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IBM z Systems Qualified DWDM Ciena 6500 Packet-Optical Platform Release 10.21

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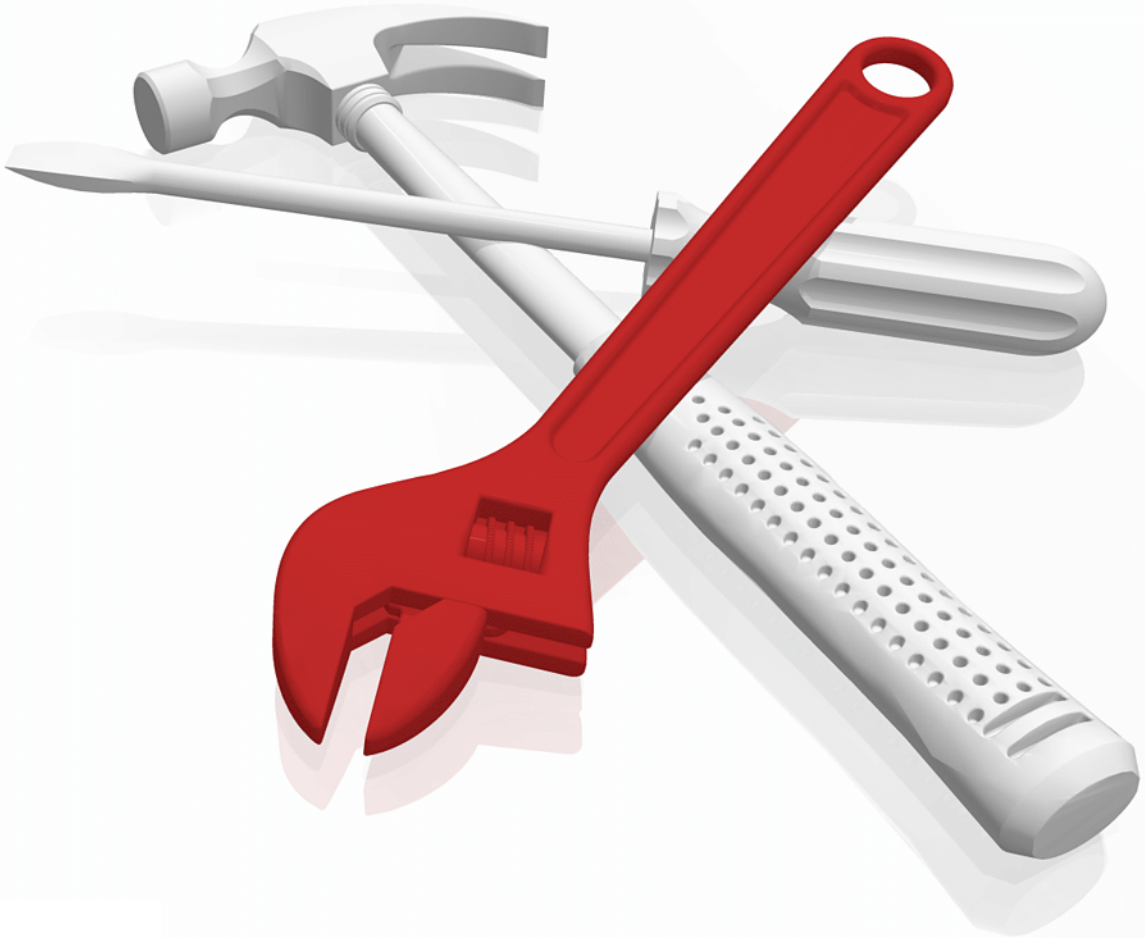

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Redpaper

IBM z Systems Qualified DWDM Ciena 6500 Packet-Optical Platform Release 10.21

This IBM® Redpaper™ publication is one in a series that describes IBM z Systems® qualified dense wavelength division multiplexing (DWDM) vendor products for IBM Geographically Dispersed Parallel Sysplex™ (IBM GDPS®) solutions with Server Time Protocol (STP). The protocols that are described in this paper are used for IBM supported solutions that require cross-site connectivity of a multisite Parallel Sysplex or remote copy technologies, which can include GDPS and non GDPS applications. GDPS qualification testing is conducted at the IBM Vendor Solutions Connectivity (VSC) Lab in Poughkeepsie, NY.

IBM and Ciena completed qualification testing of the Ciena 6500 Packet-Optical Packet-Optical platform. This paper describes the applicable environments, protocols, and topologies that are qualified for and supported by z Systems for connecting through the Ciena 6500 Packet-Optical platform hardware and software, release level 10.21.

This paper is intended for anyone who wants to learn more about Ciena 6500 Packet-Optical release level 10.21. This document is not meant to determine qualified products. To ensure that the planned products to be implemented are qualified, registered users can see the IBM Resource Link® library at this website for current information about qualified DWDM vendor products.

For more information about IBM Redbooks® publications for z Systems qualified DWDM vendor products, see the IBM Redbooks website.

z Systems GDPS qualification overview

GDPS is an enterprise-wide continuous availability (CA) and disaster recovery (DR) automation solution that can manage recovery from planned and unplanned outages across distributed servers and z Systems servers. GDPS can be configured in either a single site or in a multisite configuration. It is designed to manage remote copy configuration between storage subsystems, automate Parallel Sysplex operational tasks, and affect failure recovery. This configuration is done from a single point-of-control, which leads to improved application availability. Historically, this solution was known as a GDPS. Today, GDPS continues to be applied as a general term for a suite of business continuity solutions. This term includes solutions that do not require a dispersed or multisite sysplex environment.

GDPS supports the following forms of remote copy in multisite solutions:

- IBM System Storage® Metro Mirror, a synchronous form of remote copy that was previously known as *Peer-to-Peer Remote Copy* (PPRC)
- IBM System Storage Global Mirror, an asynchronous form of remote copy for z Systems and distributed systems
- IBM System Storage z/OS® Global Mirror, an asynchronous form of remote copy for z Systems, previously known as *Extended Remote Copy* (XRC)

Depending on the form of the remote copy that is implemented, the GDPS solution is known as one of these configurations:

- GDPS with Metro Mirror
- GDPS with Global Mirror
- GDPS with z/OS Global Mirror

GDPS also offers two solutions that combine the technologies of Metro Mirror with either Global Mirror or z/OS Global Mirror. This combination allows clients to meet requirements for CA with zero data loss locally within metropolitan distances (for most failures). The combination also provides a DR solution in the case of a region-wide disaster.

