

Cisco Network Convergence System (NCS) 1010

Next-Generation C + L-Band Open Line System

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Until the last few years optical systems have been closed and proprietary. While the concept of disaggregated or open optical line systems is not new, now providers can assemble a system themselves in the manner they choose. There are several reasons why providers would move in this direction. In most cases, it's to enable a multi-vendor solution where you can deploy best-in-breed that the industry provides. Best-in-breed is based on – best OSNR performance, highest spectral efficiency, lowest power, least amount of space, lowest cost per bit, pluggability for router/switch integration, or standardization.

The subsea market pushed for “open cables,” which enabled any vendor’s transponder to operate over an ‘open’ third-party line system already in place. This helped many operators increase their capacity on the subsea cable by moving to the latest transponder in the market. The long-haul market has already implemented open line systems, enabling multi-vendor leverage over a common infrastructure.

The NCS 1010 offers a best-in-class Open Dense Wavelength Division Multiplexing (DWDM) line system that can be managed (e.g. configured, monitored, and even automated) through a common software layer with the use of standard APIs and data models and fits the disaggregated ‘open’ line system model providers are looking for today.

As coherent technology drives spectral efficiency closer to the Shannon capacity limit, L-Band spectrum is now key to improving and expanding fiber capacity. Operators also expect to move from C-Band to C + L-Band solutions without any service impact or disruption. Enhanced visibility of the fiber network along with operational simplification through end-to-end automation of the lifecycle of the network are also top of mind for operators. The Network Convergence System 1010 is Cisco’s next-generation open line system platform that aims to deliver on these goals and much more.

Product overview – NCS 1010

Cisco NCS 1010 is a 3 RU 300-mm-deep pizza box-style platform that offers one integrated line card slot. NCS 1010 runs carrier-class IOS XR software that enables complete automation of the network life cycle.

NCS 1010 provides the following key benefits:

- **Support for any coherent source** – DCOs and high performance transponders – NCS 1010 provides an ingress EDFA to support OpenZR+ digital coherent optics that operate at -10dBm. With a coupler based add-drop structure, high-performance transponders at 72, 95, 140, and beyond GBaud/s rates with any power spectral density can be supported.
- **Scale** – NCS 1010 offers hitless migration from C-Band only to C+L-Band designs. Embedded channelized ASE loading provides consistency in performance from day 1 to full capacity growth. A 33-port twin WSS architecture allows the ROADMs to scale express capacity or add-drop capacity.
- **Simplicity** – Integrated modules in the NCS 1010 shelf minimize fiber patching and field errors. NCS 1010 is designed to operate as one ROADM degree on a shelf. The inherent degree separation provides higher availability. Embedded software on the NCS 1010 turns up ROADM to ROADM line segments automatically to a state where ASE loading runs across the full spectrum. Built-in dynamic gain equalization in an in-line amplifier provides better equalization and performance in C + L-Band designs along with better control of Raman Gain ripple.

-
- **Complete lifecycle automation** – IOS XR operating system software on NCS 1010 provides a rich suite of automation features that include zero-touch provisioning, open config YANG model support with NETCONF and gNMI, streaming telemetry, and gNOI support. Automated end-to-end turn-up of a NCS 1010 network is made possible with embedded control loops on the device. Automated connection verification checks for abnormal patch loss and validates fiber connectivity at ROADM locations. Operators are provided with enhanced visibility of their fiber network through a combination of probes based on OTDR, OSC, OCM, and coherent technology. Machine learning and neural network processing of this data allows for improving event detection.

Solution overview

Cisco's C+L-Band Open Line System solution consists of the NCS 1010 shelf with an integrated line card for a ROADM degree or an in-line amplifier coupled with fixed filters or passive breakout panels for colorless add-drop or express interconnects.

The 3RU NCS 1010 shelf hosts active components such as ROADMs and amplifiers. The ROADM line card breaks out MPO interfaces into LC connectors using breakouts in rack-mounted panels for colorless add-drop or express interconnects. The operator can choose to combine colorless add-drop with fixed 75-, 100-, or 150-GHz add-drop using 1RU a thermal Arrayed Wave Guide (AWG) filters.

NCS 1010 line cards come in the following flavors:

- Optical Line Terminal C-Band
- Optical Line Terminal C-Band with Raman amplifier
- Optical Line Terminal L-Band
- In-line Amplifier C-Band
- In-line Amplifier C-Band with 1x Raman amplifier
- In-line Amplifier C-Band with 2x Raman amplifiers
- In-line Amplifier L-Band

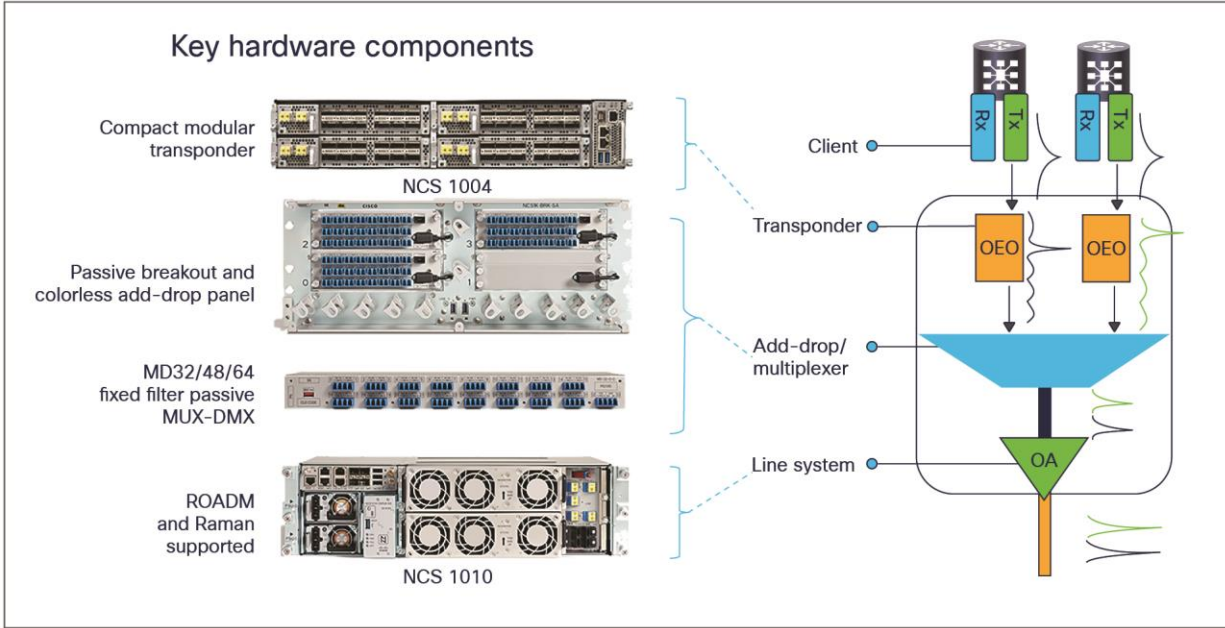


Figure 1.
NCS 1010 solution components

NCS 1010 hardware overview

The NCS 1010 is a 3RU 300-mm rack-compliant shelf with front-to-back straight-through cooling and is completely front-access. Rail kits and brackets are available to mount onto 19-, 21-, or 23-inch racks. Fixed brackets on the NCS 1010 have thumbscrews to allow for fast deployment or replacement of the shelf. Each NCS 1010 has two redundant and field-replaceable 1KW AC or DC power supply units and two field-replaceable fan trays that operate at 5+1 redundancy. It also provides a field-replaceable controller card (Figure 2). The NCS 1010 has one SSD on the shelf controller and a second SSD on the shelf to maintain redundant copies of XR images and system configuration. Each NCS 1010 chassis provides one line card slot, and the line card is field replaceable.

A range of management, USB 3.0, and timing input/output ports are provided on the top right the NCS 1010 faceplate that can be used for DCN management, daisy chaining of shelves, console access, passive device management, user data channel, and timing distribution. NCS 1010 is hardware designed to support class C-compliant 1588v2 PTP timing support.

