



Bill White
Rav Meerwald
Jeff Nesbitt

zSeries Qualified WDM Vendor: Cisco Systems

Introduction

This IBM® Redpaper is one in a series describing zSeries® qualified optical Wavelength Division Multiplexing (WDM) vendor products for Geographically Dispersed Parallel Sysplex™ (GDPS®) solutions.

International Business Machines (IBM) Corporation and Cisco Systems have successfully completed qualification testing of the Cisco ONS 15530 DWDM, ONS 15540 ESPx (Extended Services® Platform), and ONS 15454 MSTP (Multi-Service Transport Platform). This Redpaper describes the applicable environments, protocols, and topologies qualified and supported by IBM @server zSeries for connecting to the Cisco ONS 15530 DWDM and ONS 15540 ESPx products at hardware release level 5.0 and software at release level IOS 12.2 (25) SV. The ONS 15454 MSTP qualification will be described in a later version of this Redpaper. This Redpaper version supersedes and replaces all previous versions. The latest version of this Redpaper is available at:

<http://www.redbooks.ibm.com/abstracts/redp3905.html?open>

IBM @server zSeries GDPS Qualification and IBM TotalStorage® Proven™ are complementary programs leveraging the strengths of IBM licensed technologies, intellectual property, and know-how, enhancing interoperability in a multivendor environment. The two programs continue to work together as new technologies and products become available. The Cisco ONS 15530 DWDM and ONS 15540 ESPx products are also IBM TotalStorage Proven.

The zSeries qualified WDM vendor products that support GDPS are:

- ▶ Adva Fiber Service Platform 2000 (FSP 2000) DWDM system
- ▶ Cisco ONS 15530 DWDM, ONS 15540 ESPx, and ONS 15454 MSTP
- ▶ IBM 2029 Fiber Saver DWDM (withdrawn from marketing)
- ▶ Lucent Technologies Metropolis® Enhanced Optical Network (EON) System
- ▶ Nortel Networks OPTera Metro 5000 Multiservice Platform series

In addition to the above WDM products, the IBM 9036 Model 003 extender is also available to extend Sysplex Timer® (ETR and CLO) links from 3 km to 26 km. An IBM 9036-003 is available as a Request for Price Quotation (RPQ 8K1919).

zSeries GDPS qualification overview

Geographically Dispersed Parallel Sysplex™ (GDPS)®, an industry-leading ebusiness continuity solution, is a multisite solution designed to provide the capability to manage the remote copy configuration and storage subsystems, automate Parallel Sysplex operational tasks, and perform failure recovery from a single point of control, thereby helping to improve application availability. GDPS supports both the IBM TotalStorage Metro Mirror (synchronous Peer-to-Peer Remote Copy (PPRC)), as well as the IBM TotalStorage z/OS® Global Mirror (asynchronous Extended Remote Copy (XRC)) forms of remote copy. Depending on the form of remote copy implemented, the solution is referred to as GDPS/PPRC or GDPS/XRC.

IBM only supports WDM products qualified by IBM @server zSeries for usage in GDPS/PPRC and GDPS/XRC solutions. To obtain this qualification, WDM companies obtain licensed IBM patents, intellectual property, and know-how related to the GDPS architecture. This gives them access to the unique IBM protocols and applications used in a GDPS environment (including Sysplex Timer, InterSystem Channel (ISC), PPRC, and XRC). Without this information, it is not possible to reverse engineer the requirements for a GDPS environment. Qualified companies will typically license this information for an extended period of time, allowing them to subscribe to the latest GDPS architecture changes, and be among the first to market with offerings that support these features.

In addition, these vendor products have been tested and qualified by IBM with the same test labs and procedures used to test all aspects of a GDPS environment. 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 simulate failure and recovery actions, which could not be tested as part of a working client environment. IBM has the facilities to test and qualify these products with both current and legacy equipment, leveraging the size of the Vendor Solutions Connectivity Lab in Poughkeepsie, USA. This qualification testing allows IBM to reproduce any concerns that may arise while using this equipment in a client's application. Figure 1 on page 3 shows a GDPS/PPRC environment used for WDM vendor qualification.

