. It builds upon and takes forward what the Cisco NCS 1001 offered for the metro DCI space. The Cisco NCS 1014 MOLS is a Dense Wavelength-Division Multiplexing (DWDM) line system that is mechanically optimized for data center environments. It is also performance optimized for maximum capacity, provides complete automation of installation and real-time fine-grained monitoring. The latest NCS 1014 chassis allows operators to take full advantage of co-hosting industry leading transponders and pluggable optics with the line system.

Product features and benefits

The all new EDFA2 line card, the central focus of this Metro Open Line System (MOLS) offering, is hosted on the latest Cisco® Network Convergence System (NCS) 1014 platform.

The Cisco NCS 1014 is a compact modular shelf that allows operators to maximize capacity with minimum space and power footprint. At two Rack Units (2RU) and 600 mm rack support, along with four line card slots, one field-replaceable controller card, three redundant fans, and two redundant power supplies, the NCS 1014 is a compact, high-performance offering.

The NCS 1014 offers the following key benefits:

- Allows the co-hosting of next-generation transponders (with 100GE/400GE/800GE clients and high-performance or power-optimized Digital Coherent Optics [DCO] trunks) and open optical line system configuration like the MOLS.
- Supports redundant and field-replaceable units. Two AC and DC power supply units per shelf, and three fans for improved front-to-back air cooling.
- The controller card is accessible from the front and is field replaceable.
- Supports management plane resiliency through redundant and field-replaceable SSD disks with disaster recovery support and headless mode of operation that isolates the management plane and data plane.
- Supports redundancy of the Cisco IOS® XR software image and system configuration across SSDs on the controller card and the shelf.
- Introduces hardware support for precision timing distribution and backplane interconnect for dual-card modes, and remains backward compatible with currently shipping NCS 1004 transponder line cards.
- Supports hardware and software security protection and integrity checks to establish trust in hardware, verify trust in the OS, maintain trust at run-time, and measure trust.
- Supports a remote console, whereby the user can reach the remote node if the console port at the local node is connected.

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- Uses Cisco IOS XR7 software, which requires less memory and boots faster. The IOS XR carrier-class software delivers several features such as machine-to-machine APIs based on YANG data models, streaming telemetry for real-time, granular device monitoring, and an infrastructure for third-party applications.
- Supports comprehensive security features across hardware and software, to meet the needs of operators and hyperscalers.

The EDFA2 line card brings the MOLS solution to the NCS 1014 platform. This fully variable gain EDFA amplifier line card contains both a pre-amplifier and a booster amplifier and also integrates a wavelength blocker, a pluggable Optical Time-Domain Reflectometer (OTDR) module, a pluggable Optical Service Channel (OSC) module, and a pluggable link probe. Together with a pair of compact new athermal Arrayed Wave Guide (AWG) multiplexer/demultiplexers, the card enables operators to build an entire open line system solution for network architectures with 400ZR, 400ZR+ (openZR+), and 800ZR DCOs, and more. It's a truly open line system offering for metro Data Center Interconnect (DCI) applications, with no restriction on what transponder or optics can be carried over.

In a nutshell, the EDFA2 line card hosted on the Cisco NCS 1014 platform brings the MOLS solution to operators – a fully open, fully configurable, and feature-complete line system offering for metro DCI applications.

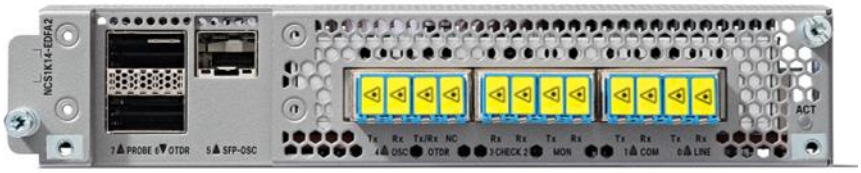


Figure 1.
The EDFA2 line card

Integrated amplifier

The new EDFA2 line card on the NCS 1014 platform is optimized for point-to-point DCI applications of today and the future, supporting all baud rates on a fluid definition of spectrum. The module integrates bidirectional EDFA with a mid-stage wavelength blocker within the booster amplifier, allowing operators to perform link-level equalization and setup. Many DCI applications today employ remote or co-hosted interfaces. A normal point-to-point DCI line system solution that is appropriate for such applications usually doesn't include a Wavelength Selective Switch (WSS) that is capable of equalizing channels of varying launch powers into the link. The distinguishing feature of the Cisco NCS 1014 MOLS EDFA2 line card is the presence of the integrated wavelength blocker that allows operators to perform dynamic equalization and a desired link setup. This allows operators to have a variety of interfaces that are remotely operated or co-hosted and of different baud rates or technologies, extracting maximum performance and value from the network.

