cisco

The bridge to possible

Cisco Network Convergence System 1004 L-Band Transponder Line Card

Contents

Service Providers continue to work with technology providers to identify innovations for scarce long haul and subsea fiber assets as demands continue to grow exponentially. Next-gen transponders provide incremental capacity improvements as we approach Shannon's limit. A key approach to tackling this head-on is extending to L-Band frequencies to double capacity on such networks. Network Convergence System 1004 uses state of the art silicon along with complete automation and real-time visibility to deliver a universal transponder solution that provides best-in-class performance for metro, long-haul and submarine applications while being simple to deploy and manage. The solution offers both C-Band and L-Band frequency solutions.

Product features and benefits of NCS 1004 L-Band transponder

The trunk ports of the NCS 1004 L-Band transponder are capable of several line rates with fine control of modulation format, baud-rate and forward error correction allowing the solution to be used for metro, terrestrial long-haul or submarine applications:

- The baud-rate can be controlled between 31.5Gbd/s and 72Gbd/s.

- The modulation format can be controlled between QPSK, 8-QAM, 16QAM and 32QAM.

- Hybrids between modulation formats can be configured to achieve 0.001 bits/symbol of granularity.

- Forward Error Correction (FEC) of 27% and 15% overhead.

- Trunk line rate from 200G to 400G in 50G increments.

Each line card can provide up to 8x100Gbe/OTU4 client ports. The client ports map to two trunk ports operating any rate between 100G and 400G in 50G increments. The baud-rate, modulation format and FEC of each trunk port is software-configurable per slice.

The Cisco NCS 1004 L band system provides the following hardware benefits:

- Transport of any trunk rate between 200 and 400Gbps wavelengths on the same platform through software provisioning.

- Support of granular control of baud-rate and modulation format to maximize spectral efficiency.

- One universal transponder that is performance optimized for metro, long-haul and submarine applications.

- Support for up to 350,000 ps/nm of residual chromatic dispersion compensation.

- Transport of 100GE and OTU4 on the same platform through software provisioning.

- 400G DWDM provides unparalleled scale and density. With 64 channels of 400G at 75Ghz, the NCS 1004 provides 25.6Tbps in 16RU.

- State of the art AES-256 Encryption at scale – 3.2Tbps of encrypted trunk capacity per 2RU.

- Non-Linear Compensation for maximum performance on compensated legacy subsea cables and for non-linear terrestrial fibers.

- SOP tracking speed of up to 10 million rad/s for aerial fiber applications.
- The Cisco NCS 1004 features software configurable modulation scheme per slice, allowing the operator to customize the spectral efficiency and reach characteristics of individual wavelengths. 69Gbaud/s symbol rate doubles capacity per interface when compared to 32Gbaud/s signals today.

Table 1.   Sample modulation format, baud-rate, line rate combinations

Modulation Type	Bits/Symbol	Baud-rate (GBaud/s)	Line rate supported (Gbps)
PM-QPSK	2	69.4351	200
PM-QPSK-8QAM hybrid	2.5	69.4351	250
PM-8QAM	3	69.4351	300
PM-8QAM-16QAM hybrid	3.5	69.4351	350
PM-16QAM	4	69.4351	400

Wavelength tunability

The line interface supports software-provisionable tunability across the full L band, covering 96 channels on the 50-GHz grid. Grid-less tuning support allows for continuous tunability in increments of 0.1 GHz and the ability to create multicarrier super-channels over flex spectrum line systems.

Protocol transparency

The Cisco NCS 1004 can transparently deliver 100Gbe and OTU4 clients over 2x 100G-400G.

Fine Control of Coherent DWDM interface

The Cisco NCS 1004 provides the ability to modify baud-rate and modulation format with fine control to meet capacity and reach requirements for a range of use-cases as shown in Figure 3.