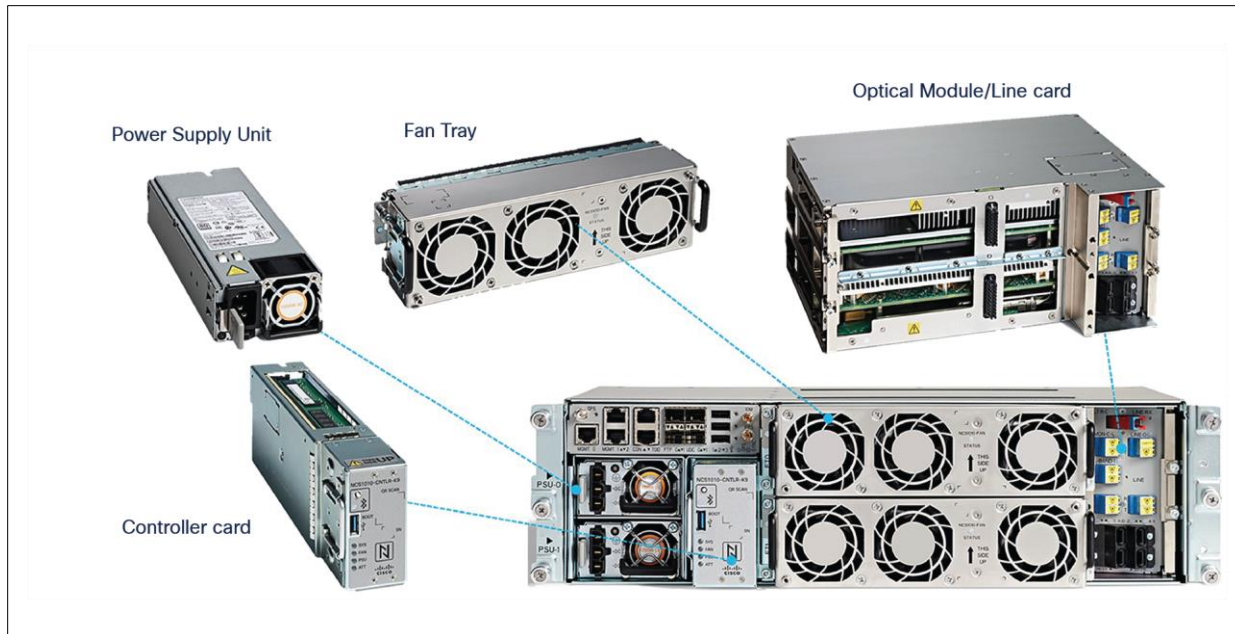


Figure 2.
NCS 1010 shelf components

NCS 1010 Optical Line Terminal

The Optical Line Terminal (OLT) provides the following key functions integrated into a line card: 25dBm variable gain preamplifier with switchable gain range, 23dBm variable gain booster amplifier, 2x33 port twin flex-grid Wavelength Selective Switch (WSS), embedded EDFA for ASE loading, embedded Fixed Gain EDFA for -10dBm digital coherent optics sources, embedded OTDR, connection verification Transmit Optical Sub Assembly, embedded OCM, FE/GE Optical Supervisory Channel with a 2x2 switch, embedded C+L-Band combiner, and optional built-in Raman amplification.

Key benefits:

- 33-port twin flex-grid WSS provides scale of a multi-degree ROADM node both for colorless add-drop ports or express ports.
- Built-in ASE loading allows for easier turn-up of the network and consistency in performance from day 1 through the life of the network.
- 25dBm true variable-gain preamplifier with switchable gain range, 23dBm true variable-gain booster amplifier.
- Dedicated fixed-gain EDFAs at the WSS add for -10dBm low-power digital coherent optics.
- Connection verification on fiber patches from ROADM to passive breakout or add-drop modules and on ROADM-to-ROADM express connections. This allows for the user to verify if patching is set up correctly or allows patching to be discovered and reported to the user.
- The OLT design allows hitless C to C+L-Band upgrade.
- Bi-directional OSC support for in-fiber communication between devices, user data channel support, and class C-compliant IEEE 1588v2 PTP timing transport. OSC is available for both C-Band and L-Band separately.

- Built in bi-directional OTDR that can run in-line with DWDM channels and take measurements in real time of loss and back reflection of both pairs of fiber in a link from both end points.
- Optical channel monitor with a 1x37 switch provides a spectrum-analyzer-like view of power distribution across the available spectrum at the WSS add ports and input and output of the PRE and BST amplifiers. This helps with troubleshooting the system and enables automatic turn-up of the ROADM through WSS attenuation and amplifier gain control loops.

OLT line card comes in three flavors: C-Band OLT, C-Band OLT with Raman, and L-Band OLT.

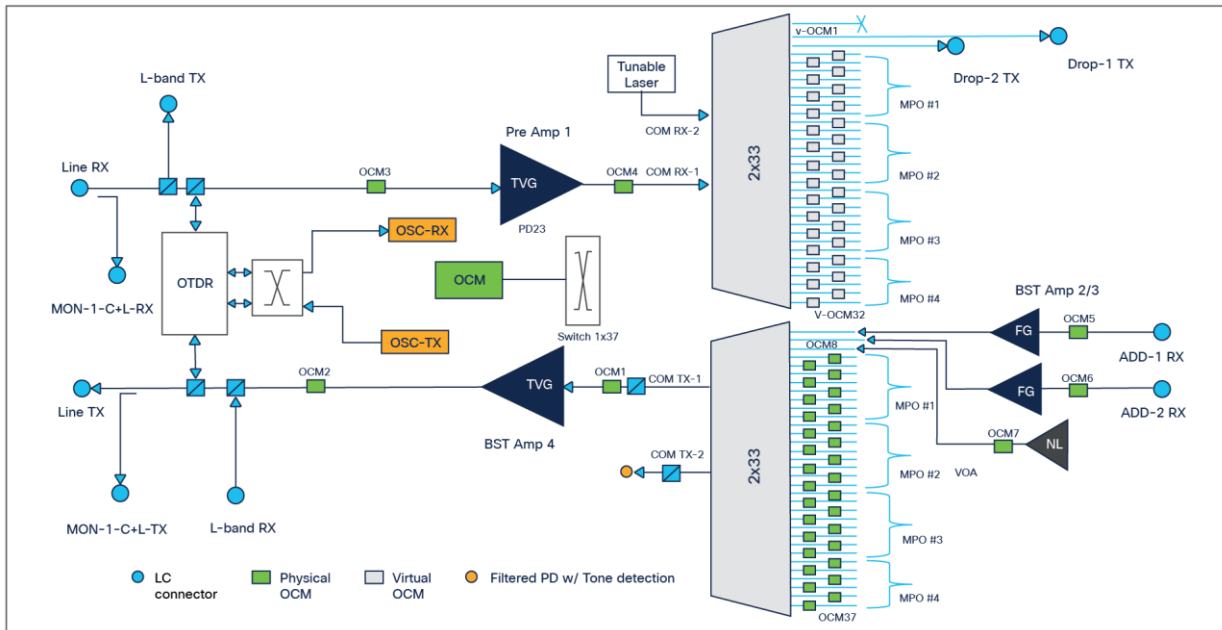


Figure 3.
NCS 1010 OLT-C functional layout

NCS 1010 ILA

In-Line Amplifier (ILA) provides the following key functions integrated into a line card: 24dBm pre-amplifier with switchable gain range, embedded dynamic gain equalization, embedded OTDR, embedded OCM, FE/GE Optical Supervisory Channel with a 2x2 switch, embedded C+L-Band combiner, and optional built-in Raman amplification.

Key features and benefits:

- Two independent “true variable-gain” EDFA blocks with identical characteristics. 23dBm total output power in fiber for both C and L-Bands. 24dBm output power @LINE-TX ports for both C and L-Band. Each integrated optical amplifier provides the following features:
 - Switchable gain ranges to provide optimized noise-figure across the whole gain range
 - Constant output power and constant gain mode
 - Non-distorting low-frequency transfer function
 - Fast transient suppression
 - Programmable tilt

- Optical safety by signal loss detection, HW LOS signal generation and alarming at any input port, fast power down control, and reduced max output power in safe power mode
- Safety Class 1M at any optical port
- 4-port optical channel monitor that provides a spectrum-analyzer-like view of power distribution across the available spectrum at the input and output of the amplifiers. This helps with troubleshooting the system and enables automatic turn-up and gain control of the ILA.
- Embedded continuous dynamic gain equalization to compensate for gain ripple caused by Raman amplification or to apply suitable deemphasis for optimal performance of C+L-Band line systems.
- Bi-directional OSC support for in-fiber communication between devices, user data channel support, and class C-compliant IEEE 1588v2 PTP timing transport. OSC is available for both C-Band and L-Band separately.
- Built in bi-directional OTDR that can run in line with DWDM channels and take measurements in real time of loss and back reflection of both pairs of fiber in a link from both end points.