The DR solutions include the following options:

- GDPS with Metro and Global Mirror (GDPS and MGM), which is a cascading data replication solution for both z Systems and distributed systems data
- GDPS with Metro and z/OS Global Mirror (GDPS with MzGM), which is a multitarget data replication solution for z Systems data

The GDPS solution is also independent of the disk vendor, if the vendor meets the specific levels of Metro Mirror, Global Mirror, and z/OS Global Mirror architectures.

For more information about GDPS, see the IBM GDPS website.

IBM supports DWDM products that are qualified by z Systems for use in GDPS solutions. To obtain this qualification, DWDM vendors obtain licensed IBM patents, intellectual property, and know-how that are related to the GDPS architecture. This licensing provides vendors access to the proprietary IBM protocols and applications that are used in a GDPS environment. These proprietary items include InterSystem Channel (ISC), STP, Metro Mirror, Global Mirror, and z/OS Global Mirror.

Licensing of IBM patents also provides the DWDM vendor with technical information that pertains to future IBM releases. Qualified vendors typically license this information for an extended period. This license allows them to subscribe to the latest GDPS architecture changes and to be among the first to the market with offerings that support these features.

Licensing: Check with your DWDM vendor for current IBM technology and patent licensing status.

In addition, IBM tested and qualified these vendor products with the same test environment and procedures that were used to test the protocols that provide the required connectivity of a GDPS configuration. This testing included function and recovery verification. Having access to these test facilities allows IBM to configure a fully functional sysplex. By using the test facilities, you can simulate failure and recovery actions that cannot be tested as part of a working client environment.

IBM has the facilities to test and qualify these products with both current and previous generation equipment within the VSC Lab. With this qualification testing, IBM can reproduce any situations that might arise when using this equipment in a client application.

Figure 1 shows the test environment that is used for DWDM vendor qualification and the logical connections for IBM System Storage Metro Mirror and Global Mirror.

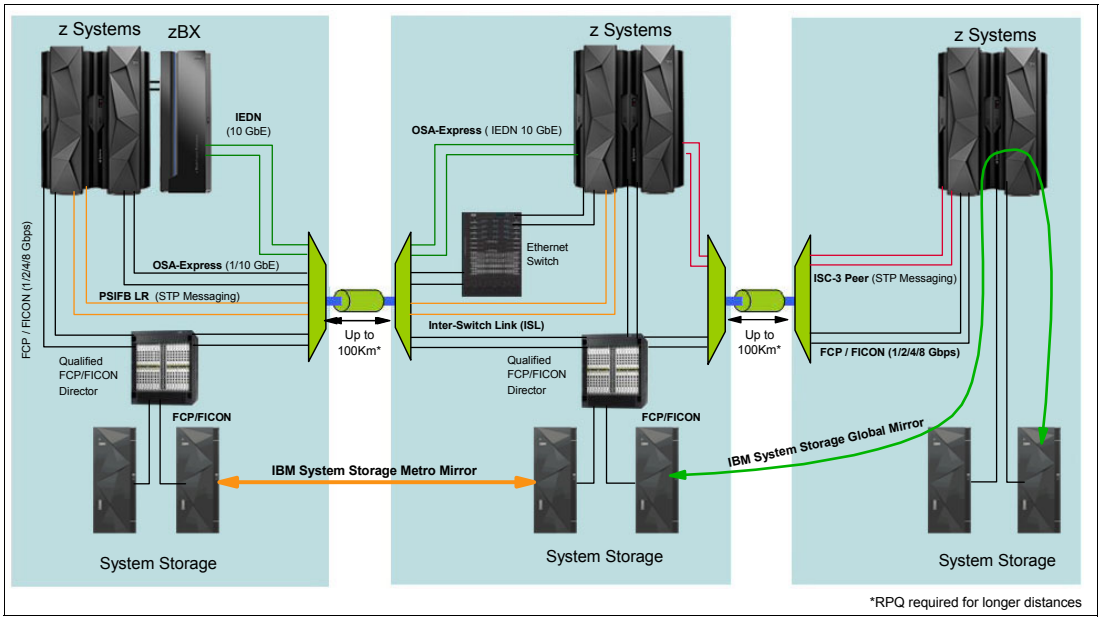

Figure 1 VSC Lab environment

Qualification testing

The VSC Lab contains z Systems hardware with software applications that test the interoperability of DWDM products within a GDPS. A typical qualification test cycle is six to eight weeks.

The hardware that is used for testing purposes includes, but is not limited to, the following components:

- z Systems servers that are enabled for STP
- IBM System Storage
- z Systems qualified Fibre Connection (IBM FICON®) Directors
- IBM Ethernet products
- IBM zEnterprise® BladeCenter Extension (10-Gigabit Ethernet)

DWDM links of varying distances are deployed by using spools of single-mode fiber in lengths of 5 - 50 km (3.11 - 31.07 miles). Multiple spools are interconnected to test DWDM link protocols up to the maximum supported distances. To achieve the maximum distances that are qualified for GDPS protocols, vendors can use optical amplifiers (OAs) and dispersion compensation units (DCUs). They can insert the OAs and DCUs, at various link points, to condition the signals on the fiber links. These links are connected to the DWDM equipment.

Qualified DCUs: Fiber-based DCUs are not qualified for use in STP applications unless stated in the qualification letter.

The operating system and application software are installed to create and to stress test the GDPS environment. The software that is used in the test environment includes, but is not limited to, the following components:

- z/OS, Linux on z Systems, and Parallel Sysplex software exploiters
- Coupling Facility Control Code (CFCC)
- IBM proprietary software and microcode utility test suites

As part of the GDPS qualification test, IBM proprietary software and microcode utility test suites are used. The software and test suites drive the various GDPS components and protocols to the full data rate of each link type that is transported by the DWDM equipment. This level of testing ensures that the maximum channel utilization is achieved and tested to levels well beyond typical client environments.

The test suites are used for verification of z Systems architecture functions. For a trial to be classified as successful during these function tests, no errors can be detected by the attached subsystems. Any errors that are detected during this testing are captured and analyzed by the test suites.

The test suites are also used for verification of z Systems architecture recovery by creating various fault and error conditions. The recovery tests check for the correct detection of a fault or error condition by the attached subsystems, and ensure that the recovery adheres to z Systems architecture rules.

Some of the recovery tests that are conducted for each link type include the following actions:

- Link state change interrupt detection and recovery: Links are deliberately broken and reestablished to ensure that detection and error recovery occur correctly.
- Link error threshold and link synchronization error detection and recovery: Errors are deliberately injected, at the application and channel subsystem levels, into the link protocol data streams to ensure that detection and error recovery take place correctly.
- Link service and maintenance package recovery: Link hardware maintenance actions are conducted to ensure that link state change detection and recovery take place correctly.

