Cisco Network Convergence System 4000 Series

Product Overview

The Cisco® Network Convergence System 4000 (NCS 4000) is a converged optical service platform providing dense wavelength-division multiplexing (DWDM), Optical Transport Network (OTN), Multiprotocol Label Switching Transport Profile (MPLS-TP), Carrier Ethernet, and label switch router (LSR) or IP multiservice capabilities (Figure 1). It delivers massive scale through a state-of-the-art silicon and system design, while offering dramatic network efficiency and simplification led by innovations in usability, automation, service management, turn-up, and monitoring.

Figure 1. Cisco NCS 4016 Chassis; Door Closed (Left) and Door Open (Right)

In order to facilitate packet-optical integration, the form factor of the Cisco NCS 4000 is compliant with typical carrier environments, with a notably shallow footprint to address ANSI and ETSI transport equipment requirements. You can deploy the system in 19- or 23-in. width ANSI footprints and 300-mm width ETSI footprints.

The Cisco NCS 4016 is a 24-rack-unit (24RU), rack-mountable solution offering 16 service line-card slots, each with a full-duplex bandwidth of 200 Gbps, with different cards for packet forwarding, OTN switching, and coherent DWDM transponder or trunk capability. Depending on the specific card configuration, the NCS 4016 supports numerous capabilities, including:

- Packet switching and routing
- OTN switching
- DWDM transponding and muxponding

You can use the Cisco NCS 4016 as a converged packet-optical platform by simultaneously combining all of these functions.

Features and Benefits

The key capabilities of the Cisco NCS 4000 platform follow:

- Packet switching: Packet switching includes full IP, MPLS, and MPLS-TP and Carrier Ethernet supporting 10, 40, and 100 Gigabit Ethernet (GE) interfaces with optional OTN (OTU-2, OTU-3, or OTU-4) encapsulation.
- OTN switching: OTN switching includes full optical channel data unit level 0 (ODU-0) switching with ports supporting SONET/SDH, Ethernet, and Channelized OTN; 10 Gigabit Ethernet (OTU-2), 40 Gigabit Ethernet (OTU-3), and 100 Gigabit Ethernet (OTU-4).
- Ultra-dense integrated DWDM: This feature offers full DWDM integration with support for IP-over-DWDM features including the Cisco nLight Control Plane Protocol.
- Hybrid traffic: OTN and packet switching can occur simultaneously, providing the ability to route or switch packet flows within a larger OTN container.
- Superior power efficiency: Cisco CPAK pluggable transceivers and innovative silicon and power management solutions minimize power draw and maximize density.

The Cisco NCS 4000 implements numerous architectural innovations, including:

- Agnostic fabric: This highly scalable fabric supports both packet and time-division multiplexing (TDM) switching, plus shelf and multichassis scale to more than 100 Tbps.
- Virtualized infrastructure: This innovative hypervisor-based software architecture supports full decoupling of the control and data planes. The architecture supports service integration capabilities that offer considerable flexibility to deploy applications within the platform or in the cloud.
- Multichassis and back-to-back (B2B) configurations: In a multichassis configuration the system delivers up to 102.4 Tbps of fully nonblocking switching capacity in a configuration with 32 line-card chassis and 4 fabric chassis (32 + 4); in a B2B configuration, the solution delivers 6.4 Tbps without requiring a fabric chassis.
- Full in-service software upgrade (ISSU) with zero topology loss (ZTL) and zero packet loss (ZPL): This feature offers improved adherence to service-level agreements (SLAs) and performance of software upgrades without requiring a maintenance window. This robust ISSU capability applies to the WDM, TDM, and packet capabilities of the system.
- State-of-the-art backplane technology ready to scale to 500 Gbps per slot: This technology provides the ability to scale the system by a factor of 2.5 within the initial footprint.

The Cisco NCS 4000 seamlessly integrates with the NCS 6000 for massively scalable IP services, and the NCS 2000 for fully programmable reconfigurable optical add-drop multiplexer (ROADM) functions. Integration can occur at the network element, control plane, and/or network management levels, meeting the diverse needs of widely varying operational models.