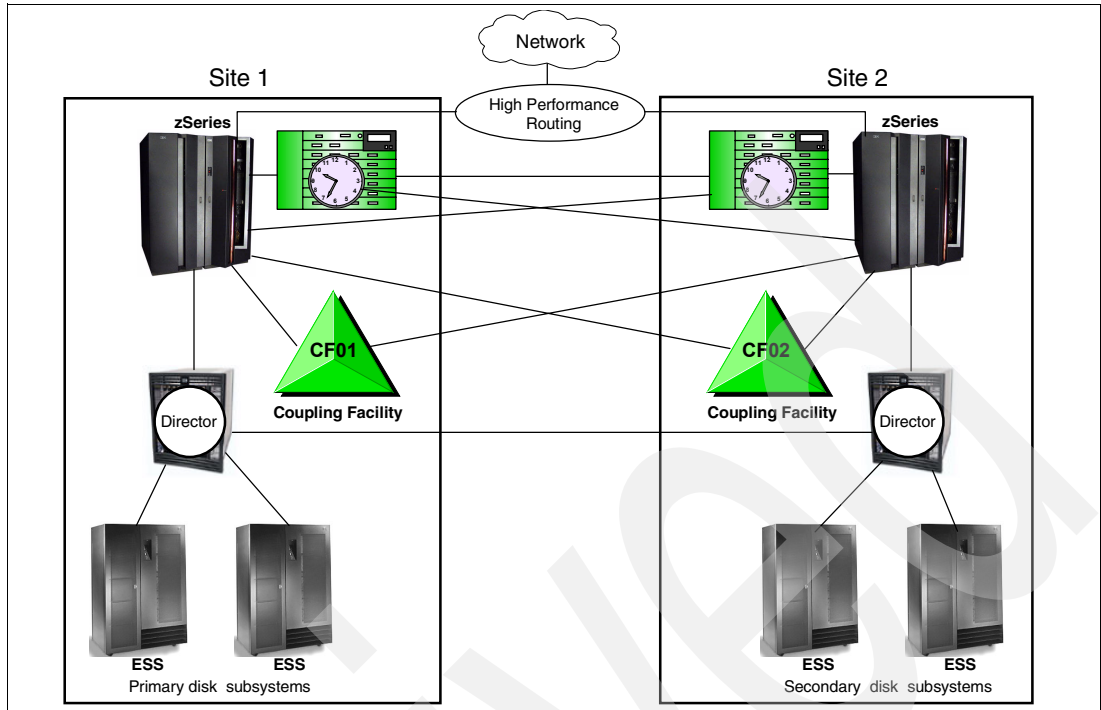


Figure 1 GDPS environment

Qualification testing

GDPS qualification testing is carried out at the IBM Vendor Solutions Connectivity Lab in Poughkeepsie, New York. The Vendor Solutions Connectivity Lab contains zSeries hardware systems with software applications allowing complete functional testing of a GDPS environment, as well as testing the interoperability of WDM products within a GDPS.

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

- ▶ IBM @server zSeries servers
- ▶ IBM 9037 Model 2 Sysplex Timers
- ▶ IBM 2105 TotalStorage Enterprise Storage Servers
- ▶ IBM 9032 ESCON® Directors
- ▶ IBM @server zSeries qualified FICON® Directors and switches

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 qualified distance of 100 km (62 miles). To achieve the maximum distances qualified for GDPS protocols, vendors may utilize erbium doped fiber amplifiers (EDFAs), inserted at various link points, to condition the signals on the fiber link connecting the WDM equipment.

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

- ▶ z/OS, Linux® for zSeries, 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 being transported by the WDM equipment. This ensures maximum channel throughput is achieved and tested to levels well beyond typical client environments.

The test suites are used for verification of z/Architecture functionality, with individual tests typically being run for up to 24 hours at a time. During these functionality tests, it is expected that zero errors will be detected by the attached subsystems for a test to be classified as successful. Any errors detected during this testing are captured and analyzed by the test suites.

The test suites are also used for verification of 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 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.
- ▶ Testing of the various WDM protection schemes are performed 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. These components may also be used by clients in environments that do not require a full GDPS solution. The testing provides a level of assurance that these components will function in a WDM environment.

Components

The following GDPS components are tested during the qualification process:

- ▶ IBM Parallel Sysplex®
- ▶ IBM TotalStorage® Enterprise Storage Server® (ESS)
- ▶ Optical Dense or Coarse Wavelength Division Multiplexer (DWDM or CWDM)
- ▶ IBM TotalStorage® Metro Mirror (Peer-to-Peer Remote Copy (PPRC)), a synchronous form of remote copy
- ▶ IBM TotalStorage® z/OS Global Mirror (Extended Remote Copy (XRC)), an asynchronous form of remote copy

The GDPS solution is also independent of disk vendor, as long as the vendor meets the specific levels of Metro Mirror (PPRC) and z/OS Global Mirror (XRC) architectures.

Protocols

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

- ▶ Enterprise Systems Connection (ESCON)
- ▶ IBM 9037 Sysplex Timer (ETR/CLO)
- ▶ Fiber Connection (FICON) (1Gbps)
- ▶ Fiber Connection (FICON) Express (1 Gbps and 2 Gbps)
- ▶ Fibre Channel (FC 100) (1 Gbps)
- ▶ Fibre Channel (FC 200) (2 Gbps)
- ▶ InterSystem Channel (ISC) and ISC-2 (1 Gbps)
- ▶ InterSystem Channel (ISC-3) Compatibility Mode (1Gbps)
- ▶ InterSystem Channel (ISC-3) Peer Mode (2 Gbps)
- ▶ InterSystem Channel (ISC-3) Peer Mode (1 Gbps), via RPQ 8P2197

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

Table 1 Qualified protocols and distances

Protocol	Data transfer rate	Max Repeated Distance
ESCON	200 Mbps	100 km ^{a b}
CLO	8 Mbps	40 km ^a
ETR	8 Mbps	100 km ^a
FICON (1 Gbps) ^c	1.062 Gbps	100 km
FICON (2 Gbps)	2.125 Gbps	100 km
Fibre Channel FC100 (1 Gbps)	1.062 Gbps	100 km
Fibre Channel FC200 (2 Gbps)	2.125 Gbps	100 km
ISC / ISC-2	1.062 Gbps	40 km
ISC-3 Compatibility Mode	1.062 Gbps	40 km
ISC-3 Peer Mode	2.125 Gbps	100 km ^a
ISC-3 Peer Mode (1Gbps) ^d	1.062 Gbps	40 km

a. Requires RPQ 8P2263 zSeries Extended Distance (8P2262 for S/390®).

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 which clocks at 1.062 Gbps in Peer and Compatibility modes.

IBM 9037 Sysplex Timer

The IBM 9037 Sysplex Timer is a mandatory component of GDPS/PPRC. The Sysplex Timer provides an External Time Reference (ETR) to synchronize the time of day (TOD) clocks on attached zSeries servers in a GDPS/PPRC environment.

The 9037 Sysplex Timer uses two link types:

- ▶ External Time Reference (ETR)

ETR links are connections between the Sysplex Timer and the zSeries server ETR ports providing TOD clock synchronization between multiple servers.

- ▶ **Control Link Oscillator (CLO)**

CLO links are connections between two Sysplex Timer units in High Availability mode allowing synchronization of the Sysplex Timer timing signals.

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).

