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Redbooks Paper

Bill White
Pasquale Catalano
Rav Meerwald

IBM System z Qualified WDM: Adva FSP 2000 at Release Level 6.2

This IBM® Redpaper is one in a series describing System z™ qualified optical Wavelength Division Multiplexing (WDM) vendor products for GDPS® solutions with Server Time Protocol (STP). The products that we describe in this series are also the IBM supported solutions for non-GDPS applications. Non-GDPS applications include the protocols that are needed for cross-site connectivity of a multi-site Parallel Sysplex® or one of the remote copy technologies that we describe in this paper. GDPS qualification testing is carried out at the IBM Vendor Solutions Connectivity (VSC) Lab in Poughkeepsie, NY, U. S.

IBM and Adva Optical Networking have successfully completed qualification testing of the Adva Fiber Service Platform 2000 (FSP 2000). This paper describes the applicable environments, protocols, and topologies that are qualified and supported by System z for connecting to the Adva FSP 2000 product hardware and software at release level 6.2. This paper supersedes all previous versions.

At the time of publication, System z qualified WDM vendor products that support GDPS and STP include:

► Adva Fiber Service Platform 2000 (FSP 2000) DWDM system
► Ciena CN 4200 FlexSelect Advanced Services Platform
► Cisco ONS 15454 Multiservice Transport Platform (MSTP)
► Nortel Networks OPTera Metro 5200 Multiservice Platform

System z qualified WDM vendor products that support GDPS but have not been qualified for STP include:

► Ciena Online Metro Multiservice DWDM and CN2000 Storage Extension platform
► Cisco ONS 15530 DWDM and ONS 15540 ESPx (withdrawn from marketing)
► Lucent Technologies Metropolis Enhanced Optical Network (EON) System

For current information about qualified vendor products, visit the Resourcelink Web site:

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

System z GDPS qualification overview

GDPS, an industry-leading e-business continuity solution, is a multisite solution that is designed to provide the capability to manage remote copy configuration and storage subsystems, automate Parallel Sysplex operational tasks, and perform failure recovery from a single point of control, thereby improving application availability. Historically, this solution was known as a *Geographically Dispersed Parallel Sysplex™*. Today, GDPS continues to be applied as a general term for a suite of business continuity solutions, including those that do not require a dispersed or multi-site sysplex environment.

GDPS supports the following forms of remote copy:

► IBM System Storage™ Metro Mirror, synchronous Peer-to-Peer Remote Copy (PPRC)
► IBM System Storage Global Mirror
► IBM System Storage z/OS® Global Mirror, asynchronous Extended Remote Copy (XRC)

Depending on the form of remote copy implemented, the solution is referred to as *GDPS/PPRC*, *GDPS/Global Mirror*, or *GDPS/XRC*. The GDPS solution is also independent of disk vendor, as long as the vendor meets the specific levels of Metro Mirror, Global Mirror, and z/OS Global Mirror architectures. For more information about GDPS, visit the GDPS Web site:

http://www.ibm.com/systems/z/gdps/

IBM only supports WDM products that are qualified by System z for use in GDPS/PPRC, GDPS/Global Mirror, and GDPS/XRC two-site solutions, as well as in GDPS Metro/z/OS Global Mirror, and GDPS Metro/Global Mirror three-site solutions. To obtain this qualification, WDM vendors obtain licensed IBM patents, intellectual property, and know-how that are related to the GDPS architecture. This gives vendors access to the proprietary IBM protocols and applications used in a GDPS environment (including Sysplex Timer®, InterSystem Channel (ISC), Server Time Protocol (STP), Metro Mirror, Global Mirror, and z/OS Global Mirror).

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

> **Note:** We recommend that you check with your WDM vendor for current licensing status.

In addition, these vendor products have been tested and qualified by IBM with the same test environment and procedures used to test the protocols used to provide the required connectivity of a GDPS configuration. This testing includes functionality, recovery, and in some cases performance measurements. Having access to these test facilities allows IBM to configure a fully functional sysplex and to simulate failure and recovery actions that could not be tested as part of a working customer environment.

IBM has the facilities to test and qualify these products with both current and previous generation equipment within the IBM Vendor Solutions Connectivity (VSC) Lab in Poughkeepsie, NY, U. S. This qualification testing allows IBM to reproduce any concerns that might arise while using this equipment in a customer's application.