ILA line cards come in four flavors - C-Band ILA, C-Band ILA with Raman amplification for one direction, C-Band ILA with Raman amplification for both directions, and L-Band ILA.

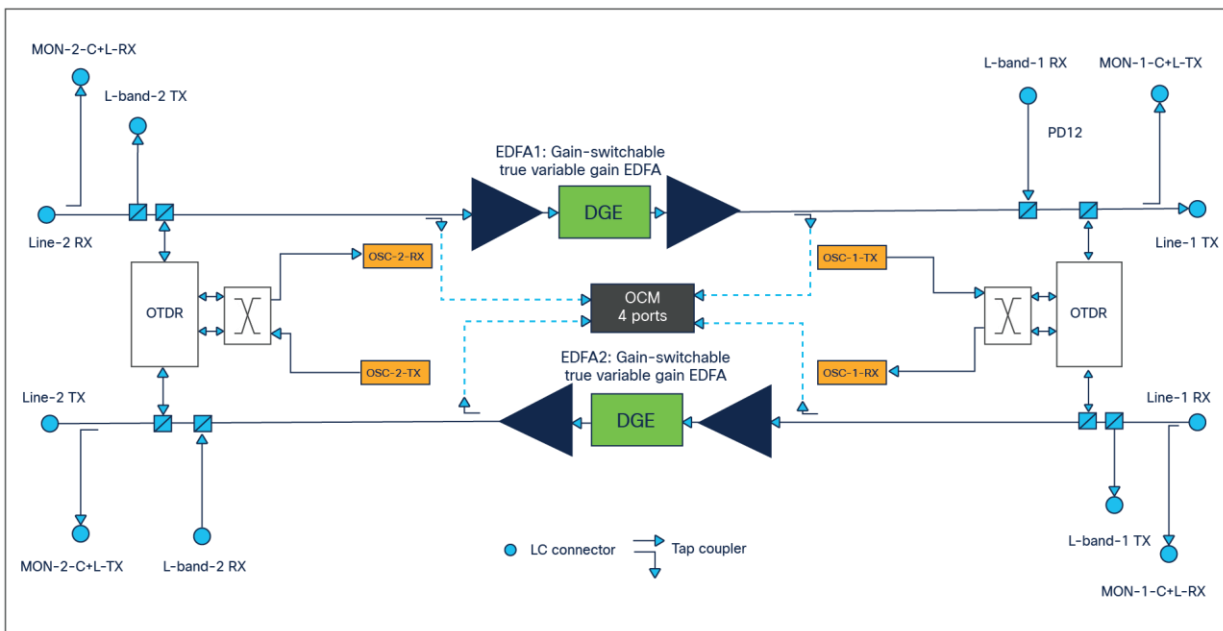


Figure 4.
NCS 1010 ILA-C functional layout

Embedded Raman amplifier option

NCS 1010 OLT and ILA come with an option for embedded Raman amplification. The counter-propagating Raman module has 5 pumps at 1424 nm, 1438 nm, 1457 nm, 1470 nm, and 1495 nm to support C+L-Band operation or only C-Band operation and provide 17-dB Raman ON/OFF gain over SMF fiber (0.2 dB/Km). A DFB laser is built in to check that the optical fiber path is closed and safe for Raman pump start. Separate PD monitors are available for the DFB probe and for ASE. automatic laser shutdown and automatic power reduction are supported to meet class 1M safety.

NCS 1010 Add / Drop options

There are different ways in which channels / wavelengths can be added or dropped on the NCS 1010 Open Line System. This datasheet details each of them in the following pages but here is a summary of all the possible options:

1. The NCS 1000 break-out modules allow colorless channel Add-Drop. There are 3 different options here the BRK-8, BRK-16 and the BRK-24.
2. The NCS 1000 multiplexer, demultiplexer (Mux/Dmux) that can do a 32-channel fixed/colored add-drop.
3. The direct LC ports on the faceplate of the enhanced faceplate version of the NCS 1010 itself offers colorless channel Add-drop.
4. The latest addition to this list are the amplified colorless Add-Drop module on the all-new NCS 1014 chassis. The options here are the CCMD-16-C (C-Band) and CCMD-16-L (L-Band). They are a colorless channel Add-Drop solution much like the break-out modules cited above, with the only difference being the channels are amplified in this case offering better power at the receiver. This in turn ensures better performance for high bit rate channels.

	<p>NCS 1010 Optical Line Terminal (OLT) Box (3RU)</p> <ul style="list-style-type: none"> • 32-ports WSS-based w/embedded EDFA + Raman (optional) • Includes OTDR, OCM, OSC and Channelized Noise Loading • 2-ports dedicated to Add-Drop for -10dBm Inputs (400G-QDD-ZR) • C-band and L-band variants 	<p>Flexible Add/Drop Structure Sites can be different Add only when and where needed</p>
	<p>32 Channels Odd/Even Colored Mux/Demux (1RU each)</p> <ul style="list-style-type: none"> • Athermal AWG, w/Power monitoring and LEDs (through USB) • Two interleaved grids of 32chs each (150GHz grid) 	
	<p>Colorless Modular Patch Panel (4RU)</p> <ul style="list-style-type: none"> • 4x passive Optical module slots, w/embedded USB hub • Up to 72 Channels Add/Drop + 8-Dir interconnection 	
	<p>Colorless Modular Patch Panel (1RU)</p> <ul style="list-style-type: none"> • 2x passive Optical module slots • Up to 32 Channels Add/Drop 	
	<p>NCS 1014 Colorless A/D Line Card for 16 channels</p> <ul style="list-style-type: none"> • 1-slot16-ch colorless A/D with bidirectional amps • More effective Nyquist spacing of channels for LH/SLTE 	

Figure 5.
The NCS 1010 Add-Drop options

NCS 1000 breakout modules

NCS 1010 offers a 4RU rack-mounted panel with 4x slots. The breakout panel has a pair of USB 3.0 connectors to connect to the NCS 1010 shelf and provides LED management and optical power monitoring on the breakout modules. An embedded USB hub allows for USB management of all 4x modules in the panel via additional internal USB 2.0 cables. The shelf supports fiber routing on either side and has adjustable cable management brackets. Bracket options are available for 19-, 21-, and 23-inch racks.

The NCS 1010 breakout shelf can accommodate the following modules:

- NCS1K-BRK-24-BRK-24 breakouts an MPO16 cable into 24 LC pairs. The module consists of eight 1x3 couplers with PD monitors for ADD RX and MPO COM RX ports. The modules support bidirectional connection verification between OLT and breakout module. This module is used for colorless add-drop and, when 4x of these modules are paired with an OLT card, provides 90 channels of colorless add-drop.
- NCS1K-BRK-16-BRK-16 breakouts an MPO16 cable into 16 LC pairs. The module consists of eight 1x2 couplers with PD monitors for ADD RX and MPO COM RX ports. The modules support bidirectional connection verification between OLT and breakout module. This module is used for colorless add-drop and, when 4x of these modules are paired with an OLT card, provides 30 channels of colorless add-drop.
- NCS1K-BRK-8 modules-BRK-16 breakouts an MPO16 cable into 8 LC pairs with PD monitors for ADD RX and MPO COM RX ports. The modules support bidirectional connection verification between OLT and breakout module. This module is used for MPO breakout for express interconnect, colorless add-drop, or connection to other add-drop modules. One module provides for 9 degrees of ROADM express support on an NCS 1010 OLT.