Platform Architecture

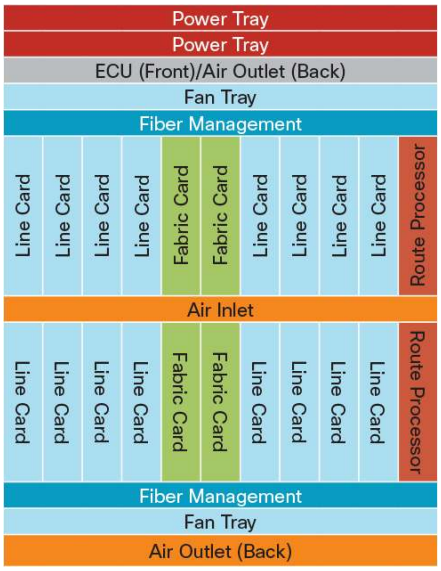
Chassis

The Cisco NCS 4016 chassis is designed to accommodate:

- Two route processors, which also act as shelf controllers for WDM or OTN applications
- Four fabric cards
- Sixteen line cards

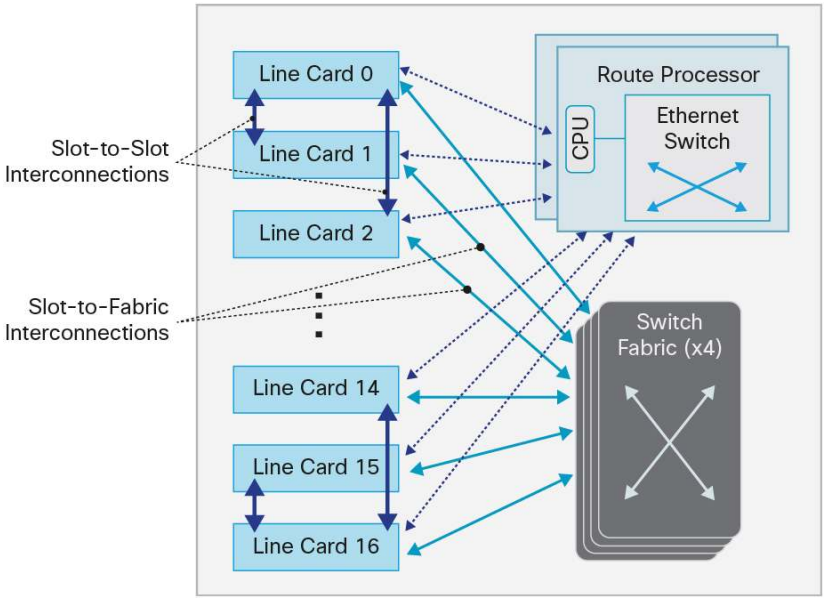
The Cisco NCS 4016 system supports 4 fabric cards, which are agnostic cross-connects based on a flexible cell switching architecture, used in a Clos configuration. The route processors handle all control functions, including both the route-processing function and the line-card processing functions necessary for high-scale Layer 1, 2, and 3 services (Figure 2).

Figure 2. Cisco NCS 4016 Shelf Architecture



Each line card is connected through the backplane to each of the four fabrics, which operate in a 3 + 1 redundant configuration (Figure 3). Additional backplane connections are available to pair slots within each quadrant of the Cisco NCS 4016 chassis, allowing direct backplane interconnection of line cards without fabric access.

Figure 3. Cisco NCS 4016 Backplane Architecture



OTN Functions

The Cisco NCS 4016 provides full ITU G.872-compliant OTN switching functions. It supports ODU-0 to ODU-4 multilayer switching and grooming including nested OTN switching. The system supports single-chassis switching of 3.2 Tbps fully nonblocking at ODU-0 level (2560 ODU-0 or ODU-Flex data units). ODU-Flex hitless resizing is supported as well.