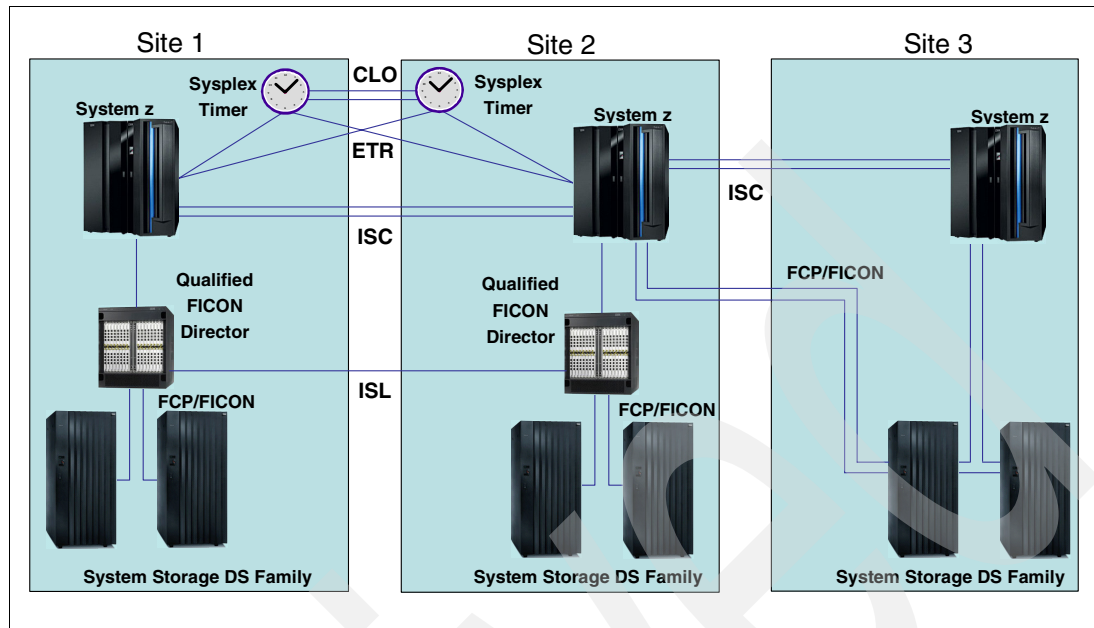Figure 1 shows one of the test configurations used for WDM vendor qualification.

Figure 1   IBM Vendor Solutions Connectivity Lab GDPS environment

Qualification testing

The VSC Lab contains System z hardware with software applications that test the interoperability of WDM products within a GDPS. A typical qualification test cycle is three to four weeks.

Hardware used for testing purposes includes (but is not limited to) the following components:

► IBM System z and zSeries® servers
► IBM 9037 Model 2 Sysplex Timers
► IBM System Storage DS™ Family
► IBM 9032 ESCON® Directors
► IBM System z qualified FICON® Directors

WDM links of varying distances are deployed using spools of single-mode fiber in lengths from 5 km to 50 km. Multiple spools are interconnected to test WDM link protocols up to the maximum supported distances. To achieve the maximum distances that are qualified for GDPS protocols, vendors can use optical amplifiers and dispersion compensation units, inserted at various link points, to condition the signals on the fiber links that are connected to the WDM equipment.

Operating system and application software is installed to create and to stress test the GDPS environment. Software used in the test environment includes (but is not limited to):

► z/OS, Linux® on System z, 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 drive the various GDPS components and protocols to the full data rate of each link type that is transported by the WDM equipment. This level of testing ensures maximum channel utilization is achieved and tested to levels well beyond typical customer environments.

The test suites are used for verification of System z architecture functionality. During these functionality tests, for a test to be classified as successful, zero errors are detected by the attached subsystems. Any errors detected during this testing are captured and analyzed by the test suites.

The test suites are also used for verification of System z 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 System z architecture rules.

Some of the recovery tests performed for each link type include:

► Link state change interrupt detection and recovery. Links are deliberately broken and re-established to ensure that detection and error recovery takes place 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 takes place correctly.

► Link service and maintenance package recovery. Link hardware maintenance actions are performed to ensure that link state change detection and recovery takes place correctly.

► Link protection schemes and recovery. Vendor-specific protection methods are tested to ensure that the expected link errors are detected, and recovery takes place correctly.