The EDFA2 line card is a +23 dBm booster and pre-amplifier that operates on the full 4.8 THz of the C-band. It integrates Optical Channel Monitor (OCM) functionality within the wavelength blocker on the booster direction and hosts an array of pluggable ports for OTDR, OSC, and probe functions.

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Pluggable OTDR function

An all new pluggable OTDR module is available alongside the EDFA2 line card of the NCS 1014. This new technology brings OTDR functions into a QSFP-DD Multisource Agreement (MSA)-compliant pluggable form factor. The pluggable module is optionally hosted on the EDFA2 line card faceplate and generates the OTDR signal pulse that is then inserted into the line by the EDFA2 line card. The point-to-point MOLS allows bidirectional OTDR scanning from both directions of the optical fiber. The onboard software is capable of automatically running the OTDR but also allows the operator to customize the function based on different zone profiles, with full alarm and monitoring capabilities integrated. The OTDR scan.SOR file is saved on the box, and span loss and alarm details are supported via telemetry, gRPC Network Operations Interface (gNOI), and OpenConfig.



Figure 2.
The pluggable QSFP-DD OTDR

Pluggable probe function

The Cisco NCS 1014 MOLS solution boasts another new industry-first feature – a link probe. The EDFA2 line card allows another QSFP-DD MSA-compliant pluggable to be hosted – this is a coherent 100GE QSFP-DD with a receiver performance far beyond the requirements of the point-to-point DCI application. The signal (much like a normal channel) is inserted into the line on day zero and allows operators to study the link performance and characterize it before the actual link turn-up. Such an evaluation gives the operator clear and much required visibility into the Signal-to-Noise Ratio (SNR) that could be achieved on a given link before it has gone live. Since it is the SNR that is being read (and not the Optical SNR [OSNR]), the operator has a clear picture of the link performance regardless of what interface, baud rate, or line rate will be used later. This simplifies the operational activity of link setup for the operator and is a welcome feature, given today's varying requirements of an operator – either low or full capacity turn-up on day zero. The Cisco NCS 1014 MOLS thus allows operators to set up the link even before the interfaces are procured or installed, enabling link performance-related issues to be highlighted significantly before the link goes into production. It is important to note that the probe channel doesn't impact or use one of the possible 64 C-band channels but is right beside them as a separate channel.

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Pluggable OSC function

The NCS 1014 MOLS also has a pluggable OSC function. The EDFA2 line card hosts another SFP+ MSA-compliant port apart from the two QSFP-DD ports cited above. The operator can host OSC pluggable optics on this port. The point-to-point link discovery, communication, and software control loop algorithms to automatically control the power of the link in different conditions all run over this OSC channel.

Channel add/drop function – 32 channel Mux / Demux (Odd and Even)

The EDFA2 line card on the Cisco NCS 1014 is a next-generation EDFA line card that hosts full link management abilities, OTDR, OSC, and the link probe. But a channel add/drop mechanism is required to make the solution an open line system. Cisco offers two new mux/demux modules to provide this function. The passive AWG modules can be hosted on a separate 1RU mechanical frame beside the Cisco NCS 1014 shelf hosting the EDFA2 line card, while inventory management is achieved over a USB link between the passive module and the NCS 1014 shelf. A 32-channel 150-GHz fixed A/D ports module offers channel add/drop in the odd wavelength list of the C-band spectrum, and another (similar) 32-channel 150-GHz fixed A/D ports module offers channel add/drop in the even wavelength list of the C-band spectrum. Operators can either build a 32-channel 150-GHz solution with one of these modules or interconnect (interleave) them together to build a 64-channel 75-GHz solution, as desired.

These modules are the standard add/drop modules offered by Cisco alongside the Cisco NCS 1014 MOLS and are custom-fit and suited for most metro DCI applications. But it is interesting to note that the Cisco NCS 1014 MOLS is a fully open and flex line system and thus can support any add/drop architecture with any channel definition and interface type.



Figure 3.
The passive mux/demux modules with the Cisco NCS 1014 MOLS solution (Odd and Even variants available. Even variant shown above)

Both the even and odd variants of the mux/dmx include a dedicated port for the probe channel. The probe channel is a 33rd channel port on the mux/dmx and is coupled into the Line using a 90-10 splitter coupler. All Mux ports to add channels have an integrated PD (photodiode to read power). The ports to couple Odd and Even channels also have integrated PD. All COM ports also have integrated PD. Operators can use just the Odd or Even Mux / Dmx modules as desired. In the event of an Odd+Even solution, the Odd and Even output have to combined using a coupler and separated using a splitter – both functions are integrated directly into the Mux / Dmx modules as shown in the following figure 4.

