EMC® Compatibility Features for IBM Copy Services on z/OS

Version 1.2

- Compatible Peer (PPRC)
- Compatible Extended (XRC)
- Compatible Native Flash (FlashCopy)

TECHBOOKS

Part number H11173

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Preface

This TechBook is intended as an introduction to EMC's compatibility features for IBM's Advanced Copy Services technologies. Its primary function is to provide EMC personnel and customers in pre-sales or early implementation activities a quick guide to the configuration and operations of PPRC, XRC, and FlashCopy compatibility features as they are supported by EMC. In addition, overview of common deployments of the Advanced Copy Services features and the degree of EMC's compliance with those features is provided, noting when relevant departures in compatibility occur. This TechBook provides the reader with functional insight into EMC's role in the deployment and operations of GDPS.

As part of an effort to improve and enhance the performance and capabilities of its product lines, EMC periodically releases revisions of its hardware and software. Therefore, some functions described in this document may not be supported by all versions of the software or hardware currently in use. For the most up-to-date information on product features, refer to your product release notes. If a product does not function properly or does not function as described in this document, contact your EMC representative.

Audience

This TechBook assumes some familiarity with the Symmetrix line of storage systems and EMC's native remote copy technology. It is the intention of this manual to document the methodology of a remote copy implementation with EMC's compatible copy services microcode features: pre-sales, customer consulting, GDPS implementation, and initial problem determination aid. The materials within do not assume that Symmetrix features will be employed in a systems managed solution (such as GDPS).

Related documentation

For EMC documentation, refer to EMC Online Support at https://support.emc.com, search by product, and choose **Documentation**.

EMC Mainframe Technology Overview

EMC Symmetrix Product Guide

EMC SRDF Product Guide

DFSMS Extended Remote Copy Reference Information for Advanced Users

DFSMS Advanced Copy Services

GDPS/PPRC Installation and Customization Guide

GDPS/HM Installation and Customization Guide

GDPS/XRC Installation and Customization Guide

GDPS/MzGM Planning and Implementation Guide

NetView and SA for z/OS manual recommendations

For IBM documentation, refer to the IBM website at http://www.ibm.com.

Note: All GDPS installation and customization guides are IBM-licensed materials and are available for use at the customer's site by the customer, the customer's contractors, and the customer's vendors once a GDPS licensing agreement is signed by the customer.

Conventions used in this document

EMC uses the following conventions for special notices:

IMPORTANT

An important notice contains information essential to software or hardware operation.

Note: A note presents information that is important, but not hazard-related.

Typographical conventions

EMC uses the following type style conventions in this document.

Normal	Used in running (nonprocedural) text for: • Names of interface elements, such as names of windows, dialog boxes, buttons, fields, and menus • Names of resources, attributes, pools, Boolean expressions, buttons, DQL statements, keywords, clauses, environment variables, functions, and utilities • URLs, pathnames, filenames, directory names, computer names, links, groups, service keys, file systems, and notifications
Bold	Used in running (nonprocedural) text for names of commands, daemons, options, programs, processes, services, applications, utilities, kernels, notifications, system calls, and man pages Used in procedures for: • Names of interface elements, such as names of windows, dialog boxes, buttons, fields, and menus • What the user specifically selects, clicks, presses, or types
Italic	Used in all text (including procedures) for: • Full titles of publications referenced in text • Emphasis, for example, a new term • Variables

`Courier`	Used for: • System output, such as an error message or script • URLs, complete paths, filenames, prompts, and syntax when shown outside of running text
`Courier bold`	Used for specific user input, such as commands
`Courier italic`	Used in procedures for: • Variables on the command line • User input variables
< >	Angle brackets enclose parameter or variable values supplied by the user
[ ]	Square brackets enclose optional values
|	Vertical bar indicates alternate selections — the bar means "or"
{ }	Braces enclose content that the user must specify, such as x or y or z
...	Ellipses indicate nonessential information omitted from the example

Where to get help

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Note: To open a service request through the EMC Online Support site, you must have a valid support agreement. Contact your EMC sales representative for details about obtaining a valid support agreement or to answer any questions about your account.

Product information

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https://support.EMC.com

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EMC offers a variety of support options.

Support by Product — EMC offers consolidated, product-specific information on the Web at:

https://support.EMC.com/products

The Support by Product web pages offer quick links to Documentation, White Papers, Advisories (such as frequently used Knowledgebase articles), and Downloads, as well as more dynamic content, such as presentations, discussion, relevant Customer Support Forum entries, and a link to EMC Live Chat.

EMC Live Chat — Open a Chat or instant message session with an EMC Support Engineer.

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Changes in Version 1.2

Support for VMAX3 related changes in CESTPATH PPRC command.

1

Introduction

This chapter provides information on what is included in this TechBook, compatibility microcode features, and remote copy technologies:

Overview

This Techbook is intended as an introduction to EMC® compatibility features for IBM's Advanced Copy Services technologies.

Its primary function is to provide EMC personnel and customers in pre-sales or early implementation activities a quick guide to the configuration and operations of PPRC, XRC, and FlashCopy compatibility features as they are supported by EMC.

In addition, this TechBook provides an overview of common deployments of the Advanced Copy Services features and the degree of EMC's compliance with those features noting, when relevant, departures in compatibility occur.

Advanced Copy Services features include:

- PPRC
- XRC (supported on VMAX 20K and 40K only)
- FlashCopy

An overview of how those features are commonly integrated into the GDPS (Geographically Dispersed Parallel Sysplex) management software offerings, including:

- GDPS/PPRC
- GDPS/HM
- GDPS/XRC
- GDPS/MzGM

This TechBook distinguishes channel compatibility (to which EMC is 100% compatible, such as FICON, MIDAW, zHPF, etc.), with copy services compatibility (to which EMC is selective), based on customer demand, perceived value, etc. This TechBook also notes which copy services options are not supported.

Intentions for this publication include:

- Feature ordering
- Diagnostic interfaces unique to EMC Symmetrix® VMAX® family arrays
- Configuration and operations of the compatibility features
- Support levels in EMC Enginuity™

- Validated z/OS release levels
- Functional overview of the compatibility features as commonly deployed
- Overview of GDPS operations and initial problem determination aid
- EMC Symmetrix Remote Data Facility (SRDF®) to PPRC conversion

Assumptions

This Techbook assumes some familiarity with the Symmetrix line of storage systems and EMC's native remote copy technology.

It is the intention of this TechBook to document the methodology of a remote copy implementation with the following EMC compatible copy services microcode features:

- Pre-sales
- Customer consulting
- GDPS implementation
- Initial problem determination aid

The materials within do not assume that Symmetrix features will be employed in a systems managed solution (such as GDPS). Consequently, the native remote copy technologies are discussed in separate sections from their possible GPDS deployment considerations.

Terminology

Throughout this manual the terms PPRC, XRC, and FlashCopy are used generically when they apply to both the EMC and IBM offerings.

Additionally, within EMC's nomenclature the terms *mirroring* and *remote copy* have very distinct meanings and are *not* synonymous. The IBM usage for these terms is frequently synonymous[1]. This is especially true in the context of GDPS remote copy operations and the status of volume pairs. Traditionally, EMC employs "mirroring" as it relates to device-level mirror positions, a concept within the Symmetrix architecture, which may or may not be an SRDF relationship.

1. The rebranding of the different modes of PPRC and XRC are case-in-point. Metro Mirror is PPRC synchronous; Global Mirror is a hardware composition of PPRC and FlashCopy; Global Copy is PPRC/XD; and z/OS Global Mirror is XRC.

GDPS deployment

One of the intentions of this manual is to provide the reader with functional insight into EMC's role in GDPS deployment and operations. Recognizing that as the Direct Access Storage Device (DASD) vendor we are in competition with organizations (within IBM and other DASD vendors), but not necessarily with the organizations responsible for the marketing, support, and implementation of GDPS.

The aim is to provide the reader with an enhanced degree of competency on GDPS implementations so as to provide additional assurance of EMC's support and competency in the GDPS market place. Moreover, since much of the GDPS implementation information is licensed to the implementation site, this manual intends to provide EMC employees and EMC's customers with information critical to GDPS planning and implementation with EMC's products.

To that end, this document focuses on topics of storage implementation and remote copy operations, but refrains from topics related to GDPS software installation, as well as GDPS z/OS systems implementations, which are otherwise quite adequately documented in their appropriate GDPS product guides.

Compatibility

In addition to this TechBook's objective of improving technical implementation competency, another intention is to improve the understanding of EMC compatible extended copy features and Symmetrix DASD in competition with other storage vendors in the GDPS market place.

This TechBook makes an effort to distinguish the different GDPS products and identify not only the requisite storage deployment, but also the required co-requisite features and expected implementation effort.

In addition to guidance on the configuration of the Symmetrix system, this TechBook also provides guidance on which compatibility features should be added to a deployment to enhance operations and which other features (such as PAVs) should be employed.

Enginuity features

While this TechBook does identify specific EMC Enginuity features implementing the copy-services functionality, the document *EMC Symmetrix VMAX and DMX Series Software Ordering Information and Configuration Guidelines* should be considered the final authority on feature ordering.

It is not the intention of this TechBook to take any position favoring the compatibility microcode features versus EMC native Symmetrix remote copy technologies (SRDF). However, this TechBook draws attention to the differences when the distinction furthers a greater understanding of the technologies, their deployment, and solution configuration.

Compatible copy services technologies

The suite of compatibility microcode features comprises remote copy technologies that have traditionally been identified with IBM and Hitachi Data Systems (HDS) DASD subsystems. These technologies constitute a significant portion of the foundational technologies of the business continuity solutions:

- GDPS/PPRC
- GDPS/XRC (VMAX 20K and 40K only)
- GDPS/MzGM (VMAX 20K and 40K only)

Note: GDPS, GDPS/PPRC, GDPS/XRC, and GDPS/MzGM are IBM trademarks.

This section briefly discusses several variants of GDPS (each individually licensed) that manage the different remote copy technologies (PPRC, XRC, FlashCopy, and Global Mirror) and their implementation over different topologies. Each of these are further discussed in more detail in this TechBook.

GDPS

GDPS is a suite of licensed software and implementation services offered by IBM to manage business continuity built on top of and extending the functionality of native remote copy technology.

Technically, the GDPS offerings are not software products; they are licensed service offerings of IBM Global Services. Support and software maintenance is delivered through normal IBM support channels. See Chapter 2, "GDPS Business Continuity Solutions," for more detailed information.

Compatible Peer (PPRC)

This feature provides synchronous and asynchronous volume remote copy technology between two volumes in different Symmetrix DASD subsystems (peer-to-peer DASD) see Chapter 3, "EMC Compatible Peer (PPRC)."

Compatible Extended (XRC) / Global Mirror

This feature provides asynchronous remote copy technology between two volumes, typically in different Symmetrix DASD subsystems over extended geographic significant distances. See Chapter 5, "Compatible Extended (XRC)."

Extended Remote Copy Enhanced Multiple Reader

This is a feature that extends the operation and performance of Compatible Extended. It would be considered for most large implementations using Compatible Extended. See "Multi-readers" on page 151.

PPRC/XRC Incremental Resync

This is a separately licensed feature that enhances the disaster-recovery availability of GDPS MzGM three- site solutions by enabling a quick resynchronization following a planned or unplanned HyperSwap. See "Three-Site Solution GDPS/MzGM" on page 205.

Compatible Native Flash (FlashCopy)

This feature provides point-in-time copy technology between two volumes in the same Symmetrix system, see Chapter 8, "Compatible Native Flash for Mainframe."

Compatibility features

The following lists EMC compatibility features with IBM remote copy features and specific GDPS offering.   Note that XRC support is only available in VMAX 20K and 40K models.

Common Name (Official IBM product name)	EMC Microcode Feature name	GDPS Offering	Related Features
PPRC (Metro Mirror) PPRC-XD (Global Copy)	Compatible Peer	GDPS/PPRC GDPS/HM GDPS/MzGM	Compatible Native Flash
XRC (z/OS Global Mirror)	Compatible Extended	GDPS/XRC GDPS/MzGM	Incremental Resynchronization Enhanced Multiple Reader Compatible Native Flash
FlashCopy	Compatible Native Flash	All versions of GDPS	

Valid combinations for compatibility features

Not all copy services features are implemented by the compatibility microcode features and that affects the combination table.

Table 1 Allowable Compatible Extended copy combinations

If device is initially—> Then it can also become:	XRC Primary	XRC Secondary	PPRC Primary	PPRC Secondary	FlashCopy Source	FlashCopy Target
XRC Primary	No, primary cannot be in 2 sessions	Yes, but timestamps are based on SDM writes	Yes, this is MzGM configuration	No, but MzGM creates shadow sessions	Yes	Yes
XRC Secondary	Yes, but timestamps are based on SDM writes	No	Yes	No	Yes	No
PPRC Primary	Yes, this is MzGM configuration	Yes	No	No, cascaded PPRC is not supported on Symmetrix systems	Yes	Yes
PPRC Secondary	No	No	No, cascaded PPRC is not supported on Symmetrix systems	No	Yes	Yes
FlashCopy Source	Yes	Yes, this is GDPS/XRC tertiary DASD	Yes, This is Remote Pair FlashCopy	Yes, This is Remote Pair FlashCopy	Yes	Yes, but not on the same extents
FlashCopy Target	No, you must XDELPAIR, FCESTABLISH XADDPAIR	No	Yes, This is Remote Pair FlashCopy	Yes, This is Remote Pair FlashCopy	Yes, but not on the same extents	Yes, but not on the same extents

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GDPS Business Continuity Solutions

This chapter provides the following information on GDPS business continuity solutions:

GDPS overview

GDPS is a suite of licensed software and implementation services offered by IBM to manage business continuity built on top of, and extending, the functionality of, native remote copy technology. There are several variants of GDPS (each individually licensed) that manage the different remote copy technologies (PPRC, XRC, FlashCopy, and Global Mirror) and their implementation over different topologies.

Technically, the GDPS offerings are not software products. Rather, they are licensed service offerings of IBM Global Services. However, support and software maintenance is delivered through normal IBM support channels.

GDPS implementations are solutions with many deliverables involving sysplex operations, sysplex definition, z/Series processors definition, LPAR definition, BCPii configuration, z/OS automation, inter-site connectivity, and DASD storage. They are multi-disciplinary implementations undertaken by a team of subject matter experts.

