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PRODUCT BROCHURE

6500 Packet-Optical Platform

Transforming Networks into Intelligent Programmable Platforms

Introduction

Ciena's 6500 Packet-Optical Platform integrates three comprehensive networking layers into a single platform to provide customizable service delivery from the metro edge, between data centers, along the backbone core, and across ocean floors.

Maximizing networking efficiencies, the 6500 converges packet, OTN, and flexible WaveLogic Photonics capabilities in a single platform, as well as across multiple shelf configurations, helping service providers streamline operations and optimize footprint, power, and capacity to specific site requirements. The system also features full instrumentation and embedded intelligence across all layers, with an emphasis on automating and simplifying operations. Network operators can leverage the flexibility and programmability of the platform and use off-board software tools to automate services, from creation through orchestration and delivery, empowering differentiation and the ability to meet their business objectives.

One platform, full flexibility

The flexibility of the 6500 platform starts with the variety of services it can support. A handful of interfaces support the full mix of Ethernet, OTN, SDH/SONET, Fibre Channel, video, and transparent DWDM services—from DS1/E1 to 100 GbE/OTU4—from metro to submarine applications. Standards-based service interfaces ensure seamless multi-vendor interoperability.

The network element can be customized to support 2.5G to 100G switched or DWDM applications as bandwidth and connectivity demands dictate. Various line and equipment protection options are available to help providers support a tiered Service Level Agreement (SLA) and differentiated service offerings that will enable expansion of the current customer base.

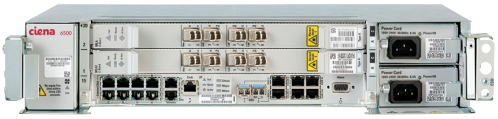

Figure 2. 6500-D2 amplifier configuration

Multiple chassis form factors are available, from a compact 2RU, up to full-rack sizes, with the ability to scale from 100 Gb/s to 500 Gb/s per slot. The smaller 6500-D2 and 6500-D7 shelf configurations offer both AC and DC power options, addressing a wide range of end-customer locations, and a 6500-D2 extended temperature solution is also available for uncontrolled outside plant environments. A single software load and management system across the various shelves reduces standardization cycles and sparing expenses and simplifies network operations. Along with the ability to tailor the customer offering, the 6500 comes with proven five-9s (99.999%) reliability, ensuring the ability to meet the strictest customer requirements.

Programmable optical layer

WaveLogic Photonics is Ciena's fully instrumented, intelligent photonic system composed of WaveLogic coherent optics and flexible line elements that combine with embedded and discrete software tools to offer better automation, control, and visibility to the optical network.

An important factor influencing business success is the ability to photonically interconnect sites quickly and economically, simplify network operations, and reduce costs, power, and latency associated with regenerators. The 6500 offers the full range of photonic architectures in one platform, from passive fixed filters

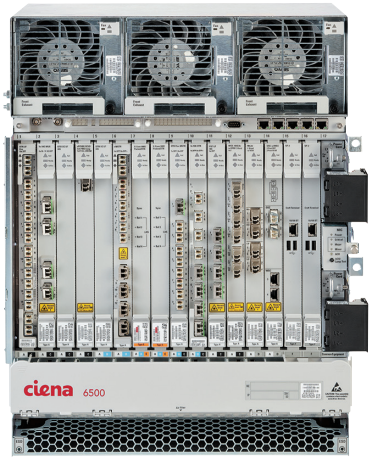

Figure 1. 6500-S14 100G ROADM configuration

Features and benefits

- Provides industry-leading 10G, 40G, and 100G coherent and control plane capabilities for scale and service differentiation
- Utilizes hybrid OTN and packet switching technologies for the most efficient use of network resources
- Offers embedded and discrete software tools to increase programmability, visibility, and control of the optical network
- Adapts to a wide variety of requirements with a minimal set of equipment, reducing standardization and operational costs
- Maximizes operational efficiencies with the ability to tailor customer solutions via various chassis, power, and configuration options

and Coherent Select for simple metro service extensions to directionless, colorless, contentionless, and flexible grid ROADMs for the power to send any service anywhere in the network, dynamically.

Learn more about Ciena's WaveLogic technology

Purpose-built for high-capacity access, aggregation, and distribution networks, Coherent Select is an innovative wavelength broadcast and select architecture that provides the operational flexibility of ROADMs at the cost point of passives, delivering the right economics to evolve from 10G to 100G and beyond.