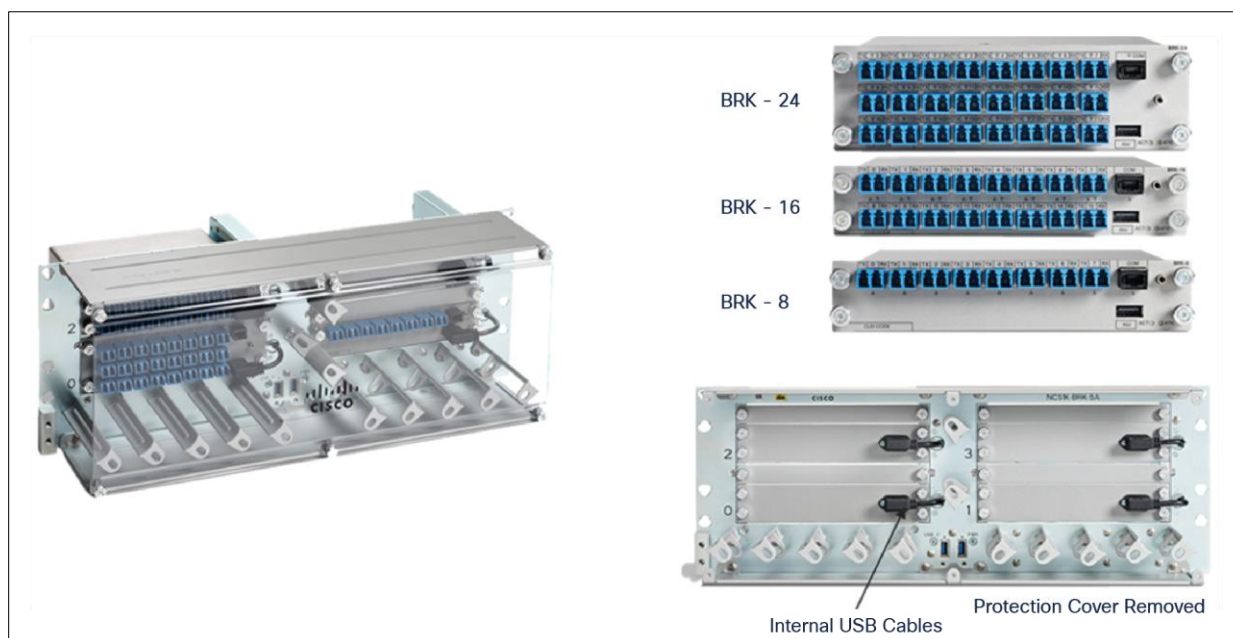


Figure 6.
NCS 1010 BRK-SA and modules

Key features and benefits:

- The NCS 1010 add-drop architecture is designed to be simple yet, scalable and easy to troubleshoot. The three breakout module options can be used to construct colorless add-drop or scale degrees as required.
- Intelligent passive modules with USB cables allow for inventory read from flash and provide power to the photodiodes and LEDs on the breakout module as well as manage these PDs and LEDs from the NCS 1010. This allows the NOC operators and field technicians to be better prepared to handle passive modules in the field.
- NCS 1000 breakout modules have photodiodes that support tone detection on the COM MPO-RX and filter for connection verification tone frequency along with a 1x8 splitter to allow connection verification in both directions between OLT and add-drop for all fibers in an MPO cable. PDs on the breakout module ADD-rx ports can detect tones and are used for connection discovery or verification with the coherent transponder.
- Each port is provided with an LED to report port status. This can be used to help field technicians identify the correct port to operate in the field.

NCS 1000 MD32 filters

NCS 1000 MD32 add-drop modules are passive 1RU rack-mounted add-drop filters. The modules are available in ODD and EVEN 150-GHz spaced 32-channel options and can allow for 64x 400ZR/400ZRP designs or 32x 800ZR/ZRP designs in the future.

Photodiode monitors are provided for all the ports of MD32 add-drop filters, and this enables connection verification or discovery between the add-drop filter and the coherent transponder. A USB 2.0 port allows for inventory information management and power monitoring per the port on the NCS 1010.



Figure 7.
NCS 1K MD32 filter

NCS 1014 Amplified Colorless Add-Drop module for the NCS 1010 Open Line System

The latest addition to the list of Add-Drop options for the NCS 1010 Open Line System, are the amplified colorless Add-Drop modules available on the NCS 1014 chassis.

The options here are the CCMD-16-C and CCMD-16-L. They are a colorless channel Add-Drop solution much like the break-out modules cited above, with the only difference being the channels are amplified in this case offering better power at the receiver. This in turn ensures better performance for high bit rate channels.

Each CCMD-16 module includes 16 optical ports for Transponders to connect. The module has integrated Pre and Booster amplifiers that ensure high and controlled launch powers at Tx-Rx of the connected optical sources / transponders. This seamlessly allows customers to leverage trunk interfaces with both low launch power and high launch power, allowing true open line system operation. Both C and L band are supported with individual CCMD-16 modules for each. Every NCS 1014 chassis supports 4 slots that can each host a CCMD-16 module (16-Channel Add-Drop).

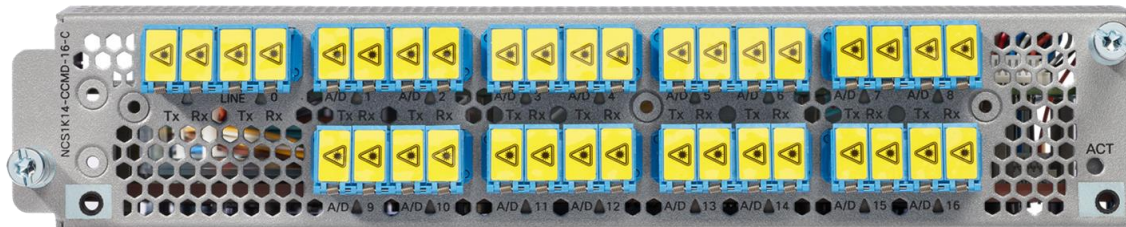


Figure 8.
The CCMD-16 amplified colorless Add-Drop

NCS 1010 Enhanced faceplate design and options

The NCS 1010 OLT and ILA Line cards come in two distinct faceplate design options. Customers are offered to choose the best faceplate design / optical port connectivity option that best suits their network requirement. Customers that prefer an MPO port for Add / Drop (via a breakout) on the OLT Line card can choose a given variant of the NCS 1010, while customers that prefer LC ports on the faceplate of the NCS 1010 can choose another variant. The ILA Raman units are also distinguished as two variants, one with the E-2000-PS port for the Raman and the other with a normal LC port for the Raman. All options are summarized below, and the following set of pictures clearly describe the faceplate of various NCS 1010 Line cards clearly.

The two faceplate options for OLT Line card:

1. The first is the standard faceplate option which has MPO ports on the faceplate of the OLT Line cards that break out to LC ports using BRK units described earlier, which can then be used for degree interconnect or Add / Drop. This is offered by the products NCS1010-OLT-C, NCS1010-OLT-R-C, NCS1010-OLT-L. These PIDs are supported from IOS XR Release 7.7.1 onwards.
2. The second is the enhanced faceplate option which has LC ports on the faceplate of the OLT Line cards that be directly used for degree interconnect or Add / Drop. This is offered by the products NCS1010-E-OLT-C, NCS1010-E-OLT-R-C, NCS1010-E-OLT-L. Note the “-E” in the product ID. These PIDs are supported from IOS XR Release 7.10.1 onwards.
3. It is critical to note that both options described above have the same hardware and software support. It is just the faceplate / optical port connectivity that is different, hence new PIDs. Both variants work with all commons described, fit and function on the NCS 1010 shelf identically.

The two faceplate options for ILA Line card:

1. The first is the standard faceplate option which has E-2000-PS high power port for the Raman on the faceplate of the ILA (Raman) Line cards. This is offered by the products NCS1010-ILA-R-C, NCS1010-ILA-2R-C. These PIDs are supported from IOS XR Release 7.7.1 onwards.
2. The second is the enhanced faceplate option which has normal LC port for the Raman on the faceplate of the ILA (Raman) Line cards. This is offered by the products NCS1010-E-ILA-R-C, NCS1010-E-ILA-2R-C. These PIDs are supported from IOS XR Release 7.10.1 onwards. There is also another NCS1010-E-ILA-R-C-2 which is supported from IOS XR Release 7.11.1 onwards.
3. Within the context of the above, there are two options for the ILA Raman line card with only one Raman amplifier. The NCS1010-E-ILA-R-C and the NCS1010-E-ILA-R-C-2. The former has Raman port defined to have East facing Raman amplification and the latter west facing. They are identical in all other aspects.
4. It is critical to note that both options described above have the same hardware and software support within. It is just the faceplate / optical port connectivity that is different, hence new PIDs. Both variants work with all commons described, fit and function on the NCS 1010 shelf identically.

NCS 1010 Flexible Consumption Model

In today's world, customers desire a simple and flexible consumption model that gives them the capability and flexibility to purchase software capacity as and when needed. When installing high-density line cards or high-capacity fixed chassis, customers usually do not need the full capabilities, i.e. capacity of the hardware from day one. Customers prefer strategic partners who can provide commercial offers permitting them to pay incrementally to expand capacity as demand for their consumer and business services rises. They want investment protection with portability of software across hardware resources to meet demand across any one of their markets. Customers also want a software license management experience that enables porting of licenses across the corporation to shift capacity to markets in demand. Pay-as-you-grow commercial offers permit service providers to pool software licenses by lowering initial investments required to incubate new services, and then invest in the network capacity as demand grows. Having this ability to add capacity as and when needed helps customers with their network and capacity planning. Cisco designed the new Cisco IOS XR Flexible Consumption Model to specifically address customer outcomes and help customers rapidly deploy innovative new network solutions.