GDPS components and protocols

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

Components

The following GDPS components are tested during the qualification process:

► IBM Parallel Sysplex
► IBM System Storage DS Family
► Optical Wavelength Division Multiplexer (WDM)
► IBM System Storage Metro Mirror (PPRC), a synchronous form of remote copy
► IBM System Storage Global Mirror
► IBM System Storage z/OS Global Mirror (XRC), an asynchronous form of remote copy

Protocols

The following GDPS connectivity protocols are tested during the qualification process:

► Enterprise Systems Connection (ESCON)
► IBM Sysplex Timer (ETR/CLO)
► Fibre Connection (FICON) (1 Gbps)
► Fibre Connection (FICON) Express2 (1 Gbps and 2 Gbps)
► Fibre Connection (FICON) Express4 (1 Gbps, 2 Gbps, and 4 Gbps)
► Fibre Channel (FCP) (FC 100) (1 Gbps)
► Fibre Channel (FCP) (FC 200) (2 Gbps)
► Fibre Channel (FCP) (FC 400) (4 Gbps)
► Fibre Channel InterSwitch Links (ISL) (up to 10 Gbps)

- ► InterSystem Channel-3 (ISC-3) Compatibility Mode (1 Gbps)
- ► InterSystem Channel-3 (ISC-3) Peer Mode (2 Gbps)
- ► InterSystem Channel-3 (ISC-3) Peer Mode (1 Gbps) through RPQ 8P2197
- ► Server Time Protocol (ISC-3 Peer Mode with STP messaging)

Often, these tested protocols are used in non-GDPS environments as well. The robust testing performed during the qualification process should provide customers with a high level of confidence when using these System z qualified optical WDM vendor products in non-GDPS environments.

Table 1 lists the data transfer rates and supported distances for GDPS qualified protocols. For some extended distances, the use of optical amplifiers might be required.

Table 1   Qualified protocols and distances

Protocol	Data transfer rate	Supported Distance[a]
ESCON	200 Mbps[b]	100 km
CLO	8 Mbps	40 km
ETR	8 Mbps	100 km
FICON (1 Gbps)[c]	1 Gbps	100 km
FICON (2 Gbps)	2 Gbps	100 km
FICON (4 Gbps)	4 Gbps	100 km
Fibre Channel FC100 (1 Gbps)	1 Gbps	100 km
Fibre Channel FC200 (2 Gbps)	2 Gbps	100 km
Fibre Channel FC400 (4 Gbps)	4 Gbps	100 km
ISC-3 Compatibility Mode	1 Gbps	40 km
ISC-3 Peer Mode	2 Gbps	100 km
ISC-3 Peer Mode (1 Gbps)[d]	1 Gbps	100 km
STP (ISC-3 Peer)	2 Gbps	100 km
STP (ISC-3 Peer 1 Gbps)[d]	1 Gbps	100 km

a. Requires RPQ 8P2263 for System z Extended Distance or 8P2262 for S/390® Extended Distance, if the actual distance is greater than the supported distance.
b. Effective channel data rate of an ESCON channel is affected by distance.
c. Including FICON Bridge card.
d. Requires RPQ 8P2197. This RPQ provides an ISC-3 Daughter Card that clocks at 1.062 Gbps in peer mode.

Note: Consult your SAN switch vendors for qualified ISL supported distances.

Server Time Protocol

Server Time Protocol (STP) is designed to provide the capability for multiple servers and Coupling Facilities to maintain time synchronization with each other, without requiring an IBM Sysplex Timer. STP can help provide functional and economic benefits when compared to the Sysplex Timer. STP allows concurrent migration from an External Timer Reference (ETR) network, and can coexist with an ETR network.

STP is a message-based protocol in which STP timekeeping information is passed over externally defined coupling links: ICB-3, ICB-4, and InterSystem Channel-3 (ISC-3) Peer Mode. ISC-3 links in Peer mode is the only coupling link that can be used to transport STP messages between data centers over a WDM.

The STP design has introduced a new concept called Coordinated Timing Network (CTN). A CTN is a collection of servers and Coupling Facilities 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 CTN. For more information, refer to *Server Time Protocol Planning Guide*, SG24-7280 and *Server Time Protocol Implementation Guide*, SG24-7281.