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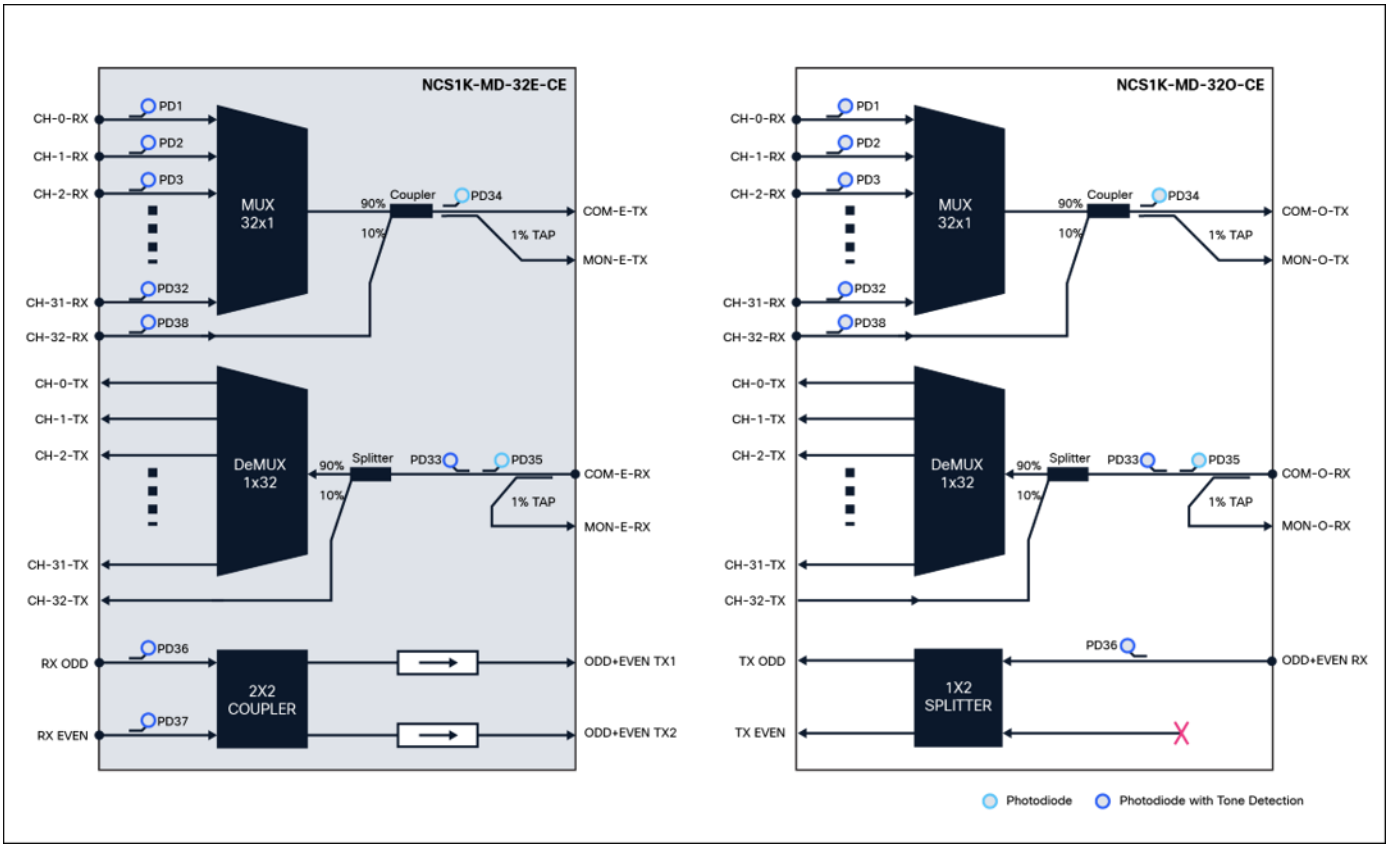


Figure 4.
Functional block diagram of the NCS1K MD32 Even and Odd modules

Management

The onboard Cisco IOS XR software on the Cisco NCS 1014 platform allows full Command-Line Interface (CLI)-based configuration and management of the MOLS solution. The Cisco NCS 1014 MOLS also supports OpenConfig and telemetry-based endpoints. From a site and network management software standpoint, the Cisco Optical Site Manager (COSM) the Cisco Optical Network Controller (CONC) and Cisco Optical Network Planner (CONP) all support the NCS 1014 shelf and the new EDFA2 line card (MOLS solution).