- Link protection schemes and recovery: Vendor-specific protection methods are tested to ensure that the expected link errors are detected and that recovery takes place correctly.
- STP timing link recovery: STP timing links are broken to ensure that changes to the Coordinated Timing Network (CTN) behave correctly when the break occurs and when the links are reconnected.

GDPS components and protocols

The IBM technologies that are featured in this section are functional components of GDPS and are tested during the qualification process. Clients can also use these components in environments that do not require a full GDPS solution. The testing provides a level of assurance that the components function when used with a qualified DWDM platform.

Components

The following GDPS components are tested during the qualification process:

- z Systems servers
- IBM Parallel Sysplex
- IBM System Storage
- IBM System Storage Metro Mirror (PPRC)
- IBM System Storage Global Mirror
- IBM System Storage z/OS Global Mirror (XRC)
- Vendor DWDM platform
- IBM Ethernet products
- IBM zEnterprise BladeCenter Extension (zBX)
- Inter-switch links (ISLs) between two z Systems qualified FICON/Fibre Channel Directors

Protocols

Table 1 lists the GDPS connectivity protocols and their data transfer rates. Not all protocols were tested on the Ciena 6500 Packet-Optical platform. For a complete list of the protocols and interface cards that were qualified, see Table 2 on page 15.

Table 1 GDPS supported protocols

Protocol	Data transfer rate
Enterprise Systems Connection (IBM ESCON)[a]	200 Mbps[b]
Fibre Connection (FICON)	1 Gbps
Fibre Connection (FICON) Express2	1, 2 Gbps
Fibre Connection (FICON) Express4	1, 2, or 4 Gbps
Fibre Connection (FICON) Express8	2, 4, or 8 Gbps
Fibre Channel FC100/ FC200/ FC400/ FC800	1, 2, 4, or 8 Gbps
Inter-Switch Link (ISL) FC100/ FC200/ FC400/ FC800/ FC1000/ FC1600	1, 2, 4, 8, 10, or 16 Gbps
InterSystem Channel-3 (ISC-3) Peer Mode[c]	2 Gbps
STP (ISC-3 Peer Mode with STP message passing)[c]	2 Gbps

Protocol	Data transfer rate
STP (Parallel Sysplex InfiniBand Long Reach (PSIFB LR) 1x IB-single data rate (SDR) with STP message passing)	2.5 Gbps
STP (PSIFB LR 1x IB-double data rate (DDR) with STP message passing)	5 Gbps
Gigabit Ethernet (GbE)	1, 10 Gbps

a. ESCON is not supported on IBM z13®, IBM z13s™, IBM zEC12, and IBM zBC12 servers.
b. The effective channel data rate of an ESCON channel is affected by distance.
c. The zEC12 and zBC12 are the last servers to support ISC-3.

Often, these supported protocols are also used in environments that are not GDPS. Robust testing is conducted during the qualification process. The results must provide clients with a high level of confidence when using these z Systems qualified DWDM vendor platforms in environments that are not GDPS.

Server Time Protocol

STP is designed to allow multiple servers and coupling facilities (CFs) to maintain time synchronization with each other.

STP is a message-based protocol in which STP timekeeping information is passed over externally defined coupling links: ISC-3 Peer Mode and PSIFB links. ISC-3 links in peer mode and PSIFB Long Reach (LR) are the only coupling links that can be used to transport STP messages between data centers over a DWDM platform.

The STP design introduced a concept that is called CTN, which is a collection of servers and CFs that are time-synchronized to a time value called Coordinated Server Time (CST). The CST represents the time for the entire network of servers. A CTN can be configured as either an STP-only CTN or a Mixed[1] CTN. For more information, see the following resources:

- *Server Time Protocol Planning Guide*, SG24-7280
- *Server Time Protocol Implementation Guide*, SG24-7281
- *Server Time Protocol Recovery Guide*, SG24-7380

[1] z13 and z13s are not supported in a Mixed CTN (STP-only CTN).

Figure 2 shows a multisite STP-only CTN.

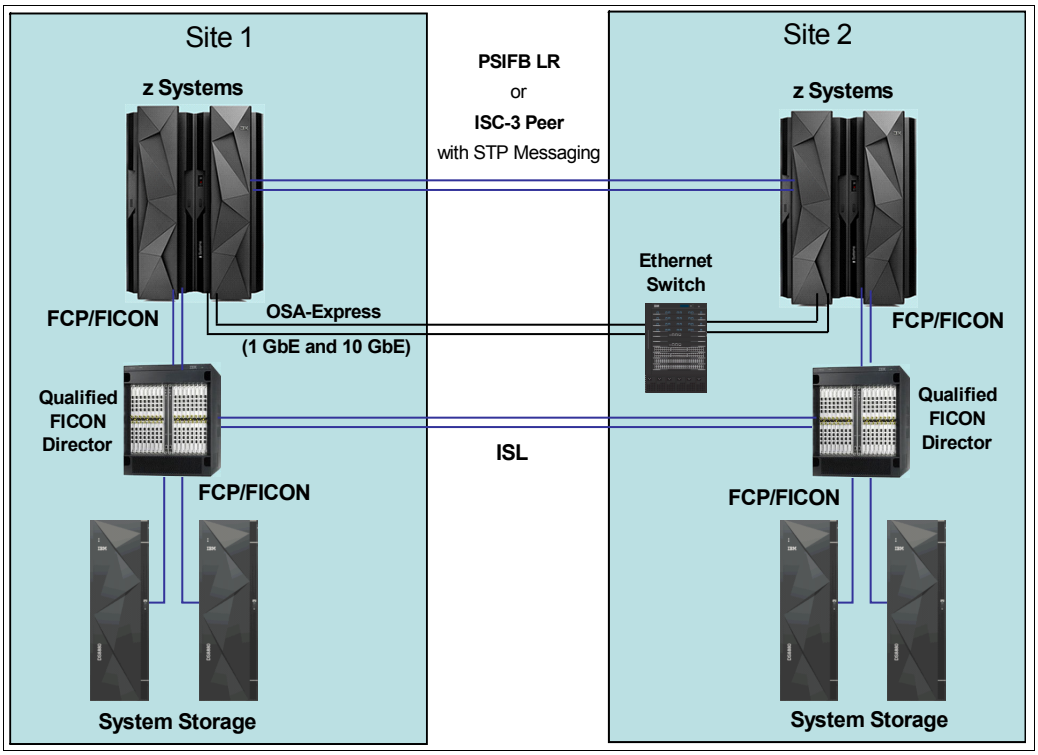

Figure 2 Multisite STP-only CTN

IBM zEnterprise BladeCenter Extension

The zBX is available as an option with the z Systems platform. The zBX brings the computing capacity of systems in blade form-factor to the z Systems platform and provides several distributed environments, such as IBM AIX® on POWER7®, Linux on System x, and Microsoft Windows on System x.