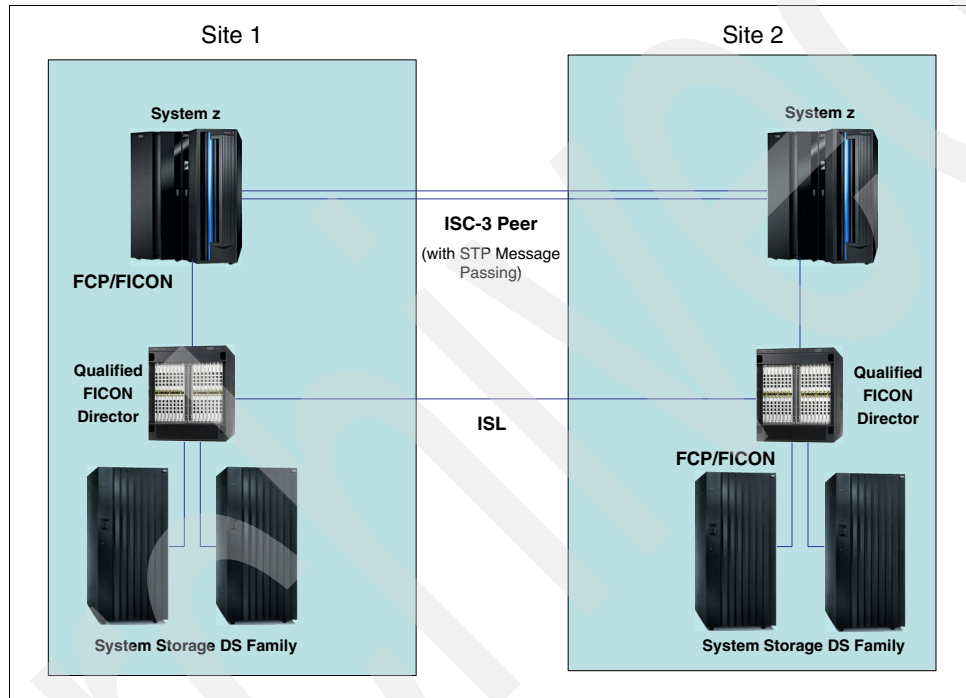Figure 2 shows a multisite STP-only CTN.

Figure 2   Multisite STP-only CTN

IBM Sysplex Timer

The IBM Sysplex Timer is a mandatory component of an ETR network and an STP Mixed CTN. The Sysplex Timer provides an External Time Reference (ETR) to synchronize the time of day (TOD) clocks on attached System z servers in a GDPS/PPRC environment.
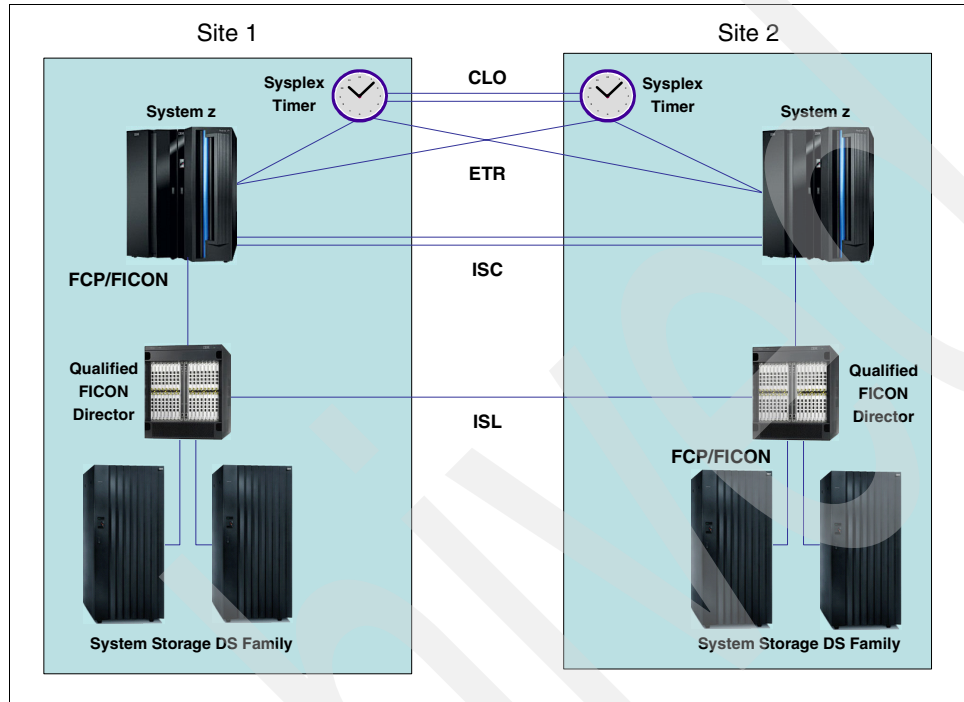
Figure 3 shows a multisite ETR network.

Figure 3   Multisite ETR network with Sysplex Timers

The Sysplex Timer uses two link types:

► External Time Reference (ETR)

ETR links are connections between the Sysplex Timer and the System z server ETR ports providing TOD clock sychronization between multiple servers.

► Control Link Oscillator (CLO)

CLO links are connections between two Sysplex Timer units in an Expanded Availability configuration allowing synchronization of the Sysplex Timer timing signals.