Special care should be taken when using EDFA optical amplifiers or dispersion compensation units (DCUs) to ensure the end-to-end lengths of the transmit and receive fibers of the link are equal (within 10 meters). EDFAs and DCUs contain significant lengths of fiber, which must be included in the total fiber distance calculation.

Protection schemes (see “Topologies and protection schemes” on page 10), capable of supporting links within the 10 meter limit, are supported for GDPS, for example, Splitter or Trunk Fiber based protection. These protection schemes are often referred to as bidirectional protection. If a GDPS/PPRC solution is to use Trunk Fiber based protection, then dual PSMs with four site-to-site fiber pairs (trunks) is recommended. The CLO links should connect via different Protection Switching Modules.

Bidirectional switching must be explicitly configured on any protected link carrying ETR or CLO signals.

Technical description

The Cisco ONS 15500 Series is a suite of optical dense wavelength division multiplexing (DWDM) equipment. The Cisco ONS 15500 Series includes the ONS 15530 DWDM Multiservice Aggregation Platform and the ONS 15540 ESPx Extended Services Platform. The ONS 15454 MSTP qualification will be described in a later version of this Redpaper

The Cisco ONS 15500 Series consists of modular chassis based optical DWDM platforms which can support up to 32 International Telecommunications Union (ITU) specific wavelengths that are multiplexed onto a single pair of fibers using optical wavelength division multiplexing (WDM).

The optical network connecting the Cisco ONS 15500 Series platforms can be configured in a two site point-to-point or a multi-site ring network topology.

A fully configured point-to-point network can consist of up to 32 unprotected or protected ITU wavelengths transported over one or two fiber pairs connected between data sites. The zSeries qualified products of the Cisco ONS 15500 Series are the:

- ▶ **ONS 15540 ESPx Extended Services Platform**
Hardware Release 5.0, Software Release IOS 12.2 (25) SV

The ONS 15540 ESPx is a 12 slot modular chassis that supports up to 32 client protected interfaces per chassis. Each client interface is converted to one ITU wavelength.

- ▶ **ONS 15530 DWDM Multiservice Aggregation Platform**
Hardware Release 5.0, Software Release IOS 12.2 (25) SV

The ONS 15530 is an 11 slot modular chassis that supports up to four protected, or eight unprotected ITU wavelengths per chassis. Multiple ONS 15530 chassis can be interconnected to form an optical network supporting up to 32 ITU wavelengths.

The ONS 15530 also supports the aggregation of multiple client interfaces on to a single ITU wavelength with the use of time division multiplexing (TDM) based Aggregation cards.

Interface cards and modules

The following is a detailed list of the Cisco ONS 15530 and ONS 15540 optical interface cards and modules qualified by IBM @server zSeries:

ONS 15540 ESPx specific components

► Transponder Modules

Transponder modules connect client equipment to the WDM platform. The Transponder module, also known as a Line Card, converts client optical signals to an ITU compliant DWDM wavelength for transmission to the remote site. The ONS 15540 ESPx Transponder modules are mounted in a Line Card Mother Board (LCMB) which houses up to four Transponder modules

There are several types of ONS 15540 ESPx Transponder modules which have been qualified by IBM @server zSeries:

- Type 1 Transponders, which have fixed non-pluggable optical transceivers for connection to a client interface, and are available in three types:
 - Multimode, 1310 nm, 16 Mbps to 622 Mbps
 - Single-mode, 1310 nm, 16 Mbps to 2.5 Gbps
 - Single-mode, 1310 nm, 10 Gbps (10-GE, 802.ae)
- Type 2 Extended Range Transponders, which have Small Form-Factor Pluggable (SFP) optical transceivers that support different fiber types and client protocols from 16 Mbps to 2.5 Gbps.

The qualified ONS 15540 ESPx Transponder types are:

- 15540-TSP1-xxA3, Type 1 Multi-Mode Transponder Module
1310 nm, 16 Mbps to 622 Mbps
- 15540-TSP1-xxB3, Type 1 Single-Mode Transponder Module
1310 nm, 16 Mbps to 2.5 Gbps
- 15540-TSP2-xx00, Type 2 Extended Range Transponder Module
- 15500-XVRA-xxxx, SFP modules supporting 850 nm, 1310 nm, 16 Mbps to 2.5 Gbps

► Line Card Mother Boards

The ONS 15540 ESPx uses Line Card Mother Boards (LCMB) to house and provide electrical power and clocking signals to the Transponder modules. The LCMB also provides the ITU optical interface from the Transponder to the site-to-site fiber link.

The splitter LCMB versions provide protection against trunk fiber failure by optically splitting the output ITU wavelengths from the associated transponder modules for connection to diverse site-to-site fiber link. In case of a traffic disruption on one fiber path, traffic is automatically switched to the working fiber path.

Up to eight LCMBs can be mounted in each ONS 15540 ESPx chassis, each LCMB houses up to four Transponders, allowing up to 32 Transponders per ONS 15540 Chassis. Up to 16 10 Gbps Transponders can be mounted in one ONS 15540 ESPx Chassis due to their larger physical size.

The qualified ONS 15540 ESPx Line Card Mother Boards types are:

- 15540-LCMB-1100, 2.5 Gbps LCMB with splitter protection (2.5 Gbps Type-1 and Type-2)
- 15540-LCMB-1200, 2.5 Gbps LCMB without splitter protection (2.5 Gbps Type-1 and Type-2)
- 15540-LCMB-1400, 10 Gbps LCMB with splitter protection (10 Gbps Type-1)

- 15540-LCMB-1401, 10 Gbps LCMB without splitter protection (10 Gbps Type-1)

ONS 15530 specific components

▶ Transponder Line Cards

The Transponder Line Card connects client equipment to the WDM platform, it converts client optical signals to an ITU compliant DWDM wavelength for transmission to the remote site. ONS 15530 Transponder Line Cards combine the functions of the Transponder Module and Line Card Mother Board used on the ONS 15540 ESPx into one package.