The zBX is designed with a redundant hardware infrastructure that supports the multi-platform environment in a seamless, integrated way. Its hardware features are part of the mainframe, not add-ons.

The zBX and the z Systems platform are interconnected through a high-speed private network that is called an *intraensemble data network* (IEDN), which consists of top-of-rack 10 GbE switches in the zBX and OSA-Express 10 GbE features in the z Systems platform. The IEDN provides private and secure data paths between all elements of a z Systems ensemble. A z Systems ensemble is a collection of highly virtualized diverse systems that can be managed as a single logical entity, and where diverse workloads can be deployed. It is composed of up to eight z Systems nodes, each of which consists of a z Systems platform and an optional zBX (see Figure 3).

Note: With zBX Model 004, the direct management connection with a z Systems server has been eliminated. There are two 1u Support Elements that are installed in the zBX that connect to the ensemble Hardware Management Console (HMC). An inter-node management network (INMN) connection is not required. The zBX still accesses data through the IEDN and the IEDN can be attached to only one server.

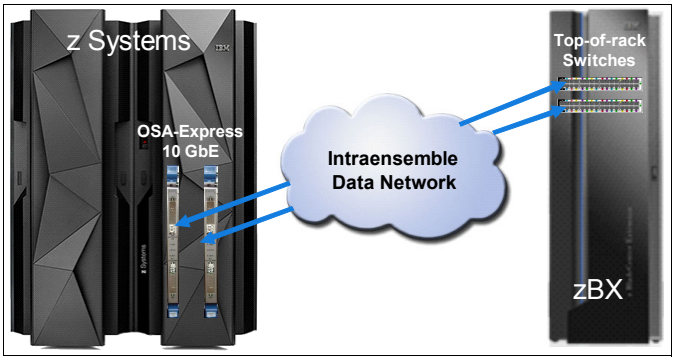

Figure 3 z Systems node

GDPS/PPRC and GDPS/GM support zBX hardware components, providing workload failover for automated multi-site recovery. These capabilities can help facilitate the management of planned and unplanned outages across the z Systems platform.

For more information about the zBX, see *Building an Ensemble Using IBM zEnterprise Unified Resource Manager,* SG24-7921.

IBM 10 Gigabit Ethernet (10GbE) RoCE Express

The 10GbE RoCE Express feature uses Remote Direct Memory Access over Converged Ethernet (RoCE) and is designed to provide fast memory-to-memory communications between two z Systems platforms.

Use of the 10GbE RoCE Express feature helps reduce consumption of CPU resources for applications by using the TCP/IP stack, and might also help to reduce network latency with memory-to-memory transfers by using Shared Memory Communications over Remote Direct Memory Access (SMC-R).

SMC-R uses a TCP connection to determine the eligibility to use the RoCE fabric and then to build a point-to-point SMC-R link for the data flow over the RDMA connection path. TCP/IP is used to establish the TCP/IP and RDMA connections and Keepalive functions, and terminate the TCP and the associated RDMA connections. The standard TCP/IP path over an OSA-Express port does not need to be dedicated to RDMA usage. It can be used simultaneously for other, non-RDMA traffic.

The OSA-Express port and the 10GbE RoCE Express port can be attached to a 10 Gigabit Ethernet switch[2] or they can both have a point-to-point connection (see Figure 4).

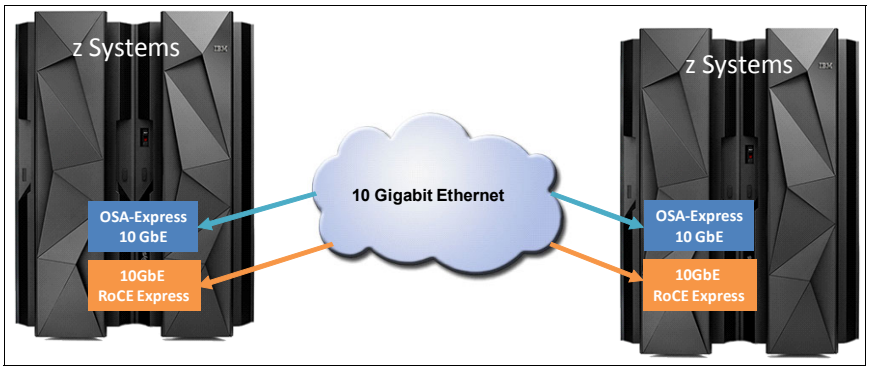

Figure 4 RoCE in a two-site configuration by using DWDM

The 10GbE RoCE Express feature uses an SR laser as the optical transceiver and supports the use of a multimode fiber optic cable that terminates with an LC Duplex connector.

If the IBM 10GbE RoCE Express features are connected to 10 GbE switches, the switches must support the following requirements:

- Global Pause function enabled
- Priority Flow Control (PFC) disabled
- No firewalls or routing

Note: The 10GbE RoCE Express feature is supported only on the z13, z13s, zEC12, and zBC12 systems.

For more information about the 10GbE RoCE Express feature, see *IBM z Systems Connectivity Handbook*, SG24-5444.

Connectivity considerations with DWDM

When planning DWDM intersite connectivity for GDPS environments, consider the following items:

- *Differential delay* is the difference in the distance or latency between a transmit fiber and a receive fiber in a single fiber pair of a timing link.

  When configuring, adhere to the following requirements:

  – To ensure correct server time synchronization, examine the end-to-end lengths of the transmit and receive fibers within an individual STP link (ISC-3 Peer Mode with STP messaging or PSIFB). The lengths must not exceed the equivalent of *900 meters* differential delay between the transmit and receive paths of the link. This stipulation includes all DWDM components, OAs, DCUs,[3] dark fiber links, and any time-division multiplexing (TDM)-based aggregation.

  Supported devices: DCUs can contain significant lengths of fiber that must be included in the differential delay calculation for timing links. Not all DCUs are supported. Always check the qualification letters for supported devices.

[2] The current implementation of the SMC-R requires TCP/IP connectivity in the same subnet.
[3] Fiber-based DCUs are not qualified for use in STP applications unless stated in the qualification letter.