The Cisco NCS 4016 is compliant with ITU G.709/G.798, allowing the cascading of at least 20 OTN cross-connects while maintaining jitter and wander specifications. It is also ITU G.709 operations, administration, and maintenance (OAM)-compliant, with six levels of tandem connection monitoring (TCM) support.

OTN configuration, provisioning, and protection are managed by a Generalized MPLS (GMPLS)-based OTN control plane supporting an embedded User-Network Interface (UNI) as the communication interface between control planes managing different transport layers within the same system. The control-plane instance runs inside the optical domain (overlay network scenario), providing an external UNI interface to client nodes for invocation of on-demand services.

As an extension of the Cisco nLight Control Plane Protocol, an OTN circuit between ingress and egress nodes can be established statically or dynamically using Resource Reservation Protocol (RSVP) signaling. An OTN circuit is established and maintained as a label switched path (LSP) between the ingress and egress LSRs switched through transit LSRs. An LSP can be established as a soft permanent connection (SPC) when the request comes from the User Interface (UI).

Protection Mechanisms

The Cisco NCS 4016 platform provides a variety of different protection mechanisms operating at different layers. Although pure Layer 3, Layer 2, Layer 1, and Layer 0 protection mechanisms are defined, a holistic approach to protection is critical when multiple layers are operating simultaneously.

Supported protection mechanisms are:

- Layer 3: IP/MPLS: IP Fast Reroute (FRR) (link, path, and node) and equivalent MPLS FRR
- Layer 2: Carrier Ethernet: G.8032
- Layer 2: MPLS-TP: 1:1 LSP protection
- Layer 1: OTN: Subnetwork Connection Protection (SNCP/I and SNCP/N), 1+1 and 1:N
- Layer 1: SONET/SDH: 1+1 APS/MSP, 1+1 UPSR/SNCP, 2F-BLSR/MS-SPRING
- Layer 0 (WDM): Y-cable at transponder and muxponder level

Management Solution

The Cisco NCS 4016 solution integrates a state-of-the-art local craft interface which can install, configure, monitor, and troubleshoot NCS 4016 applications both at node and at network level.

Cisco Prime™ Carrier Management provides end-to-end management as well as a full fault, configuration, accounting, performance, and security (FCAPS) functionalities for the Cisco NCS 4016, Cisco NCS 2000, and Cisco ONS devices. It also provides end-to-end management of OTN and IP + Optical converged services, making it possible to manage transport and IP networks with fewer steps to promote operational efficiency.

Cisco NCS 4016 Line Cards

The following line cards are available for the Cisco NCS 4016:

Commons:

- NCS 4000 Router Processor and Controller
- NCS 4000 External Connection Unit
- NCS 4016 Agnostic Cross Connect - Multi-chassis

OTN line cards:

- NCS 4000 2 x 100G CPAK - OTN Line Card - CPAK
- NCS 4000 24 Port Low rate OTN Line Card - SFP
- NCS 4000 20x10G OTN Line Card - SFP+

DWDM line card:

- NCS 4000 2 x 100G CP-DQPSK - Full C band Tunable Line Card

Route Processor

The Cisco NCS 4016 Route Processor is based on an Intel IvyBridge 10-core CPU with 32 Gigabytes of RAM and equipped with a 50-Gigabyte solid-state drive (SSD). A second SSD drive is accessible through the faceplate on the external connection unit (ECU) to provide access to logging data and additional storage space. A USB flash memory device is also available for debugging capabilities.

Figure 4. Route Processor Line Card

The route processor holds the control, timing, monitoring, and management functions of the Cisco NCS 4016 chassis. Multiple LEDs are available on the face plate to summarize the status of the system and provide information such as lack of line card power failure of line card loading, and software booting conditions. The RP provides external interfaces through an ECU and supports the following interfaces on the front panel:

- One USB 2.0 for CPU access
- Two RJ-45 10/100/1000 Ethernet interface
- Two Small Form-Factor Pluggable (SFP+) 10 Gigabit Ethernet management interfaces

External Connection Unit

The ECU provides all shelf electrical I/O connectivity to the active and standby route-processor line cards (Figure 5). In addition, the ECU houses two 1.8-in. SSDs, plus the serial interface connector for the touch screen. The ECU board and carrier have openings to permit exhaust air from the fans to pass through the ECU and flow through the power filters for cooling. The available interfaces of the ECU are listed in Table 1.