- Use 69Gbaud/s line rates to maximize capacity at lowest price per bit for Metro and Long-Haul networks.
- Use real-time network bandwidth and performance data to maximize line rate capacity on coherent DWDM interface.
- Support line rates that can maximize capacity for bandwidth constrained 50Ghz and 100Ghz spaced legacy ROADM networks.
- Maximize spectral efficiency on submarine cable line system for the target Q-margin.

Encryption

With increasing asks for data privacy and data protection across the globe, encryption of any data that leaves the Data Center facility is becoming an important requirement for cloud operators. The NCS 1004 provides AES256 based OTN-Sec encryption for 100GE and OTU4 clients. IKEv2 is used for authentication of the devices in an encryption session and the protocol provides pre-shared keys, certificates or 802.1X based authentication options. Elliptical Curve Diffie Hilman (ECDH) Key Exchange protocol runs over a GCC (Generic Communication Channel) between two NCS1004 nodes.

Management

The Cisco NCS 1004 provides comprehensive management capabilities to support Operations, Administration, Maintenance, and Provisioning (OAM&P) capabilities through IOS-XR CLI, SNMP, Syslog, and XML. In addition, iPXE for automated software download and Zero Touch Provisioning (ZTP) for automated configuration download are available for simplified installation. For machine-to-machine configuration and management of NCS 1004, NETCONF, RESTCONF and gRPC transport protocols with JSON, XML and GPB encoding are provided. OpenConfig protocols for management GNMI and operations GNOI are also supported. The NCS 1004 provides a set of native YANG models as well as the ability to map into any industry standard or customer defined YANG data models. For monitoring, NCS 1004 provides a streaming telemetry feature that relies on a push mechanism to disseminate user selected PM and status information at user specified frequencies at granular 10 second intervals. This improves monitoring speed and scale compared to traditional pull based mechanisms such as SNMP. The telemetry infrastructure also allows for events such as alarms, port-state changes to be notified.

The NCS 1004 can also support third application hosting. Such an application can be hosted in a container or docker and can perform provisioning and monitoring on the NCS 1004.

Performance monitoring

The Cisco NCS 1004 supports performance monitoring of optical parameters on the client and DWDM line interface including laser bias current, transmit and receive optical power. Ethernet RMON statistics for the client ports and OTN error counters for the trunk are also available. 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 polarization mode dispersion, accumulated chromatic dispersion, pre-FEC Bit Error Rate and received Optical Signal-to-Noise Ratio (OSNR) are also included in the set of performance-monitoring parameters. These parameters can greatly simplify troubleshooting operations.

The NCS 1004 provides a set of port and system LEDs for a quick visual check of the operational status. The various LEDs are described in detail in Table 9.

Headless operation

The headless operation allows for NCS 1004 data plane to operate errorless during software upgrades and when the controller card is either physically absent or in a failed state. Trunk and client statistics will be accumulated and will be available to the user once the controller is up. In addition, fault propagation will continue to operate for client and trunk failures without the presence of the controller module.

Feature summary

The following table summarizes the features of the NCS 1004 L-Band Line Card

Table 2. Feature summary

Feature	Description
Software Compatibility	• IOS-XR 7.2.0 or later
Port Density	• 32 QSFP28 client-side ports in 2RU • 8 DWDM line/trunk ports in 2RU
OTN feature summary	• Alarm reporting for Loss of Signal (LOS), Loss of Frame (LOF), Loss of Multi-frame (LOM), Alarm Indication Signal (AIS), Backward Defect Indicator (BDI) • OTUk, ODUk, OPUk Performance Monitoring • Threshold Crossing Alerts (TCAs) • Local (internal) and line (network) loopbacks • Trunk Trace Identifier, Generic Communication Channel • L1 AES-256 encryption
Optical Feature Summary	• 50GHz and flex-grid (0.1GHz) tunable lasers • Nyquist shaping • Non Linear Equalization • Electronically compensated CD and PMD • Performance Monitoring and Threshold Crossing Alerts (TCAs) • Tx and Rx power monitoring
Ethernet Feature Summary	• Alarms and Performance Monitoring • Squelch and Local Fault Propagation • LLDP Snooping • Performance Monitoring and Threshold Crossing Alerts (TCAs) • Local (internal) and line (network) loopbacks
Availability	• Online insertion and Removal of the Controller • Headless mode of operation
Network Management	• iPXE and Zero Touch Provisioning (ZTP) • IOS XR CLI • SNMP • Streaming Telemetry including event driven telemetry • NETCONF, RESTCONF, gRPC with YANG data models
Environmental Conditions	• Operating Temperature: 0 to 40 °C (32 to 104 °F)