- If both the CF data and STP timing information must be transmitted between two servers, you cannot select a subset of coupling links to be used just for STP timing information.
- Protection schemes, for individual timing links or for fiber trunks that transport timing links, must be bidirectional (switch both transmit and receive paths during a failure). This configuration ensures that the correct differential delay is maintained.
- DWDM configurations must have high availability topologies in place to ensure that there are no single points of failure.
- Fiber trunk protection schemes must be designed with two trunk-switching modules and four site-to-site fiber pairs that are carried over at least two diverse routes. STP links must connect by using separate trunk-switching modules to ensure that a fiber trunk protection event does not interrupt all timing links simultaneously.
- TDM-based aggregation DWDM hardware can be used for STP links (ISC-3 Peer Mode or PSIFB LR with STP message passing) only if it is qualified for STP use.
- GDPS DWDM configuration must be a point-to-point fixed dark fiber network.

For more information about the STP recovery process, see the *Server Time Protocol Recovery Guide*, SG24-7380.

Technical description

The Ciena 6500 Packet-Optical platform is a scalable, high-speed fiber-optic data transport system. It consists of a modular chassis, which can be interconnected to form an optical network that supports International Telecommunications Union (ITU)-specific wavelengths. The wavelengths are multiplexed onto a single pair of fibers by using DWDM.

The optical network that connects the Ciena 6500 Packet-Optical can be configured in a two-site point-to-point, multisite ring, or meshed network.

Support note: IBM qualifies point-to-point topologies only for GDPS solutions. Other topologies might contain significant length variations of fiber that go beyond the differential delay limits for timing links and are therefore not supported.

Multiple client interfaces can be aggregated onto a single wavelength with the use of Muxponder interface cards.

The Ciena 6500 Packet-Optical platform was qualified by using software release level 10.21. It has a modular chassis that can house multiple optical interface cards, depending on the chassis. Multiple Ciena 6500 Packet-Optical chassis can be interconnected to support larger quantities of client interfaces.

Interface cards and modules

This section includes a detailed list of the Ciena 6500 Packet-Optical optical interface cards and modules that are qualified by z Systems GDPS testing.

The following optical interface cards and modules are qualified by z Systems GDPS testing:

- Transponder cards

  Transponder cards connect client equipment to the DWDM platform. The transponder card converts client optical signals to an ITU-compliant DWDM wavelength for transmission to the remote site.

  Ciena 6500 Packet-Optical Packet-Optical Transponder cards have pluggable client optical transceivers.

  The following Ciena 6500 Packet-Optical Transponder card types are qualified:

  - 2x10G Optical Transponder (OTR) with Strong Forward Error Correction (FEC) and FC800/FC1200.
  - 4x10G Optical Transponder (OTR) 4x XFP/ 4x SFP+.
  - 4X10G Optical Transponder (OTR) 4x XFP/4X SFP+ with Encryption.

- Muxponder cards

  The Ciena 6500 Packet-Optical supports the aggregation of client signals. Muxponder cards use TDM and or Optical Transport Network (OTN[4]) technologies to aggregate optical interfaces for transport over a single ITU-specific wavelength.

  Muxponder cards have pluggable client optical transceivers that support different client protocols and fiber types.

  The following Ciena 6500 Packet-Optical Muxponder card types are qualified:

  - eDC40G OCLD MetroHRSx with 4xOC-192/STM-64/10 GbE/OTU2/FC Mux OCI XFP.
  - eDC100G OCLD (Metro) with 10x10G Mux Multi-Protocol XFP.
  - 100G MOTR WL3n Basic C-Band 10x SFP+.
  - Flex MOTR 8x SFP, 2x XFP, 8 client, and 2-line port card.
  - OTN Flex MOTR 8x SFP, 1x XFP, 8 client, and 1-line port card.
  - SuperMux 24-Port I/O 1x XFP and 10x SFP, 24-port card.
  - SuperMux 10-Port SFP 10G DWDM, 10-port card.

- Optical Filter Modules

  The Optical Filter Modules are optical components that combine (multiplex) or separate (demultiplex) multiple optical signals onto a fiber link.

  The reconfigurable optical add-drop multiplexer (ROADM) allows adding or dropping of optical signals at the wavelengths layer without an optical-electrical-optical conversion in multiple directions in an optical cross-connect system.

  The Ciena 6500 Packet-Optical supports a series of optical filter modules that can multiplex or demultiplex signals onto a fiber pair or a single fiber for transmission between sites. Optical filter modules are used in a tiered arrangement to multiplex or demultiplex groups of client channels on a fiber link for transmission between sites.

[4] Optical Transport Network - ITU G.709

- Dispersion Compensation Unit

  The DCU provides compensation for chromatic dispersion fiber impairment, which causes signal degradation and limits the transmission distance:

  – The CN2110-T0-70P[5]: A DCU that is based on Fiber Bragg Gratings and is a qualified DCU type of the Ciena 6500 Packet-Optical Platform.

  – The fixed DCU modules from the Ciena 4200 Advanced Services Platform[5] can be used with the Ciena 6500 Packet-Optical Platform.

  Delay calculation for timing links: OAs and DCUs contain significant lengths of fiber, which must be included in the differential delay calculation for timing links.

- Protection Switch Module (PSM)

  The Ciena 6500 Packet-Optical Platform supports optically switched fiber protection for point-to-point DWDM links with the use of the PSM. The PSM protects site-to-site traffic from physical damage to a fiber or fiber pair by switching bidirectionally to a redundant fiber or fiber pair.

  The following Ciena 6500 Packet-Optical Platform PSM types are qualified:

  – Photonic Trunk Switch (PTS): Bidirectional optical splitter and switch module (qualified for use with STP).

  – Enhanced Trunk Switch (ETS): Optical splitter and switch module.

  – Optical Protection Switch (1x OPSM): In-skin optical splitter and switch module.

  Note: The ETS and 1x OPSM are not qualified for use with STP links.

Topologies and protection schemes

z Systems qualifies a two-site point-to-point DWDM network topology and protection against failures in site-to-site fiber links or failures in individual components within the DWDM network for GDPS.

GDPS is a high-availability solution that can use several protection schemes. Some restrictions apply for particular protocols, for example STP (ISC-3 Peer Mode and PSIFB LR) links.

Important: Protection schemes must ensure the correct differential delay for individual timing links. STP links must not exceed the equivalent of *900 meters* differential delay between the transmit and receive paths of the link.

[5] CN2110-T0-70P and the fixed DCUs from the Ciena 4200 Advanced Services Platform are qualified for STP.