EMC's role is confined directly to the Symmetrix system: Feature configuration, remote copy, connectivity, and those GDPS issues relevant to the implementation and operations of GDPS related to storage and remote copy.

GDPS is marketed by IBM Global Services as an "open" solution, meaning it can be implemented on any DASD subsystem that supports the remote copy features required by the version of GDPS.

GDPS/PPRC

GDPS/PPRC is a business-continuity solution employing Compatible Peer (PPRC) for volume remote copy. GDPS/PPRC was the first variant of GDPS and established many of the architectural components and operations associated with GDPS.

GDPS/PPRC is one of the technologies that implement the foundational capabilities of FREEZE and HyperSwap.

- FREEZE is a process (like an EMC CONGROUP trip) to preserve the dependent write consistency of the secondary DASD in order to facilitate the restart of systems, applications, and workloads using the secondary DASD. GDPS supports both planned and unplanned FREEZE events to facilitate recovery operations due to DASD, processor and site failures. FREEZE is an integral part of GDPS/PPRC, implemented through PPRC's directive CGROUP FREEZE operation.
- HyperSwap is a process (like EMC AutoSwap™) to transparently swap device access between DASD units in order to eliminate DASD subsystems as a single point of failure. GDPS supports both planned and unplanned HyperSwap to facilitate continuous operations due to DASD or site failures. HyperSwap also promotes continuous availability by nearly eliminating system outage due to planned DASD outages. GDPS/PPRC may or may not be implemented with a HyperSwap capability.
- zHyperWrite is a performance solution for the DB2 active log and requires a Hyperswap environment. With zHyperwrite enabled DB2 active log writes are directed to the PPRC primary and PPRC secondary devices over the FICON channels required for Hyeprswap configuraitons. These writes do not flow across the PPRC links from primary to secondary as normal writes do in a PPRC environment. This result in much lower latency for the DB2 active log datasets. zHyperWrite is supported on VMAX3 and VMAX All Flash arrays running HyperMax OS only, and is not supported on VMAX 20K or 40K models.

GDPS/PPRC is tightly bound to its sysplex and seeks to be in the position of systems and storage control. Consequently, implementation and control of the remote copy operations and the systems in the sysplex require:

- There is a one-to-one-to-one correspondence of GDPS/PPRC, the sysplex, and the GDPS/PPRC FREEZE GROUP. All z/OS systems in the sysplex must be in the same GDPSplex[1] and there is only one write dependency in the sysplex.

1. The operational boundaries of GDPS/PPRC are significantly different than GDDR. GDPS/PPRC is bound to the sysplex and all systems must be in a sysplex with GDPS K systems. All systems must be in the same sysplex. GDPS does not support non-sysplex systems (except for the very restrictive "foreign system" implementation). In contrast, GDDR is bound to the CONGROUP and can scale over multiple sysplexes and support sysplexed systems or non-sysplexed systems.

- Operations must avoid z/OS systems HMC management, as well as PPRC operations performed manually outside of GDPS/PPRC. System operations must use the GDPS facilities, or they must be confined to specific operational techniques (even Stand Alone Dump operations requires a GDPS-specific methodology to avoid interference with GDPS). SFM policies are also restricted in a GDPS implementation (system reset is GDPS's decision alone).
- PPRC DASD defined to GDPS must not be updated by systems outside the sysplex (or employ a "foreign system" architecture as outlined in the *GPDS/PPRC Installation and Customization Guide*). Data integrity of the FREEZE operation is dependent upon initial notification being presented to and processed by GDPS/PPRC.

Note: Even read access to PPRC remotely copied DASD is prohibited since OPEN for READ generates a write to update the VTOC.

- Geographic distances are technically limited to sysplex connectivity and practically limited by application sensitivity[1] to synchronous remote copy.

Depending on the implementation topology and availability expectations, GDPS/PPRC can resemble either GDDR CONGROUP or GDDR AutoSwap.

More information is provided in Chapter 3, "EMC Compatible Peer (PPRC)."

1. Geographic distance imposes application restrictions for a number of technical reasons, not limited to remote copy and connectivity. Applications based on shared data in coupling facilities in multisite workloads can experience distance limitations more restrictive than synchronous remote copy and DASD connectivity.

GDPS/HM

GDPS/HyperSwap Manager (GDPS/HM) is a related product to the more full-function GDPS/PPRC. GDPS/HM lacks the automation of GDPS/PPRC but provides the basic storage management and autonomic operations of FREEZE and HyperSwap.

Throughout this document references to GDPS/PPRC are applicable to GDPS/HM, except where noted.

GDPS/XRC

GDPS/XRC (Compatible Extended) is a business-continuity solution for disaster recovery based on XRC. XRC is a long-distance, asynchronous copy technology with limited performance impact to the production environment, and is only supported by the VMAX 20K and 40K models

GDPS/XRC requires an extensive deployment of z/OS systems and DASD at the recovery site. GDPS facilitates the operation of DASD recovery, z/Series system management and restart of production z/OS systems, applications and workload.

GDPS/XRC has some superficial architectural resemblance to GDDR SRDF/A in that it is an asynchronous replication solution, but XRC secondary volumes lack personality-swap capability. GDPS/XRC has no inherent reverse site switch capability following an unplanned outage.

GDPS/XRC was the second variant of GDPS introduced.

More information is provided in Chapter 5, ”Compatible Extended (XRC).”

GDPS/MzGM

GDPS/MzGM is a three-site business-continuity solution combining high-availability and disaster recovery.

It is built upon a combination of GDPS/PPRC and GDPS/XRC. GDPS/PPRC manages operations between SITE1 and SITE2. GDPS/XRC manages operations between the current primary DASD SITE and SITE3.

GDPS/MzGM offers limited interoperability between the two component solutions. Interoperation between the GDPS/PPRC and GDPS/XRC is loosely coupled with few provisions for joint or coordinated operations.

More information is provided in "Three-Site Solution GDPS/MzGM" on page 207.

Unsupported GDPS architectures

EMC does not support Global Mirror-based solution GDPS/GM, nor its three-site implementation, GDPS/MGM.

Common features of GDPS versions

This section contains the following information for common features:

Supported GDPS Releases

EMC has validated GDPS/PPRC, GDPS/XRC and GDPS/MzGM Releases 3.9 and 3.10.

NetView and system automation for z/OS components

Most GDPS functions run in the NetView address space and employ NetView and System Display Facility (SDF) panels for the operator interface, variable management, automated operations, DASD remote copy relationships, and inter system connectivity. GDPS is an application within NetView, which makes use of many of the imbedded technologies and automated operations capabilities of NetView.

GDPS employs System Automation for z/OS (also known as "SA") for definition of the computing architecture, the business availability and recovery policies, host systems and coupling facility definitions, BCPii interface, recovery scripts, as well as maintenance of the interface to manage the definitions saved in the Production Data Base (PDB).

NetView operator

Netview operator provides the human interface to GDPS (also available through a web interface).

- Top-down DASD remote copy panels with display, status, and manual operations
- Site and remote copy status
- Sysplex and systems management
- Execution of control scripts
- Activation of new PPRC definitions and GEOPLEX policy
- Access to system automation's SDF for dynamic monitoring and warning

SCRIPT language with TAKEOVER, CONTROL, and BATCH scripts

GDPS scripts[1] consist of GDPS keywords that execute in the NetView Address space[2]. There are three kinds of scripts. The real distinction is when and how they can be invoked.

- TAKEOVER scripts are run as a result of unplanned events, such as DASD failure, remote copy linkage failure, system failure, and site failure. Also known as unplanned actions, they cannot be invoked by manual operations (although there are known activities that can precipitate the failure symptoms and invoke the scripts). It is unlikely that EMC personnel would be involved with TAKEOVER script creation and or maintenance. TAKEOVER script names are generally reserved names that identify the failure or component.
- CONTROL scripts are run by a NetView operator as a result of selecting the CONTROL script for execution.
- BATCH scripts resemble CONTROL scripts, but can be invoked externally to the GDPS NetView operator.

GDPS scripts are unique to every GDPS implementation. The scripts are very specific to the individual product, with few examples of scripts that can be run in every environment.

This TechBook describes some operational aspects and documents the GDPS SCRIPT keywords. Documentation of creation,

1. GDPS scripts are significantly different in form and operation from GDDR scripts.
2. GDPS scripts are not REXX scripts, although there are keywords to invoke external REXX operations.

management, and activation of the SCRIPTs, which requires using the SA for z/OS ISPF interface, is beyond the scope of this manual.

GEOPARM and GEOXPARM storage policy definitions

GEOPARM specifications establish the remote copy relationships between volumes (PPRC, XRC, and FlashCopy). PPRC GEOPARM establishes the expected linkage definitions and FREEZE GROUP definitions. XRC GEOXPARM defines to GDPS the expected SDM architecture. GEOPARM syntax is very dependent on the type of GDPS employed. Component specification, volume inclusion, and the definition of volume remote copy relationships establish the GDPS policy of the limit of operations and operational awareness.

Basically, the GEOPARM is a PDS with one active member allocated to the NetView domain[1] (started task) running GDPS and edited through ISPF.

Alteration of GDPS's mirroring definitions requires that you first alter the GEOPARM definitions, followed by validation and activation of the new GEOPARM.

Policy Data Base (PDB)

GEOPLEX policy is defined in SA for z/OS Policy Database. The operational policies of GDPS are established in the PDB, and the available settings are very dependent on the deployed version of GDPS. For instance, the FREEZE and SWAP policies of GDPS/PPRC are established in GDPS/PPRC PDB. Creation of the GDPS policy requires extensive customization of the standard sections of the PDB, as well as the addition of User ET pairs[2]. GDPS SCRIPTs also reside in the PDB as keyword pairs.

1. It is not uncommon to encounter environments with NetView domains dedicated to operations other than GDPS; only the GDPS NetView has a GEOPARM DD statement.
2. In form and structure, the PDB somewhat resembles the registry of Windows: Keywords and values.

Sysplex

GDPS employs sysplex functionality and must be implemented as a sysplex. The one notable exception is GDPS/GM, which employs Global Mirroring, employs limited sysplex functionality, and is not supported by EMC's compatibility features. GDPS/PPRC is an integral part of the production sysplex. GDPS/XRC runs a distinct recovery sysplex dedicated to running GDPS at the remote disaster recovery (DR) site.

K systems

A required feature of GDPS solutions are GDPS K[1] z/OS systems (like GDDR C systems), which provide operational control. They should be designed with sufficient redundancy and separation to provide a point of control independent of DASD, processor, or site failures.

The GDPS K systems have specific Symmetrix implementation requirements. Principally, K system connectivity and K system isolation are important deliverables of EMC in a GDPS deployment.

1. GDPS was developed for VPC (now Euroclear Sweden) in Stockholm Sweden. Throughout the GDPS code, panel names, and global variables, there are legacy references to the initial site and its Swedish origin. The K, for KONTROL, is one of these legacies.

Documentation

This section provides documentation references.

Advanced Copy Services

The *DFSMS Advanced Copy Services* manual documents XRC, FlashCopy, PPRC operations, TSO commands, batch interfaces, diagnostic system commands, and assembler interfaces.

The EMC suite of compatible Advanced Copy Services is externally compliant with the documentation. EMC does not provide separate user guides for these features.

GDPS manuals

Generalized information regarding GDPS is available in *GDPS Family – An Introduction to Concepts and Capabilities*, which is available for download. Detailed implementation, customization, and operations material is available in the individual offering installation and customization guides, which are licensed IBM materials.

3

EMC Compatible Peer (PPRC)

This chapter provides the following information on EMC Compatible Peer (PPRC):

PPRC overview

Compatible Peer (PPRC) is a volume-to-volume physical remote copy feature between different Symmetrix DASD subsystems. The EMC official name for this feature is Compatible Peer.

- Externally, it is somewhat analogous to SRDF/S and Adaptive Copy[1], and there is some overlap in their operational modes.
- Internally, Compatible Peer Remote Copy employs SRDF/S and Adaptive Copy[2] operations and physical components in a manner of operation compatible with PPRC.

Because microcode operation shares some of the same components as SRDF, but is managed as PPRC, it is sometimes referred to as PPRC emulation.

EMC Compatible Peer is operationally equivalent to PPRC in a GDPS/PPRC implementation and most native PPRC implementations. When enabled with the compatible PPRC feature, EMC Symmetrix subsystems respond to PPRC CCWs, report errors as PPRC would, and can be managed through the external interfaces of TSO commands, ICKDSF directives, and the Advanced Copy Services API. This enables manual management or automated management (GDPS/PPRC or GDPS/HM) of PPRC operations on a Symmetrix system.

Compatible Peer's volume pairs must be composed of EMC volumes. However, Symmetrix systems with Compatible Peer can be configured with other vendor DASD subsystems employing PPRC (side-by-side).

Even though Compatible Peer employs SRDF/S microcode operations and physical Symmetrix components, it is operated entirely by PPRC directives. Compatible Peer requires no EMC software for its definition and operation; in fact, the Symmetrix Control Facility address space (SCF) is counter-indicated in many GDPS/PPRC implementations.

1. Compatible Peer employs SRDF/S and Adaptive Copy operations and components for remote copy operations. PPRC Primary Volumes and PPRC Secondary Volumes are SRDF/S R1 and R2 devices. It also uses the RDF linkage between a Symmetrix system and internally employed by SRDF Device Groups.
2. Operation of PPRC volumes by SRDF commands is not supported.

PPRC components

Figure 1 illustrates the components of Compatible Peer implemented in a Symmetrix system.

