

PRODUCT BROCHURE

6500 Packet-Optical Platform

Enabling a Programmable Infrastructure Foundation for the Adaptive Network

Introduction

Ciena's 6500 Packet-Optical Platform leverages the latest technology innovation to deliver new levels of scale, flexibility, and programmability across three comprehensive networking layers for customizable service delivery over any distance.



Today, providers need a more adaptive network—one that leverages a programmable infrastructure that can scale and respond on demand, to meet changing customer expectations and unpredictable traffic requirements. The 6500 addresses these challenges directly by providing a technology-leading programmable infrastructure that enables the software control, automation, and intelligence required for a more adaptive network.

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 features advanced instrumentation and embedded intelligence across all layers, with the full suite of open APIs and modern data models needed for real-time network telemetry and increased automation and simplified operations. Network operators can leverage the flexibility and programmability of the platform with software-defined control to rapidly plan, provision, turn up, and troubleshoot multi-layer services from the metro edge, between data centers, along the backbone core, and across ocean floors.

One platform, full flexibility

The flexibility of the 6500 platform starts with the variety of services it can deliver over a wide range of applications. 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.



Figure 2. 6500-D2 amplifier configuration

The network element can be customized to support 2.5G to 100G switched or DWDM applications from 2.5G up to 400G, 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.

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 management system and reusable cards 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.

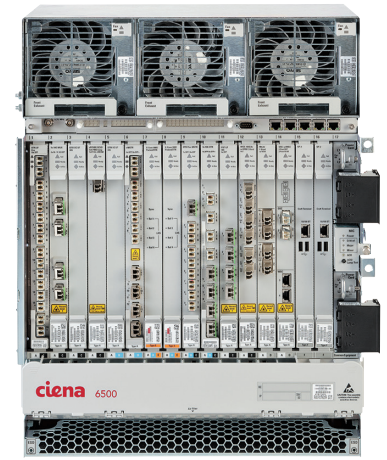


Figure 1. 6500-S14 100G ROADM configuration

Features and benefits

- Leverages industry-leading coherent technology with unprecedented intelligence and programmability required to build on-demand, programmable networks
- Utilizes hybrid OTN and packet switching with control plane capabilities for the most efficient use of network resources and service differentiation
- 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
- Delivers the full suite of open APIs for advanced programmability, automated provisioning, and streaming telemetry

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, to simplify network operations, and reduce costs, power, and latency associated with regenerators. The 6500 offers the full range of photonic architectures, from passive fixed filters and Coherent Select for simple metro service extensions to colorless, directionless, contentionless (CDC) and flexible grid ROADMs for the power to send any service anywhere in the network, dynamically.

Increasing Competitive Advantage
with WaveLogic Photonics
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With flexible grid CDC, users gain an agile photonic foundation that is responsive to application needs, an increasingly critical requirement in the move towards a more adaptive network. 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.

The latest addition to the 6500 Family of Packet-Optical Platforms is the 6500 Reconfigurable Line System (RLS), a modular line system with advanced programmability and openness, that scales from the lowest to the highest bandwidth requirements. Despite its compact size, the 6500 RLS provides highly dense ROADM and amplifier configurations, offering pay-as-you-grow flexibility as nodal capacity requirements increase. It is purpose-built with the flexibility to fit into a variety of disaggregated line system applications and offers the ability to double fiber capacity with its integrated C&L-band architecture.

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.

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 400G 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 high-capacity portfolio with programmable hardware to address metro, regional, long-haul, and submarine applications.

Ciena's WaveLogic 3 coherent optical processors enable 100G to 200G-optimized applications through the use of innovative technology such as Soft-Decision Forward Error

Correction (SD-FEC), a very robust DSP-assisted receiver, and the integration of DSP in the transmitter (Tx DSP). Ciena's next-generation coherent technology, WaveLogic Ai, provides unprecedented systems intelligence and programmability to address the increasingly dynamic service requirements of today's on-demand networks. WaveLogic Ai builds upon the best-in-class performance of WaveLogic 3, and uses an advanced, 400G-optimized engine to significantly improve transport economics: driving twice the capacity per channel, three times the distance at equivalent capacity, and four times the service density.