Protection schemes

The Ciena 6500 Packet-Optical platform provides the following protection schemes:

- Unprotected

  An unprotected transponder or Muxponder card is connected to one client interface and to one site-to-site fiber link only. A failure of the transponder or Muxponder card or the site-to-site fiber link results in a loss of client communications.

- Client-based protection

  Client-based protection uses at least two client interfaces that are connected to the DWDM. These interfaces are arranged so that the transponder or Muxponder cards that connect the two sites are distributed over two diverse site-to-site fiber links. The client device is responsible for ensuring that a failure of a DWDM module or of a single site-to-site fiber link does not result in a total loss of client communications.

  GDPS timing links (STP) are qualified for use in a client-based protection scheme if they are using separate paths (routes).

  Diagram components: For simplicity, several of the components in the optical path are not shown in the diagrams in this section.

  Figure 5 shows a high-level view of the client-based protection scheme. In this case, a client device has two separate site-to-site connections: One through Card A and the other through Card B. Transponder card-based and Muxponder card-based schemes for the Ciena 6500 Packet-Optical are shown separately.

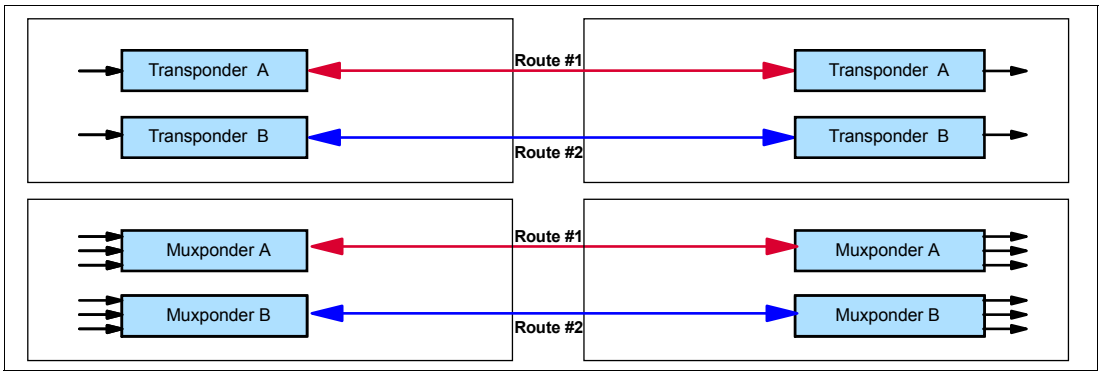

Figure 5 Client-based protection scheme

- Optically Switched Fiber protection

  The PSM provides protection at the site-to-site fiber level. It protects all wavelengths that are being carried on a fiber pair simultaneously. If a site-to-site fiber failure occurs, all traffic is switched bidirectionally to the backup link.

  The PSM is only available for point-to-point DWDM network topologies.

  Figure 6 shows a high-level view of the Optically Switched Fiber protection scheme.

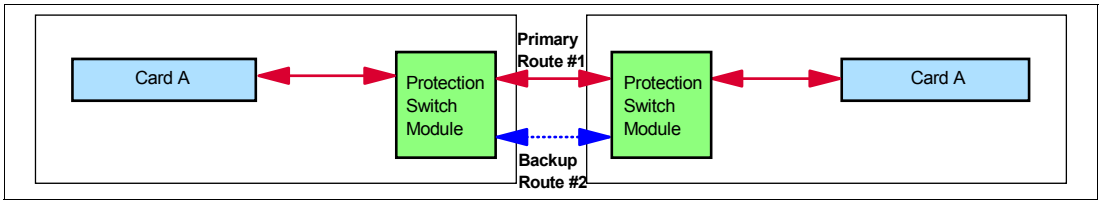

Figure 6 Optically Switched Fiber protection

- In-card line side protection

  Certain DWDM cards can support in-card line side protection. In-card line side protection uses two line-side ports for protection of a line side wavelength. If a site-to-site fiber failure occurs on the “working” line port, all traffic on the line side link is switched bi-directionally to the backup link.

  In-card Line Side Protection is available only for point-to-point DWDM network topologies. Figure 7 shows a high-level view of the in-card line side protection scheme.

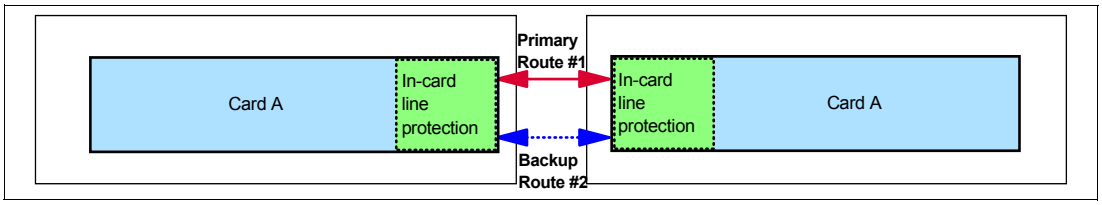

Figure 7 In-card 1+1 line protection

GDPS timing links (STP) are not qualified for use with a single PSM at each site. A single PSM-based, Optically Switched Fiber protection or in-card line protection schemes must not be used with GDPS or PPRC. Client-based protection scheme must be used for GDPS timing links.

If a GDPS or PPRC solution is to use Optically Switched Fiber protection, dual PSMs at each site with four site-to-site fiber pairs (trunks) are suggested. The GDPS timing links must connect by using separate cards and PSMs to ensure that cross site connectivity is not lost during a switch-over.

Figure 8 shows a high-level view of the dual Optically Switched Fiber protection scheme.

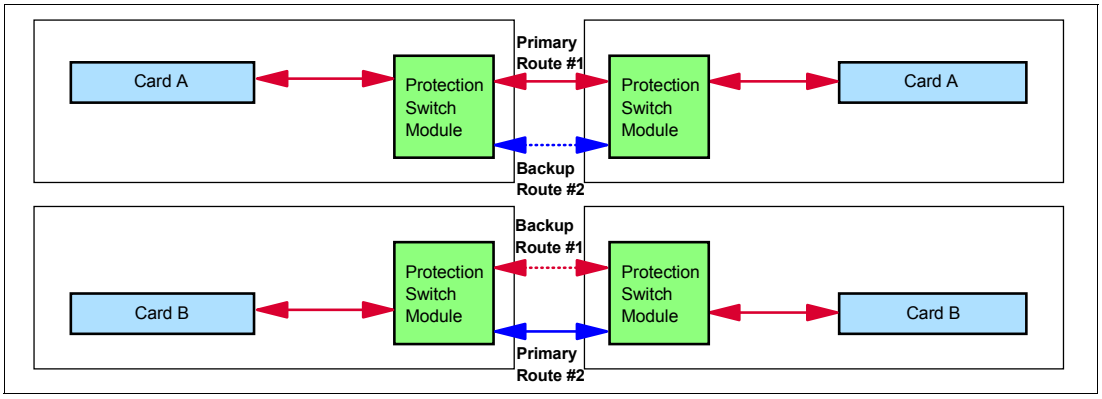

Figure 8 Dual Optically Switched Fiber protection

Protection scheme intermix

All protection schemes can be intermixed within the same Ciena 6500 Packet-Optical chassis or network on an individual client interface basis.