GDPS connectivity considerations with WDM

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

► Differential Delay, the difference in distance or latency between a transmit fiber and a receive fiber in a single fiber pair, of timing links must adhere to the following requirements:

  – To ensure correct server time synchronization, the end-to-end lengths of the transmit and receive fibers within an individual STP link (ISC-3 Peer Mode with STP messaging) must not exceed the equivalent of $900\ meters$ differential delay between transmit and receive paths of the link. This includes all DWDM components, optical amplifiers (OAs), dispersion compensation units (DCUs), dark fiber links, and any time division multiplexing (TDM) based aggregation.

– To ensure correct Sysplex Timer and server time synchronization, the end-to-end lengths of the transmit and receive fibers within an individual ETR or CLO link must be equal (within *10 meters*). This includes all DWDM components, optical amplifiers (OAs), dispersion compensation units (DCUs), dark fiber links.

> **Note:** OAs and DCUs contain significant lengths of fiber that must be included in the differential delay calculation for timing links.

► Protection schemes for individual timing links, or for fiber trunks transporting timing links, must be bidirectional to ensure the correct differential delay is maintained.

► WDM configurations should have high availability topologies to ensure that there are no single points of failure.

► Fiber trunk protection schemes should be designed with two trunk switching modules and four site-to-site fiber pairs carried over at least two diverse routes. STP, ETR, and CLO links should connect using different trunk switching modules to ensure that a fiber trunk protection event does not interrupt all timing links simultaneously.

► Unless specifically qualified by IBM GDPS testing, STP links (ISC-3 Peer Mode with STP messaging) should not be transported by TDM-based aggregation WDM hardware.

► GDPS WDM configurations should be a point-to-point fixed dark fiber network.

Technical description

The Adva Fiber Service Platform 2000 (FSP 2000) is a scalable, high-speed fiber-optic data transport system. It consists of multiple shelves that can be interconnected to form an optical network supporting up to 64 International Telecommunications Union (ITU) wavelengths. These ITU wavelengths are multiplexed onto a pair of fibers using optical wavelength division multiplexing (WDM). The Adva FSP 2000 also supports the use of a single fiber multiplexing solution.

The optical network connecting the shelves can be configured in a two site point-to-point or a multi-site ring network. A fully configured point-to-point network can consist of up to 64 ITU wavelengths (32 data channels) over a single fiber or up to 64 ITU wavelengths (64 data channels) over a fiber pair connected between data sites. Multiple client interfaces can be aggregated on to a single ITU wavelength with the use of time division multiplexing (TDM) based interface cards.

The System z qualified product in the Adva Fiber Service Platform series is Adva Fiber Service Platform 2000 (FSP 2000), Software Release 6.2. The Adva FSP 2000 is a rack mountable shelf capable of housing up to eight client optical interface cards. Multiple FSP 2000 shelves can be interconnected to support larger quantities of client interfaces.

Interface cards and modules

This section includes a detailed list of the Adva FSP 2000 optical interface cards and circuit packs qualified by System z GDPS testing.

Interface cards and circuit packs:

► WDM Channel Module

The WDM Channel Module (WCM) connects customer equipment to the WDM platform. The WCM converts client optical signals to an ITU compliant wavelength for transmission to the remote site. The WCMs qualified are based on DWDM ITU wavelengths.

The qualified DWDM based WCM types are:

– DWCM/LS-T-1310L, 8 Mbps to 200 Mbps, 1310 nm (1 port, fixed local interface)

– DWCM-PLR/ 2G5-MC2G, 100 Mbps to 2.5 Gbps, 850 nm or 1310 nm (1 port, pluggable local and remote interface)

– DWCM-PL/10G-MC10G, 10 Gbps, 850 nm or 1310 nm (1 port, pluggable local interface)

► TDM Channel Module (TCM)

The Time Division Multiplexing Channel Module (TCM) uses time division multiplexing (TDM) to aggregate multiple client optical interfaces for transport over a single ITU specific wavelength. The TCMs qualified are based on DWDM ITU wavelengths.

The qualified DWDM based TCM type is:

– D4TCM-PL/4G-MC4G, 1.062 Gbps to 4.250 Gbps, 850 nm or 1310 nm (4 port, pluggable local interface)

► Optical Filter Modules

Optical Filter Modules are passive optical components which combine (multiplex) or separate (demultiplex) multiple optical signals onto a fiber link. Optical filter modules are used in a tiered arrangement to multiplex or demultiplex groups of client channels on to a fiber link for transmission between sites. The Adva FSP 2000 supports a series of optical filter modules which can multiplex or demultiplex signals onto a fiber pair or a single fiber for transmission between sites.