Regulatory compliance

Table 3 lists regulatory compliance information for the trunk card. Note that all compliance documentation may not be completed at the time of product release. Please check with your Cisco sales representative for countries other than Canada, the United States, and the European Union.

Table 3.   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 - 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
EMC (ETSI/EN)	- EN 300 386 Telecommunications Network Equipment (EMC) - EN55032 Electromagnetic Compatibility of Multimedia Equipment – Emission Requirements - Information Technology Equipment (Emissions) - EN55035 Electromagnetic Compatibility of Multimedia Equipment – Immunity Requirements - EN55024 Information Technology Equipment (Immunity) - EN61000-1/EN61000-6-2 Generic Immunity Standard - EN61000-3-2 Power Line Harmonics - EN61000-3-3 Voltage Changes, Fluctuations, and Flicker

ANSI System	ETSI System
Safety	
• CSA C22.2 #60950-1 – Edition 7, March 2007 • UL 60950-1 – Edition 2, 2014	• 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 Safety Directive: 2014/35/EC
Laser	
• 21CFR1040 (2008/04) (Accession Letter and CDRH Report) Guidance for Industry and FDA Staff (Laser Notice No. 50), June 2007	• IEC 60825-1: 2014 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 fibre 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 Failure (MTBF)	

Table 4 provides the DWDM specifications, Table 5 details receive-side optical performances, Table 6 lists performance-monitoring parameters, Table 7 provides card specifications, Table 8 gives ordering information.

Table 4.   DWDM specifications

Parameter	Value
Baud rate	28 to 72Gbaud/s
Automatic laser shutdown and restart	ITU-T G.664 (06/99)
Nominal wavelengths (λ_{Tnom})	Fully tunable between 1571.91 to 1612.3 nm
Connector type (TX/RX)	LC, duplex (shuttered)
Optical Transmitter	
Type	PM-BPSK modulation format PM-QPSK modulation format PM-8QAM modulation format PM-16QAM modulation format Hybrids of adjacent modulation allowing 1 to 4 bits/symbol in 0.001 bits/symbol increments.
Output power	+3 to -10 dBm in 0.01 dBm increments
Required Optical Return Loss, minimum (ORLmin)	24 dB

Parameter	Value
Laser safety class	1
Optical Receiver	
Frequency range	186.10 to 190.85 Thz (1571.91 to 1612.3 nm)
Input Power Range (16QAM)	-17 to +5 dBm
Input Power Range (8QAM,QPSK)	-22 to +5 dBm
Power accuracy	+/- 1 dBm
Optical Return Loss	27 dB
PMD tolerance @ 69Gbaud/s	64ps max DGD
Chromatic Dispersion tolerance @ 0.5db penalty	+/-100,000 ps for QPSK/8QAM +/-80,000 ps for 16QAM
Chromatic Dispersion tolerance @ 1db penalty	+/-350,000 ps/nm for QPSK, 2.5 bits/sym +/-280,000 ps/nm for 8QAM +/-200,000 ps/nm for 3.5 bits/sym +/-150,000 ps/nm for 16QAM
State of Polarization change tolerance	10 mn rad/s for QPSK 3 mn rad/s for 8QAM