Figure 5. External Connection Unit

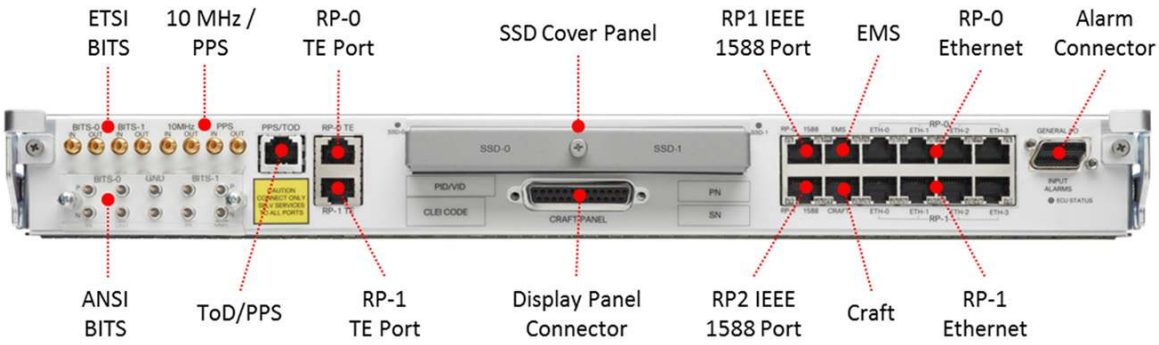


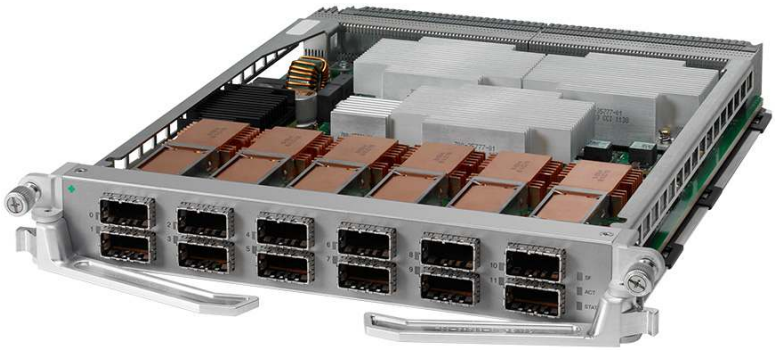
Table 1. External Connection Unit Interfaces

I/O Standard	I/O Connector Type	Quantity	Function
Fast or Gigabit Ethernet	RJ-45	1	Management of administrative virtual machine
Fast or Gigabit Ethernet	RJ-45	1	Management of XR Virtual machine
Fast or Gigabit Ethernet	RJ-45	6	Multishelf management of NCS 2006
Fast or Gigabit Ethernet	RJ-45	2	IEEE 1588 Ethernet port
Proprietary	RJ-45	2	Proprietary timing expansion ports
Proprietary	Small Computer System Interface (SCSI)	2	2 dry contacts or alarm SCSI connectors
Telecom E1	Mini BNC	2	Building Integrated Timing - ETSI In/Out
Telecom T1	Mini BNC	2	Building Integrated Timing - ANSI In/Out
SSD	1.8-in. drive	2	1 SDD for RP0 + 1 SDD for RP1
Touchscreen connector	Universal Asynchronous Receiver/Transmitter (UART)	1	ECU touchscreen connections
RS-422	RJ-45	1	IEEE 1588 Time of Day/Pulse Per Second (TOD/PPS)
	Mini BNC	2	IEEE 1588 10-MHz Clock In/Out
	Mini BNC	2	IEEE 1588 Synch In/Out

Multichassis Fabric Line Card

The Cisco NCS 4016 system supports four fabric line cards operating in a 3 + 1 redundant configuration (Figure 6). Each fabric card supports equally distributed connectivity across all 16 line cards. The fabric card is managed directly by the centralized RP.