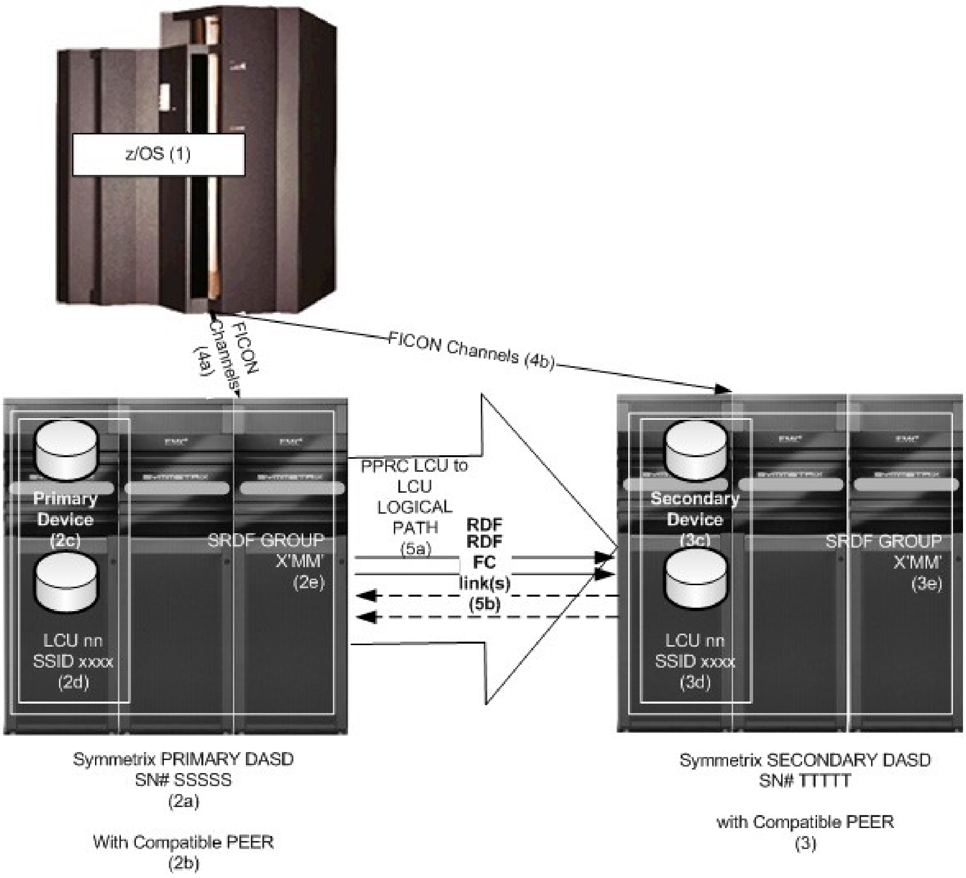

Figure 1 PPRC components

Major PPRC components, as shown in Figure 1, include:

1. z/OS system PPRC links, devices, and remote copy are defined and managed from z/OS PPRC directives exclusively.
2. PRIMARY Symmetrix DASD subsystem.
   a. Symmetrix Primary DASD serial number required for PPRC directives.

   b. Compatible Peer licensing.

   c. PRIMARY DASD device addresses required for PPRC directives.

   d. LCUs and SSIDs required for PPRC directives. The LCU and SSID have roles in the definition of the logical PPRC paths as well as identifying the device-to-device remote copy relationships.

   e. SRDF GROUP (in the range 00-3F), defined in the Symmetrix configuration, is required for PPRC directives.

3. SECONDARY Symmetrix DASD subsystem.

   a. Symmetrix Secondary DASD serial number required for PPRC directives.

   b. Compatible Peer licensing.

   c. SECONDARY DASD device addresses required for PPRC directives.

   d. LCUs and SSIDs required for PPRC directives.

   e. SRDF GROUP (in the range 00-3F), defined in the Symmetrix configuration, is required for PPRC directives (although the SRDF GROUP on the secondary VMAX is not required to be the same as the SRDF GROUP on the primary VMAX, it typically is).

4. FICON channel connectivity.

   a. FICON channel connectivity to Primary DASD.

   b. FICON channel connectivity to Secondary DASD.

5. SRDF linkage.

   a. VMAX-to-VMAX physical links are used to define the LCU-to-LCU logical PATHs.

   b. Physical RDF linkage (up to 8 shared physical RDF links per PPRC logical PATH between LCUs). The RDF ports can either be Fibre Channel or GigE boards in the VMAX. When distance requirements demand, Fibre Channel can employ SAN switches or FCIP converter. When using GigE ports connectivity can use either IPV4 or IPV6 GigE network. If no switch is employed the SRDF GROUP must be x’00’.

SRDF/S operations and Compatible Peer

IMPORTANT

The Symmetrix configuration file and physical connectivity must be in agreement for Compatible Peer to emulate PPRC predictably, especially in GDPS/PPRC implementations.

Compatible Peer actually employs components and some microcode operations of SRDF/S. Compatible Peer's PPRC PATHs, PPRC volume pairs, and CGROUPs operate exactly as PPRC PATHs, volume pairs, and CGROUPs.

The logical entity of SRDF/S GROUP name defined in the Symmetrix configuration file and the physical SRDF links are two components that are externalized in Compatible Peer definition and operation.

External manifestation of the SRDF/S GROUP name

- The SRDF/S GROUP Name defined in the Symmetrix configuration file is represented in the PPRC PATH LINK definition between LCUs.
- Typically, multiple SRDF/S GROUP Names are created in the Symmetrix configuration file. PPRC paths can all employ the same SRDF/S GROUP name or use different ones. With PPRC, preservation of the dependent writes is formed by some external entity using CGROUP FREEZE/RUN technology, such as GDPS/PPRC. Therefore, it is immaterial if different SRDF/S GROUP names are used or the same one.
- Except for its role in the definition of PPRC PATHs, the SRDF/S GROUP Name is not involved in the formation of consistency or the external operation of Compatible Peer.
- Symmetrix configuration file definition for RDF_Directors and the RDF_GROUPs should be in agreement with the intended LINK definitions in the PPRC CESTPATH definitions.
- Because the underlying technology is SRDF, successful PPRC logical PATH management (through CESTPATH, CDELPATH, abd CGROUP FREEZE) depend upon agreement between the Symmetrix configuration file definition and CESTPATH definitions (and GDPS GEOPARM specification of the links between SSIDs in the LINKs Section).

Supported and non-supported PPRC modes

Compatible Peer supports two modes of PPRC operations:

- Metro Mirror is a synchronous remote copy between volume pairs using PPRC PATHs over physical links. Additionally, it is capable of forming dependent write consistency.
- Global Copy, or PPRC XD, is a non-synchronous copy of changed tracks, without regard for consistency and without a CGROUP. It is primarily used for copying data when dependent write consistency can be externally accomplished. Also, it is used by GDPS as a performance feature during resynchronization operations, when consistency is unattainable. PPRC XD is similar in operation to SRDF Adaptive Copy Disk Mode.

The following modes of PPRC operation are not supported by Compatible Peer:

- Global Mirror (GM): A combination of PPRC XD, FlashCopy and remote control by a designed control DASD subsystem.
- Metro Global Mirror (MGM): A cascaded configuration of Metro Mirror and Global Mirror to create a three- site solution.

PPRC operation

The following is an overview of Compatible Peer implementation, management, operations, and device status (state transitions).

1. Identify pairs of Symmetrix DASD subsystems (primary Symmetrix and secondary Symmetrix system).
   a. Define Compatible Peer options in the Symmetrix configuration.
   b. Define SRDF group connectivity for SRDF/S.
2. Establish the PPRC logical paths between pairs of LCUs (SSIDs) designating multiple physical link address(es) with the TSO COMMAND CESTPATH or through GDPS/PPRC GEOPARM definition.
   a. Enable PPRC consistency group (CGROUP) for those LCU pairs whose volumes require consistency. CGROUP is a consistency capability based on the paired volumes within a pair of LCUs and their logical paths.
   b. Logical paths are unidirectional, designating a primary LCU with primary volumes and secondary LCU with secondary volumes.
3. Establish the remote copy sessions for pairs of z/OS volumes in SIMPLEX state (not in a remote copy relationship) and the synchronization option in LCU pairs with the previously defined PPRC paths using the TSO COMMAND CESTPAIR (or through GDPS/PPRC GEOPARM definition) and operations. Typically, the primary volume is online and secondary volume is offline. The primary volume remains online and available while the secondary volume goes into an unavailable state.
   a. Designate which volume pairs are PPRC synchronous.
   b. Designate which volume pairs are PPRC eXtended Distance.
   c. Depending on MODE specification, volume pairs automatically begin initial COPY. Primary and secondary volumes are initially in PENDING state and transition to DUPLEX state as they complete initial copy.
4. Operation of a Remote Copy of writes.
   a. When PPRC is in synchronous mode.

  - Write from the production system.
  - Write is accepted by primary Symmetrix.
  - Update is sent to secondary Symmetrix.
  - Acknowledgement from secondary Symmetrix to primary Symmetrix.
  - Acknowledgement to system.

b. When PPRC is in XD mode.

  - Write from production system.
  - Write is accepted by primary Symmetrix.
  - Acknowledgment to the production system.
  - Asynchronous update to secondary Symmetrix.
  - Acknowledgement from secondary Symmetrix to primary Symmetrix.

5. Remote Copy suspension: The primary and secondary volumes are in suspended state with updates to the primary volumes tracked in a bitmap (owed tracks). The volumes are in PRIMARY SUSPENDED state and SECONDARY SUSPENDED state.

   a. Unplanned suspension with PPRC CGROUP occurs when there is a failure to remotely copy a write to the secondary volume (including a linkage failure). The ELB timer provides an opportunity for the external management system to preserve write dependency in the secondary volumes.

   b. Unplanned suspension without PPRC CGROUP also occurs when there is a failure to remotely copy a write to the secondary volume. No provision is made to preserve write consistency in the secondary volumes.

   c. Planned suspension with TSO COMMAND CSUSPEND or GDPS/PPRC operations.

6. PPRC resynchronization operation: volumes start in PRIMARY SUSPENDED and SECONDARY SUSPENDED.

   a. Suspended volume pairs start resynchronization through the TSO COMMAND CESTPAIR with MODE(RESYNC) or the equivalent GDPS/PPRC operation.

   b. Primary and secondary volumes return to DUPLEX state when resynchronization completes.

7. PPRC FailOver/FailBack (FO/FB) is performed through the CESTPAIR TSO COMMAND CESTPAIR or GDPS/PPRC operations.

   a. FAILOVER is equivalent to an EMC SRDF half-swap operation. Typically, it is employed after HyperSwap establishing the previous secondary volumes are primary volumes (without necessarily defining the secondary volume) in anticipation of eventual resynchronization actions. Updates are now tracked in the new primary volume's bitmap, enabling a quick resynchronization after failover to secondary DASD.

   b. It is an enabling technology for HyperSwap.

   c. FAILBACK re-establishes the original primary/secondary relationship. Changed tracks, recorded since FAILOVER are copied to the specified secondary.

8. Remove volume remote copy session between volume pairs by using the TSO COMMAND CDELPAIR or GDPS/PPRC operations.

   a. Primary and secondary volumes are returned to SIMPLEX state.

9. Remove the logical Path and LCU to LCU pairing by using the TSO COMMAND CDELPATH or GDPS/PPRC operations.

10. Conversion of Metro Mirror to Global Copy.

Figure 2 on page 56 shows the abbreviated PPRC states.

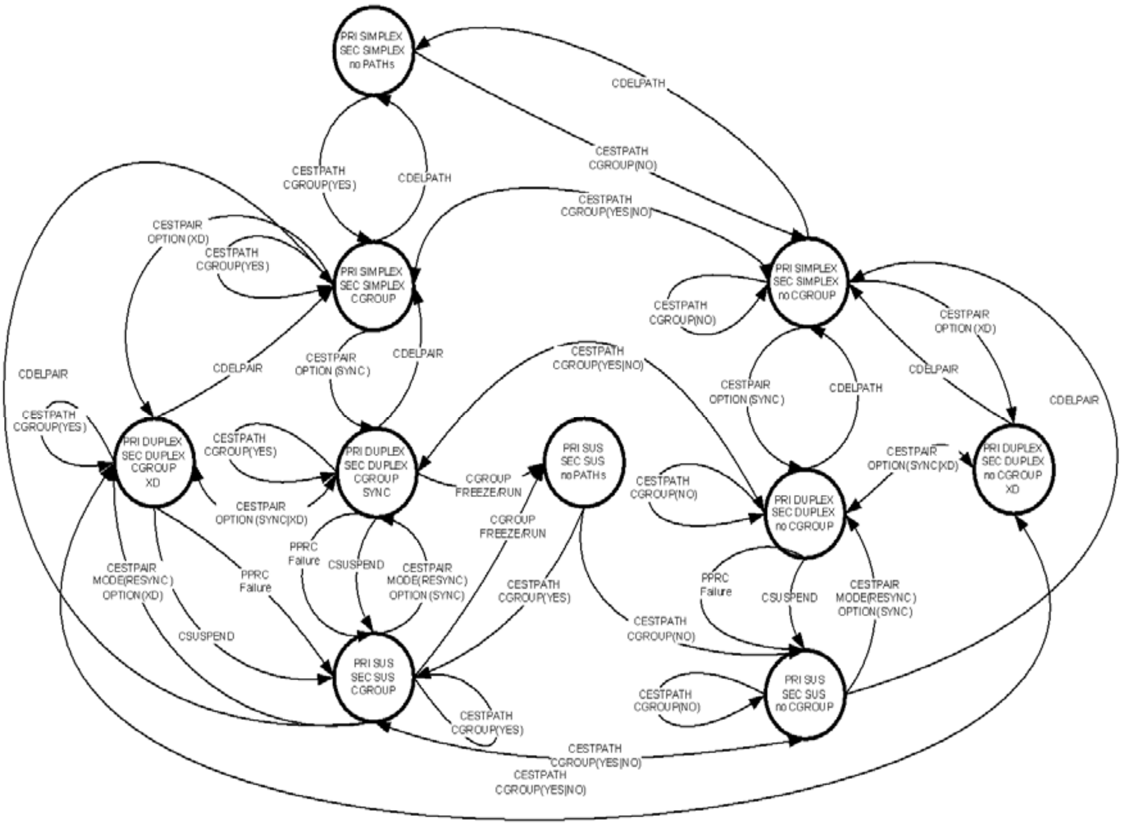

Figure 2 **Abbreviated PPRC states**

Supported PPRC features

The following supported PPRC features are briefly discussed in this section:

Metro Mirror and Global Copy

While it might seem convenient to think of the volume-to-volume relationship first, in actuality a more complete understanding of PPRC operations (as well as the management systems like GDPS) can be realized by first understanding the logical path definitions and physical RDF linkage used by PPRC.

By relating Logical Control Unit (LCU) pairs to the physical links and the consistency requirements, the logical pathing becomes the foundation of PPRC CGROUP consistency.

PPRC Consistency Group

PPRC consistency group is the basis by which dependent write consistency is formed by automation products, such as GDPS. It is based on the definition of the links between two LCUs, the physical SRDF links, the SRDF GROUP, and whether CGROUP is enabled for that LCU pairing and pathing or not when the PPRC PATH is established.