Interface card specifications

Table 2 on page 15 lists the specifications of the qualified Ciena 6500 Packet-Optical interface cards and tested protocols.

For particular extended distances, the use of OAs and DCUs might be required. For distance and link budget specifications, see the DWDM vendor documentation.

Table 2 Qualified client interface card details

Card type and protocol	Fiber type	Light source	Qualified distance[a,b]
SuperMux 10-Port SFP 10G DWDM, 10-port card[c]			
Fibre Channel (1, 2, or 4 Gbps)[d]	SM	1310 nm	100 km (62 miles)
Fibre Channel (1, 2, or 4 Gbps)[d]	MM	850 nm	100 km
FICON (1, 2, or 4 Gbps)[d]	SM	1310 nm	100 km
FICON (1, 2, or 4 Gbps)[d]	MM	850 nm	100 km
ISL (1, 2, or 4 Gbps)[e]	SM	1310 nm	100 km
ISL (1, 2, or 4 Gbps)[e]	MM	850 nm	100 km
Gigabit Ethernet (1 Gbps)	SM	1310 nm	100 km
Gigabit Ethernet (1 Gbps)	MM	850 nm	100 km
SuperMux 24-Port I/O 1x XFP and 10x SFP, 24-port card[c]			
Fibre Channel (1, 2, or 4 Gbps)[d]	SM	1310 nm	150 km (93 miles)
Fibre Channel (1, 2, or 4 Gbps)[d]	MM	850 nm	150 km
FICON (1, 2, or 4 Gbps)[d]	SM	1310 nm	150 km
FICON (1, 2, or 4 Gbps)[d]	MM	850 nm	150 km
ISL (1, 2, or 4 Gbps)[e]	SM	1310 nm	150 km
ISL (1, 2, or 4 Gbps)[e]	MM	850 nm	150 km
Gigabit Ethernet (1 Gbps)	SM	1310 nm	150 km
Gigabit Ethernet (1 Gbps)	MM	850 nm	150 km
Flex MOTR 8x SFP, 2x XFP, 8 client, and 2-line port card[c]			
Fibre Channel (1, 2, or 4 Gbps)	SM	1310 nm	150 km
Fibre Channel (1, 2, or 4 Gbps)	MM	850 nm	150 km
FICON (1, 2, or 4 Gbps)	SM	1310 nm	150 km
FICON (1, 2, or 4 Gbps)	MM	850 nm	150 km
ISL (1, 2, or 4 Gbps)[e]	SM	1310 nm	150 km
ISL (1, 2, or 4 Gbps)[e]	MM	850 nm	150 km
ISC-3 Peer Mode (2 Gbps)[f] with STP[g]	SM	1310 nm	150 km
Gigabit Ethernet (1 Gbps)	SM	1310 nm	150 km
Gigabit Ethernet (1 Gbps)	MM	850 nm	150 km
OTN Flex MOTR 8x SFP, 1x XFP, 8 client, and 1-line port card[c]			
Fibre Channel (1, 2, or 4 Gbps)[d]	SM	1310 nm	150 km
Fibre Channel (1, 2, or 4 Gbps)[d]	MM	850 nm	150 km
FICON (1, 2, or 4 Gbps)[d]	SM	1310 nm	150 km
FICON (1, 2, or 4 Gbps)[d]	MM	850 nm	150 km
ISL (1, 2, or 4 Gbps)[e]	SM	1310 nm	150 km
ISL (1, 2, or 4 Gbps)[e]	MM	850 nm	150 km
Gigabit Ethernet (1 Gbps)	SM	1310 nm	150 km
Gigabit Ethernet (1 Gbps)	MM	850 nm	150 km

Card type and protocol	Fiber type	Light source	Qualified distance[a,b]
2x10G Optical Transponder (OTR) with Strong FEC and FC800/FC1200[c]			
Fibre Channel (8 Gbps)	SM	1310 nm	150 km
Fibre Channel (8 Gbps)	MM	850 nm	150 km
FICON (8 Gbps)	SM	1310 nm	150 km
FICON (8 Gbps)	MM	850 nm	150 km
ISL (8, 10 Gbps)[e]	SM	1310 nm	150 km
ISL (8, 10 Gbps)[e]	MM	850 nm	150 km
PSIFB 1x IFB-DDR LR (5 Gbps)[f,h] with STP	SM	1310 nm	150 km
Gigabit Ethernet (10 Gbps)[i]	SM	1310 nm	150 km
Gigabit Ethernet (10 Gbps)[i,j]	MM	850 nm	150 km
4x10G Optical Transponder (OTR) 4x XFP/ 4x SFP+[c]			
Fibre Channel (4, 8 Gbps)	SM	1310 nm	150 km
Fibre Channel (4, 8 Gbps)	MM	850 nm	150 km
FICON (4, 8 Gbps)	SM	1310 nm	150 km
FICON (4, 8 Gbps)	MM	850 nm	150 km
ISL (4, 8, 10 Gbps)[e]	SM	1310 nm	150 km
ISL (4, 8, 10 Gbps)[e]	MM	850 nm	150 km
PSIFB 1x IFB-DDR LR (5 Gbps)[f,k] with STP	SM	1310 nm	150 km
ISC-3 Peer Mode (2 Gbps)[f] with STP[g]	SM	1310 nm	150 km
Gigabit Ethernet (10 Gbps)[i]	SM	1310 nm	150 km
Gigabit Ethernet (10 Gbps)[i,j]	MM	850 nm	150 km
4x10G Optical Transponder (OTR) 4x XFP/ 4x SFP+ with Encryption[c]			
Fibre Channel (4, 8 Gbps)	SM	1310 nm	150 km
Fibre Channel (4, 8 Gbps)	MM	850 nm	150 km
FICON (4, 8 Gbps)	SM	1310 nm	150 km
FICON (4, 8 Gbps)	MM	850 nm	150 km
ISL (4, 8, 10 Gbps)[e]	SM	1310 nm	150 km
ISL (4, 8, 10 Gbps)[e]	MM	850 nm	150 km
Gigabit Ethernet (10 Gbps)[i]	SM	1310 nm	150 km
Gigabit Ethernet (10 Gbps)[i,j]	MM	850 nm	150 km
eDC40G OCLD MetroHRSx with 4xOC-192/STM-64/10 GbE/OTU2/FC Mux OCI XFP[c]			
Fibre Channel (8 Gbps)	SM	1310 nm	150 km
Fibre Channel (8 Gbps)	MM	850 nm	150 km
FICON (8 Gbps)	SM	1310 nm	150 km
FICON (8 Gbps)	MM	850 nm	150 km
ISL (8, 10 Gbps)[e]	SM	1310 nm	150 km
ISL (8, 10 Gbps)[e]	MM	850 nm	150 km
Gigabit Ethernet (10 Gbps)[i]	SM	1310 nm	150 km