The Cisco IOS XR Flexible Consumption Model (FCM) is comprised of three main parts:

1. The hardware is the first part in the model.
2. The two other parts are components of the software and are defined by the:
 - a. The perpetual software component, also known as Right To Use (RTU).
 - b. The ongoing, recurring software component, also known as Software Innovation Access (SIA).

RTU perpetual software licenses involve two software suites, Essentials Software and Advantage Software. The Essential Software licenses include fundamental features. The Advantage Software licenses include advanced features on top of the essential fundamental ones. The tracking of the licenses on the smart licensing server is also done at a whole smart account level. The IOS XR Flexible Consumption Model thus enables the software solution at the overall network level as opposed to just a single device. Here below is a summary of what is included as part of these licenses on the NCS 1010 IOS XR Software and how the license is counted / tracked. All the license PIDs are summarized in table 5.

1. Essential License:

- a. Includes fundamental features like OSC, Safety, Link Tuning, APC, ASE, Raman, management and automation.
- b. To get this, an Essential RTU perpetual license and an Essential SIA3 (0-59 months) recurring license must be procured.
- c. All NCS 1010 Line cards are expected to have at least the Essential license purchased and installed.

2. Advantage License:

- a. It includes essential / fundamental features like OSC, Safety, Link Tuning, APC, ASE, Raman, management and automation and additionally also includes Advantage features like timing access, OTDR access, SLTE mode, Omnidirectional Add / Drop, Connection Verification.
- b. To get this, an Essential and Advantage RTU perpetual license each must be procured. Additionally, an Essential and Advantage SIA3 (0-59 months) recurring license each must be procured.
- c. Customers can choose to procure an Advantage license on top of the essentials license, if needed. The Advantage licenses are an option based on customer requirements and not mandatory like the Essential ones are.

3. License counting / tracking:

- a. For the OLT line card, the ESS and ADV licenses need to be purchased on a per port basis (0-32 ports). For each port that a customer plans to use of the 0 - 32 ports on the faceplate of the NCS 1010 OLT, customers can choose to purchase ESS (RTU and SIA) or ESS+ADV (RTU and SIA) licenses. This allows customers fine granularity in achieving a strong pay-as-you-grow approach optimizing expenditures on their networks.
- b. For the OLT line card, customers that don't desire to have a port by port license are also offered a 32-port single license that enables all the 32 ports in one-go as well.
- c. For the ILA line card, the ESS and ADV licenses need to be purchased on a per line card basis and there is no port count to be considered given the ILA doesn't do any Add / Drop or degree interconnect.



Figure 9.
NCS 1010 OLT-C with LC ports on faceplate (C-Band)



Figure 10.
NCS 1010 ILA-C amplifier card without any Raman amplification for C-Band

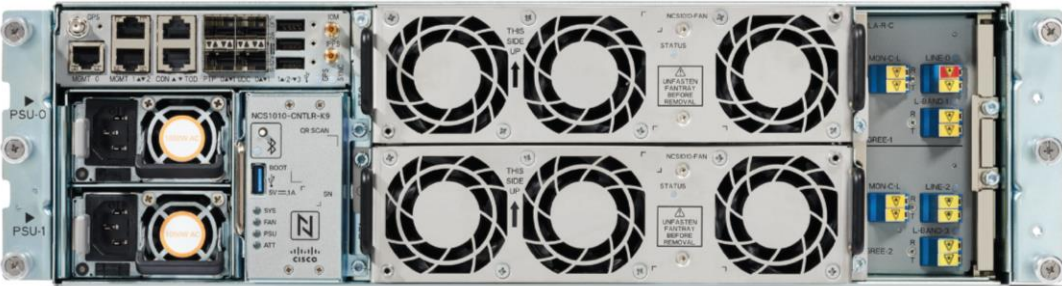


Figure 11.
NCS 1010 ILA-R-C amplifier card with Raman amplification on one direction

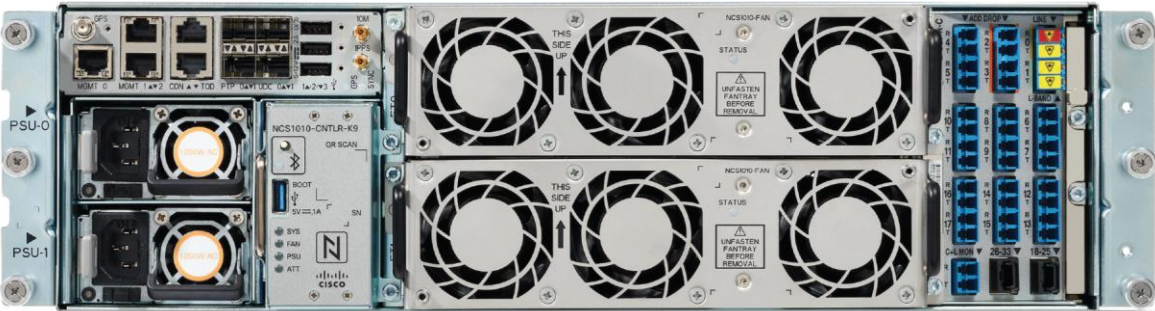


Figure 12.
NCS 1010 OLT-R-C with LC ports on faceplate and Raman amplification ability (C-Band)



Figure 13.
NCS 1010 ILA-2R-C card with Raman amplification on both directions

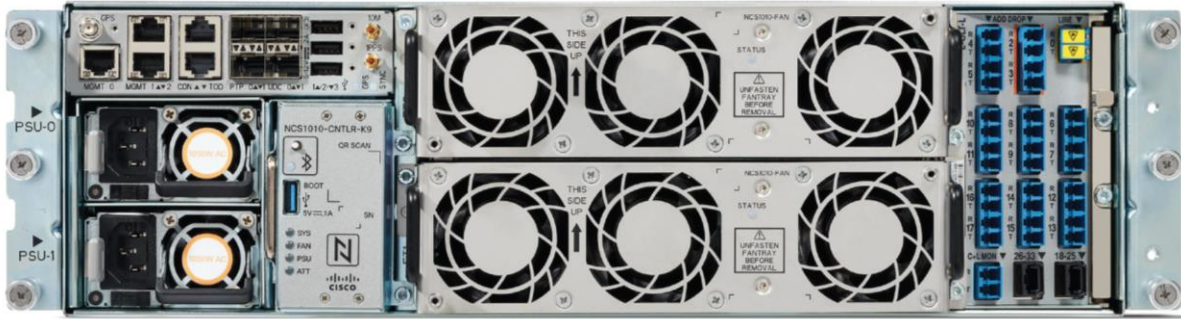


Figure 14.
NCS 1010 OLT-L with LC ports on faceplate (L-Band)



Figure 15.
NCS 1010 ILA-C amplifier card without any Raman amplification for C-Band

NCS 1010 management and automation

The Cisco NCS 1010 provides comprehensive management capabilities to support Operations, Administration, Maintenance, and Provisioning (OAM&P) 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 the NCS 1010, 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 1010 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, the NCS 1010 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 and port state changes to be notified.

NCS 1010 takes a hybrid approach where critical/basic control loops run in the embedded OS software (IOS XR) on each network element and enhanced control loops run on a centralized server in the form of **Cisco Optical Network Controller (CONC)**. The control loops that run on the NCS 1010 include channel and optical XC management, node adjacency discovery with OSPF, OTDR traces and event reporting, span loss verification, Dynamic ASE loading, Raman Tuning, E2E Link performance tuner and simulator, automatic power control, and connection discovery. Enhanced control functions provided on the centralized controller include connection verification, network topology discovery and reporting, optical path computation, and machine learning OTDR events with localization over GIS maps. CONC offers a TAPI-based north-bound API for integration into the operator's in-house tools.