- A PPRC consistency group is on a LCU-to-LCU basis. It is explicitly enabled by the CGROUP parameter of the CESTPATH command, and its boundaries are limited to the volumes in a LCU pair.
- The logical PATH between LCU pairs is established by the link addresses of the CESTPATH command and is essentially a logical representation of the physical links between Symmetrix subsystems using SRDF groups in the link address parameter of the CESTPATH command. The physical links are typically shared over many PPRC consistency groups (LCU pairs). The logical path between two LCU pairs can consist of up to 8 logical links between LCU pairs.
- Typically, volumes and LCUs are established on a one-to-one basis. However, a primary LCU can be in more than one consistency group if the secondary volumes reside in multiple LCUs (fan out). Likewise, a secondary LCU can be in multiple consistency groups if the primary volumes are in multiple LCUs (fan in). A failure in one PPRC CGROUP does not imply failures in other PPRC consistency groups, even if the LCUs are in the same DASD subsystems.
- PPRC remote copy failures (signaled by an interrupt from the CU) are issued only for the first write I/O that fails, then a long busy is raised for up to the duration of the PPRC Consistency Group Timer (ELB Timer). Subsequent writes to other volumes in that CGROUP will encounter long busy for the duration of the long busy delay.
- ENF is raised and z/OS issues an IEA491E message.
- If no action is taken during the LONG BUSY and the LONG BUSY "expires", PPRC is suspended for the volume pairs in the consistency group and subsequent write I/Os do not result in LONG BUSY conditions.
- The LONG BUSY enables automated operations to suspend all other PPRC remote copy relationships and preserve dependent write consistency.

Preservation of dependent write consistency during the LONG BUSY is one of the primary purposes of GDPS/PPRC. It is responsible for recognizing the first failure of remote copy volume pair in its policy, which might be the first indication of a disaster, and ensure dependent write consistency of the secondary DASD by propagating that suspension over all remaining remote copy pairs in its policy while applications are waiting on the long busy indication. CGROUP only applies to PPRC synchronous. PPRC XD operation does not maintain consistency.

Note: An often-repeated misrepresentation of GDPS processing is to say that GDPS responds to the long busy, which it emphatically cannot recognize. GDPS responds to the external symptoms (ENF warning) and exploits the long busy during which it ensures the dependent write consistency of the secondary DASD.

CRIT(Y)

CRIT(Y) is now an infrequently-employed technique for establishing data consistency and is actually somewhat incompatible with GDPS/PPRC. However, some customers still employ it as the means of achieving a near zero data loss policy.

Compatible Peer Supports CRIT(Y) specification and Symmetrix configuration file settings also support both CRIT(YES-ALL) and CRIT(YES-PATHS).

IBM DASD subsystem setting	Symmetrix DASD subsystem setting	Interpretation
CRIT(YES-ALL)	CRIT HEAVY = YES	Inhibits writes on any PPRC write failure, including secondary device failure
CRIT(YES-PATHS)	CRIT HEAVY = NO	Inhibits writes when all paths to a secondary volume are unavailable

PPRC/FlashCopy Consistency Group Timeout

PPRC/FlashCopy Consistency Timer setting, also known as both LCU Long Busy and ELB Timer, is the duration that a device can present long busy after it reports a failure of a remote copy write in a CGROUP. It provides an opportunity of finite duration for automation systems to recognize the remote copy failure, propagate a CGROUP FREEZE across all PPRC CGROUPS, and, in doing so, preserve the dependent write consistency across all secondary volumes in multiple LCU pairs.

On Symmetrix systems, the ELB is set on the Symmetrix configuration IMPL initialization panel for CKD devices, PPRC/FlashCopy Consistency Group Timeout value.

Volume pairs

A Compatible Peer volume relationships on Symmetrix system consists of:

- PPRC PRIMARY volume online to applications and can be read or written to. The device is actually an SRDF/S R1.
- PPRC SECONDARY volume offline to applications. The z/OS volume shares the same VOLSER as the primary volume. The device is actually an SRDF/S R2.

Compatible Peer requires that the R1 and R2 devices are in different Symmetrix DASD Subsystems.

Compatible Peer requires that the devices are defined in the VMAX Configuration file Section VolMap as dynamic SRDF, setting DRX.

Volume-pair relationships are managed though the PPRC directives[1] (typically, TSO commands):

- CESTPAIR: Establishes remote copy between two volumes.
- CDELPAIR: Deletes the PPRC session between two volumes and makes both volumes simplex.
- CSUSPEND: Stops active remote copy and makes the primary volume suspended, PRI(SUS), and the secondary volume suspended, SEC(SUS).
- CRECOVER: Deletes the PPRC session on the secondary device and makes the former secondary volume available for access by applications (as a simplex volume).

PPRC pathing

Compatible Peer supports the physical RDF linkage to support PPRC logical pathing operations, definitions, management, error recovery and reporting.

- A PPRC path is a logical relationship between LCU to LCU over specific RDF links and a specified consistency (CGROUP).
- The logical path is composed of at least one, and up to eight, physical RDF links.

1. In addition to TSO COMMANDS, there is also the ICKDSF statements and assembler API. GDPS/PPRC employs the API.

- Physical links are typically shared by as many paths between LCU pairs as required.
- Sending and receiving side director numbers are often the same position port and director but can be different.
- Sending and receiving side SRDF Groups are often the same on the R1 and R2 Symmetrix DASD subsystems but may be different (i.e., GROUP 10 to GROUP 20).
- Link definitions (linkaddr in the CESTPATH TSO command) are unique to Symmetrix systems. Symmetrix physical architecture differs from other vendor’s hardware offerings and definition of the links (linkaddr) will differ as well.
- The formation of Symmetrix linkaddr is described in Appendix A, “PPRC PATHing and Linkage Address.”
- The formation of dependent write consistency over multiple LCU pairs spanning multiple DASD subsystems is dependent on the timely interruption of the logical paths by some external management such as GDPS. EMC Consistency Group software, such as SCF, does not form PPRC CGROUP consistency and is not required.
- Transparent definition and management through the existing PPRC TSO commands, with the exception of the before-mentioned linkaddr definitions, unique to Symmetrix connectivity.
- Warning and failure reporting consistent with PPRC operations and compliant with GDPS/PPRC.
- There is no mechanism to add or delete single links in a PPRC path. Issuing subsequent CESTPATHs for the same LCU pairs constitutes a complete replacement for all links between the LCUs. As previously mentioned, because the underlying remote copy technology is SRDF/S, Compatible Peer, PATH management operates most consistently with PPRC operations when the Symmetrix configuration file definitions of RDF_Director and RDF_GROUPs are in agreement with the PPRC CESTPATH definitions.

Logical paths are managed through the following PPRC command directives (TSO Command names):

- CESTPATH creates or replaces all existing linkage between LCU pairs.
- CDELPATH deletes all the existing linkage between LCU pairs.

- CGROUP FREEZE deletes all existing linkage between LCU pairs and suspends all volume pairs.

Path specifications unique to EMC

In addition to the linkaddr physical differences related to the PPRC PATH specification, there is another difference, unrelated to remote copy operations, that effects Symmetrix path definitions. Recent IBM DASD Subsystems support World Wide Node Name (WWN) reference of their Fibre Channel adapter number instead of by serial number. The change in IBM connectivity (physical ESCON to FCP) corresponded to WWNN support.

SRDF ports (FCP or GigE) on Symmetrix systems do not use WWNN identification and definitions of the PPRC logical paths. Instead, they must employ serial number format. This difference is also reflected in the definition of the paths in the GDPS GEOPARM. See "GEOPARM specifications unique to Symmetrix systems" on page 104 for further discussion on pathing definition under GDPS.

TSO CESTPATH examples

Establish pathing between two LCUs without a consistency group

```
CESTPATH DEVN(x'nnnn') SUBCHSET(0) PRIM(x'ssid' serialno x'lss') SEC(x'ssid'
   serialno x'lss') LINK(x'linkaddr',…,x'linkaddr') CGROUP(NO)
```

- nnnn is 4 character hex device address in the primary LCU
- ssid identifies the Service Set Identifier (SSID), uses the ssid and serial number specification instead of WWNN specification.
- serialno is the serial number of the Symmetrix system.
- lss is the LCU.
- linkaddr 1 to 8 RDF links in PPRC format. For a description of linkaddr formation, see Appendix A, "PPRC PATHing and Linkage Address".

Establish pathing between two LCU and establish a consistency group

```
CESTPATH DEVN(x'nnnn') SUBCHSET(0) PRIM(x'ssid' serialno x'lss') SEC(x'ssid'
   serialno x'lss') LINK(x'linkaddr',…,x'linkaddr') CGROUP(YES)
```

Remove pathing between two LCUs

```
 CDELPATH DEVN(x'nnnn') SUBCHSET(0) PRIM(x'ssid' serialno x'lss') SEC(x'ssid'
   serialno x'lss')
```

Freeze PPRC between two LCUs

```
CGROUP FREEZE DEVN(x'nnnn') SUBCHSET(0) PRIM(x'ssid' serialno x'lss') SEC(x'ssid'
  serialno x'lss')
```

Resume I/O after a FREEZE

```
CGROUP RUN DEVN(x'nnnn') SUBCHSET(0) PRIM(x'ssid' serialno x'lss') SEC(x'ssid'
  serialno x'lss')
```

Recommendations on cabling and director/port selection

Keep the SRDF FCP linkage simple. Most large-scale remote copy solutions feature symmetrical configurations of the local and remote Symmetrix DASD subsystems.

Dependent write consistency

A key feature of any meaningful computing is the concept of dependent writes. Applications perform writes in a known order by waiting for a write to complete before initiating a second write. Critical to the restart of most database systems is the ability of the application to determine the state of transactions and back out of incomplete changes. Regardless of whether restart is attempted against the PPRC primary DASD or the recovered PPRC secondary DASD, successful restart of most applications depends upon the preservation of dependent writes in that set of DASD subsystems. There can be no “missing” writes.

Large-scale remote copy, that is, remote copy that involves many thousands of volumes in multiple DASD subsystems connected by multiple physical links, introduces susceptibility in disaster recovery scenarios when a rolling disaster suspends remote copy operations at different times. Allowing the uncoordinated and incomplete remote copy suspension in the secondary DASD subsystems has the very real potential for creating a state where some but not all dependent writes have been mirrored. This can result in data base management systems that cannot RESTART when they detect the loss of dependent write consistency. Or worse, there may be a loss of data integrity that is undetectable by the applications.

From the perspective of applications, the choice is stark:

- Application restart: Resumption of operations that resemble a restart after a power loss; or
- Application recovery: Resumption of operations that depend upon restoration of backups and application of logs.

An application restart takes place in a known period of time, typically measured in tens of minutes. However, an application recovery is a nearly open-ended proposition that, depending on the backups, logs, and applications, can take days.

It is for this reason that EMC developed SCF CONGROUP, and IBM developed GDPS/PPRC FREEZE.

CGROUP FREEZE/RUN and the preservation of dependent write consistency

The PPRC directive CGROUP (TSO command or API) is the mechanism used by automation systems to preserve dependent write consistency in the secondary PPRC DASD. An overview of consistency group operations follows:

1. Create logical paths between LCU with CESTPATH and establish a PPRC consistency group using CGROUP(Y) (or use GDPS/GEOPARM GEOPARM).
2. Create volume pairs. Once copy operations complete, the volumes pairs are in duplex state.
3. When primary Symmetrix Compatible Peer detects a remote copy failure of a write I/O to a PPRC SECONDARY volume it interrupts the z/OS host that issued the write, and then puts the primary PPRC volume in long busy for the duration of the ELB timer.
4. Subsequent writes to other volumes in same LCU pair CGROUP simply WAIT. The primary Compatible Peer makes no effort to re-notify the host of any subsequent remote copy failures.
5. An automation system (such as GDPS/PPRC) detects the failure, and while applications are waiting, the automation system must preserve all dependent write consistency in the secondary DASD by using CGROUP FREEZE to delete all PPRC PATHS and suspend all PPRC pairs in LCU pairs with CGROUP(Y).
6. Once all CGROUP FREEZEs complete, a CGROUP(RUN) can be issued by the automation system to enable writes to the primary DASD.

Failover Failback (FO/FB)

Failover/Failback is a PPRC management feature to improve resynchronization performance, reduce exposure to failures during resynchronization, and simplify failover and failback during site swaps. Without FO/FB capability, PPRC must completely resynchronize volumes after an unplanned DASD site swap.

Conceptually, FO/FB operates much like an SRDF half swap. It creates a bit table of changed tracks on a newly enabled PPRC primary device that had previously been a PPRC secondary device. Failover is established by the CESTPAIR command using the ACTION parameter. EMC Compatible Peer feature supports FO/FB.

GDPS/PPRC exploits FO/FB to speed resynchronization after HyperSwap and FREEZE.

Link failure warning

In Compatible PPRC operations, RDF Link failures generate message IEA498I to indicate that a PPRC link status has changed. This feature is implemented on Symmetrix systems for GDPS/PPRC support.

See discussion in Chapter 4, "GDPS/PPRC," on the warning status related to trapping the IEA498I message.

MIDAW and PPRC

The primary and secondary volumes in a PPRC pair must both have the same MIDAW status when HyperSwap is deployed.

Query storage controller status

This feature enables automation (such as GDPS) to query the status of secondary DASD subsystems and potentially reduce false-freezes events. VMAX DASD subsystems are recognized by GDPS/PPRC as Reduced False Freeze-capable when QSCS is implemented on all VMAX DASD subsystems.

Comparison of IBM and EMC query storage controller status

During FREEZE operation, while production systems' writes are waiting on the ELB timer (prevented from updating primary or secondary PPRC DASD in FREEZE GROUPs) automation systems can employ the Query Storage Controller Status feature as the mechanism to determine the cause of the FREEZE.

Table 2 Query DASD storage controller status comparison

PPRC Remote Copy failure	IBM DS8700 DS8800 Microcode response	Symmetrix Compatible Peer Microcode response
Device Is Fenced	Applies	Does not apply to Symmetrix system
Pinned Data Exists for the Device	Applies	Does not apply to Symmetrix system
Device is in Long Busy	Applies	Applies
Write Inhibited	Applies	Applies
Device exists on an Array that is rebuilding	Applies	Does not apply to Symmetrix system
Data Exists in the failed non-volatile storage for this device	Applies	Does not apply to Symmetrix system
Rank State is Inaccessible	Applies	Does not apply to Symmetrix system
Rank State is Offline	Applies	Does not apply to Symmetrix system
Other Symmetrix and SRDF/S failures	Does not apply to IBM	Applies

Summary event notification for PPRC suspends

This is a feature of the DS8K Synergy Package 2. It is a combination of z/OS 1.13 and microcode that affects operator notification when volume paris suspend. When PPRCSUM is enabled, the DASD subsystem issues only a single summary message on an LCU basis, instead of issuing a state change interrupt and message for every device pair suspended.