The 6500 supports all ROADM configurations, including flexible grid CDC, which enables an agile photonic foundation that is responsive to application needs, an increasingly critical requirement in the move towards software-driven, web-scale networks. The 6500 CDC solution future-proofs the network, eliminating wavelength routing restrictions that have previously limited operators' ability to quickly turn-up new services. Reconfigurations such as wavelength defragmentation and route optimization can also be performed to scale the network for continued service growth.

A unique benefit of Ciena's WaveLogic Photonics is the support of PinPoint Advanced Fiber Analytics, which provides unprecedented visibility from the NOC directly into the fiber plant. PinPoint integrates Optical Time Domain Reflectometer (OTDR) capabilities for both EDFA and Raman-amplified links, allowing operators to quickly identify and localize high connector losses or reflections and ensure their fiber plant is conditioned for optimal performance. In particular, Ciena's Smart Raman combined with PinPoint eliminate the pain points of traditional Raman deployments by providing simplified, controlled turn-up and fast, precise pinpoint of faults.

Finally, contrary to other 'boxed-in' vendor solutions, 6500's advanced monitoring and software control features allow for an elegant expansion of the network. Operators are able to expand connectivity to additional sites with in-service ROADM additions and channel add/deletions as needed.

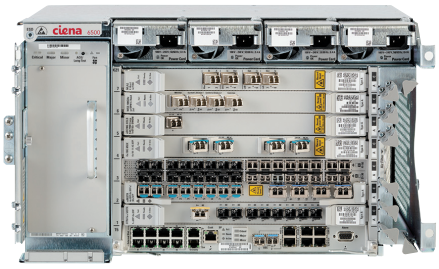

Figure 3. 6500-D7 ROADM configuration

Smarter, high-capacity coherent technology

An important benefit of the 6500 is that the same platform can be tailored to cost-effectively address applications from 2.5G to 200G DWDM and beyond. It also provides an elegant evolution path to multi-carrier Terabit/s channels, leveraging existing infrastructure investments.

As the pioneer of coherent optical technology, Ciena offers a comprehensive 40G/100G portfolio with hardware tailored to address metro, regional, long-haul, and submarine applications.

The cornerstone of Ciena's 100G coherent solution is based on WaveLogic 3 coherent optical processors. Key WaveLogic 3 design elements include Soft-Decision Forward Error Correction (SD-FEC), a very robust DSP-assisted receiver, and the integration of DSP in the transmitter (Tx DSP). These innovations translate into industry-leading performance, enabling 100G transport over longer distances with fewer regenerators. WaveLogic 3 delivers unmatched Polarization Mode Dispersion (PMD) tolerance, enabling 100G operation over any, including very old, fiber. The Tx DSP performs spectral shaping to improve system margin, which is especially useful in situations where signals traverse cascaded filters or OADMs. Spectral shaping is also required for close packing of wavelengths for optimal spectral efficiency, important in flexible grid networks and critical for multi-carrier channel transmission. Another important function enabled by Tx DSP is programmable modulation, providing application-responsive intelligence with the ability to optimize capacity for specific reach requirements.

Building off of WaveLogic 3, Ciena has also developed WaveLogic 3 Extreme and WaveLogic 3 Nano chipsets that deliver coherent solutions tailored for specific applications. WaveLogic 3 Extreme provides extreme performance for all coherent networking applications through the use of additional modulations and enhanced mitigation of both linear and non-linear impairments. Example benefits include doubling of capacity in metro/regional applications through 16QAM modulation, 50% additional capacity per wavelength (150 Gb/s) in long-haul applications via 8QAM modulation, or 40% capacity increase in submarine applications via innovative 8D-2QAM modulation.

WaveLogic 3 Nano enables wide-scale deployment of 100G in metro/regional environments, with a design optimized for smallest footprint and lowest power consumption. Designed with robust phase noise tolerance, WaveLogic 3 Nano also allows for simple 100G overlay in existing 10G compensated networks.

10G – 200G wire-speed encryption protecting all data, all the time

Ciena offers advanced integrated encryption capabilities in both 10G and WaveLogic 3 Extreme coherent optics, providing operators a simple way to safeguard all their in-flight data against breaches. Meeting the highest recognized security standards, these FIPS-certified, AES-256, protocol-agnostic, wire-speed encryption solutions address all infrastructure requirements, from 10G to 200G, from metro to submarine distances. Advanced security features include two distinct keys for authentication and data encryption functions, with hitless key rotation every second. A dedicated encryption management interface, MyCryptoTool, provides full control of security parameters to the end-user or security officer.