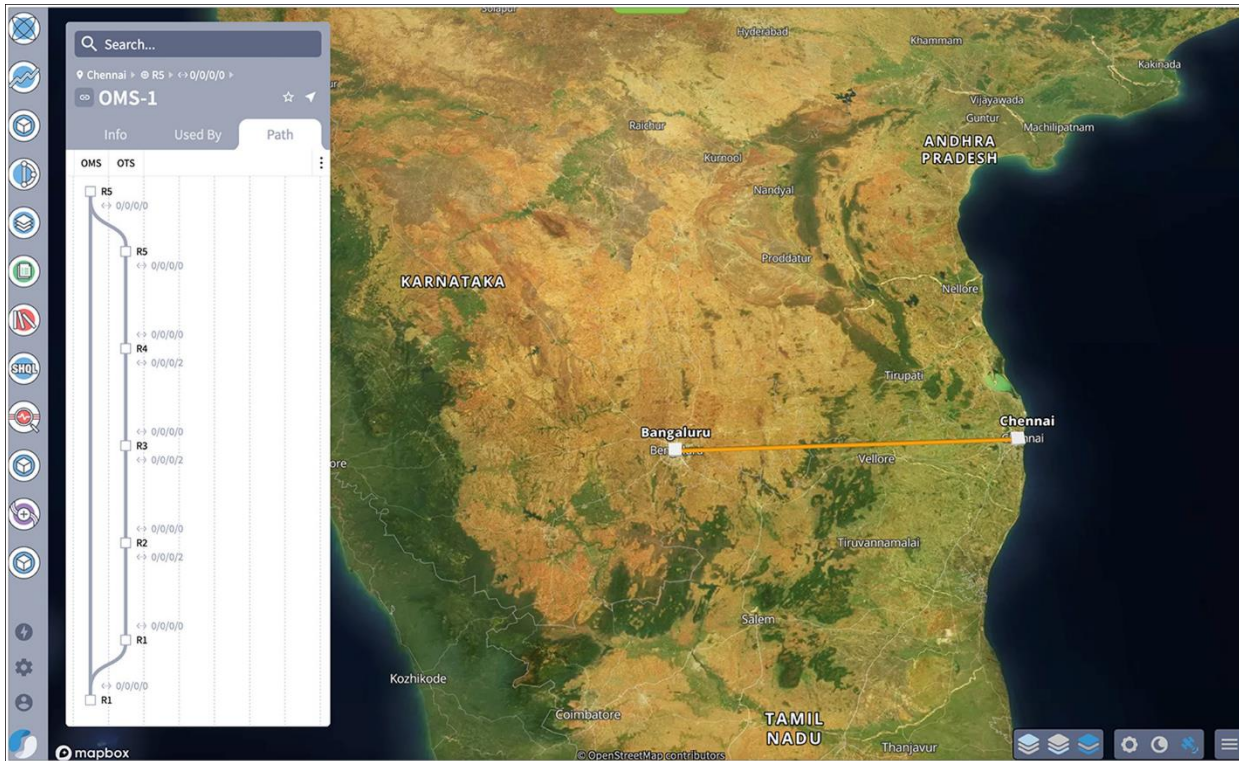


Figure 16.
Two-node network topology visualization in CONC

Evolved Programmable Network Manager offers an element management solution for NCS 1010 performance and fault monitoring along with inventory, software, and database management.

Operators can use **Cisco Optical Network Planner (CONP)** to model NCS 1010 networks and generate rack layouts, bill of materials, fiber connectivity layouts, YANG configuration file, and optical performance results. Alien OCHNC circuits can be simulated for any Cisco or non-Cisco transponder over a NCS 1010 Open Line System. REST-based north-bound API is supported for operator integration. An Optical Path Computation Engine algorithm is common across CONP and CONC and ensures consistency in network modeling and design between planning and deployment phases.

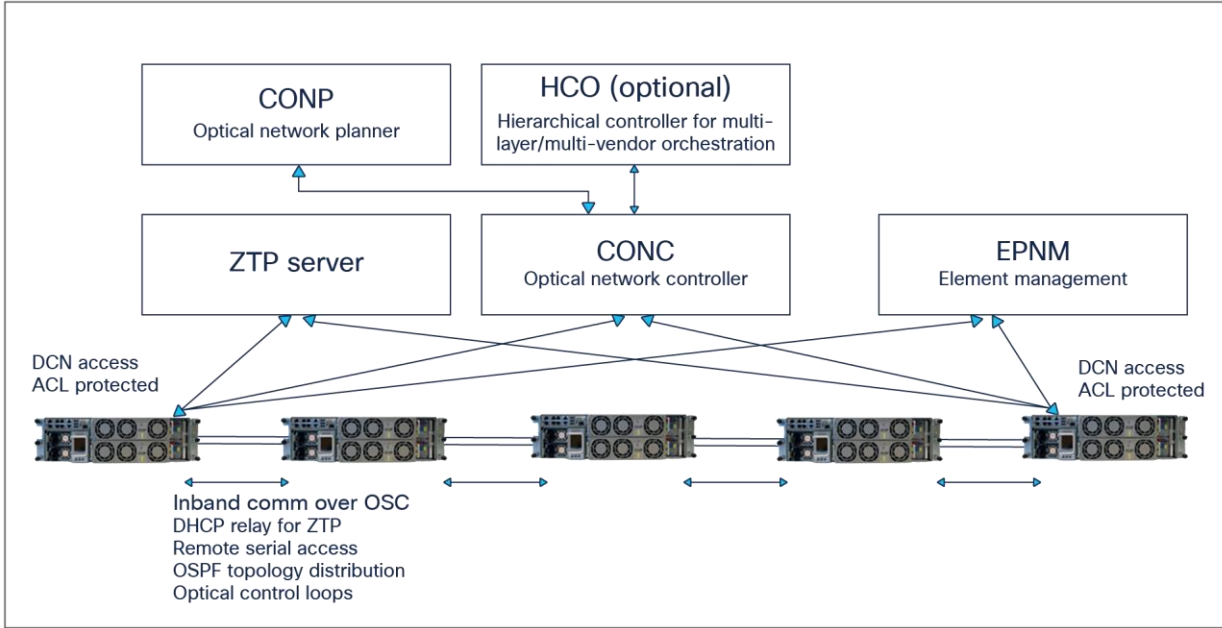


Figure 17.
Overall architecture for automation and management

Features and benefits

Table 1. Benefits of NCS 1010 modules

Feature	Benefit
Optical Line Terminal (OLT)	<ul style="list-style-type: none"> • 33-port twin flex-grid WSS provides scale of a multi-degree ROADM node both for colorless add-drop ports or express ports. • Built-in ASE loading allows for easier turn-up of the network and consistency in performance from day-1 through the life of the network. • 25dBm true variable-gain preamplifier with switchable gain range, 23dBm true variable-gain booster amplifier • Dedicated fixed-gain EDFAs at the WSS add for -10dBm low-power digital coherent optics • Connection verification exists on fiber patches from ROADM to passive breakout or add-drop modules and on ROADM-to-ROADM express connections. This allows for the user to verify if patching is set up correctly or allows patching to be discovered and reported to the user. • The OLT design allows hitless C to C+L-Band upgrade. • Bi-directional OSC support for in-fiber communication between devices, user data channel support, and class C-compliant IEEE 1588v2 PTP timing transport. OSC is available for both C-Band and L-Band separately. • Built in bi-directional OTDR that can run in line with DWDM channels and take measurements in real time of loss and back reflection of both pairs of fiber in a link from both end points. • 34-port optical channel monitor that provides a spectrum-analyzer-like view of power distribution across the available spectrum at the WSS add ports and input and output of the PRE and BST amplifiers. This helps with troubleshooting the system and enables automatic turn-up of the ROADM through WSS attenuation and amplifier gain control loops.