Summary Event Notification is not supported by Compatible Peer

Storage controller health message

This is a feature of the DS8K Synergy Package 2. IBM DASD uses it to notify the operating system of moderate and acute alerts. EMC DASD subsystems do not issue Storage Controller Health Messages. GDPS/PPRC's ENQ listener routine recognizes only two acute alerts, "pinned non-retryable error on a device or data loss occurred" as potential HyperSwap triggers. EMC believes that there are no analogous failure scenarios on VMAX arrays and support is unwarranted at this time.

CQUERY LINKINFO

This is a feature of DFSMS 1.13. As of this writing, feature support is under review.

PPRC TSO commands

Table 3 provides a brief description of the native TSO PPRC commands.

Table 3 PPRC TSO commands

Command	Purpose	Primary Volume	Secondary Volume
CDELPAIR	Removes the volume pair from PPRC	Y	Y
CDELPATH	Deletes the PPRC Path froma primary LCU to a secondary LCU.	Y	N
CESTPAIR	Establishes a PPRC relationship, or resynchronize two volumes. Also used in conjunction with HyperSwap or FO/FB to perform the equivalent of a half swap. Establishes synchronous or XD relationship.	Y	Y for Failover; Otherwise, N
CESTPATH	Establishes a PPRC path between two LCUs or replaces the existing linkage definitions between two LCUs, optionally establishes CGROUP for all volume pairs in the LCU-to-LCU pairing. Note that subsequent CESTPATH commands replace all existing pathing information between two LCUs.	Y	N
CGROUP	For FREEZE option, removes the path between two LCUs and suspends all PPRC relationships. The RUN option resumes applications suspended because of CGROUP FREEZE or CGROUP long busy.	Y	N
CQUERY	Queries the status of primary or secondary volumes, as well as the pathing status.	Y	Y
CRECOVER	Alters the status of a secondary volume from suspended to simplex, volume can be put online to a system and used. Once a volume is CRECOVERed in order to resume remote copy operations it must be entirely recopied.	N	Y
CSUSPEND	Suspends the remote copy relationship of a volume pair, but updates are tracked, and remote copy between the primary and secondary volumes can be resumed.	Y	Y

Other PPRC interfaces

The assembler interface ANTRQST is supported, as well as the TSO and ICKDSF interfaces.

GDPS DASD Mirroring Panel and DASD SCRIPT commands are completely supported by Compatible Peer. Compatible Peer volumes cannot be managed by SRDF commands.

In addition, EMC services actions must consider the presence of PPRC mode volumes.

The ICKDSF PPRCOPY commands are also supported.

Compatible Peer versus SRDF/S and Adaptive Copy

The technology of dependent write consistency preservation in the secondary DASD subsystems is a principle difference between Compatible Peer and its underlying technology, SRDF/S.

Native SRDF/S's consistency within a Symmetrix system is based on SRDF Device and propagation of dependent write consistency over multiple Symmetrix systems and devices requires EMC CONGROUP software.

Compatible Peer dependent write consistency is based on PPRC CGROUP on an LCU-to-LCU basis. Preservation of dependent write consistency requires an external automation system, such as GDPS/PPRC.

FAST and Compatible Peer

EMC FAST™ statistics are transmitted by Compatible Peer from the Primary DASD subsystem to the Secondary DASD subsystem. Unlike other PPRC implementations, Compatible Peer ensures that the secondary DASD Tiering is representative of the primary DASD subsystem. Consequently, I/O performance is not adversely affected through tiering misalignment on VMAX arrays.

Compatible Peer limitations

Consider the following significant limitations:

- Compatible Peer does not support PPRC "loop back" configurations, which link a Symmetrix DASD subsystem's SRDF back to itself, as well as defined PPRC paths from LCUs back to other LCUs in the same Symmetrix system. Compatible Peer, like its underlying SRDF technology, only allows remote copy definitions (paths and volume pairs) between LCUs in different Symmetrix systems.
- Compatible Peer does not support PPRC open systems FBA devices. It only supports PPRC directives from FICON connectivity.
- Compatible Peer does not support cascaded PPRC.

Designing the solution for z/OS

This section describes the actions required for enabling Compatible Peer on a Symmetrix DASD subsystem and contains the following information:

PPRC Symmetrix system configuration specifications

Symmetrix configuration settings, shown in Table 4, are set by EMC Customer Service.

Table 4 Symmetrix configuration settings for PPRC compatibility (page 1 of 2)

Name	Value	Description
CKD->impl_fix_part->Enable Page data set MODE	YES | NO	If page data sets' volumes are remote copied, then set to YES. When HyperSwap is implemented, page data sets must be mirrored. Check GDPS GEOPLEX OPTIONS PRIMARYFAILURE or FREEZE policy for a SWAP setting.
CKD->impl_fix_part->Enable Cache Fast Write	YES | NO	HyperSwap requires that writes be hardened to primary DASD and remote copied to secondary DASD. Set to NO for HyperSwap implementations. Check GDPS GEOPLEX OPTIONS PRIMARYFAILURE or FREEZE policy for SWAP setting.
CKD->impl_fix_part->PPRC Crit Heavy	YES | NO	Validate setting with customer. Unused in most GDPS/PPRC deployments.
CKD->impl_fix_part->PPRC/FlashCopy Consistency Grouping	YES | NO	Enables PPRC consistency grouping for CESTPATH. Required for GDPS/PPRC implementations.

Table 4 Symmetrix configuration settings for PPRC compatibility (page 2 of 2)

Name	Value	Description
CKD->impl_fix_part->PPRC/FlashCopy Consistency grouping timer	0:65535 seconds	AKA ELB, default of 0 results in a value of 120 seconds which is typical of many GDPS/PPRC implementations. A nonzero value specifies duration in seconds. Too low of a value can result in corruption of the dependent write consistency on the secondary DASD if GDPS is unable to complete all CGROUP FREEZE and CGROUP RUN prior to the expiration of the timer. Some GDPS/PPRC implementations require maximum ELB settings. To avoid data corruption, review the implementation topology and intended availability requirements against the current GDPS/PPRC Installation and Customization Guide for the proper ELB settings. The Consistency Timer value applies to all LCUs in the Symmetrix system.
RDF->impl_fix_part->RDF Mode	SRDF	Set to SRDF for Compatible Peer
RDF->Switched RDF	YES I NO	Set to YES

Volume Map PARMs

Set SRDF attributes to DRX to enable a volume to be either an R1 or R2, which is required for GDPS/PPRC.

PPRC connectivity

Compatible Peer employs the same physical linkage as SRDF/S, and it can be implemented with the same FCP linkage used for SRDF/S. However, to form dependent write consistency, PPRC requires automation technology, such as GDPS/PPRC. GDPS, which is dependent upon a z/OS sysplex at both the primary and secondary sites, introduces network connectivity issues and requirements that tend to dominate the network provisioning. In addition, high-availability deployments employing HyperSwap require cross-site FICON connectivity compatible with system and applications operations, which also dominates decisions regarding the network provisioning.

These considerations dictate a physical network not always typical of simple PPRC and SRDF/S, but they are required of most solutions employing Symmetrix Compatible Peer (similar performance considerations exist for many GDDR deployments). See "GDPS/PPRC networking topologies" on page 120 for a discussion of networking topologies typical of a GDPS/PPRC deployment.

Any proposed Compatible Peer RDF linkage and cross-site FICON linkages must be consistent with the GDPS/PPRC network deployment, which more often than not, employs DWDM infrastructure and redundant dark-fiber implementation.

Security authorization

When implementing Compatible Peer, refer to the IBM Advanced Copy Services manual for direction on securing PPRC TSO commands.

EMC PPRC link definition

Refer to Appendix A, "PPRC PATHing and Linkage Address," for examples of defining the LINKADDRESS parameter in the CESTPATH command to define PPRC links on Symmetrix systems.

Conversion from SRDF/S to PPRC emulation

Compatible Peer employs SRDF/S components and operations. It is feasible to convert from SRDF/S to Compatible Peer, as well as the reverse, without initially copying all the data. These procedures are intended to be performed as attended operations (by EMC), as planned actions without updates from production.

4

GDPS/PPRC

This chapter provides the following information on GDPS/PPRC:

GDPS/PPRC and GDPS/HyperSwap Manager (GDPS/HM)

GDPS/PPRC is a business-continuity solution based on sysplex technology and PPRC remote copy. GDPS/PPRC is implemented in a variety of deployments to tailor different systems and storage availability, from near continuous availability with HyperSwap to simple disaster recovery deployments, using only CGROUP FREEZE and restart of workloads. GDPS/PPRC, like EMC GDDR, provides not only storage availability but systems availability and automation as well.

GDPS/PPRC is not IBM's only offering with some of these functionalities. The IBM TotalStorage Productivity Center for Replication for System z product provides some of the same functionality as GDPS/PPRC and GDPS/HM.

GDPS/PPRC operations are dependent upon sysplex connectivity between both sites. New implementations require sysplex connectivity between all systems and sites as a single sysplex. It is sometimes suggested that GDPS is required for multi-site sysplex. However, in actuality, GDPS requires multi-site sysplex topology and connectivity as one of its pre-requisite technologies[1].

GDPS/PPRC is the responsible agent for dependent write consistency. Compatible PPRC in a GDPS/PPRC requires no EMC storage management or availability components in ResourcePak for the management of the underlying SRDF operations. The only required management resources is GDPS/PPRC. Even TSO PPRC commands must be employed with caution to as not to instigate unintended GDPS/PPRC autonomic operations.

1. The exception is the rarely deployed Business Continuance architecture of GDPS/PPRC, which calls for an active K systems at the primary site, and allows for extremely limited cross-site connectivity, and no multi-site sysplex connectivity. Deployment further requires maintaining a K system image at the disaster-recovery site that is NOT part of the production GDPS sysplex. The restart of operations requires a manual re-IPL of the GDPS/K system, followed by CRECOVER operations of the PPRC secondary DASD, and GDPS assisted re-IPL of the production systems, and restart of workload.

GDPS/PPRC components

Figure 3 illustrates a GDPS/PPRC topology and common components.

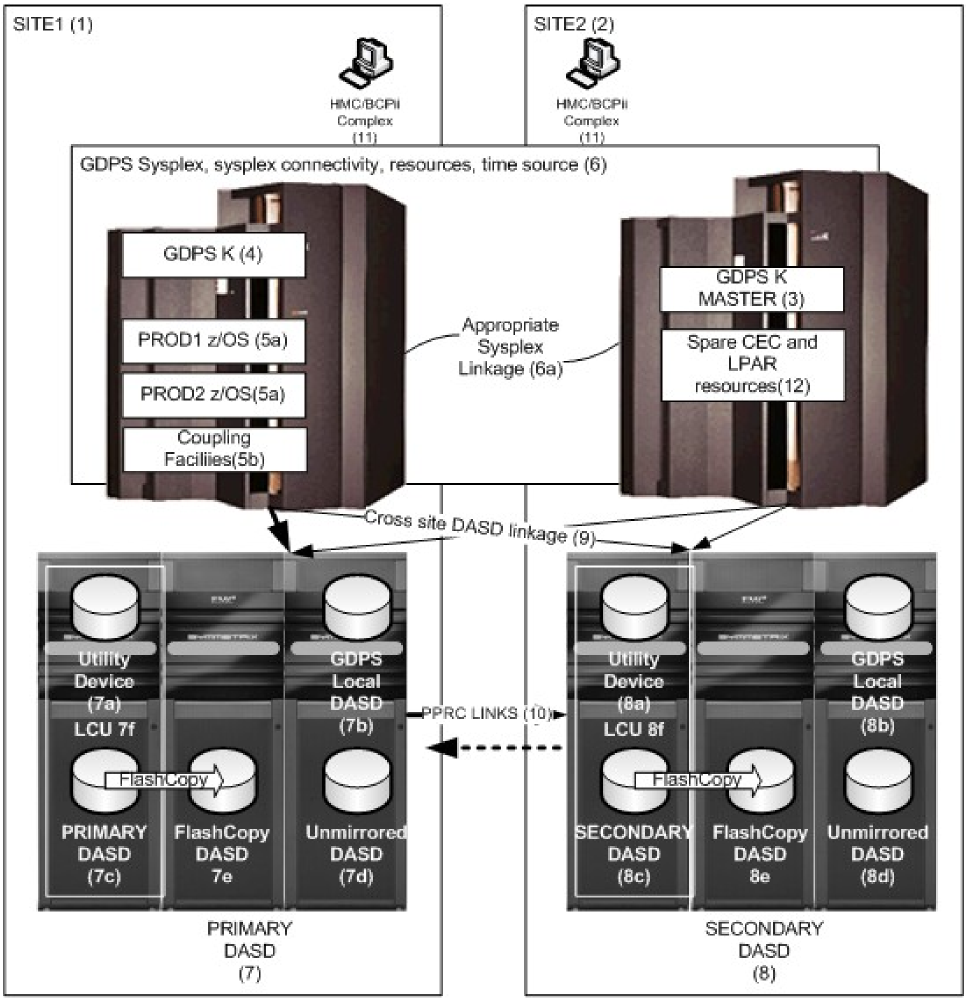

Figure 3 GDPS/PPRC components

Major GDPS/PPRC components, shown in Figure 3 on page 79, are listed below. Not all of these are germane to EMC's role and responsibilities in a GDPS/PPRC implementation, but have been included:

1. **SITE1**: The inventory of physical resources defined as residing at SITE1, including DASD, systems, processors (assumed to be the location of primary DASD most of the time).
2. **SITE2**: The inventory of physical resources defined as residing at SITE2.
3. **GDPS K Master K system**: At least one GDPS/PPRC K z/OS system is required, typically architected at SITE2. GDPS runs on all z/OS systems, but the GDPS/PPRC K systems are specially designed systems. They must be members in the sysplex (6). They require access to all the SITE1 DASD subsystems (7) and SITE2 DASD subsystems (8). They require utility devices (7a, 7b) for management of PPRC. However, the K systems cannot use any of the mirrored DASD (7c, 8C). They must have connectivity and use the sysplex data sets (7d, 8d). They must use their own isolated local DASD (7b, 8b), which cannot be remote copy volume.
4. Other **GDPS/PPRC K systems**: Two GDPS/PPRC systems are recommended (especially if HyperSwap policy is intended in the architecture).
5. **Production systems**: Usually the production systems are local to one site, but architectures with higher levels of availability do not restrict application systems to one site.
    a. z/OS systems in the sysplex.
    b. Coupling facilities used in the sysplex.
6. **A sysplex**: A GDPS/PPRC instance must reside in a sysplex, and a GDPS instance can only manage one-time consistency. Multiple sysplexes require multiple instances of GDPS/PPRC. Typically, sysplex connectivity requires DWDMs and dark-fiber. Sysplex protocols require qualified DWDMs and cards.
7. **SITE1 DASD**: Traditionally the primary DASD. However, HyperSwap implementations, especially implementations at zero distance, enables an agnostic approach to the situational locality of "primary" PPRC DASD.

a. GDPS/PPRC utility volumes for PPRC operations by K systems. In the GEOPARM these devices are identified in the NONSHARE section, NONSHARE keywords.

b. GDPS local DASD: The DASD used by the GDPS K system; SIMPLEX (not remote copied); not subject to a PPRC FREEZE; and must not be used by other systems; and typically the volumes for each K system are confined to a dedicated LCU without any PPRC logical paths. These devices are not explicitly identified in GEOPARM.

c. PPRC primary DASD: In some architecture always the PRIMARY PPRC DASD, but architectures with continuous availability do not require the association of primary DASD to a physical site (two logical sites within a physical site). In a HyperSwap implementation, both system and application access to this set of DASD is swapped with 8c. These devices are identified in the GEOPARM, section MIRROR PPRC keyword parameter s1dev.

d. Simplex DASD: For a variety of uses depending on GDPS architecture and availability requirements, but also the sysplex data sets. With architectures that do not involve HyperSwap this could be infrastructure volumes required for restart of systems, such as page data sets and volumes containing temporary data sets. These devices are not identified in the GEOPARM.

e. Optional GDPS/PPRC managed FlashCopy DASD at SITE1: Principally provisioned for two purposes: 1) established a FlashCopy relationship from 7c to 7e prior to re-synchronizing from 8c to 7c, during which time 7c's dependent write consistency is corrupt, 2) DR test image. GDPS/PPRC only supports FlashCopy interface (Compatible Native Flash). In the GEOPARM FlashCopy targets are identified in the MIRROR section, PPRC keyword parameters "s1fdev". FlashCopy target devices are typically defined in their own LCUs distinct from their FlashCopy source devices. Generally, these FlashCopy target LCUs have the same offset addressing as their source LCUs.

f. The primary PPRC LCU: Part of the LCU pair identified by the creation of a CGROUP. It contains PPRC primary volumes 7c and is further augmented by the provisioning of a GDPS/PPRC utility volume 7a.

8. **SITE2 DASD**: Traditionally the secondary DASD.
   a. Utility devices. Like 7a, these devices are identified in the NONSHARE section of the GEOPARM keyword nonshare.
   b. GDPS/PPRC local DASD. Typically the GDPS/PPRC K Master System's local DASD, like 7b, these devices are not explicitly identified by the GEOPARM.
   c. PPRC secondary DASD. Like 7c these devices are identified by the PPRC statements in the GEOPARM. They are specified in the GEOPARM mirror section, keyword PPRC parameter s2dev.
   d. Simplex DASD.
   e. Optional GDPS/PPRC managed FlashCopy DASD at SITE2: Has similar provisional considerations as 7e. They are identified in the MIRROR section, PPRC keyword's parameters "s1fdev". As is the case with the primary FlashCopy targets (7e), these too are generally confined to their own LCU.
   f. The secondary PPRC LCU: Part of the LCU pair identified by the creation of a CGROUP. It contains PPRC secondary volumes 8c and is further augmented by the provisioning of a GDPS/PPRC utility volume 8a.
9. **cross-site DASD connectivity**: Complexity and bandwidth depends on the solution's implementation and intended system and DASD availability. Non-HyperSwap solutions require modest cross-site connectivity (only the K Master system needs access to the SITE1 DASD from SITE2). Because HyperSwap assumes that operations must continue after a HyperSwap, those implementations' cross-site connectivity must have the performance and redundancy of local-site connectivity.
10. **PPRC linkage:** Symmetrix RDF links used to form PPRC paths. Identified in the GEOPARM SITE1 and SITE2 statements.
11. **BCPii:** Interfaces and components, HMCs, SEs, TCP/IP connectivity.
12. **Spare CEC and LPAR:** Resources required and capacity on standby.

EMC DASD Support Matrix for GDPS/PPRC

See Appendix D, "GDPS/PPRC Support Matrix," for the complete VMAX array, base Enginuity, Compatible Peer, and Compatible Native Flash matrix.

GDPS/PPRC storage management functions

The following are the basic operations, operational goals, and how GDPS/PPRC accomplishes them.

- GDPS/PPRC FREEZE and HyperSwap are features of automation technologies. They are not native operations of the DASD subsystem, but they exploit the CGROUP FREEZE feature of PPRC capable controllers.
- PPRC path management definition: starting and stopping of paths and CGROUP FREEZE.
- PPRC device management, pair definitions, operations, starting and suspending PPRC through panel operations, script operations, and autonomic operations .
- Availability through planned and unplanned HyperSwap operations.
- Remote Copy status monitoring. GDPS/PPRC has monitoring functions to constantly validate many aspects of the solution’s integrity.
- FlashCopy management to create DR copies, as well as ensure a recoverable point-in-time copy during resynchronization.

GEOPARM

GDPS's GEOPARM data set defines the expected remote copy definitions, PPRC and FlashCopy, as well as GDPS's operational realm.

In addition to establishing the remote copy relationships between volumes, the GEOPARM establishes the consistency requirements (PPRC CGROUP), the logical PPRC pathing, GDPS/PPRC utility devices, and site inventory, (that is, which subsystem is at which site). The GEOPARM functions as the principal definition of the remote copy architecture and establishes GDPS/PPRC's policy domain for planned and unplanned storage operations.

Autonomic policies and GEOPLEX

The different operational goals of a GDPS/PPRC implementation, and to some extent the system topology, are dependent upon the GEOPLEX policy definition in System Automation (SA for z/OS). Understanding the role of policy and the topology of the implementation has a role in the deployment of not only PPRC but also the provisioning of FlashCopy licensing and Symmetrix capacity; as well as requisite Symmetrix cross-site DASD connectivity, which is directly dependent upon the number of Symmetrix engines to provide the FICON and FCP connectivity; HyperSwap imposes different rules on the replication settings in the Symmetrix configuration and volume addressing. Consequently, it is important to understand the customer's GDPS/PPRC policy settings and their effect on Symmetrix configuration specification. However, the inherent configurability of Symmetrix systems make it a excellent GDPS/PPRC candidate.

GDPS/PPRC 3.8 introduced “Split Freeze Policy,” which replaces a single GEOPLEX OPTIONS FREEZE policy, with separate policies for primary DASD failures (PRIMARYFAILURE) and PPRC failures (PPRCFAILURE). VMAX and Compatible Peer are now detected by GDPS/PPRC as Reduced False Freeze-capable and enable GDPS/PPRC to employ support Enhanced Conditional Freeze&Stop operations during unplanned freeze operations when PPRCFAILURE is COND.

This section contains the following information:

“GEOPLEX options PRIMARYFAILURE” on page 84

“GEOPLEX options PPRCFAILURE” on page 85

“Policy implications and remote copy definition” on page 87

GEOPLEX options PRIMARYFAILURE

The PRIMARYFAILURE options are “GO”, “STOP”, “SWAP,GO” and “SWAP,STOP” and determine the autonomic operations in the event of a failure of primary DASD (write I/O error or connectivity error):

- GO: in the event of a primary DASD failure, GDPS/PPRC first does a Freeze to assure dependent write consistency of the secondary DASD then z/OS systems are allowed to continue. If the failure is a precursory event to an actual disaster, SITE1 operations must be stopped, secondary DASD must be CRECOVER and production z/OS systems must be restarted at SITE2. Implementations with GO tend to have high-availability requirements and are tolerant of some data loss, if primary DASD failures are precursory events to an actual disaster. Implementations with PRIMARYFAILURE of GO frequently provision a FlashCopy capability at SITE2.

- STOP: in the event of a primary DASD failure, GDPS/PPRC does a Freeze&Stop to assure dependent write consistency of the secondary DASD, then z/OS systems are stopped (reset). If the failure is a precursory event to an actual disaster, secondary DASD require CRECOVER operations and production systems need to be restarted at SITE2. Implementations with STOP have lower z/OS system availability requirements and are intolerant of data loss. Implementations with PRIMARYFAILURE of STOP frequently provision a FlashCopy capability at SITE2.
- SWAP: in the event of a primary DASD failure GDPS/PPRC performs a HyperSwap switching production systems' access from all primary PPRC volumes DASD to the secondary PPRC volumes, without restarting the systems or applications. This is typical of solutions with high-availability requirements and a low tolerance for data loss. The two operational sites must be close enough that operations can perform adequately after a HyperSwap, without moving systems. There must be extensive cross-site connectivity, and the solution is typically not provisioned with FlashCopy at either site.

Note: "GO" and "STOP" policies have significantly different volume layouts and require different LCU considerations than a "SWAP" policy. Without SWAP, infrastructure volumes do not require dependent write consistency. Consequently, they may or may not be remotely copied, and do not require FREEZE operations. This implies that there are different classifications of LCU pairs and their logical path definitions (the CGROUP is imbedded in the path's definition): Those that require FREEZE and those that do not. How a customer wishes to manage their infrastructure volumes and their inclusion or exclusion from FREEZE GROUPS (LCU PAIRs subject to a FREEZE) results in significant differences in the volume and LCU layout requirements.

GEOPLEX options PPRCFAILURE

PPRCFAILURE options are "GO"," STOP", and "COND". These options determine autonomic operations when there has been a failure to “mirror” writes to a primary volume to the secondary volume.

- Freeze&Go: In the event of a failure to mirror from a primary to secondary PPRC volume, GDPS/PPRC performs a FREEZE operation. (See “FREEZE autonomic operation” on page 88 for a description of how GDPS performs a FREEZE). This operation preserves dependent write consistency in the secondary volumes. System operations continue at existing site. This is typical of a solution with high-system availability requirements and can tolerate data loss if a freeze is a precursory event to a disaster. Recovery is dependent upon a restart of systems and workload at the recover site. Without SWAP, this solution typically has modest cross DASD connectivity, and the solution is usually provisioned with FlashCopy licensing and capacity at the recovery site.
- Freeze&Stop: In the event of a remote copy failure from a primary to secondary PPRC volume, GDPS/PPRC performs a FREEZE operation to preserve dependent write consistency in the secondary volumes. z/OS System operations are then stopped. This is also typical of a solution with moderate availability requirements but is intolerant of data loss. Recovery depends upon a restart of systems and workload at the recovery site. Without SWAP, this solution typically has modest cross-site DASD connectivity requirements and the solution is usually provisioned with FlashCopy licensing and capacity at the recovery site.
- Freeze&Stop Conditional: Like Freeze&Stop, conditional attempts to eliminate data loss by stopping application systems, but GDPS/PPRC will allow operations to continue if it can determine that the cause of the freeze is confined to the secondary DASD subsystem. Failures to mirror a write to the secondary DASD are unlikely to be precursory events to a disaster. GDPS/PPRC employs two techniques to determine if the secondary DASD subsystem is the cause of the failure. The newer Enhanced False Freeze detection technique uses the Query Storage Controller Status feature when all DASD subsystems support the QSCS feature and PPRCFAILURE is COND. Otherwise, GDPS/PPRC will continue to employ Basic False Freeze technique based on console messages. COND is employed by customers with a low tolerance for data loss but want to maximize possible system availability.

Policy implications and remote copy definition

Non HyperSwap implementations (GEOPLEX OPTION PRIMARYFAILURE of GO, or STOP or GEOPLEX OPTION PPRCFAILURE=STOP,GO,COND) are solutions that require the restart of systems and applications after a site swap (abandonment of SITE1). Only data which changes and must be recovered at SITE2 must be actively mirrored by PPRC. This implies that significant DASD resources do not require active remote copy, such as temporary data sets infrastructure (data sets and volumes) and page data set infrastructure. The infrastructure (page data sets and work volumes) is required for the restart of the workload but the data contained within is not. As a business continuity solution, this architecture is typically employed for disaster recovery applications. The solution is somewhat static in nature. It assumes remote copy principally in a single direction. Restarted systems, even though they are still in the same sysplex, require multiple I/O Gens (one employed by z/OS systems for DASD operations at SITE1, another for DASD operations at SITE2).

HyperSwap implementations (GEOPLEX OPTION of FREEZE set to SWAP, or GEOPLEX OPTION PRIMARYFAILURE set to SWAP) are solutions that must provide continuous operations. A failure of the primary DASD is usually judged insufficient criteria by itself for a total-site failure and site swap. All data required for z/OS systems and application operations must be remotely copied by PPRC[1] and in a FREEZE group. As a business-continuity solution this architecture is one of the foundations of continuous availability[2]. It does not necessarily assume remote copy operation in either direction (SITE1->SITE2 or SITE2->SITE1). However, this implementation often requires multiple I/O GENs (typically employed after an unplanned DASD swap and re-IPL, when both SITE1 and SITE2 DASD with duplicate VOLSERs might be presented as online[3] and a system IPLs after an unplanned HyperSwap).

1. With the principal exception of the sysplex control data sets.
2. It is generally accepted that continuous availability requires redundancies of system, sysplex, networking, and application capabilities in addition to DASD.
3. Another nuance of PPRC operations that is different than SRDF/S and AutoSwap.

FREEZE autonomic operation

GDPS's FREEZE is in some ways analogous to EMC's CONGROUP SCF functionality. Both seek to preserve dependent write consistency in the secondary DASD upon the initial symptom of a rolling disaster. When GDPS/PPRC detects[1] a failure to mirror for a write I/O to a remote copied primary volume in its FREEZE policy, and while the application is waiting for completion of the I/O during the ELB LONG BUSY, GDPS breaks all PPRC pathing for all PPRC Consistency Groups in its policy. GDPS breaks the links by issuing simultaneous CGROUP FREEZE operations for all LCU pairs. The multitasking aspect of this operation is accomplished by NetView Auto Operators, the number of which is dependent on the number of LCU pairs with FREEZE groups. In so much as the mirrored writes of different applications are stopped at different times, the GDPS FREEZE operation does not actually create a "time consistency" so much as it preserves application write dependencies.