► Remote Switch Module (RSM™)

The Adva FSP 2000 supports optically switched fiber protection for point-to-point DWDM links with use of the Remote Switch Module (RSM). The RSM protects site-to-site traffic from physical damage to a fiber or fiber pair, by switching bidirectionally to a redundant fiber or fiber pair.

Optical Line Monitoring (OLM) is a feature that gathers statistical information about the quality of the site-to-site fiber link, and allows long term and short term events to be monitored and alerted. OLM can be used to detect degradation or intrusions of the site-to-site fiber link, and instruct the RSM to switch to the alternative fiber link.

The qualified Protection Switch Modules card type is:

– RSM-OLM/1630, RSM with Optical Supervisor Channel and Optical Line Monitoring, dual fiber

► Erbium Doped Fiber Amplifiers (EDFAs)

Optical amplifier modules provide in-line optical amplification of multiple ITU specific wavelengths within a fiber. For some extended distances, the use of these erbium doped fiber amplifiers (EDFAs) might be required. EDFAs cannot be used to amplify CWDM signals.

The qualified Erbium Doped Fiber Amplifiers (EDFAs) modules are:

– EDFA-C-S10-GC, C-Band EDFA Pre Amplifier module
– EDFA-C-S15-GC, C-Band EDFA Mid-span Optical Amplifier module
– OPT/EDFA-XE200-C & OPT/EDFA-XT200, RAMAN extended distance amplifiers

Note: OFAs and DCUs contain significant lengths of fiber that must be included in the differential delay calculation for timing links.

Topologies and protection schemes

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

GDPS is a high availability solution that can use several protection schemes. Some restrictions apply for particular protocols, for example, Sysplex Timer (ETR/CLO) and STP (ISC-3 Peer Mode with STP messaging) links.

Important: Protection schemes must guarantee the correct differential delay for individual timing links.

► STP links must not exceed the equivalent of 900 meters differential delay between transmit and receive paths of the link.

► ETR and CLO links must not exceed the equivalent of 10 meters differential delay between transmit and receive paths of the link.

Protection schemes

The Adva FSP 2000 provides the following protection schemes:

► Unprotected

An *unprotected* Channel Module (TCM or WCM) is connected to one client interface and to one site-to-site fiber link only. A failure of the Channel Module or the site-to-site fiber link will result in a loss of client communications.

► Client-based protection

Client-based protection uses at least two client interfaces that are connected to the WDM. These interfaces are arranged so that the Channel Modules 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 WDM module or of a single site-to-site fiber link will not result in total loss of client communications.

GDPS timing links (STP, ETR, and CLO) are qualified for use in a client-based protection scheme, as long as they are using separate paths (routes).

Note: For simplicity, we do not show all components in the optical path in the diagrams in this section.

Figure 4 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 Channel Module A and the other through Channel Module B.
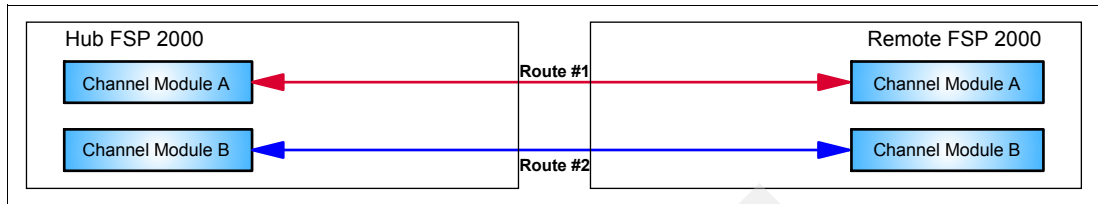
Figure 4   Client-based protected scheme

► Optically Switched Fiber protection

The Remote Switch Module (RSM) provides protection at the site-to-site fiber level. The RSM protects all wavelengths being carried on a fiber pair simultaneously. In the event of a site-to-site fiber failure, all traffic is switched bidirectionally to the backup link.

The RSM is only available for point-to-point WDM network topologies.