ONS 15530 Transponder Line Cards have fixed non-pluggable optical transceivers.

The splitter Transponder Line Card versions provide protection against trunk fiber failure by optically splitting the output ITU wavelength for connection to diverse site-to-site fiber links. In case of a traffic disruption on one fiber path, traffic is automatically switched to the working fiber path.

The qualified ONS 15530 Transponder Line Card types are:

- 15530-TSP1-xx11, Multi-Mode Transponder Line Card with splitter protection 1310 nm, 16 Mbps to 622 Mbps
- 15530-TSP1-xx21, Multi-Mode Transponder Line Card without splitter protection 1310 nm, 16 Mbps to 622 Mbps
- 15530-TSP1-xx12, Single-Mode Transponder Line Card with splitter protection 1310 nm, 16 Mbps to 2.5 Gbps Mbps
- 15530-TSP1-xx22, Single-Mode Transponder Line Card without splitter protection 1310 nm, 16 Mbps to 2.5 Gbps Mbps

▶ Aggregation Cards

The ONS 15530 supports the aggregation of client signals. Aggregation cards use time division multiplexing to connect multiple client equipment interfaces to the WDM platform. Aggregation cards convert client optical signals to electrical signals that are multiplexed and transported on the chassis backplane to a digital switch fabric located on the CPU Switch module. The switch fabric connects these signals to one or more ITU Trunk cards. Aggregation cards have Small Form-Factor Pluggable (SFP) optical transceivers that support different client protocols and fiber types.

The qualified 15530 Aggregation card types are:

- 15530-LCMB-0200, 10-Port ESCON Aggregation Card
- 15530-FCGE-8P, 8-Port Fibre Channel/Gigabit Ethernet Aggregation Card
- 15530-FC-4P, 4-Port Fibre Channel/FICON Aggregation Card
- 15500-XVRA-xxxx, SFP modules supporting 850 nm, 1310 nm, 16 Mbps to 2 Gbps

Aggregation cards are supported on the ONS 15530 only.

▶ Muxponder Card

The ONS 15530 8-Port Multiservice Muxponder Card, combines the function of an Aggregation card and Transponder Line Card into one package, up to 8 client interfaces can be multiplexed into a single 2.5 Gbps ITU wavelength. Muxponder cards have Small Form-Factor Pluggable (SFP) optical transceivers that support different client protocols and fiber types.

The qualified 15530 Muxponder card types are:

- 15530-MSMP-xx121, 8-Port Multiservice Muxponder Card with splitter protection
- 15530-MSMP-xx221, 8-Port Multiservice Muxponder Card without splitter protection

- 15500-XVRA-xxxx, SFP modules supporting 850 nm, 1310 nm, 16 Mbps to 1.25 Gbps

The splitter Muxponder Card versions provide protection against trunk fiber failure by optically splitting the output ITU wavelength for connection to diverse site-to-site fiber links. In case of a traffic disruption on one fiber path, traffic is automatically switched to the working fiber path.

► CPU Switch Module

The CPU module provides control and management and clocking functions for the ONS 15540 ESPx and ONS 15530.

The ONS 15530 CPU card also contains a switch fabric, which provides a digital cross connect function for signals from client facing ESCON, 8-Port FC/GE or 4-Port FC/FICON Aggregation cards to the site-to-site fiber facing ITU Trunk and 10Gbps Uplink cards. A chassis can be configured to have redundant CPU Switch modules; which for the ONS 15530 also provides redundancy for the switch fabric.

► ITU Trunk Cards

An ITU Trunk card receives electrical signals from aggregation cards via the switch fabric and converts these electrical signals to an optical ITU compliant wavelength for transmission to the remote site. The splitter trunk cards provide protection against site-to-site fiber failure by optically splitting the output ITU wavelength for connection to diverse site-to-site fiber links.

ITU Trunk cards are supported on the ONS 15530 only. The qualified 15530 ITU Trunk types are:

- 15530-ITU3-xx10, 2.5 Gbps ITU Trunk Card with splitter protection
- 15530-ITU3-xx20, 2.5 Gbps ITU Trunk Card without splitter protection
- 15530-ITU2-xx10, 10 Gbps ITU Trunk Card with splitter protection
- 15530-ITU2-xx20, 10 Gbps ITU Trunk Card without splitter protection

► 10 Gbps Uplink Cards

The 10 Gbps Uplink card receives electrical signals from aggregation cards via the switch fabric and converts these electrical signals to a non-ITU optical 10 Gbps, 1310 nm, single-mode output for connection to an ONS 15530 10 Gbps Uplink Card or an ONS 15540 ESPx 10 Gbps Transponder module.

The 10 Gbps Uplink card is supported on the ONS 15530 only. The qualified 15530 10 Gbps Uplink card is:

- 15530-10GE-UPLINK, 10 Gbps Uplink Card, 1310 nm

Common ONS 15530 and 15540 ESPx components

► Mux/Demux

The optical mux/demux modules are passive devices that optically multiplex and demultiplex a specific band of ITU wavelengths.

In the transmit direction, the optical mux/demux modules multiplex signals transmitted by Transponders or Trunk cards, and provide the interfaces to connect the multiplexed signal to the DWDM site-to-site fiber link.

In the receive direction, the optical mux/demux modules demultiplex the signals from the site-to-site fiber link before passing to the corresponding Transponder or Trunk card.

► Protection Switch Module (PSM)

The Protection Switch Module (PSM) provides protection against site-to-site (trunk) fiber failure for point-to-point topologies by optically splitting and sending data over two diverse

fiber paths. It protects site-to-site traffic from physical damage to a fiber pair (trunk) by switching bi-directionally to a redundant fiber pair. Protection switch modules are supported for the ONS 15530 and ONS 15540 ESPx.