Figure 6. Multichassis Fabric Line Card



The fabric is considered agnostic because it switches cells of variable sizes without knowledge of the protocol being transported - OTN or Ethernet. Each Cisco NCS 4016 line card is connected to all four fabric cards, one of which is redundant, allowing for full operation with three functional planes. Twelve CXP front-panel connections allow a single-chassis system to migrate to a back-to-back or multichassis configuration.

Cisco NCS 4016

Table 2 lists the specifications of the Cisco NCS 4016.

Table 2. Cisco NCS 4016 Product Specifications

Feature	Description
Software compatibility	Cisco IOS XR Software Release 5.2.0 or later running under Cisco nVisor
Protocols	Control plane: • Simple Network Management Protocol (SNMP) • Programmatic interfaces (XML) • GUI (Cisco Transport Controller) Control management: • SNMP • Programmatic interfaces (XML) • GUI (Cisco Transport Controller) • Command-line interface (CLI) • Transaction Language 1 (TL1) Security • Message Digest Algorithm 5 (MD5) • IP Security (IPsec) Protocol • Secure Shell (SSH) Protocol Version 2 (SSHv2) • Secure FTP (SFTP) • Secure Sockets Layer (SSL)
Components	Each Cisco NCS 4016 chassis supports: • Two route processors • Two fan trays and filters • Four fabric cards • One ECU • Two power shelves (either DC or AC) • Cisco NCS 4000 Line Cards
Line Cards	OTN line cards • 2 x 100G CPAK - OTN Line Card - CPAK • 24 Port Low rate OTN Line Card - SFP • 20x10G OTN Line Card - SFP+ DWDM line card: • 2 x 100G CP-DQPSK - Full C band Tunable Line Card

Feature	Description
Features and functions	OTN switching: • Full ODU-0 level switching with ports supporting SONET/SDH, Ethernet, Channelized OTN, 10 GE (OTU-2), 40 GE (OTU-3), and 100 GE (OTU-4) • ODU-Flex support • 6-level TCM WDM functions: • Thirty-two 100 GE CP-DQPSK 96chs tunable 4500 km capable reach WDM interfaces OTN over WDM (OTNoWDM) functions: • Any mix of OTN and WDM services in the same chassis up to chassis capacity • OTNoWDM services without need of external cable connectivity between OTN and WDM line card (backplane connectivity between OTN LC and WDM LC)
System capacity	Capability of 200 Gbps per line card for a 3.2-Tbps total switching capacity
Reliability and availability	System redundancy: • Power-shelf redundancy 4:4 • Fan-tray redundancy 1:1 • Route-processor redundancy 1:1 • Fabric-card redundancy 1:4 Software features: • Line-card online insertion and removal (OIR) support • Fabric-card OIR support • Out of resource management • Virtual machine (VM) redundancy • O-SNCP/I 1 + 1 protection • O-SNCP/N 1 + 1 protection • O-SNCP/S 1 + 1 protection • 1 + R ODUk restoration in real time • 1 + 1 automatic protection switching (APS) for SONET client
MIBs	SNMP framework support: • SNMPv1 • SNMPv2c • SNMPv3 • MIB II, including interface extensions (RFC 1213) • SNMP-FRAMEWORK-MIB • SNMP-TARGET-MIB • SNMP-NOTIFICATION-MIB • SNMP-USM-MIB • SNMP-VACM-MIB System management: • CISCO- BULK-FILE-MIB • CISCO-CONFIG-COPY-MIB • CISCO-CONFIG-MAN-MIB • CISCO-FLASH-MIB • CISCO-MEMORY-POOL-MIB • Cisco FTP Client MIB • Cisco Process MIB • Cisco Syslog MIB • CISCO-SYSTEM-MIB • CISCO-CDP-MIB • IF-MIB (RFC 2233/RFC 2863) Quality of service (QoS): • MQC-MIB (Cisco Class-Based QoS MIB) • CISCO-PING-MIB Chassis: • ENTITY-MIB (RFC 2737) • CISCO-entity-asset-MIB