In order to allow GDPS/PRPC to execute a FREEZE properly it is critically important that the GDPS/PPRC CGROUP definitions conform exactly to the SRDF GROUP and link definitions in the VMAX Configuration file.

Preserving the write dependencies of application I/O in the secondary Symmetrix DASD subsystems ensures that systems and applications can successfully "restart" using the secondary volumes in the event of an actual disaster and forced abandonment of the primary site operations.

This section contains the following information:

"Planned FREEZE" on page 88

"GDPS/PPRC DASD script keywords" on page 89

Planned FREEZE

Planned FREEZE, a planned operation to create a dependent write consistent version on the secondary DASD, is typically performed through a CONTROL or a BATCH script. Other reasons to suspend

1. GDPS detects this remote copy failure based on I/O interrupt and ENF reporting it no longer bases detection on error messages. Moreover, it is impossible to trip a FREEZE event by simply issuing IEA491E messages.

mirroring would be as part of planned operation to stop using SITE2 DASD (combined with operations to bring down K systems using the SITE2 DASD), or as part of a planned site switch of DASD and systems without HyperSwap.

GDPS/PPRC DASD script keywords

This section contains information on script keywords.

GDPS/PPRC DASD STOP SECONDARY script keyword

Suspends mirroring for volume pairs:

- If the volumes are in a FREEZE group then GDPS issues a CGROUP FREEZE and CGROUP RUN.
- If the volumes are not in a FREEZE group then GDPS simply CSUSPENDs the PPRC pairs.

Note: Any use of the PPRC secondary DASD requires a full resynchronization.

GDPS/PPRC DASD RECOVER script keyword

Recover script keyword enables the use of the secondary DASD by making it a simplex device.

GDPS/PPRC DASD START SECONDARY script keyword

Restarts remote copy from the current primary DASD to the current secondary DASD.

Sharing VMAX DASD subsystems

Frequently, there are demands to share VMAX DASD subsystems. This can be done with GDPS/PPRC, but only within certain rules.

- PPRC DASD managed by GDPS cannot be shared outside its GDPS/PPRC sysplex. (Even an OPEN for READ generates updates against the VTOC.) If this write is the first failed PPRC write, then the first indication of an error would be lost to GDPS/PPRC with the potential for data loss and corruption of the dependent writes in the secondary DASD.
- GDPS/PPPRC K systems LOCAL DASD is typically confined to a separate dedicated LCU. Under no circumstances should the K system use PPRC DASD.

If a VMAX array will be shared between multiple GDPS sysplexes, then partition the usage by LCU. The PPRC volumes in an LCU should be dedicated to only the systems of one sysplex.

While formation of the dependent write consistency is entirely dependent upon GDPS/PPRC issuance of CGROUP FREEZE/RUN operations and completely independent of the SRDF GROUP number, prudence suggests that the different sysplexes do not share the same SRDF Group number.

HyperSwap autonomic operations (unplanned HyperSwap)

When GDPS/PPRC detects a failure to write or no paths available to a primary PPRC volume in its policy it swaps all system and application usage and simultaneously makes all secondary DASD available on all systems. From a z/OS system or application standpoint, HyperSwap is basically analogous to AutoSwap.

This section contains the following information:

Requirements

Requirements for HyperSwap enablement:

- Cross-site DASD linkage compliant with cross-site z/OS systems and applications operations and sufficient engines to provide the required FICON connectivity
- All DASD mirrored for system and application operations in FREEZE groups
- UCBs enabled for HyperSwap
- PPRC volume pairs with same DCA offset (the primary and secondary devices must have the same offset)
- Hardware RESERVE/RELEASE converted by GRS into Global ENQ/DEQ[1]
- NetView parallelism requirements[2]
- Multiple HCDs to support re-IPL of z/OS systems after a HyperSwap on either set of DASD

- All DASD must be available to all systems
- Proper SRDF replication settings in the VMAX configuration file

Not all GDPS/PPRC configurations support HyperSwap. Reasons vary from the physical connectivity, operational requirements in the policy, lack of DASD symmetry, or current operational state of readiness.

1. Unlike SRDF/S and AutoSwap, Compatible Peer and PPRC do not propagate reserves to the PPRC secondary volumes. Without converting reserves to GRS GLOBAL ENQs, a HyperSwap could result in data-integrity exposures on the new primary DASD after a HyperSwap.
2. Parallelism requirements depend upon number of LCUs created in the Symmetrix system.

GDPS with HyperSwap architecture

Figure 4 shows an example of GDPS with HyperSwap architecture and DASD connectivity.

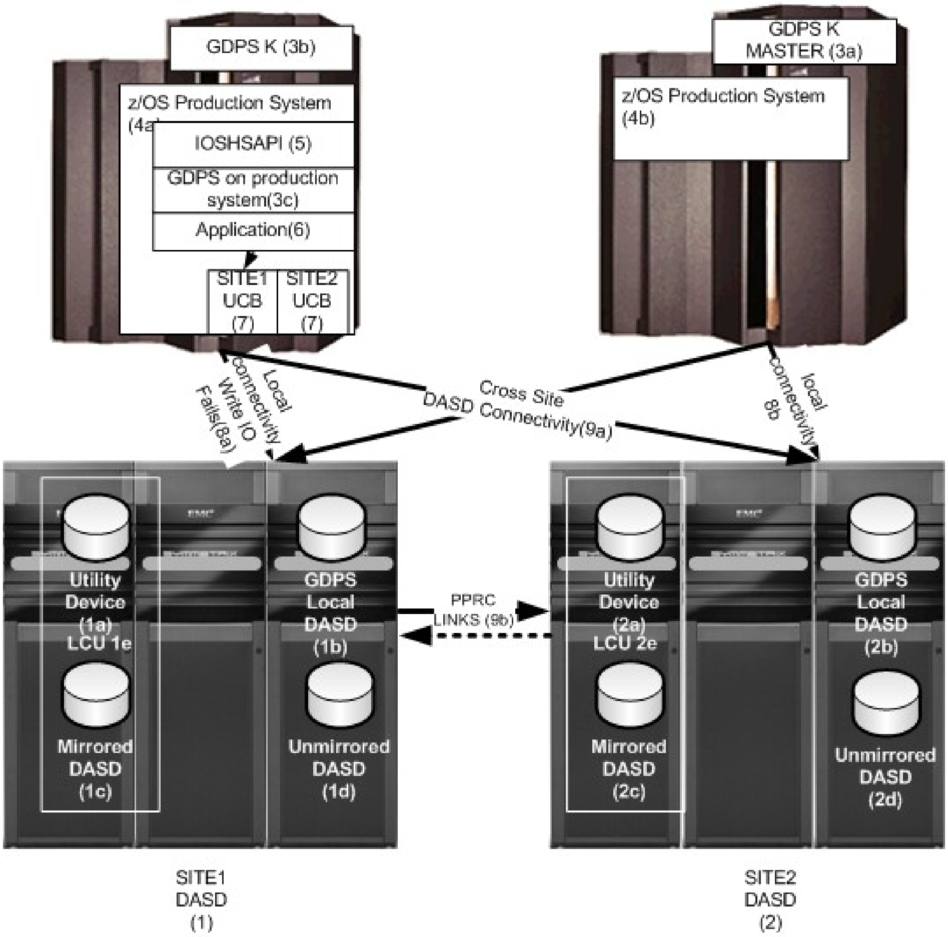

Figure 4 GDPS with HyperSwap architecture and DASD connectivity example

Components for GDPS/PPRC enabled for HyperSwap:

1. SITE1 DASD: Storage resources designated as residing at SITE1 in GEOPARM (technically, the SSIDs at SITE1). Compatible Peer must be installed on SITE1 and SITE2 DASD. The optional FlashCopy capability is often not employed with GDPS/PPRC with a HyperSwap policy.

   Note: HyperSwap enablement requires that all hardware volume RESERVES/RELEASEs are converted by GRS into GLOBAL ENQ/DEQ. This also applies to Compatible Peer.

   a. GDPS/PPRC utility devices.

   b. GDPS/PPRC K system's local DASD (simplex and not swappable), typically in dedicated LCUs.

   c. PPRC DASD enabled for HyperSwap: This includes everything necessary for system and application operation. PAGE and TEMPORARY data sets must be PPRC volumes and swappable. This can be PPRC primary or PPRC secondary, depending on DASD status. To be swappable, all PPRC DASD must have UCBs that have been "prepared" for HyperSwap. In addition, on an LCU-by-LCU basis there must be symmetry of the PPRC volumes (the primary and secondary volumes of a PPRC pair must have the same CUA offset in their LCUs). Validate that NetView has been configured with a sufficient number of NetView auto operators to enable HyperSwap parallel operation by LCU.

   d. Simplex DASD: This DASD is not swappable, typically sysplex data sets. Application and system usage of un-mirrored DASD must not be required for operation (if the intention is to keep those systems operating).

   e. SITE1 DASD LCU of PPRC volumes, composed of one GDPS/PPRC Utility Device (1a), and some number of mirrored volumes (1c).

2. SITE2 DASD: Storage resources designed as residing at SITE2 in GEOPARM. Compatible Peer must be installed on SITE2 DASD.

   a. GDPS/PPRC utility devices.

   b. GDPS/PPRC K system's local DASD (simplex, dedicated and not swappable).

   c. PPRC DASD: This can be PPRC secondary or primary.

   d. Simplex DASD.

   e. SITE2 LCUs of mirrored DASD.

3. GDPS/PPRC.

   a. GDPS/PPRC Master K system: If PPRC primary is at SITE1, then the GDPS/PPRC master is at SITE2. GDPS attempts to keep the role of the Master K system at the site with the secondary DASD. GDPS will then swap the role of master after a successfully HyperSwap. Planned HyperSwap is initiated on the GDPS/PPRC Master K system by script or command directive.

   b. GDPS/PPRC System K: It is highly recommended that there be two GDPS/PPRC systems deployed in GDPS/PPPRC with HyperSwap, each with its own local DASD (1b and 2b).

   c. GDPS/PPRC code in each system in the sysplex: NetView with GDPS must be active in all systems in the sysplex.

4. z/OS production system in the GDPSplex: It should be noted that the concept of SITEs often adopts a somewhat ambiguous meaning in HyperSwap especially in the case of high-availability deployments that are geographically at "zero distance". From the perspective of GDPS/PPRC, the constituent processor and DASD resources of a site are the result of their designation in the GEOPLEX SITE table and GEOPARM.

   a. Production at SITE1: These are systems running in LPARs, designed in the GEOPLEX SITE table as existing at SITE1.

   b. Production at SITE2: Depending on the deployment and geographic deployment, there may or may not be z/OS systems, or z/Series processing, installed, and operations running at, SITE 2.

5. IOSHSAPI HyperSwap address space[1] and GEOXCFST [2].

6. Applications using mirrored and swappable DASD: Their IOS control blocks point to UCBs that are “prepared” for HyperSwap.

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1. In some older releases of GDPS/PPRC, GDPS provided its own HyperSwap services interface in the form of GEOXHSWP.
2. Technically, the IOSHSAPI and GEOXCFST are required for all GDPS/PPRC deployment, regardless if the PRIMARYFAILURE is SWAP.

7. HyperSwap prepared UCBs: HyperSwap is mediated by toggling access to DASD through the pairs of prepared UCBs.
    a. UCB that points to one of the PPRC volume pair (in this case, assume it to be PPRC primary).
    b. UCB that points to the other volume (in this case, assume it to be the PPRC secondary).
8. Local Connectivity
    a. Local FICON connectivity at SITE1: If there is some I/O failure for unplanned HyperSwap, the I/O error must be for a PPRC-mirrored volume in the GDPS/PPRC policy (GEOPARM).
    b. Local FICON connectivity at SITE2.
9. Networked connectivity: DASD and RDF linkage.
    a. FICON cross-site DASD connectivity: This connectivity must be entirely redundant. From the local access DASD connectivity to the local connectivity (8) and 9a, no components should be share. There should be no single point of failure between the local access (SITE1 DASD) and remote access (SITE2 DASD). This additional cross-site linkage must be satisfied by additional VMAX engines or a redundant FICON fabric.
    b. RDF linkage.

Planned HyperSwap

There are actually three kinds of planned HyperSwap (RESYNCH, SUSPEND, and TERMINATE). They all swap access from the primary DASD to the secondary DASD. The differences are the end-point status, particularly of the secondary DASD.

When there are two active GDPS/PPRC K systems, the master K system swaps sites automatically after a HyperSwap, aligning the master K system with the secondary DASD.

In GDPS/PPRC, HyperSwap is invoked through CONTROL and BATCH SCRIPT directives. Lacking automation scripts, GDPS/HM uses the NetView HYPERSW command.

HyperSwap RESYNCH

All production systems and applications swap mirrored DASD sites and remote copy resumes in the reverse direction. This operation does not involve resynchronization and FO/FB is not an issue.

It is a good practice to follow up the swap with reconfiguring "un-mirrored" DASD resources (such as sysplex data sets), aligning their primary usage with the primary DASD site.

HyperSwap RESYNCH is disabled in GDPS/MzGM configurations. All CONTROL and BATCH scripts with HyperSwap RESYNCH are disabled.

HyperSwap SUSPEND

During a primary DASD swap with FO/FB, the old secondary volumes become PRIMARY SUSPENDED (and tracks changes). By making the previous secondary volumes primary suspended volumes, and tracking updates for later resynchronization, FO/FB enhances the HyperSwap SUSPEND operation. Without FO/FB, the old secondary volumes are CRECOVERed (with an implicit full resynchronization back to the previous primary).

Planned HyperSwap Suspend should be followed up with policy selection insuring sysplex data set redundancy at the intended primary site. Swap to alternate CDS then activate the spare CDS to insure CDS redundancy.

Of the three forms of planned HyperSwap, HyperSwap Suspend most closely resembles unplanned HyperSwap.

HyperSwap TERMINATE

Primary DASD swaps and the old secondary volumes become simplex DASD. (There is no PPRC relationship). As is the case with HyperSwap RESYNCH and MzGM, all planned operations with HyperSwap TERMINATE are disabled.

GDPS/PPRC DASD SWITCH HYPERSWAP SCRIPT keyword

This CONTROL and BATCH script keyword performs a planned HyperSwap.