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Feature summary

The following table summarizes the features of the NCS 1014 MOLS solution.

Table 1. Feature summary

Feature	Description
Software compatibility	• Cisco IOS XR 26.2.1 is the latest recommended SW version (or later)
Port density	• 2 QSFP-DD line side ports per card, 1 for OTDR and 1 for link probe • 1 SFP+ line side port per card for OSC • 6 dual-LC ports: 1 for OSC, 1 for OTDR, 2 for monitor, 1 COM, 1 LINE
Optical feature summary	• Flex-grid open line system • Any line rate, baud rate, interface type supported • 32, 64, or any channel system • Automatic link setup • Automatic Power Control (APC) loop software • Bidirectional and event-based OTDR scan
Network management	• iPXE and Zero-Touch Provisioning (ZTP) • Cisco IOS XR CLI • OpenConfig • Streaming telemetry, including event-driven telemetry. • NETCONF, RESTCONF, gNMI, gNOI, gRPC with YANG data models
Physical dimensions (NCS 1014 EDFA2 line card)	• 1.59 in. tall x 7.55 in. wide x 10.90 in. deep (4.04 x 19.18 x 27.69 cm) • Weight: 3.2 kg (7.05 lb)
Power, temperature, humidity (NCS 1014 EDFA2 line card)	• Power: Typical: 130W; maximum: 160W (including optics hosted) • Temperature: Long term: 0° to +40°C (32° to 104°F); short term: -5° to +55°C (23° to 151°F); storage: -40° to +85°C (-40° to +185° F) • Humidity: 5% to 95% (operational)
Mean time between failures (MTBF) for line card and 2x CIM 8 pluggables	• 567,040 hours

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Regulatory compliance

Table 2 lists regulatory compliance information for the NCS 1014 platform. Note that all compliance documentation may not be completed at the time of product release. Please check with your Cisco sales representative for countries that are not listed below.

Table 2. Regulatory compliance

ANSI system	ETSI system
Countries and regions supported	
• **Canada** • **United States** • **Korea** • **Japan** • **European Union**	• European Union • Africa • CSI • Australia • New Zealand • China • Korea • India • Saudi Arabia • South America
• **EMC (emissions)**	• FCC 47CFR15, Class A • AS/NZS CISPR 32, Class A • CISPR 32, Class A • CISPR 22, Class A • EN55032, Class A • ICES-003, Class A • VCCI, Class A • KN 32, Class A • KN61000—3-2 • KN61000-3-3 • CNS-13438, Class A
• **EMC (immunity)**	• IEC/EN61000-4-2 Electrostatic Discharge Immunity • IEC/EN61000-4-3 Radiated Immunity • IEC/EN61000-4-4 EFT-B Immunity • IEC/EN61000-4-5 Surge AC Port • IEC/EN61000-4-6 Immunity to Conducted Disturbances • IEC/EN61000-4-11 Voltage Dips, Short Interruptions, and Voltage Variations • KN 35

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ANSI system	ETSI system
• **EMC (ETSI/EN)**	• EN 300 386 Telecommunications Network Equipment (EMC) • EN55032 Electromagnetic Compatibility of Multimedia Equipment-Emission Requirements • EN55022 Information Technology Equipment (Emissions) • EN55035 Electromagnetic Compatibility of Multimedia Equipment-Immunity Requirements • EN55024 Information Technology Equipment (Immunity) • EN61000-6-1/EN61000-6-2 Generic Immunity Standard • EN61000-3-2 Power Line Harmonics • EN61000-3-3 Voltage Changes, Fluctuations, and Flicker
Safety	
• **CSA C22.2 #60950-1 - Edition 7, March 2007** • **BS/IEC/EN 62368-1** • **CAN 22.2 No. 62368-1** • **UL 62368-1**	• IEC 60950-1 Information technology equipment Safety Part 1: General requirements - Edition 2, 2005 + Amendment 1 2009 + Amendment 2 2013 • EN 60950-1: Edition 2 (2006) Information technology equipment - Safety - Part 1: General requirements + A11:2009 + A1:2010 + A12:2011 + A2:2013 • CE Low Voltage Directive (LVD): 2014/35/EC • A/NZS 62368.1
Laser	
• **21CFR1040 (2008/04) (Accession Letter and CDRH Report) Guidance for Industry and FDA Staff (Laser Notice No. 56), May 2019**	• IEC 60825-1: 2014-05 Ed. 3.0 Safety of laser products Part 1: Equipment classification, requirements and users guide • IEC60825-2 Ed.3.2 (2010) Safety of laser products Part 2: Safety of optical fiber communication systems
Optical	
• **ITU-T G.691**	• ITU-T G.975
Quality	
• TR-NWT-000332, Issue 4, Method 1 calculation for 20-year Mean Time Between Failures (MTBF)	

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Table 3 provides the optical specifications of the NCS 1014 EDFA2 line card, and Table 4 provides the same for the mux/demux modules.