Feature	Description
	• CISCO-entity-sensor-MIB • CISCO-FRU-MIB (Cisco-Entity-FRU-Control-MIB) Fabric: • CISCO-Fabric-Mcast-MIB • CISCO-Fabric-Mcast-Appl-MIB Traps: • RFC 1157 • Authentication • Linkup • Linkdown • Coldstart • Warmstart
Network management	• Enhanced CLI • XML interface • SNMP and MIB support • Cisco Transport Controller local craft interface • TL1 • Cisco Prime Network
Programmatic interfaces	• XML schema support
Power	Support for both DC and AC power modules:* • 2.75-kW AC power module • 2.75-kW DC power modules • Worldwide ranging AC (200 to 240V; 50 to 60 Hz; 16A maximum) • Worldwide ranging DC (-40 to -72V; 60A maximum)
Environmental conditions	• Storage temperature: -40 to 158℉ (-40 to 70℃) • Operating temperature: ◦ Normal: 41 to 104℉ (5 to 40℃) ◦ Short term: 23 to 122℉ (-5 to 50℃) ** ◦ Relative humidity: 5 to 85%

* Mixing of AC and DC modules is not supported.

** 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.)

Approvals and Compliance

Table 3 lists compliance and agency approvals for the Cisco NCS 4016 Single-Chassis System.

Table 3. Compliance and Agency Approvals for Cisco NCS 4016

Feature	Description
Safety standards	• UL/CSA/IEC/EN 60950-1 • IEC/EN 60825 Laser Safety • FDA: Code of Federal Regulations Laser Safety
Electromagnetic interference (EMI)	• FCC Class A • ICES 003 Class A • CISPR 22 (EN55022) Class A • VCCI Class A • IEC/EN 61000-3-2: Power Line Harmonics • IEC/EN 61000-3-3: Voltage Fluctuations and Flicker

Feature	Description
Immunity (basic standards)	• IEC/EN-61000-4-2: Electrostatic Discharge Immunity (8-kV contact, 15-kV air) • IEC/EN-61000-4-3: Radiated Immunity (10V/m) • IEC/EN-61000-4-4: Electrical Fast Transient Immunity (2-kV power, 1-kV signal) • IEC/EN-61000-4-5: Surge AC Port (4-kV CM, 2-kV DM) • IEC/EN-61000-4-5: Signal Ports (1 kV) • IEC/EN-61000-4-5: Surge DC Port (1 kV) • IEC/EN-61000-4-6: Immunity to Conducted Disturbances (10 Vrms) • IEC/EN-61000-4-8: Power Frequency Magnetic Field Immunity (30A/m) • IEC/EN-61000-4-11: Voltage Dips, Short Interruptions, and Voltage Variations
ETSI and EN	• EN300 386: Telecommunications Network Equipment (EMC) • EN55022: Information Technology Equipment (Emissions) • EN55024: Information Technology Equipment (Immunity) • EN50082-1/EN-61000-6-1: Generic Immunity Standard
Network Equipment Building Standards (NEBS)	This product is designed to meet the following requirements (qualification in progress): • SR-3580: NEBS Criteria Levels (Level 3) • GR-1089-CORE: NEBS EMC and Safety • GR-63-CORE: NEBS Physical Protection

Warranty Information

Find warranty information on Cisco.com at the Product Warranties page.

Ordering Information

To place an order, visit the Cisco Ordering Home Page and refer to Table 4. To download software, visit the Cisco Software Center.

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For More Information

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