Card type and protocol	Fiber type	Light source	Qualified distance[a,b]
Gigabit Ethernet (10 Gbps)[i,j]	MM	850 nm	150 km
eDC100G OCLD (Metro) with 10x10G Mux Multi-Protocol XFP[c]			
Fibre Channel (8 Gbps)	SM	1310 nm	150 km
Fibre Channel (8 Gbps)	MM	850 nm	150 km
FICON (8 Gbps)	SM	1310 nm	150 km
FICON (8 Gbps)	MM	850 nm	150 km
ISL (8, 10 Gbps)[e]	SM	1310 nm	150 km
ISL (8, 10 Gbps)[e]	MM	850 nm	150 km
Gigabit Ethernet (10 Gbps)[i]	SM	1310 nm	150 km
Gigabit Ethernet (10 Gbps)[i,j]	MM	850 nm	150 km
100G MOTR WL3n Basic C-Band 10x SFP+[c]			
Fibre Channel (8 Gbps)	SM	1310 nm	150 km
Fibre Channel (8 Gbps)	MM	850 nm	150 km
FICON (8 Gbps)	SM	1310 nm	150 km
FICON (8 Gbps)	MM	850 nm	150 km
ISL (8, 10 Gbps)[e]	SM	1310 nm	150 km
ISL (8, 10 Gbps)[e]	MM	850 nm	150 km
Gigabit Ethernet (10 Gbps)[i]	SM	1310 nm	150 km
Gigabit Ethernet (10 Gbps)[i,j]	MM	850 nm	150 km
SM = Single-mode fiber (9/125 micron) MM = Multimode fiber (50/125 or 62.5/125 micron)			

a. The qualified distance is based on the VSC Lab test environment, which is a physical point-to-point topology without any intermediate nodes besides OAs and DCUs.
b. Requires a request for price quotation (RPQ) - 8P2340 (z196, z114), 8P2581 (zEC12), 8P2781(zBC12), 8P2981 (z13), or 8P2781 (z13s) for distances over 100 km.
c. The protocol and wavelength support depend on a pluggable client interface transceiver.
d. The Supermux 10 port and 24 port cards and the OTN Flex MOTR card are not supported for direct attachment to the IBM z Systems® FICON Express16s card. ISLs between Cascaded Directors/switches are required.
e. The protocol is configured as FCP on DWDM.
f. Multiple STP links can be supported on the same card.
g. ISC-3 without STP also is supported.
h. The 2x10G OTR card between two HCA3-O LR (4 port IBM z Systems PS-IFB) cards might cause PS-IFB ports to go into a disabled state in a link recovery scenario. A link recovery scenario can be caused by a fiber cut, hardware failure, or manual intervention. Customers might need to disable and re-enable the ports on both sides of the PS-IFB link by using the SE in “Service” in the “Advanced Facilities - Card Specific Advanced Facilities” to get the port back online. PS-IFB links were qualified over the 2x10G OTR in steady state operation.
i. The 10 GbE connection is also qualified with the IBM z Systems IEDN.
j. On this card, the 10 GbE connection is also qualified for RoCE by using SMC-R on the z13, z13s, zEC12, and zBC12 systems.
k. Tested also with in-card 1+1 line protection for PSIFB.

Qualified distances: For qualified ISL-supported distances, consult your storage area network (SAN) switch vendors.

References

For more information about z Systems connectivity, see the following resources:

- z Systems I/O connectivity home page

  http://www.ibm.com/systems/z/hardware/connectivity/index.html
- *IBM z Systems Connectivity Handbook*, SG24-5444

  http://www.redbooks.ibm.com/abstracts/sg245444.html?Open
- *FICON Planning and Implementation Guide*, SG24-6497

  http://www.redbooks.ibm.com/abstracts/sg246497.html?Open
- *Implementing and Managing InfiniBand Coupling Links on IBM System z*, SG24-7539

  http://www.redbooks.ibm.com/abstracts/sg247539.html?Open

For more information about GDPS, see the following resources:

- GDPS home page

  http://www.ibm.com/systems/z/advantages/gdps/index.html
- *IBM GDPS Family: An Introduction to Concepts and Capabilities*, SG24-6374

  http://www.redbooks.ibm.com/abstracts/sg246374.html?Open

For more information about STP, see the following resources:

- Parallel Sysplex home page:

  http://www.ibm.com/systems/z/advantages/pso/index.html
- *Server Time Protocol Planning Guide*, SG24-7280

  http://www.redbooks.ibm.com/abstracts/sg247280.html?Open
- *Server Time Protocol Implementation Guide*, SG24-7281

  http://www.redbooks.ibm.com/abstracts/sg247281.html?Open
- *Server Time Protocol Recovery Guide*, SG24-7380

  http://www.redbooks.ibm.com/abstracts/sg247380.html?Open

For current information about qualified DWDM vendor products, registered users can see the library at the IBM Resourcelink website:

https://www.ibm.com/servers/resourcelink/lib03020.nsf/pages/systemzQualifiedWdmProductsForGdpsSolutions?OpenDocument&pathID=

For current information about qualified vendor switches and directors for IBM z Systems FICON and FCP channels, registered users can see the library at the Resourcelink website:

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http://www.redbooks.ibm.com/cgi-bin/searchsite.cgi?query=qualified+AND+wdm&SearchOrder=1&SearchFuzzy=

For details about designing and managing an end-to-end extended distance connectivity architecture for z Systems, see *System z End-to-End Extended Distance Guide*, SG24-8047:

http://www.redbooks.ibm.com/abstracts/sg248047.html?Open

For more information about the Ciena 6500 Packet-Optical platform, see the following website:

http://www.ciena.com/products/6500/

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