Packet and OTN efficiencies

The 6500 offers unrestricted, agnostic OTN and packet switching, enabling Terabit-class scaling of packet and multi-protocol services. Operators can select the most flexible networking model, i.e. the most suitable of packet and/or OTN switching and redundancy options as needed. The 6500 can operate as a full OTN or native packet switch with no capacity or functionality constraints. Alternatively, operators can offer a mix of both; for example, an operator offering OTN-switched services can introduce co-resident packet-switched services for new revenue streams.

A handful of 6500 OTN, packet, and hybrid packet/OTN interfaces support a wide range of protocols, allowing for rapid response to service requests and faster time to revenue, even in an unpredictable environment.

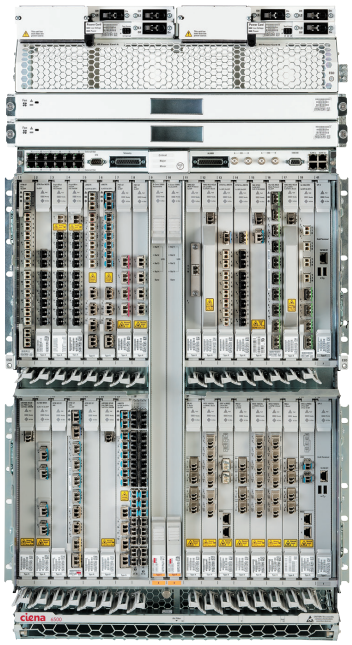

Figure 4. 6500-S32 Packet/OTN switching configuration

The 6500 supports ODUFlex mapping, which allows for adjustable bandwidth containers, from 1G to 100G in 1.25G increments. Grooming of partially filled wavelengths and GbE/10GbE/100GbE ports ensures the most efficient bandwidth utilization and scaling of the network, resulting in the efficient transport of traffic across fewer connections using less network bandwidth.

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OTN switching provides transparent transport of all native services, along with end-to-end management of these services, all over a single converged network. the 6500 also provides Tandem Connection Monitoring (TCM) for improved service assurance, giving service providers a better service fault correlation and troubleshooting capability when handling third-party traffic.

From a packet-switching perspective, 6500 supports several modules specializing in packet switching that leverage Ciena's Service-Aware OS (SAOS), which is available across the company's Packet Networking portfolio and deployed on more than 750,000 platforms worldwide. This common technology implementation, shared across different devices, allows for rich functionality implementation and maximum operational efficiencies across an end-to-end service offering.

Ciena's 6500 supports both muxponder and central fabric-based packet and OTN switching solutions; operators can cost optimize the configuration based on traffic requirements, selecting to express wavelengths or aggregate and switch sub-rated ports where needed, without compromise.

Advantages of Ciena's packet/OTN switched solutions include:

- Customized configurations based on connectivity requirements
- Very granular sub-wavelength and sub-GbE grooming, for efficient utilization of network resources
- Unrestricted hybrid packet/OTN centralized switching, with the ability to tune for packet and/or OTN in any ratio
- Flexible protection options for all hardware options, enabling a tiered SLA offering

Integrated photonic and OTN control plane intelligence

A distributed control plane can be an important component of software-defined networks, enabling a programmable network foundation that can support changing service requirements and the bandwidth-on-demand type of services becoming prevalent with cloud and software-defined networks.

Ciena's OneConnect control plane allows the transport network to automate and distribute many functions formerly performed through a combination of centralized management systems and manual processes. In particular, OneConnect provides the following advantages:

- Uses real-time network topology to provide accurate and automated inventory of equipment and bandwidth resources
- Uses signaling to provide accelerated service provisioning and faster turn-up
- Offers tunable SLAs for revenue growth via flexible protection and restoration options

Operators can leverage both Photonic and OTN OneConnect control planes to offer a wide range of SLA offerings. SLAs can range from unprotected to 50ms protection against any number of failures, and everything in between. For unprotected services, Photonic OneConnect ensures Mean Time To Repair (MTTR) guarantees can be met at little incremental cost.