Table 5.   DWDM receive-side optical performances

Modulation Type	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	CD Tolerance	DGD	Required worst case OSNR (0.1 nm RBW)
PM-QPSK (200G)	SD-FEC (27% overhead)	<3.75x10E (-2)	<10E (-15)	0 to -13 dBm	0 ps/nm	-	14.5dB
					+/- 100,000 ps/nm	64 ps	15 dB
					+/- 350,000 ps/nm	64 ps	15.7dB

Modulation Type	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	CD Tolerance	DGD	Required worst case OSNR (0.1 nm RBW)
PM-8QAM (300G)	SD-FEC (27% overhead)	<3.75x10E (–2)	<10E (–15)	0 to –11 dBm	0 ps/nm	–	19.1 dB
					+/– 100,000 ps/nm	64 ps	19.6 dB
					+/– 280,000 ps/nm	64 ps	20.3 dB
PM-16QAM (400G)	SD-FEC (27% overhead)	<3.75x10E (–2)	<10E (–15)	0 to –10 dBm	0 ps/nm	–	22.1 dB
					+/– 80,000 ps/nm	64 ps	22.8 dB
					+/– 150,000 ps/nm	64 ps	23.3 dB

Table 6.   Trunk performance-monitoring parameters

Area	Parameter Name	Description
OTUk Monitoring (Near-end, Far-end, OTUk-SM, ODUk-PM)	BBE	Number of background block errors
	BBER	Background block error ratio
	ES	Number of errored seconds
	ESR	Errored seconds ratio
	SES	Number of severely errored seconds
	SESR	Severely errored seconds ratio
	UAS	Number of unavailable seconds
	FC	Number of failure counts
FEC	Bit errors	Number of corrected bit errors
	Uncorrectable words	Number of uncorrectable words
	Q	Q-factor
	Q-Margin	Q-factor margin

Area	Parameter Name	Description
Trunk optical performance monitoring	OPT	Transmitter 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
	SOPMD	Second Order PMD (SOPMD) Estimation
	SOPCR	Polarization Change Rate Estimation
	PDL	Polarization Dependent Loss (PDL) Estimation

Table 7.   NCS 1004 specifications

Management	
Client and DWDM port LEDs	
• No alarms	• Green
• Minor alarms	• Amber
• Critical and Major alarms	• Red
Physical	
Dimensions	NCS1K4-1.2TL-K9 1.6" wide x 12.4" deep x 3.3" tall
Weight	NCS1K4-1.2TL-K9 3.32 Kg
Storage temperature	-28°C to 70°C (-20°F to 158°F)
Operating temperature	
• Normal	• 0°C to 40°C (32°F to 104°F)
Relative humidity	
• Normal	• 5% to 85%, noncondensing
• Short-term[1]	• 5% to 90% but not to exceed 0.024 kg water/kg of dry air

[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 (a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period). The values shown are valid for M6 or M2 chassis.

Table 8.   Ordering information

Part Number	Description
NCS1K4-1.2TL-K9=	Network Convergence System 1004 L Band Card
XR-NCS1K4-720LK9	NCS 1004 L band IOS XR Software Release 721 RTU-USB key
SF-NCS1K4-R720LK9	NCS 1K – R720 SW, NCS1004 L band

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 "Environment Sustainability" section of Cisco's Corporate Social Responsibility (CSR) Report.

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

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

Cisco makes the packaging data available for informational purposes only. It may not reflect the most current legal developments, and Cisco does not represent, warrant, or guarantee that it is complete, accurate, or up to date. This information is subject to change without notice.

Cisco Capital

Flexible payment solutions to help you achieve your objectives

Cisco Capital makes it easier to get the right technology to achieve your objectives, enable business transformation and help you stay competitive. We can help you reduce the total cost of ownership, conserve capital, and accelerate growth. In more than 100 countries, our flexible payment solutions can help you acquire hardware, software, services and complementary third-party equipment in easy, predictable payments. Learn more.

Document history

New or revised topic	Described In	Date