The qualified PSM Module types are:

- 15540-PSM-01, ONS 15540 ESPx Protection Switch Module
- 15530-PSM-01, ONS 15530 Protection Switch Module

► Optical Erbium Doped Fiber Amplifier (EDFA)

Erbium-Doped Fiber Amplifiers (EDFAs) optically amplify up to 32 ITU wavelengths for transmission over longer distances, and can be used within ONS 15530 and ONS 15540 ESPx networks.

The qualified Optical Amplifier types are:

- Cisco ONS 15501 (EDFA)
- Cisco ONS 15216 (EDFA)

Topologies and protection schemes

IBM @server zSeries qualifies the 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 utilize several protection schemes; some restrictions apply for particular protocols, for example, Sysplex Timer (ETR/ECLO) links.

Important: Protection schemes that cannot guarantee ETR and CLO link (transmit and receive) lengths within the 10 meter limit are not supported by the IBM 9037 Sysplex Timer.

Throughout this section of the document, we use the term *Transponder* to refer to the Transponder Module (ONS 15540 ESPx) and to the Transponder Line Card (ONS 15530), where the function being described is applicable to both types.

Protection schemes

The Cisco 15500 Series platform provides the following protection schemes:

► Unprotected

An unprotected Transponder is connected to one client interface and to one site-to-site fiber link only. A failure of the Transponder or the site-to-site fiber link will result in a loss of client communications.

An unprotected port on an Aggregation card is similarly connected one ITU Trunk card, which is connected to the remote site using only one site-to-site fiber link.

► Client based protection

Client based protection uses at least two client interfaces connected to the WDM. These interfaces are arranged so that the Transponders or ITU Trunk cards connecting 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.

IBM 9037 Sysplex Timer CLO links are qualified for use in a Client based protection scheme, as long as they are using separate paths (routes).

Note: For simplicity, not all components in the optical path are shown in the following diagrams.

Figure 2 shows a high level view of the Client based protection scheme. Transponder based schemes for the ONS 15540 and ONS 15530, and Aggregation card based schemes for the ONS 15530 are shown separately.

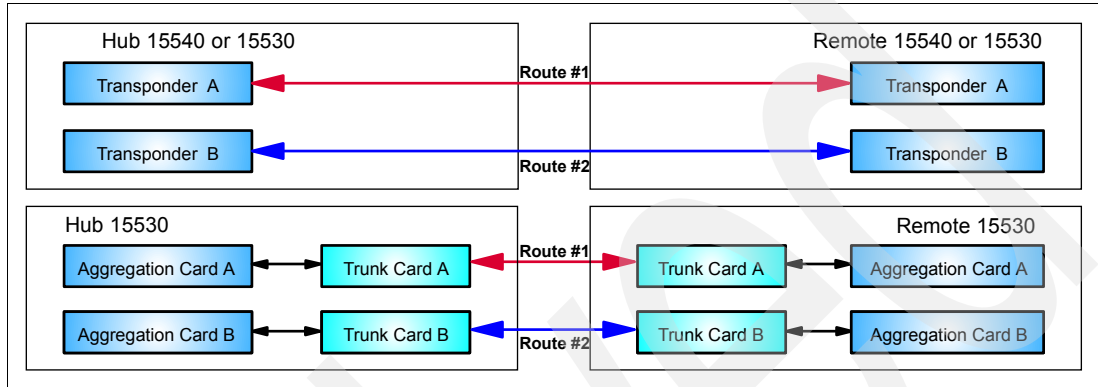


Figure 2 Client based protected scheme

► Splitter Protection

Splitter protection provides per wavelength protection against a site-to-site fiber failure, the ITU signal from a Transponder or Trunk card is optically split and carried over redundant diverse site-to-site fiber links. At the remote site, WDM control logic selects one of the fiber links as the active and the other as backup for each Transponder or Trunk card. Splitter based cards and modules can be configured to perform bidirectional switching, which ensures that both ends of the link are switched to the same site-to-site fiber pair.

IBM 9037 Sysplex Timer ETR and CLO links can be used with Splitter protected Transponder modules only if the protection is configured as bidirectional.

Figure 3 shows a high level view of the Splitter protection scheme. Transponder based schemes for the ONS 15540 and ONS 15530, and Aggregation card based schemes for the ONS 15530 are shown separately.

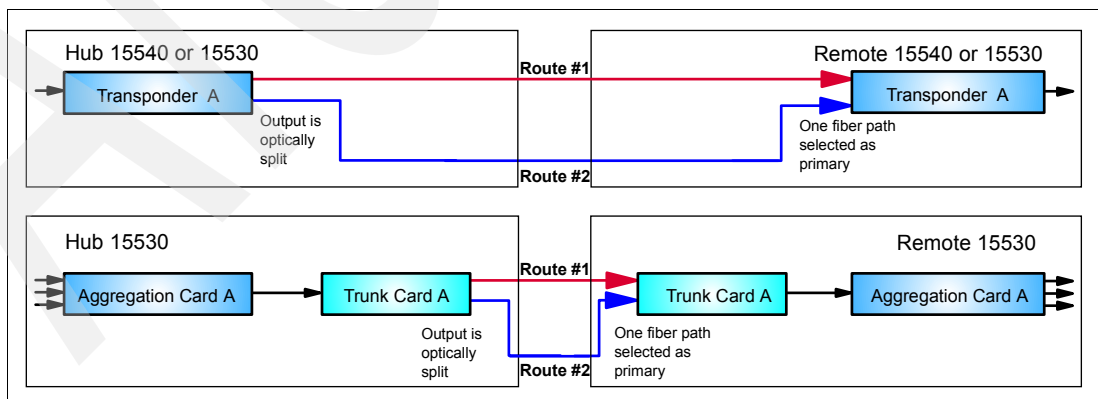


Figure 3 Splitter protected scheme

► Y-Cable Line Card Protection

Y-Cable Line Card protection provides per wavelength protection against a Transponder module failure, and also against a site-to-site fiber failure. The signal received from the

client is optically split via a Y-Cable and connected into two Transponder modules. The Transponder modules are configured to send their trunk facing signals over two diverse site-to-site fiber links. At the remote site, WDM control logic ensures that the client facing transmit laser of only one Transponder module is enabled for the remote client interface.