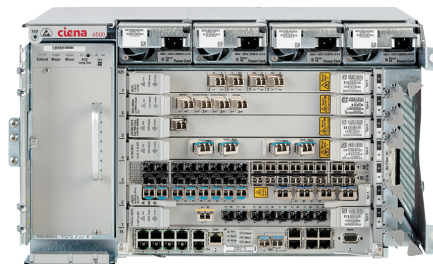


Figure 3. 6500-D7
ROADM configuration

WaveLogic Ai operates at a selectable baud rate of 35Gbaud or 56Gbaud, providing the ability to trade channel throughput for optical performance and spectrum usage while delivering power and space efficiency benefits over both fixed and flexible grid photonic line systems. A key benefit is that it offers the widest range of tunable capacities in the industry, from single carrier 100G to 400G in 50G increments, with embedded unique, real-time link monitoring capabilities, allowing operators to rapidly determine exactly how much margin is currently present in the network, as well as the optimal capacity they can deploy. Operators can benefit from simplified sparring and forecasting with hardware that can address any application, from high-capacity short-reach metro, to ultra-long-haul and submarine, all while leveraging a pay-as-you-grow approach. Additionally, with Ciena's best-in-class SD-FEC and DSP algorithms, operators can deploy higher capacity channels over longer reaches and eliminate regens from the network.

24/7 in-flight data protection with wire-speed encryption

As part of Ciena's multi-layer security approach that ensures the confidentiality, integrity, and availability of data in the network, the 6500 offers advanced integrated AES-256 encryption capabilities providing operators a simple way to safeguard all their in-flight data against breaches. Meeting the highest recognized security standards, which include Common Criteria and FIPS certification, these simple-to-deploy, 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 key advantage of deploying a packet/OTN switched architecture is the decoupling of the client and line, which allows for fast service turn-up, a key building block for enabling a more dynamic, adaptive network. 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.

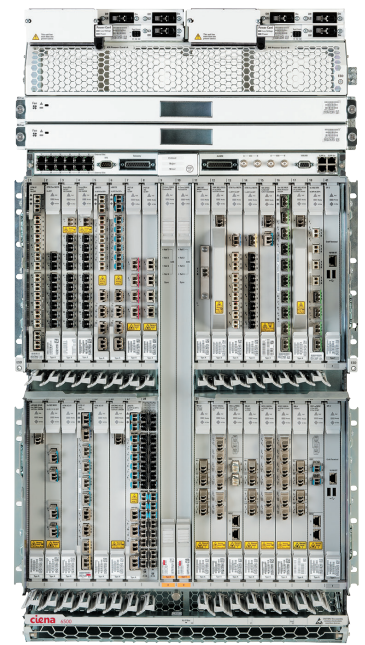


Figure 4. 6500-S32 Packet/OTN switching configuration

WaveLogic Ai: Laying the Foundation
for the Adaptive Network
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The 6500 supports ODUFlex mapping, which allows for in-service 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.

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. Additionally, OTN future-proofs the network with built-in support for new clients, such as Flex Ethernet (FlexE) and line rates beyond 100G (B100G).

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 1 million 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

The 6500 Packet Transport System (PTS) configuration is designed to address the growing need to maintain profitable delivery of TDM services while future-proofing investments toward an all-packet network modernization. The 6500 PTS supports replacement of massive legacy 3/1 DACS, enabling DS1 and VT1.5 level switching through a packet fabric equipped on the 6500-S8/S14 shelves. The same fabric also allows operators to replace and consolidate MSPP SONET/SDH platforms, with the ability to transport circuit-switched Ethernet services using a variety of encapsulation protocols. Multiple Add-Drop Multiplexer (ADM) rings are also supported on the 6500 PTS, saving even more space and power. In addition, the 6500 PTS operates as a standard MPLS switch for transport and switching of Ethernet services and a pathway to future IP services. With these capabilities, network operators can modernize their TDM network, enabling migration of TDM services to an MPLS protected core network.

Integrated photonic and OTN control plane intelligence

A control plane is another 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 intelligent 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, it 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 (L0) and OTN (L1) 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, L0 control plane ensures Mean Time To Repair (MTTR) guarantees can be met at little incremental cost.