Feature	Benefit
In-line Line Amplifier (ILA)	<ul style="list-style-type: none"> • Two independent “true variable-gain” EDFA blocks with identical characteristics. 23dBm total output power in fiber for both C and L-Bands. 24dBm output power @LINE-TX ports for both C and L-Bands. Each integrated optical amplifier provides the following features: <ul style="list-style-type: none"> ◦ Switchable gain ranges, to provide optimized noise-figure across the whole gain range. ◦ Constant output power and constant gain mode ◦ Non-distorting low-frequency transfer function ◦ Fast transient suppression ◦ Programmable tilt ◦ Optical safety by signal loss detection, HW LOS signal generation and alarming at any input port, fast power down control, and reduced max output power in safe power mode. ◦ Safety class 1M at any optical port • 4-port optical channel monitor that provides a spectrum-analyzer-like view of power distribution across the available spectrum at the input and output of the amplifiers. This helps with troubleshooting the system and enables automatic turn-up and gain control of the ILA. • Embedded continuous dynamic gain equalization to compensate for gain ripple caused by Raman amplification or to apply suitable pre-emphasis for optimal performance of C+L-Band line systems. • Bi-directional OSC support for in-fiber communication between devices, user data channel support, and class C-compliant IEEE 1588v2 PTP timing transport. OSC is available for both C-Band and L-Band separately. • Built in bi-directional OTDR that can run in line with DWDM channels and take measurements in real time of loss and back reflection of both pairs of fiber in a link from both end points.
Passive Breakout	<ul style="list-style-type: none"> • The NCS 1010 add-drop architecture is designed to be simple yet scalable and easy to troubleshoot. The three breakout module options can be used to construct colorless add-drop or scale degrees as required. • Intelligent passive modules with USB cables allow for inventory read from flash and to provide power to the photodiodes and LEDs on the breakout module as well as manage these PDs and LEDs from the NCS 1010. This allows the NOC operators and field technicians to be better prepared to handle passive modules in the field. • NCS 1000 breakout modules have photodiodes that support tone detection on the COM MPO-RX and filter for connection verification tone frequency along with a 1x8 splitter to allow connection verification in both directions between OLT and add-drop for all fibers in an MPO cable. PDs on the breakout module ADD-rx ports can detect tones and are used for connection discovery or verification with the coherent transponder. • Each port is provided with an LED to report port status. This can be used to help field technicians identify the correct port to operate in the field.
NCS 1010 commons features	<ul style="list-style-type: none"> • 300-mm-compliant, front-to-back airflow • Field-replaceable optical module/line card • Field-replaceable 1KW AC or DC PSUs, fan tray • Field-replacement controller card • Redundant SSDs for copies of SW image and configuration • Bluetooth and NFC support – support read-only UI on handheld devices • Rail kits with thumbscrews for shelf replacement without any tools • USB ports for passive device management – inventory, LEDs, optical power • 1588v2 PTP timing support – GPNSS, 10 MHz, TOD inputs, and output ports • Secure crypt processors on shelf, controller, and optical module to ensure integrity of HW, SUDI certificate installed at manufacturing • IOS XR software for zero-touch processing, vendor-neutral YANG models, streaming telemetry

Products overview

Table 2. Product feature sets

Product family	Platforms supported
Software compatibility	IOS XR 7.7.1 or above for C-Band IOS XR 7.9.1 or above for C+L Band IOS XR 7.10.1 IOS XR 7.11.1, 7.11.2
Physical dimensions (NCS 1010)	Occupies 3RU Fits into 2-post 19-in., 300-mm ETSI, 23-in. racks
Thermals	Front-to-back air cooling +5 to +40° C normal operation at 0 to 1800 meters -5 to +55° C short operation for 96 hours
Line cards supported in various IOS XR SW versions	NCS1010-CNTRLR (7.7.1 onwards) OLT-C (7.7.1 onwards) OLT-C-R (7.7.1 onwards) ILA-C (7.7.1 onwards) ILA-C-R (7.7.1 onwards) ILA-C-2R (7.7.1 onwards) OLT-L (7.9.1 onwards) ILA-L (7.9.1 onwards) NCS1010-CTLR-B (7.10.1 onwards) E-OLT-C (7.10.1 onwards) E-OLT-R-C (7.10.1 onwards) E-OLT-L (7.10.1 onwards) E-ILA-R-C (7.10.1 onwards) E-ILA-2R-C (7.10.1 onwards) E-ILA-R-C-2 (7.11.1 onwards)

Product family	Platforms supported
Maximum power consumption	OLT-C, E-OLT-C 142W OLT-C-R, E-OLT-R-C 247W ILA-C 99W ILA-C-R, E-ILA-R-C, E-ILA-R-C-2 204W ILA-C-2R, E-ILA-2R-C 309W OLT-L, E-OLT-L 148W ILA-L 96W NCS1010-CNTRLR-K9 70W NCS1010-FAN 110W Power supplies operate at 90% efficiency
Typical power consumption	OLT-C, E-OLT-C 96W OLT-C-R, E-OLT-R-C 147W ILA-C 68W ILA-C-R, E-ILA-R-C, E-ILA-R-C-2 119W ILA-C-2R, E-ILA-2R-C 170W OLT-L, E-OLT-L 104W ILA-L 68W NCS1010-CNTRLR-K9 40W NCS1010-FAN 35W Power supplies operate at 90% efficiency
NCS 1010 common units	2x fan trays with 3x fans each and 5+1 redundancy 1KW 36-72 Vdc DC redundant PSU 1KW 90-140 Vac AC redundant PSU FRU controller with redundant SSD disks Management I/O ports: <ul style="list-style-type: none"> • 1x console • 3x RJ45 • 1x TOD • 2x optical GE SFP - 1588v2 PTP • 2x optical GE SFP - 1588v2 PTP or UDC • 3x USB 3.0 ports • 1x GNSS, 1x 10MHz, 1x PPS

Product family	Platforms supported
Dimensions	<p>NCS1010-SA= 17.5 in. wide x 8.7 in. deep x 5.1 in. tall</p> <p>NCS1010-DC-PSU= 2.9 in. wide x 8.9 in. deep x 1.1 in. tall</p> <p>NCS1010-AC-PSU= 2.9 in. wide x 8.9 in. deep x 1.1 in. tall</p> <p>NCS1010-FAN= 9.1 in. wide x 2.8 in. deep x 2.4 in. tall</p> <p>NCS1010-CNTRLR-K9, NCS1010-CTRLR-B-K9 2.3 in. wide x 9.9 in. deep x 3.3 in. tall</p> <p>NCS1K-OLT-C=(and other optical LC modules) 11 in. wide x 8.3 in. deep x 4.8 in. tall</p>
Weight	<p>NCS1010-SA= 6.52 kg (empty chassis)</p> <p>NCS1010-DC-PSU 0.85 kg</p> <p>NCS1010-AC-PSU 0.85 kg</p> <p>NCS1010-FAN= 0.75 kg</p> <p>NCS1010-CNTRLR-K9, NCS1010-CTRLR-B-K9 0.8 kg</p> <p>NCS1K-OLT-C=, NCS1K-OLT-L=, NCS1K-E-OLT-C=, NCS1K-E-OLT-L= 6.4 kg</p> <p>NCS1K-OLT-R-C=, NCS1K-E-OLT-R-C= 7.3 kg</p> <p>NCS1K-ILA-C=, NCS1K-ILA-L= 5 kg</p> <p>NCS1K-ILA-R-C=, NCS1K-E-ILA-R-C=, NCS1K-E-ILA-R-C-2= 5.6 kg</p> <p>NCS1K-ILA-2R-C=, NCS1K-E-ILA-2R-C= 6 kg</p>
Availability features	<p>Online insertion and removal of the controller</p> <p>Online insertion and removal of the optical line card</p> <p>Headless mode of operation</p> <p>Redundant SSD disks between shelf and controller card</p>
Manageability features	<p>iPXE and ZTP</p> <p>Cisco IOS XR Software CLI</p> <p>SNMP</p> <p>Streaming telemetry</p> <p>NETCONF, RESTCONF, gRPC with YANG data models incl. OpenConfig, GNMI, GNOI</p> <p>EPNM 7.0 and later</p> <p>CONC 2.0, 3.0 and later</p> <p>CONP 5.1, 5.2 and later</p>

Product family	Platforms supported
Control plane features	Channel and optical XC management Node adjacency discovery OTDR traces and event reporting Span loss verification Dynamic ASE loading Raman tuning Link performance tuner and simulator Automatic power control Connection discovery Connection verification (Cisco Optical Network Controller) Network topology (Cisco Optical Network Controller) Optical Path Compute Engine (Cisco Optical Network Controller)
Routing features	iBGP over OSC interface and eBGP over management interface OSPF over OSC interface and management interface
MTBF	NCS1010-SA= 487,640 hrs. NCS1010-FAN= 14,722,040 hrs. NCS1010-DC-PSU= 721,131 hrs. NCS1010-AC-PSU= 721,131 hrs. NCS1K-OLT-C=, NCS1K-OLT-L=, NCS1K-E-OLT-C=, NCS1K-E-OLT-L= 294,460 hrs. NCS1K-OLT-R-C=, NCS1K-E-OLT-R-C= 231,520 hrs. NCS1K-ILA-C=, NCS1K-ILA-L= 460,930 hrs. NCS1K-ILA-R-C=, NCS1K-E-ILA-R-C=, NCS1K-E-ILA-R-C-2= 321,860 hrs. NCS1K-ILA-2R-C=, NCS1K-E-ILA-2R-C= 243,540 hrs. NCS1010-CNTRLR-K9=, NCS1010-CTLR-B-K9= 571,990 hrs.