Figure 5 shows a high-level view of the *Optically Switched Fiber* protection scheme.
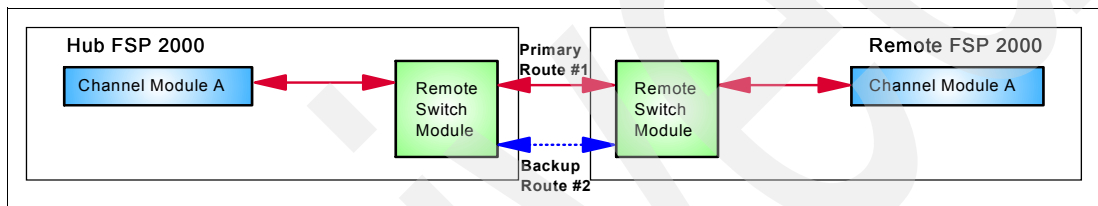

Figure 5   Optically Switched Fiber protection

GDPS timing links (STP, ETR, and CLO) are not qualified for use with a single RSM at each site. A single RSM based, Optically Switched Fiber protection scheme should not be used with GDPS/PPRC.

If a GDPS/PPRC solution is to use Optically Switched Fiber protection, then dual RSMs at each site, with four site-to-site fiber pairs (trunks) are recommended. The CLO links should connect using different Channel Modules and RSMs.

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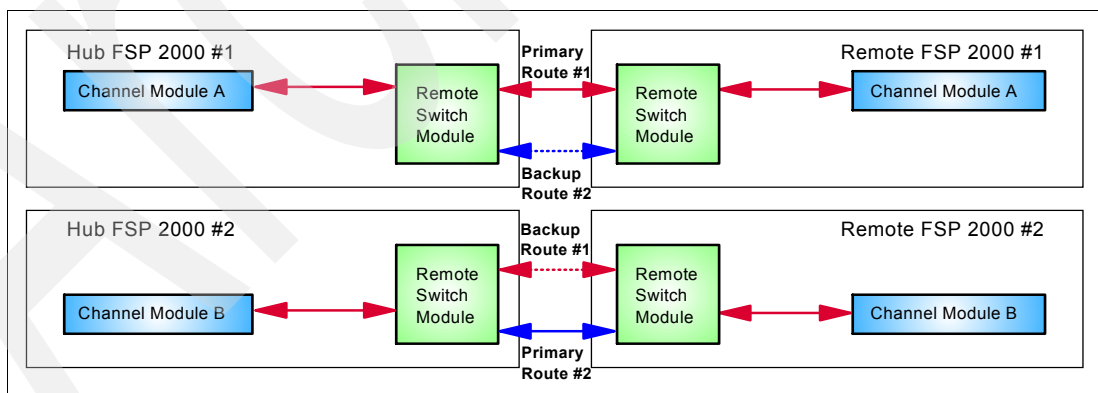

Figure 6   Dual Optically Switched Fiber protection

Optically Switched Fiber protection schemes using RSMs can only be used with EDFA Optical amplifiers if the amplifiers are not used in a mid-span configuration.

Protection scheme intermix

Unprotected and Client protected schemes can be mixed within the same Adva FSP2000 shelf or network on a per client interface basis.

Interface card specifications

Table 2 lists the specifications of the qualified Adva FSP 2000 interface cards.

Adva FSP 2000 interface cards do not support auto-negotiation of link speeds. For System z FICON and FCP client links, the desired link speed must be preconfigured in the WDM Channel Module client interface at both ends of the link.

Refer to the WDM vendor documentation for distance and link budget specifications.

Table 2   Qualified client interface module details

Module Type / Protocol	Fiber Type	Client Attenuator on WDM Tx or Rx port
WCM/LS-T-1310L, 8 Mbps to 200 Mbps, 1310 nm, (1 port, fixed local interface)		
ETR/CLO MM	MM 50 / 62.5 um	n/a
WCM-PLR/2G5-MC2G, 100 Mbps to 2.5 Gbps, 850 nm or 1310 nm, (1 port, pluggable local and remote interface)[a]		
FICON (1 Gbps, 2 Gbps), MM, 850 nm	MM 50 / 62.5 um	n/a
FICON (1 Gbps, 2 Gbps), SM, 1310 nm	SM 9 um	n/a
Fibre Channel (1 Gbps, 2 Gbps), MM, 850 nm	MM 50 / 62.5 um	n/a
Fibre Channel (1 Gbps, 2 Gbps), SM, 1310 nm	SM 9 um	n/a
ISC-3 Compatibility Mode	SM 9 um	n/a
ISC-3 Peer 1 Gbps[b]	SM 9 um	n/a
ISC-3 Peer 2 Gbps	SM 9 um	n/a
ISL (1 Gbps, 2 Gbps), MM, 850 nm[c]	MM 50 / 62.5 um	n/a
ISL (1 Gbps, 2 Gbps), SM, 1310 nm[c]	SM 9 um	n/a
STP (ISC-3 Peer Mode with STP messaging)	SM 9 um	n/a
DWCM-PL/10G-MC10G, 10 Gbps, 850 nm or 1310 nm (1 port, pluggable local interface)[a]		
ISL (10 Gbps), MM, 850 nm[c]	MM 50 / 62.5 um	n/a
ISL (10 Gbps), SM, 1310 nm[c]	SM 9 um	n/a
D4TCM-PL/4G-MC4G, 1.062 Gbps to 4.250 Gbps, 850 nm or 1310 nm (4 port, pluggable local interface)[a]		
ISL (4 Gbps), MM, 850 nm[c]	MM 50 / 62.5 um	n/a
ISL (4 Gbps), SM, 1310 nm[c]	SM 9 um	TX: 3 dB
SM = single-mode fiber (9/125 micron) MM = multimode fiber (either 50/125 or 62.5/125 micron) ISL = Inter Switch Links		