Transponder based Y-Cable Line Card protection is supported on the ONS 15530 and ONS 15540 ESPx.

The ONS 15530 provides Y-Cable Line Card Protection using ports connected to the 8-Port Fibre Channel/Gigabit Ethernet or 4-Port Fibre Channel/FICON Aggregation cards only. The operation is similar to the Transponder based Y-Cable Line Card protection scheme.

Y-cable protection is not supported for ESCON Aggregation cards, client based protection is the preferred protection scheme for ESCON.

ESCON, FICON, FCP, and ISC-3 Peer mode links can be used with Y-Cable Line Card protection. Protection of ESCON interfaces using Transponder based Y-Cable Line Card protection is supported.

Do not configure Y-cable protection with Sysplex CLO, Sysplex ETR, or ISC-1, ISC-2 or ISC-3 Compatibility Mode protocol encapsulations.

Figure 4 shows a high level view of the Y-Cable Line Card protection scheme. Transponder based schemes for the ONS 15540 and ONS 15530, and Aggregation card based schemes for the ONS 15530 are shown separately.

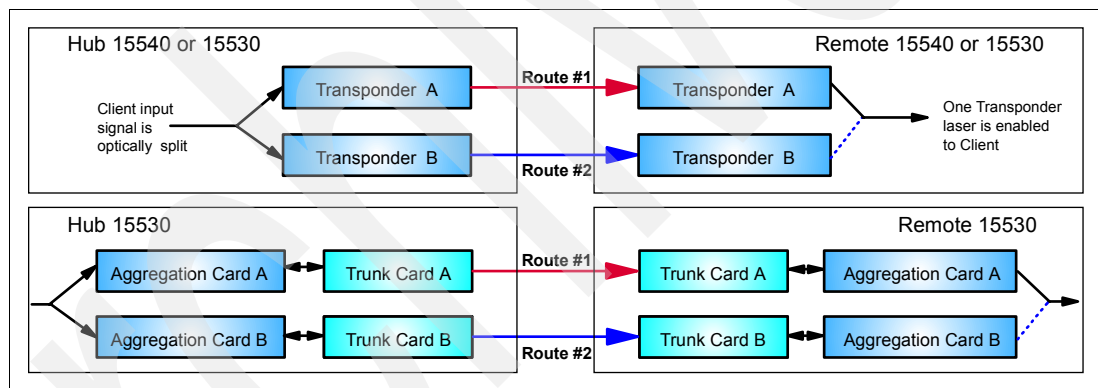


Figure 4 Y-Cable Line card protected scheme

► Switch Fabric Based Line Card Protection

The ONS 15530 also supports Switch Fabric based Line Card protection, the signal received from the client interface attached to a port on one Aggregation card is electrically split within the Switch Fabric located on the CPU card, this signal is connected to two ITU Trunk cards. The ITU Trunk cards are configured to send their trunk facing signals over two diverse site-to-site fiber links. At the remote site, WDM control logic ensures that the remote Aggregation card receives data from only one ITU Trunk card via the active switch fabric. This scheme protects against failures in the site-to-site fiber, ITU Trunk cards and the Switching Fabric within the CPU cards.

ESCON, FICON, FCP, and ISC-3 Peer mode links can be used with Switch Fabric based Line Card protection.

Figure 5 on page 13 shows a high level view of the Switch Fabric based Line Card protection scheme for the ONS 15530.

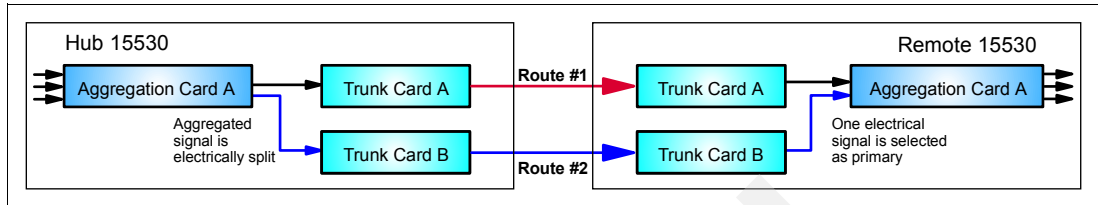


Figure 5 Switch Fabric Based Line Card Protection scheme

► Trunk Fiber Based Protection

The Protection Switch Module (PSM) provides protection at the site-to-site fiber level. The PSM 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 PSM is only available for point-to-point WDM network topologies.

Figure 6 shows a high level view of the Trunk Fiber Based protection scheme.

Note: Transponder based schemes for the ONS 15540 and ONS 15530 are shown. Aggregation card based schemes for the ONS 15530 have not been included to reduce complexity of the diagrams.

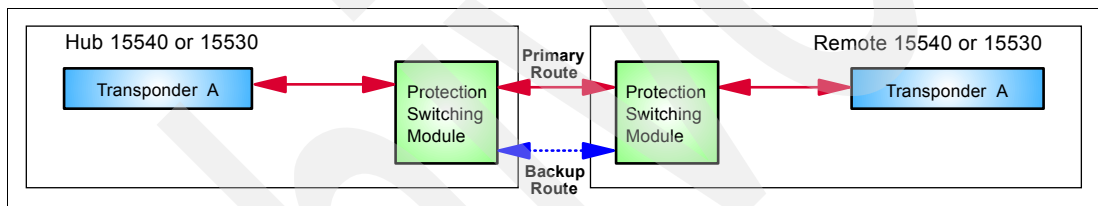


Figure 6 Trunk Fiber based protected scheme

IBM 9037 Sysplex Timer ETR and CLO links are qualified for use with the PSM; however, a single Trunk Fiber based protection scheme should not be used with GDPS/PPRC.