Table 3. Optical specifications of the NCS 1014 EDFA2 line card

Parameter	NCS 1014 EDFA2 line card	Pluggable OTDR	Pluggable OSC
Channel plan/grid	32, 64, any	–	–
Wavelength/frequency range	191.375 THz to 196.100 THz	1518 nm	1510 nm
Gain	Booster (EDFA2-BST2): Up to 24 dB (with controlled tilt) Up to 27dB (with uncontrolled tilt) Pre-amplifier (EDFA2-PRE): Gain range 1: Up to 25dB Gain range 2: Up to 36dB (with controlled-tilt; up to 39dB uncontrolled tilt)	–	–
Output power	Booster: Up to +22.7dBm Pre-amplifier: Up to +22.2 dBm	13 dBm (mean launch power)	5.5 dBm
Input power range	Booster: -23 to 16 dBm Pre-amplifier: -44 to 2 dBm	–	–
Receiver sensitivity	120 Km+ (subject to design)	Span reach: 24.7 dB Dynamic range: 27.7 dB	Rx for FE: -33 dB Rx for GE: -30.5 dB

Table 4. Optical specifications of the mux/demux alongside the NCS 1014 MOLS

Parameter	NCS 1014 mux/demux
Channel plan/grid	32 or 64
Common Specifications	Wavelength range: 32ch Odd Grid: 196.1 THz to 191.450 THz 32ch Even Grid: 196.025THz to 191.375THz Group Delay Ripple (GDR): +/- 1ps (any SOP within OTR) Chromatic Dispersion: +/- 12ps/nm Return Loss: 40dB (minimum) Polarization Dispersion Loss (PDL): 0.5dB (maximum) Polarization Mode Dispersion (PMD): 0.5ps (maximum)

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Parameter	NCS 1014 mux/demux
Typical / Average Insertion loss	AWG (of Mux/Dmx): 5.4dB (max loss of 6.5dB) Splitter (for splitting Odd+Even in drop direction): 3.7dB Coupler (for coupling Odd+Even in add direction): 4.0dB Probe Tx path: 10.9dB Probe Rx path: 10.9dB
Isolation	Adjacent channel isolation (within operating bandwidth): 2dB (minimum) Adjacent channel isolation (at central wavelength position): 15dB (minimum) Non-adjacent channel isolation (within operating bandwidth): 25dB (minimum) Non-adjacent channel isolation (at central wavelength position): 30dB (minimum)

Table 5. Ordering information

Part number	Description
NCS1K14-EDFA2=	NCS 1014 EDFA terminal with equalization
ONS-QSFP-OTDR=	ONS OTDR pluggable module
ONS-SC-PTP-1510=	Multirate GE, FE pluggable optics, 1510nm, C-temp
DP01QSDD-ZT5-A1=	100 GBPS COHERENT QSFP-DD, OpenZR+, C-band Tunable
NCS1K-MD-32O-CE=	NCS 1000 32chs Odd Mux/Demux-150GHz-C-band Enhanced
NCS1K-MD-32E-CE=	NCS 1000 32chs Even Mux/Demux-150GHz-C-band Enhanced

Warranty

The EDFA2 line card has the following warranty:

- Hardware warranty duration: 5 years
- Software warranty duration: 1 year
- Hardware replacement, repair, or refund procedure: Cisco or our service center will use commercially reasonable efforts to ship a replacement part for delivery within 15 working days after receipt of the defective product at Cisco's site. Actual delivery times of replacement products may vary depending on customer location.

Your formal warranty statement appears in the Cisco Information Packet that accompanies your Cisco product.

Product warranty terms and other information applicable to Cisco products are available at: www.cisco.com/go/warranty.

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Cisco environmental sustainability

Information about Cisco's environmental sustainability policies and initiatives for our products, solutions, operations, and extended operations or supply chain is provided in the "Environmental Sustainability" section of Cisco's Corporate Social Responsibility (CSR) Report.

Reference links to information about key environmental sustainability topics (mentioned in the "Environmental Sustainability" section of the CSR Report) are provided in the following table.

Table 6. Links to sustainability topics

Sustainability topic	Reference
Information on product material content laws and regulations	Materials
Information on electronic waste laws and regulations, including products, batteries, and packaging	WEEE compliance

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