a. Protocol and wavelength support is dependant on pluggable client interface transceiver.
b. To support ISC-3 Peer at 1 Gbps (RPQ 8P2197), configure the WDM interface protocol as: Fibre Channel FC100 (1 Gbps).
c. ISL is configured as Fibre Channel protocol on WDM

References

For more information about System z connectivity, see:

http://www.ibm.com/systems/z/connectivity/

For more information about GDPS solutions, see:

- ► GDPS home page:

  http://www.ibm.com/systems/z/gdps/

- ► Parallel Sysplex home page:

  http://www.ibm.com/systems/z/pso/index.html

- ► GDPS White paper:

  http://www.ibm.com/servers/eserver/zseries/library/whitepapers/

- ► *GDPS Family An Introduction to Concepts and Capabilities*, SG24-6374

  http://w3.itso.ibm.com/abstracts/sg246374.html?Open

For more information about STP, see:

- ► *Server Time Protocol Implementation Guide*, SG24-7281

  http://w3.itso.ibm.com/abstracts/sg247281.html?Open

- ► Server Time Protocol Planning Guide

  http://w3.itso.ibm.com/abstracts/sg247280.html?Open

For more information about the Adva Fiber Service Platform 2000 (FSP 2000), see:

http://www.advaoptical.com

For information about other current System z qualified WDM vendor products, see the following IBM Redbooks publications and Web sites:

- ► *IBM System z Qualified WDM: Ciena CN 4200*

  http://www.redbooks.ibm.com/abstracts/redp3907.html?Open

  Ciena Web site

  http://www.ciena.com

- ► *IBM System z Qualified WDM: Cisco ONS 15454*

  http://www.redbooks.ibm.com/abstracts/redp4395.html?Open

  Cisco Web site

  http://www.cisco.com

- ► *IBM System z Qualified WDM: Nortel Optical Metro 5200*

  http://www.redbooks.ibm.com/abstracts/redp3904.html?Open

  Nortel Web site

  http://www.nortel.com

For information about previous generation System z qualified WDM vendor products, see the following IBM Redbooks publications and Web sites:

► *zSeries Qualified WDM Vendor: Lucent Techologies, REDP-3906*

http://www.redbooks.ibm.com/abstracts/redp3906.html?Open

Lucent Web site

http://www.lucent.com

IBM GDPS qualification letters are available on Resource Link:

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

The team that wrote this IBM Redpaper

This paper was produced by a team of specialists working at the International Technical Support Organization (ITSO), Poughkeepsie Center.

Bill White is a Project Leader and Senior Networking and Connectivity Specialist at the ITSO, Poughkeepsie Center.

Pasquale Catalano is a Staff Engineer at the IBM Vendor Solutions Connectivity Lab in Poughkeepsie, NY, U. S. He has five years of experience in WDM vendor qualification testing. He holds an MS in Electrical Engineering from the State University of New York at New Paltz.

Rav Meerwald is a Networking Systems Services Representative with IBM Australia. He has 19 years of field experience with IBM, including Networking and WDM products. He provides design, implementation, and technical support for WDM solutions.

Thanks to the following people for their contributions to this project:

Connie Beuselinck
System z Hardware Product Planning, IBM Poughkeepsie

Casimer DeCusatis
Distinguished Engineer, STG Development, IBM Poughkeepsie

Noshir Dhondy
System z Hardware Brand Technology, IBM Poughkeepsie

Charles Grizzaffi
System z WDM Program Manager, IBM Poughkeepsie

Jeff Nesbitt
Advanced Account System Service Representative, IBM Australia

David Raften
System z Parallel Sysplex and GDPS Planning, IBM Poughkeepsie

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