If a GDPS/PPRC solution is to use Trunk Fiber based protection, then dual PSMs, and four site-to-site fiber pairs (trunks) are recommended. The CLO links should connect via different PSMs. Figure 7 shows a high level view of the dual Trunk Fiber based protection scheme.

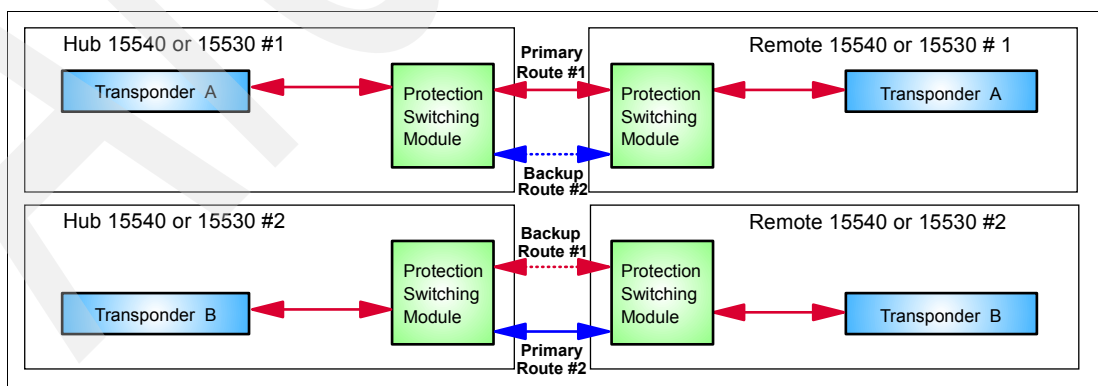


Figure 7 Dual Trunk Switch Protected scheme

Protection scheme intermix

Unprotected, Client protected, Splitter and Line Card protected schemes can be intermixed within the same Cisco 15500 Series chassis or network on a per client interface basis.

Splitter and Switch Fabric Based Line Card protection schemes should not be intermixed with Trunk Fiber Based protection using the PSM.

If using PSMs in an amplified point-to-point network, no more than two EDFAs can be on the same site-to-site fiber; due to the cumulative effect of noise from the EDFAs. If more than two EDFAs are required, use splitter protection.

Interface card specifications

Table 2 lists the specifications of the Cisco ONS 15500 Series interface cards qualified by IBM zSeries.

Cisco ONS 15500 Series interface cards do not support auto-negotiation of link speeds. For zSeries FICON and FCP client links, the desired link speed must be pre-configured in the WDM Transponder 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 card details

Card Type / Protocol	Fiber Type	Client Attenuator on WDM Tx port
Transponder: Type-1, Multimode, 1310nm, 16 Mbps -> 622 Mbps (ONS 15540 and ONS 15530)		
ESCON/SBCON MM	MM 50 / 62.5 um	14 dB
ETR/CLO MM	MM 50 / 62.5 um	14 dB
Transponder: Type-1, Single-mode, 1310nm, 16 Mbps -> 2.5 Gbps (ONS 15540 and ONS 15530)		
ESCON/SBCON SM	SM 9 um	3 dB
FICON 1.062 Gbps	SM 9 um	3 dB
FICON 1.062 Gbps	MM 50 / 62.5 um	3 dB
FICON Express 2.125 Gbps	SM 9 um	3 dB
Fibre Channel 1.062 Gbps	SM 9 um	3 dB
Fibre Channel 2.125 Gbps	SM 9 um	3 dB
ISC / ISC-2 / ISC-3 Compatibility Mode	SM 9 um	3 dB
ISC-3 Peer 1 Gbps ^{a b}	SM 9 um	3 dB
ISC-3 Peer 2 Gbps	SM 9 um	3 dB
Transponder: Type 2, Extended Range, Pluggable SFPs, 16 Mbps -> 2.5Gbps (ONS 15540)		
ESCON/SBCON MM, 1310 nm	MM 50 / 62.5 um	n/a
ESCON/SBCON SM, 1310 nm	SM 9 um	n/a
ETR/CLO MM, 1310 nm	MM 50 / 62.5 um	n/a
FICON 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
FICON 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a

Card Type / Protocol	Fiber Type	Client Attenuator on WDM Tx port
FICON Express 2.125 Gbps, MM,850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
FICON Express 2.125 Gbps, SM, 1310 nm	SM 9 um	n/a
Fibre Channel 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
Fibre Channel 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a
Fibre Channel 2.125 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
Fibre Channel 2.125 Gbps, SM, 1310 nm	SM 9 um	n/a
ISC / ISC-2 / ISC-3 Compatibility Mode	SM 9 um	n/a
ISC-3 Peer 1 Gbps ^{a b}	SM 9 um	n/a
ISC-3 Peer 2 Gbps	SM 9 um	n/a
Transponder: Type-1, 10 Gbps (ONS 15540 only)		
10G-BASE-LR, IEEE 802.ae, SM, 1310 nm	SM 9 um	n/a
10-Port ESCON Aggregation Card (ONS 15530 only)		
ESCON/SBCON MM	MM 50 / 62.5 um	n/a
ESCON/SBCON SM	SM 9 um	n/a
8-Port FIBRE CHANNEL/GIGABIT ETHERNET Aggregation Card (ONS 15530 only)		
FICON 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
FICON 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a
Fibre Channel 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
Fibre Channel 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a
ISC / ISC-2 / ISC-3 Compatibility Mode	SM 9 um	n/a
4-Port Fibre Channel / FICON Aggregation Card (ONS 15530 only)		
FICON 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
FICON 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a
FICON Express 2.125 Gbps, MM,850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a