Regulatory compliance

Table 3. Regulatory compliance for ANSI and ETSI specifications

ANSI system	ETSI system
Countries and regions supported	
<ul style="list-style-type: none"> • Canada • United States • Korea • Japan • European Union 	<ul style="list-style-type: none"> • European Union • Africa • CSI • Australia • New Zealand • China • Korea • India • Saudi Arabia • South America
EMC emissions	
<ul style="list-style-type: none"> • ICES-003 Class A • AS/NZS CISPR 22 Class A • CISPR 22 Class A • EN55022 Class A • FCC 47CFR15 Class A 	<ul style="list-style-type: none"> • VCCI Class A • KN32 Class A • CNS 13438 Class A • EN61000-3-2 Power Line Harmonics • EN61000-3-3 Voltage Changes, Fluctuations, and Flicker • EN 300 386 Telecommunications Network Equipment (EMC) • EN55022 Information Technology Equipment (Emissions)
EMC immunity	
<ul style="list-style-type: none"> • 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 • KN35 Class A 	<ul style="list-style-type: none"> • EN55024/CISPR 24 Information Technology Equipment (Immunity) • EN50082-1/EN61000-6-1 Generic Immunity Standard
Safety	
<ul style="list-style-type: none"> • CSA C22.2 #60950-1 - Edition 7, March 2007 • UL 60950-1 - Edition 2, 2014 	<ul style="list-style-type: none"> • 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

ANSI system	ETSI system
Laser	
<ul style="list-style-type: none"> • 21CFR1040 (2008/04) (Accession Letter and CDRH Report) Guidance for Industry and FDA Staff (Laser Notice No. 56), May 2019 	<ul style="list-style-type: none"> • 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	
<ul style="list-style-type: none"> • ITU-T G.691 	<ul style="list-style-type: none"> • ITU-T G.975
Quality	
<ul style="list-style-type: none"> • TR-NWT-000332, Issue 4, Method 1 calculation for 20-year Mean Time Between Failure (MTBF) 	

Ordering information

Table 4. Ordering PID list for NCS 1010 hardware

Part number	Description
NCS1010-CNTRLR-K9=	NCS 1010 Controller (*with 112500bps default console baud rate)
NCS1010-CTRLR-B-K9=	NCS 1010 Controller, 9600bps console baud-rate
NCS1010-SA=	NCS 1010 Shelf Assembly
NCS1010-FAN=	NCS 1010 Shelf Fan Assembly
NCS1010-DC-PSU=	NCS 1010 DC Power Supply Unit
NCS1010-DC-CBL-ET=	NCS 1010 DC Cable - ETSI compliant
NCS1010-AC-PSU=	NCS 1010 AC Power Supply Unit
NCS1010-SYS	NCS 1010 Assemble to Order
NCS1010-FTF=	NCS 1010 Fan Tray Filter
NCS1010-ACC-KIT=	NCS 1010 Accessory Kit for 19-inch racks
NCS1010-23-KIT=	NCS 1010 Accessory Kit add-on for 23-inch racks
NCS1010-ETSI-KIT=	NCS 1010 Accessory Kit add-on for ETSI racks
NCS1010-E-ACC-KIT=	NCS 1010 Accessory Kit for 19-inch racks, enhanced
NCS1K-E-LC-LC-5=	NCS 1010 LC-LC 5m cable with pull tab
NCS1010-USB-1M=	NCS 1010 USB Cable - 1 meter
NCS1010-USB-3M=	NCS 1010 USB Cable - 3 meters
NCS1K-E-OLT-C=	NCS 1010 Optical Line Terminal - C-band, enhanced

Part number	Description
NCS1K-E-OLT-R-C=	NCS 1010 Optical Line Terminal with Raman - C-band, enhanced
NCS1K-E-OLT-L=	NCS 1010 Optical Line Terminal - L-band, enhanced
NCS1K-E-ILA-R-C=	NCS 1010 In-Line Amplifier with 1x Raman - C-band, enhanced
NCS1K-E-ILA-2R-C=	NCS 1010 In-Line Amplifier with 2x Raman - C-band, enhanced
NCS1K-E-ILA-R-C-2=	NCS 1010 In-Line Amplifier with 1x Raman west facing - C-band, enhanced
NCS1K-OLT-C=	NCS 1010 Optical Line Terminal - C-band
NCS1K-OLT-R-C=	NCS 1010 Optical Line Terminal with Raman - C-band
NCS1K-ILA-C=	NCS 1010 In-Line Amplifier - C-band
NCS1K-ILA-R-C=	NCS 1010 In-Line Amplifier with 1x Raman - C-band
NCS1K-ILA-2R-C=	NCS 1010 In-Line Amplifier with 2x Raman - C-band
NCS1K-OLT-L=	NCS 1010 Optical Line Terminal - L-band
NCS1K-ILA-L=	CS 1010 In-Line Amplifier - L-band
NCS1K-MD-32O-C=	NCS 1000 32 chs Odd Mux/Demux Patch Panel - 150GHz - C-band
NCS1K-MD-32E-C=	NCS 1000 32 chs Even Mux/Demux Patch Panel - 150GHz - C-band
NCS1K-BRK-SYS	NCS 1000 shelf for 4 passive modules - assemble to order
NCS1K-BRK-SA=	NCS 1000 shelf for 4 passive modules
NCS1K-BRK-KIT=	NCS 1K Breakout Shelf Accessory Kit for 19-inch racks
NCS1KB-23-KIT=	NCS 1K Breakout Shelf Accessory Kit add-on for 23-inch racks
NCS1KB-ETSI-KIT=	NCS 1K Breakout Shelf Accessory Kit add-on for ETSI racks
NCS1K-BRK-24=	NCS 1000 MTP/MPO to 24 colorless chs passive breakout module
NCS1K-BRK-16=	NCS 1000 MTP/MPO to 16 colorless chs passive breakout module
NCS1K-BRK-8=	NCS 1000 MTP/MPO to 8 port passive breakout module

Table 5. Ordering PID list for NCS 1010 software

Part number	Description
SF-NCS1K10-R7101K9	NCS 1010 R7.10.1 Preloaded SW
SF-NCS1K10-R791K9	NCS 1010 R7.9.1 Preloaded SW
SF-NCS1K10-R771K9	NCS 1010 R7.7.1 Preloaded SW
ESS-ILA-RTU	NCS 1010 ILA Essentials RTU
ESS-OLT-1P-RTU	NCS 1010 OLT 1x WSS port Essentials RTU
ADV-ILA-RTU	NCS 1010 ILA Advantage RTU
ADV-OLT-1P-RTU	NCS 1010 OLT 1x WSS port Advantage RTU
ESS-OLT-32P-RTU	NCS 1010 OLT 32x WSS port Essentials RTU
ADV-OLT-32P-RTU	NCS 1010 OLT 32x WSS port Advantage RTU
ESS-ILA-SIA3	NCS 1010 ILA Essentials SIA for 3 years
ESS-OLT-1P-SIA3	NCS 1010 OLT 1x WSS port Essentials SIA for 3 years
ADV-ILA-SIA3	NCS 1010 ILA Advantage SIA for 3 years
ADV-OLT-1P-SIA3	NCS 1010 OLT 1x WSS port Advantage SIA for 3 years
ESS-OLT-32P-SIA3	NCS 1010 OLT 32x WSS port Essentials SIA for 3 years
ADV-OLT-32P-SIA3	NCS 1010 OLT 32x WSS port Advantage SIA for 3 years

A single ATO/bundle for the NCS 1010 system (NCS1010-SYS) is available in the Cisco Global Pricelist to configure the entire chassis with ancillaries, line-cards included.

Warranty

The following are the warranty terms:

- 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.

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.

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Document history

New or revised topic	Described in	Date
NCS 1010 Enhanced LC faceplate variant included. Licensing scheme detailed.	NCS 1010 Enhanced faceplate design and options	July 27, 2023
Updated software compatibility, power consumption, manageability features	Table 2 - Product feature sets	April 17, 2024

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Singapore

Europe Headquarters
Cisco Systems International BV Amsterdam,
The Netherlands

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