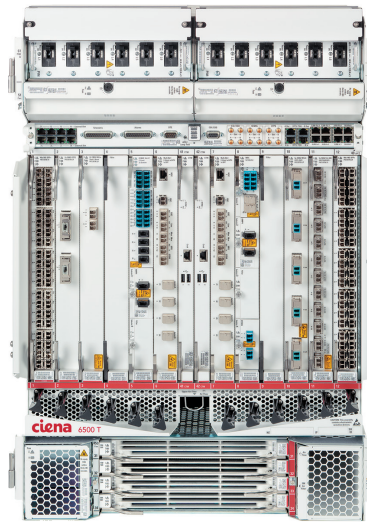


Figure 5. 6500-T12 Packet/OTN switching configuration

Another important benefit of L0 control plane 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.

Learn more about the 6500 PTS



Software control of multi-layer lifecycle operations with Blue Planet MCP

Blue Planet Manage, Control and Plan (MCP) is Ciena's domain controller, unifying and automating lifecycle operations of Ciena's packet and optical infrastructure across domains (access, metro, core, and subsea). No longer do operators have to swivel-chair between multiple legacy network management systems, with lengthy error-prone processes. MCP synchronizes operations across multiple network protocol layers so operators can quickly create, activate and troubleshoot end-to-end services deployed over the 6500 optical network, including OTN and Layer 2 services such as ELINE, ELAN and ETREE. In addition to its rich GUI visualization, MCP offers open REST APIs for ease of integration into adjacent systems, enabling automation of network operators' business processes.

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 is an offline application that correlates data from different network layers, allowing the network planner to easily see the association between services, facilities, and equipment on the 6500. MCP integrates seamlessly with OnePlanner to provide online capacity planning and the ability to correlate real-time network utilization data from multiple network layers to customer services. This allows the operator to dynamically add new capacity, allocate and tune service bandwidth, and adjust service routes to satisfy customers' bandwidth and reliability demands most efficiently.

Fully programmable and instrumented infrastructure with Liquid Spectrum™

The 6500 can be deployed as part of Ciena's Liquid Spectrum network solution, which combines highly instrumented, programmable hardware with advanced software applications to help operators extract the most value from their existing network resources. Value can be quantified as improved efficiency, increased capacity, stronger channel reach, increased service availability, or increased automation for faster time to market.

Integrated as part of Blue Planet MCP, Liquid Spectrum analytics apps leverage the programmability of WaveLogic coherent hardware to precisely match the capacity of a wavelength to the system margin required to traverse a specific path of the network, at any point in time. As an example, operators can mine available network margin and convert it to capacity on demand, allowing them to instantly dial bandwidth up or down, or improve service availability during a disaster recovery situation. With Liquid Spectrum, operators can leverage a fully programmable infrastructure with operational simplicity via sophisticated applications, enabling access to new revenue streams and the ability to more fully monetize existing assets.

Summary

Deployed by more than 600 operators, the 6500 underpins service, content, and cloud 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 ongoing efficiency, scalability, and programmability required for a more adaptive network.

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)

6500-R4:

4U 177mm (H) x 440mm (W) x 593mm (D)
4U 6.97in (H) x 17.33in (W) x 23.35in (D)

Capacity

Packet/OTN: 12 Tb/s
System: Up to 30.4 Tb/s
WDM: 2.5G to 400G DWDM
Packet/OTN XC: 600G to 12T

Photonics

Full suite of passive filters, 50GHz, 75GHz,
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 FC3200
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 400G muxponder (4x100G) with
integrated OPS (Optical Protection Switch)
Coherent 400G flexible service transponder
(34 client ports) with integrated OPS (Optical
Protection Switch)
Coherent 100GE/OTU4 transponder
Coherent 100G muxponder (10x10G)
Coherent tunability from 100G to 400G in 50G
increments
Coherent 200G client card: 2x100GE or
5x40GE/10GE
Coherent 100G client cards: 10x10GE, 10x10G
multi-rate, 2x40G+2x10G, 100GbE/OTU4 client
FIPS-certified AES-256 wire-speed coherent
100G/200G encryption solution
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
10x10G PKT/OTN
1x100G + 2x40G PKT/OTN
100G DWDM PKT/OTN
16x2.7G OTN
48xGbE

Intelligent Control Plane

Photonic, OTN

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)
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

Certifications

Common Criteria Network Device Collaborative
Protection Profile
FIPS 140-2 Level 2 and 3
FIPS 197 AES-256
BSI (German Federal Office of Information
Security)
IBM GDPS
SAN environments: Dell/EMC, Brocade and Cisco
switches

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

* Extended temperature uncontrolled OSP Class 2 GR-3108-
CORE variant also available.

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