Card Type / Protocol	Fiber Type	Client Attenuator on WDM Tx port
FICON Express 2.125 Gbps, SM, 1310 nm	SM 9 um	n/a
Fibre Channel 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
Fibre Channel 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a
Fibre Channel 2.125 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
Fibre Channel 2.125 Gbps, SM, 1310 nm	SM 9 um	n/a
ISC / ISC-2 / ISC-3 Compatibility Mode	SM 9 um	n/a
ISC-3 Peer 1 Gbps ^{a b}	SM 9 um	n/a
ISC-3 Peer 2 Gbps	SM 9 um	n/a
8-Port Multiservice Muxponder Card (ONS 15530 only)		
ESCON/SBCON MM, 1310 nm	MM 50 / 62.5 um	n/a
ESCON/SBCON SM, 1310 nm	SM 9 um	n/a
FICON 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
FICON 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a
Fibre Channel 1.062 Gbps, MM, 850 nm	MM 50 um 500 MHz*km MM 62.5 um 200 MHz*km MM 62.5 um 160 MHz*km	n/a
Fibre Channel 1.062 Gbps, SM, 1310 nm	SM 9 um	n/a
SM = single-mode fiber (9/125 micron) MM = multimode fiber (either 50/125 or 62.5/125 micron) MCP = Mode Conditioning Patch Cable LX = long wavelength, 1310 nm SX= short wavelength, 850 nm		

a. To support ISC-3 Peer at 1 Gbps (RPQ 8P2197), configure the WDM interface protocol as: Fibre Channel FC100 (1 Gbps).

b. ISC-3 Peer at 1 Gbps (RPQ 8P2197), is a configurable protocol at IOS version 12.2(23)SV or higher.

References

For more information about zSeries connectivity, see:

<http://www.ibm.com/servers/eserver/zseries/connectivity/>

For more information about GDPS solutions, see:

- ▶ Parallel Sysplex home page:

<http://www.ibm.com/servers/eserver/zseries/ps/>

- ▶ GDPS White paper:

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

For more information about the IBM TotalStorage Proven program, see:

<http://www.storage.ibm.com/proven/index.html>

For more information about the Cisco ONS 15500 Series, see:

<http://www.cisco.com>

For information about other zSeries qualified WDM vendor products, see the following Redpapers and Web sites:

- ▶ *IBM 2029 Fiber Saver DWDM, SG24-5608*(withdrawn from marketing)

<http://www.redbooks.ibm.com/abstracts/sg245608.html?open>
<http://www.ibm.com>

- ▶ *zSeries qualified WDM vendor: Adva Optical Networking, REDP-3903*

<http://www.redbooks.ibm.com/abstracts/redp3903.html?open>
<http://www.advaoptical.com>

- ▶ *zSeries qualified WDM vendor: Lucent Technologies, REDP-3906*

<http://www.redbooks.ibm.com/abstracts/redp3906.html?open>
<http://www.lucent.com>

- ▶ *zSeries qualified WDM vendor: Nortel Networks, REDP-3904*

<http://www.redbooks.ibm.com/abstracts/redp3904.html?open>
<http://www.nortelnetworks.com>

IBM GDPS qualification letters are available on ResourceLink:

<https://www.ibm.com/servers/resourceLink/1ib03020.nsf/pages/zseriesQualifiedExtendersAndWdmProductsForGdpsSolutions?OpenDocument&pathID=>

The team that wrote this Redpaper

This Redpaper was produced by a team of specialists working at the International Technical Support Organization, Poughkeepsie Center.

Bill White is a Project Leader and Senior Networking Specialist at the International Technical Support Organization, Poughkeepsie Center.

Rav Meerwald is a Networking Systems Services Representative with IBM Australia. He has 16 years of field experience with IBM, including Networking and WDM products. He provides design, implementation, and technical assistance for WDM solutions.

Jeff Nesbitt is a zSeries Systems Services Representative with IBM Australia. He has 21 years of field experience in zSeries and S/390 servers and networking products. He also provides professional services and training to zSeries clients.

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

Connie Beuselinck
zSeries Product Planning, IBM Poughkeepsie

Casimer DeCusatis
zSeries Development Lab Connectivity Solutions, IBM Poughkeepsie

Noshir Dhondy
zSeries Product Planning, IBM Poughkeepsie

Sam Mercier
Vendor Solutions Connectivity Lab, IBM Poughkeepsie

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing, IBM Corporation, North Castle Drive Armonk, NY 10504-1785 U.S.A.

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrates programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs. You may copy, modify, and distribute these sample programs in any form without payment to IBM for the purposes of developing, using, marketing, or distributing application programs conforming to IBM's application programming interfaces.

This document created or updated on April 5, 2005.




Send us your comments in one of the following ways:

- ▶ Use the online **Contact us** review redbook form found at:
ibm.com/redbooks
- ▶ Send your comments in an email to:
redbook@us.ibm.com
- ▶ Mail your comments to:
IBM Corporation, International Technical Support Organization
Dept. HYJ Mail Station P099
2455 South Road
Poughkeepsie, NY 12601-5400 U.S.A.

Trademarks

The following terms are trademarks of the International Business Machines Corporation in the United States, other countries, or both:

@server®	Sysplex™	S/390®
Enterprise Storage Server®	GDPS®	Sysplex Timer®
Extended Services®	IBM TotalStorage Proven™	TotalStorage Proven™
ESCON®	IBM®	TotalStorage®
FICON®	Parallel Sysplex®	z/OS®
Geographically Dispersed Parallel	Redbooks (logo)  ™	zSeries®

The following terms are trademarks of other companies:

Linux is a trademark of Linus Torvalds in the United States, other countries, or both.

Other company, product, and service names may be trademarks or service marks of others