Another important benefit of OneConnect is it facilitates wavelength re-grooming, enabling operators to perform proactive network maintenance in a condensed maintenance window, with fewer truck rolls. Wavelength re-grooming can also be used to reroute wavelengths onto shorter, more optimized paths to reduce regenerator ports and service latency and rebalance wavelengths to extend the life of the existing network.

Ciena was among the first to deploy control plane in DWDM systems and optical cross-connects. The innovative control plane functionality—hardened with over 15 years of global field experience and scaling to networks of 1,000 nodes—places Ciena well ahead of the competition for robust and reliable optical control plane software.

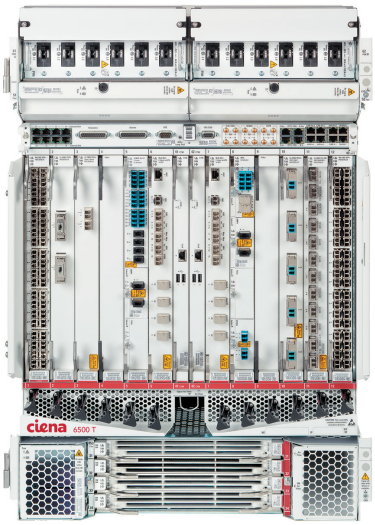

Figure 5. 6500-T12 Packet/OTN switching configuration

Full network, multi-layer visibility and optimization with OneControl and OnePlanner

Ciena's OneControl Unified Management System offers comprehensive network and service management for end-to-end Ciena networks. Through a unified GUI and common management model, Network Operations Center (NOC) operators can rapidly deploy new service offerings that cut across domains (access, metro, core, and subsea) and coordinate across network protocol layers (photonic, transport, and packet) to ensure efficient use of critical network assets and bandwidth optimization.

OneControl GUI allows NOC personnel to create and activate end-to-end services at the optical layer, including OTN/SONET/SDH and Layer 2 services such as E-LAN/E-Line. Once enabled, OneControl provides complete visualization of the entire end-to-end service with multilayer correlation, facilitating proactive root-cause analysis and troubleshooting.

Ciena's OnePlanner Unified Design System is an advanced, multi-layer network design and optimization tool that leverages Ciena's extensive background in Layer 1 control plane planning and simulation, photonic system design, advanced algorithm research, and GUI development into a comprehensive and easy-to-use platform. OnePlanner correlates data from different network layers, allowing the network planner to easily see the association between services, facilities, and equipment.

Summary

Deployed by more than 500 operators, the 6500 underpins service provider, research and education, government, and enterprise networks around the globe. Its popularity hinges on several key factors:

- It can be tailored for an economic fit into a variety of applications
- It very efficiently delivers a wide range of services leveraging packet and/or OTN switching
- It practically scales to elegantly handle step increases in capacity over existing infrastructure

In short, with the 6500, operators are able to drive network transformation without restrictions or compromise, with room to grow.

Technical information

Physical Dimensions

6500-D2:
- 2U 89 mm (H) x 443.2 mm (W) x 281 mm (D)
- 2U 3.5 in. (H) x 17.5 in. (W) x 11.1 in. (D)

6500-D7:
- 6U 267 mm (H) x 440.5 mm (W) x 281 mm (D)
- 6U 10.5 in. (H) x 17.3 in. (W) x 11.1 in. (D)

6500-S8:
- 7U 310 mm (H) x 440.5 mm (W) x 281 mm (D)
- 7U 12.2 in. (H) x 17.3 in. (W) x 11.1 in. (D)

6500-S14:
- 13U 577.1 mm (H) x 440.5 mm (W) x 280 mm (D)
- 13U 22.7 in. (H) x 17.3 in. (W) x 11.0 in. (D)

6500-S32:
- 22U 977 mm (H) x 498.0 mm (W) x 277.5 mm (D)
- 22U 38.5 in. (H) x 19.6 in. (W) x 10.9 in (D)

6500-T12:
- 17U 754 mm (H) x 498.0 mm (W) x 430 mm (D)
- 17U 29.7 in. (H) x 19.6 in. (W) x 16.9 in (D)

6500-T24:
- 36U 1590 mm (H) x 498 mm (W) x 433 mm (D)
- 36U 62.6 in (H) x 19.6 in (W) x 17.0 in (D)

