

# 6500 Packet-Optical Platform

Enabling a Programmable Infrastructure Foundation for the Adaptive Network



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 to 400GbE—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 800G, 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.

## 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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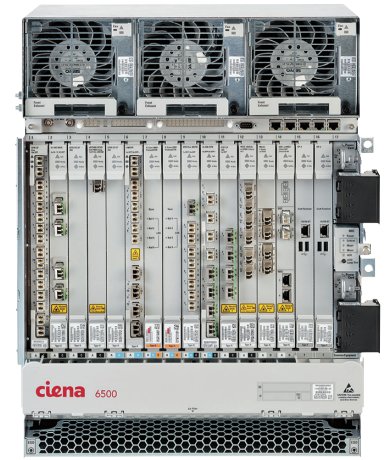


Figure 1. 6500-S14 100G ROADM configuration

## 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

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 ROADMs 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 ROADMs 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 800G 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.

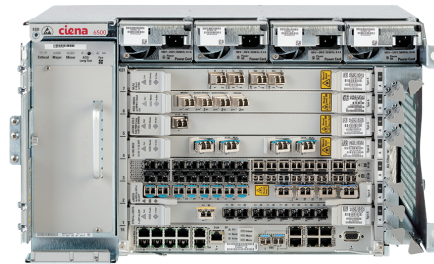


Figure 3. 6500-D7 ROADMs configuration

Ciena's WaveLogic 3 coherent optical processors are optimized for 50GHz systems and enable 100G to 200G 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). WaveLogic Ai, the fourth generation of Ciena's industry-leading coherent technology, provides unprecedented systems intelligence and programmability to address the increasingly dynamic service requirements of today's on-demand networks. It 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 and three times the distance at equivalent capacity compared to 100G/200G solutions.

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 a wide range of tunable capacities, 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 sparing 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.

Ciena's latest generation of coherent technology, WaveLogic 5, brings single-wavelength 800G and new levels of performance and efficiency to the industry for the first time, as well as footprint-optimized solutions to extend the WaveLogic benefits to new, innovative applications. With WaveLogic 5 Extreme, operators can optimize capacity across any path with unmatched programmable capacity from 200G to 800G in 50G increments, with selectable baud options up to 95Gbaud, enabling 50 percent more capacity per wavelength and up to 20 percent higher spectral efficiency over competing solutions. It provides operators the ability to evolve to 400G-interface routers with efficient 400GbE client connect across any distance—from across the metro to across the Pacific. 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.

With WaveLogic 5 Nano, operators can address the expanded market of footprint-optimized coherent 100G-400G applications with the ability to support a range of solutions that meet specific space, power, and operational requirements—from extended-temperature, standards-based optical modules for access applications to compact coherent optics with seamless photonic layer integration for metro/ regional networks. WaveLogic 5 Nano operates at multiple bauds, can support rates of 100G to 400G, and implements multiple FEC schemes to enable interoperability for a range of rates and line formats. Operators can leverage these benefits across 6500 hardware that supports compact WaveLogic 5 Nano 100G/200G CFP2-DCO pluggables.

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

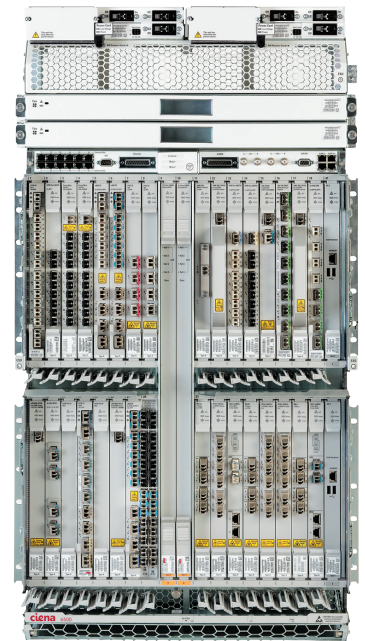
As part of Ciena's multi-layer security approach that ensures the confidentiality, integrity, and availability of data in the network, the 6500 offers advanced integrated AES-256 encryption capabilities providing operators a simple way to safeguard all their in-flight data against breaches. Meeting the 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.

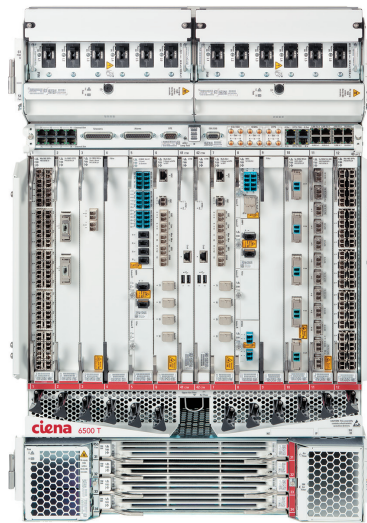


Figure 5. 6500-T12 Packet/OTN switching configuration

[Learn more about the 6500 PTS](#)



Another important benefit of LO 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.

### **Software control of multi-layer lifecycle operations with MCP**

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 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 88 mm (H) x 443 mm (W) x 280 mm (D)  
2U 3.5 in. (H) x 17.4 in. (W) x 11.0 in. (D)

#### 6500-D7:

6U 266 mm (H) x 443 mm (W) x 280 mm (D)  
6U 10.5 in. (H) x 17.4 in. (W) x 11.0 in. (D)

#### 6500-S8:

7U 310 mm (H) x 443 mm (W) x 280 mm (D)  
7U 12.2 in. (H) x 17.4 in. (W) x 11.0 in. (D)

#### 6500-D14/S14:

13U 577 mm (H) x 443 mm (W) x 280 mm (D)  
13U 22.7 in. (H) x 17.4 in. (W) x 11.0 in. (D)

#### 6500-S32:

22U 977 mm (H) x 498 mm (W) 280 mm (D)  
22U 38.5 in. (H) x 19.6 in. (W) x 11.0 in (D)

#### 6500-T12:

17U 754 mm (H) x 498.0 mm (W) x 433 mm (D)  
17U 29.7 in. (H) x 19.6 in. (W) x 17.0 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-R2:

2U 88 mm (H) x 440 mm (W) x 593 mm (D)  
2U 3.5 in. (H) x 17.33 in. (W) x 23.35 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 38.4 Tb/s

WDM: 2.5G to 800G 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 (and FICON equivalents)

SONET/SDH: OC-3/STM-1 through

OC-768/STM-256

Electrical: DS1, E1, DS3, E3, STM-1e

ESCON

DVB-ASI

10G CE LR

ISC3

### Transponders/Muxponders

Coherent 800G muxponder (4x100GbE + 1x400GbE, 8x100GbE)

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 2x100G CFP2 OTN Flex MOTR (36 client ports)

Coherent 100GbE/OTU4 transponder

Coherent 100G muxponder (10x10G)

Coherent tunability from 100G to 800G in 50G increments

Coherent 200G client card: 2x100GbE or 5x40GbE/10GbE

Coherent 100G client cards: 10x10GbE, 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

500G 2xUSS/2xQSFP28 PKT/OTN

- 400G WaveLogic Ai USSM

- 12x 10G USSM

- 5x 40G/100G USSM

40x10G PKT/OTN

5x100G/12x40G PKT/OTN

5x100G DWDM PKT/OTN

10x10G PKT/OTN

1x100G CFP2 + 2x40G PKT/OTN

1x100G QSFP28 + 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)

ASNC

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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Get answers to your questions