Shelf pre-mounted in 44RU EIA Rack:
- 2134 mm (H) x 660 mm (W) x 457 mm (D)
- 84.0 in (H) x 26.0 in (W) x 18.0 in (D)

Capacity

SONET/SDH: 640 Gb/s
Packet/OTN: 12 Tb/s
System: Up to 19.2 Tb/s
WDM: 2.5G/10G/40G/100G/200G DWDM
Wavelength support: 96 wavelengths in C-band, full band tunable optics
SONET/SDH XC: 20G to 80G low order, 80G to 640G high order
Packet/OTN XC: 600G to 5T

Photonics

Full suite of passive filters, 50GHz, 100GHz, flexible grid ROADMs
Colorless, Directionless, Contentionless
Coherent Select Architecture
EDFAs, Smart Raman
PinPoint Advanced Fiber Analytics

Services

Ethernet: 10M, 100M, 1GbE, 10GbE, 40GbE, 100GbE
MEF CE 2.0-certified EPL, EVPL, EP-LAN, EP-LAN EPL-Access, and EVPL-Access services
OTN: OTU0 to OTU4, ODUFlex
FC100 to FC1200
SONET/SDH: OC-3/STM-1 through OC-768/STM-256
Electrical: DS1, E1, DS3, E3, STM-1e
ESCON
DVB-ASI
PSIFB

Transponders/Muxponders

Coherent 100GE/OTU4 transponder
Coherent 100G muxponder (10x10G)
Coherent 100G/150G/200G line cards: metro, regional, long haul, ultra long haul, enhanced PMD, submarine
Coherent modulations: 16QAM, 8QAM, 4ASK, QPSK, BPSK, 8D-2QAM
FIPS-certified AES-256 wire-speed coherent 100G/200G encryption solution
Coherent 200G client card: 2x100GE or 5x40GE/10GE
Coherent 100G client cards: 10x10GE, 10x10G multi-rate, 2x40G+2x10G, 100GbE/OTU4 client
Coherent 40G line cards: metro, regional, long haul, ultra long haul, enhanced PMD, submarine, colorless
Coherent 40G client cards: 4x10G multi-rate, 40G multi-rate
10G: 4x10G multi-rate OTR with FIPS-certified AES-256 wire-speed encryption
Ethernet: 152G eMOTR, 68G eMOTR Edge, 30G L2MOTR
OTN modules: 8-port OTN Flex MOTR (10G), 1+8 port OTN Flex MOTR (20G)
SONET/SDH 10G ADM-on-a-blade: SuperMux

Packet/OTN switched modules

40x10G PKT/OTN
5x100G/12x40G PKT/OTN
5x100G DWDM PKT/OTN
20x10G OTN
2x100G OTN
2x100G DWDM OTN
10x10G PKT/OTN
1x100G + 2x40G PKT/OTN
100G DWDM PKT/OTN
40G DWDM OTN
16x2.7G OTN
48xGbE

SONET/SDH switched modules

Ethernet: L2 service switch, PDH Gateway, EPL
Electrical: E1, DS1, DS3, EC-1, E3
Optical: OC-3/STM-1 through OC-192/STM-64

Distributed Control Plane

Photonic, OTN, SONET/SDH

Configurations

Unprotected
1+1/MSP linear
1+1 OTN line-side
LAG
1+1 Enhanced Trunk Switch (ETS)
1+1 Transponder Protection Tray
1+1 Optical Protection switch (incl. fast coherent recovery times)
2-Fiber BLSR/MS-SPRing
4-Fiber BLSR/MS-SPRing/HERS
UPSR/SNCP
ASNCP
Mesh restorable control plane connections at L0 and L1
MPLS-TP
G.8032 Ethernet Ring Protection

Common Equipment

Full common equipment redundancy
Field-replaceable units
-48Vdc input voltage range:
-40Vdc to -75Vdc
24Vdc input voltage range: +20Vdc to +30Vdc
AC input voltage range: 90Vac to 264Vac

Environmental Characteristics

6500-D2 extended temperature solution: -40°C to 65°C (-40°F to 149°F)
Normal Operating Temperature: +5°C to +40°C (+41° F to +104° F)
Short Term Operating Temperature: -5° C to +55° C (+23° F to +131° F) for 6500-D2/D7/S8/S14; -5° C to +50° C (+23° F to +122° F) for 6500-S32/T12/T24
Normal operating humidity: 5% to 85% RH
Earthquake/seismic: Zone 4

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