GDPS/HM HYPERSW commands for HyperSwap and recovery operations

GDPS/HM is said to lack automation. It responds to external events with FREEZE and SWAP autonomic operations, but it has no planned actions, such as CONTROL or BATCH scripts. However, GDPS/HM does have exclusive extensions to the HYPERSW command that allows the GDPS/HM operator to direct manual operations.

FAST and HyperSwap

Compatible Peer is built upon an SRDF/S base. This dependency on SRDF allows the tiering statics of FAST for the primary DASD to be transmitted and maintained on the secondary DASD. Consequently, following a HyperSwap, the new primary VMAX array delivers nearly identical performance to the previous primary DASD.

GDPS/PPRC DASD subsystem components

GDPS/PPRC imposes additional requirements to the VMAX solution above and beyond simple PPRC.

HCD definition with GDPS/PPRC

The different categories of GDPS/PPRC volumes require specific HCD definitions for proper execution by GDPS/PPRC. The IBM GDPS Installation and Customization Guides provide the necessary HCD specifications.

Both the FlashCopy source and target volumes are defined as z/OS volumes. Typically, target volumes are offline when FlashCopy is invoked, and HCD ONLINE/OFFLINE status should be planned according to usage.

GDPS/PPRC requires that the primary volumes are online to the GDPS/PPRC K systems but unallocated. This is validated by GDPS/PPRC MONITOR3.

This section contains the following information:

"GDPS K system LOCAL DASD resource" on page 99

"GDPS/PPRC utility device" on page 100

"LCU design" on page 100

GDPS K system LOCAL DASD resource

In order to execute during the ELB timer duration and perform the FREEZE GDPS, the K system must be dispatchable: The K system cannot itself FREEZE. This is the primary reason why the K systems' DASD must be SIMPLEX volumes and the K system must not allocate or depend upon any operation on DASD that is remote copied and possibly subject to the ELB LONG BUSY or a CGROUP FREEZE.

While most GDPS/PPRC implementations with simple FREEZE policies utilize a single GDPS K system at SITE2 (with the PPRC secondary volumes), more complex GDPS/PPRC implementations, especially those with SWAP policies, employ two GDPS K systems, one at each site. In such cases, each GDPS K system requires its own dedicated set of SIMPLEX volumes, the LOCAL DASD.

A PPRC FREEZE is a complex operation dependent not only on correct hardware settings, but also requires specific infrastructural implementation of the DASD subsystems, correct definition of the FREEZE groups, and adherence to GDPS deployment to ensure that the K system remains dispatchable during FREEZE operations. EMC has partial responsibility for understanding the requirements and configuration of the LOCAL DASD.

GDPS/PPRC utility device

The purpose of GDPS/PPRC utility device(s), is to enable GDPS K systems to execute PPRC directives for volumes in an LCU quickly and without interference by mirroring operations, systems I/O, or applications. They are very different in purpose than XRC's utility devices. The utility volumes are:

- Only a single device is required in an LCU (all SITE1 LCUs and all SITE2 LCUs). LCUs composed of nonPPRC and LOCAL DASD do not require GDPS/PPRC utility volumes.
- The utility device must be a simplex volume (not a PPRC primary or PPRC secondary).
- It should be offline to application systems (to avoid any possibility of reserves).
- It should be genned as unshared (to avoid any possibility of reserves).
- A single cylinder CKD device is sufficient.
- Specified in the GEOPLEX NONSHARE non-shared section.

The purposes and deployment of the GDDR's gatekeeper volumes and GDPS's utility devices are significantly different.

LCU design

LCU design is integral to the GDPS/PPRC delivery in many aspects and is a critical aspect to the implementation of robust GDPS/PPRC implementations. As the storage vendor, EMC has many responsibilities related to the LCU design:

- PPRC pairing: The very basis of the PPRC CGROUP, is based on LCU pairing.

- Whether the volumes in a LCU FREEZE or do not FREEZE is based on the PATHing definition and must be in accordance with the GEOPLEX policies.
- GDPS employs special utility devices for PPRC directives and expects a utility device in every LCU.
- The GEOPARM components are all based in some way on LCU inclusion or exclusion.
- The K system's dispatchability is dependent on uniquely defined LCUs. The local GDPS K system's volumes are typically confined to a single LCU. These volumes must be dedicated to the K system. No other system should access those volumes. Each K system requires its own set of isolated volumes. The expectation of GDPS is that no single failure can disable all the K systems and the primary DASD. The K systems' DASD LCU should be isolated to the site where the K system actually operates.
- The number of NetView's Auto Operators, which provide GDPS with its ability to mutitask FREEZE or SWAP autonomic operations, is based on the number of LCUs. The number of LCUs defined on the VMAX must be in accordance with the NetView AutoOperator definitions.
- For HyperSwap implementations, symmetric device configurations on an LCU-by-LCU pair basis (primary and secondary volume in a PPRC PAIR must have the same DCA offset).

GDPS/PPRC's ability to recognize and respond to unplanned events and perform FREEZE and SWAP autonomic operations is dependent on many aspects of the LCU design. The Symmetrix configuration file design must be GDPS/PPRC compliant.

The PPRCFAILURE and PRIMARYFAILURE policies directly affect the PPRC CGROUPs and consequently have direct bearing on the GEOPARM specification.

GDPS/PPRC GEOPARM specification

The GEOPARM defines the extent of GDPS remote copy and local copy policies. GDPS only manages and responds to volume access and mirroring issues within its current GEOPARM. The GEOPARM is data set allocated to the NetView instance[1] running GDPS.

Note also, because the GDPS GEOPARM configuration (CONFIG) operation does not validate the PPRC PATH connectivity, it is often expedient to validate new PPRC connectivity and configuration through the use of native PPRC TSO commands prior[2] to defining the PPRC configuration in the GEOPARM.

Examples of GEOPARMs for EMC Symmetrix systems are included in Appendix C, “Sample GEOPARM (GEOXPARM).”

This section contains the following information:

GEOPARM specifications unique to Symmetrix systems

There are two principal differences required of Compatible PEER in the GEOPARM.

1. As mentioned earlier, the PPRC PATH LINKADDR physical specifications are unique to Symmetrix system’s SRDF linkage.

---

1. It is not uncommon for a customer to employ multiple instances of NetView. GDPS implementation does not require a dedicated NetView instance but is typically implemented with a dedicated NetView.
2. To avoid unanticipated autonomic operations by GDPS, the use of TSO PPRC commands should be used with extreme prudence once a GEOPARM is activated.

2. The protocol specification for the RDF linkage is different than the IBM DASD subsystem PPRC linkage. GDPS distinguishes this difference in IBM DASD WWNN naming by employing a "protocol" indicator in the PATH definitions in the GEOPARM SITE1 and SITE2 statements. Consequently, even though RDF employs Fibre Channel Protocol and connectivity, the Symmetrix DASD LCUs must be identified by serial number and the ESCON PROTOCOL_IND "E" indicators in the GEOPARM's SITE statements. See section "GEOPLEX MIRROR" on page 105.

GEOPARM coding

To create a GEOPARM member, you need the following information:

- All SITE1 (primary) SSIDs and LCUs.
- All SITE2 (secondary) SSIDs and LCUs.
- Each range of PPRC primary volumes (starting address and number) in each primary SSID.
- Corresponding range of possible SITE1 FlashCopy volumes
- Each range of PPRC secondary volumes (starting address and number) in each secondary SSID[1].
- Corresponding range of possible SITE2 FlashCopy volumes.
- The address of the designated GDPS utility device in each primary LCU (a non-shared device).
- The address of the designated GDPS utility device in each secondary LCU (a non-shared device).
- Symmetrix Link Addressing, refer to Appendix A, "PPRC PATHing and Linkage Address." (Coding is simplified if the SRDF linkage is symmetric between SITE1 VMAX arrays and SITE2 VMAX arrays).
- SRDF GROUP IDs on PRIMARY and SECONDARY DASD. (Coding is simplified if these are the same on SITE1 VMAX arrays and SITE2 VMAX arrays) from the Symmetrix configuration file.

1. HyperSwap imposes a further consideration that the DCA offset of a primary PPRC device must match the DCA offset of its secondary PPRC device.

The GEOPARM consists of three sections:

- GEOPLEX LINKS, which becomes the LINK definitions that PPRC uses and are displayed in GDPS SSID-pairs panel.
- GEOPLEX MIRROR, which becomes the volume pair definitions that PPRC uses and are displayed in the GDPS volume pair panel.
- GEOPLEX NONSHARE, which becomes the GDPS/PPRC utility devices.

IMPORTANT

It is strongly recommended that you review the IBM GDPS/PPRC Installation and Customization Guide for detailed guidance on MSS implementation and other coding rules.

GEOPLEX links

```
SITE1='SITE1_SSID,SITE2_SSID,FREEZE_IND,CRIT_IND||PROTOCOL_IND,linkaddr1,linkadd
   r2,…,linkaddr8'

SITE2='SITE2_SSID,SITE1_SSID,FREEZE_IND,CRIT_IND||PROTOCOL_IND,linkaddr1,linkadd
   r2,…,linkaddr8'
```

Pairs of SITE1/SITE2 statements for each LCU pairing

The SITE1 and SITE2 statements establish the PPRC pathing (equivalent to the PPRC CESTPATH command) used by the PPRC mirroring between a pair of LCUs. It also identifies the direction of mirroring and the inventory of Symmetrix system resources at each computing site.

In most implementations, a SITE1_SSID is only one SITE1 statement, likewise a SITE2_SSID will be in only one SITE2 statement. However, fan in and fan out of PPRC volume mirroring affects this. The SITE1/SITE2 statements represent the pairing of LCU. If the primary volumes are mirrored to more than one SSID (fan out) then each of those PPRC LCU pairings must have its own SITE1/SITE2 specification.

SITE1 and SITE2 statements are usually specified in pairs of SITE1 and SITE2. The linkaddr specifications are usually mirror images. The SITE2 statement is used for site swaps between SITE2 and SITE1 and in some legacy GDPS/PPRC environments the SITE2 statements may be omitted.

Where:

- SITE1_SSID: A four-character, upper case, SSID of the initial primary SSID for this LCU pairing.
- SITE2_SSID: A four-character, uppercase, SSID of the initial secondary SSID for this LCU pairing.
- FREEZE_IND: A one-character indicator Y|N, indicating whether CGROUP FREEZE is enabled for the volumes, typically Y.
- CRIT_IND||PROTOCOL_IND: A two-character indicator, with the first character Y|N, indicating whether PPRC critical attribute is enabled for the PPRC CESTPAIRs in the LCU. This is an obsolete parameter and should be coded as N unless otherwise directed. The second character is E for ESCON, F for FCP. Symmetrix requires the E character.
- linkaddrN: A one to eighty-eight character Symmetrix PPRC link addresses to create the PPRC path between the LCU.

Continuation of link addresses on the SITE1 and SITE2 statements follows a very exacting format. Note that the continuation is signaled with a C and end-quotation mark, but that the continuation line requires no opening quotation mark.

```
SITE1='PPPP,SSSS,Y,NE,00000000,11111111,22222222,33333333,44444444,55555555,C'
      66666666,77777777,88888888'
SITE1='PPPP,SSSS,Y,NE,00000000,11111111,22222222,33333333,44444444,55555555,C'
      66666666,77777777,88888888'
```

GEOPLEX MIRROR

The GEOPLEX MIRROR section specifies the volume's remote copy definitions between primary PPRC, secondary PPRC, and FlashCopy targets. It is composed of two kinds statements. The PPRCSSID statement identifies the SSID-to-SSID relationship and the PPRC statement identifies ranges of remote copy and local copy addresses within the previous PPRCSSID pairing. There can be a variable number of PPRCSSIDs statements, and each PPRCSSID can be followed by a variable number of PPRC statements.

```
GEOPLEX MIRROR
A variable number of PPRCSSID statements
PPRDSSID='SITE1_SSID,SITE2_SSID'
Each PPRCSSID is followed by variable number of PPRC statements (as many as ranges
   of addresses)
PPRC=s1dev,s2dev,nn,CRIT_IND,s1fdev,s2fdev'
```

Where

- SITE1_SSID: A four-character, upper case, SSID of the initial primary SSID for this LCU pairing.
- SITE2_SSID: A four-character, uppercase, SSID of the initial secondary SSID for this LCU pairing.
- s1dev: A four- or five-character device address of the first PPRC primary address in this range.
- s2dev: A four- or five-character device address of the first PPRC secondary address in this range.
- nn: The number of continuous addresses in this range.
- CRIT_IND: A one-character indicator, Y|N, indicating whether PPRC critical attribute is enabled for the CESTPAIR in the LCU. This is an obsolete parameter and should be coded as N, unless otherwise directed.
- s1fdev: A four-character device address of the first FlashCopy target for the source dev1 address. This is an optional parameter and is only specified if FlashCopy is provisioned at SITE1.
- s2fdev: A four-character device address of the first FlashCopy target for the source dev2 address. This is an optional parameter and is only specified if FlashCopy is provisioned at SITE2.

GEOPLEX NONSHARE

```
GEOPLEX NONSHARE
A variable number of NONSHARE statements, 1 for each SSID
NONSHARE='nnnn'
-or-
NONSHARE='mnnnn'
```

Where

- nnnn: A four-character hex device address.
- mnnnn: m is the one-character MSS id (0 or 1) and nnnn is the A four-character hex device address.

Activation of a new GEOPARM (CONFIG)

The GEOPARM is usually edited on the MASTER GDPS K system. The GEOPARM can be edited by ISPF editor. It is typically managed as a member of a PDS. Activation of a new GEOPARM is accomplished by the ACTIVATE option from the main GDPS panel.

Configuration error messages can be found in the NetView log.[1]

1. From the NetView/GDPS command input line, enter “BR NETLOGA”.

FlashCopy with GDPS/PPRC

Using Compatible Native Flash, Symmetrix FlashCopy capability can be provisioned and managed by GDPS/PPRC, at either or both SITE1 or SITE2. Validate the customer's requirements of the deployment architecture and operations and the suitability and requirement of a FlashCopy capacity and licensing of Compatible Native Flash.

This section contains the following information:

Justification

Note: The justification criteria for FlashCopy with GDPS/PPRC is very different than with GDPS/XRC. With GDPS/PPRC, the employment is dependent largely on a customer's perception of risk and their FREEZE and SWAP policies. In the case of GDPS/XRC, it is almost always employed.

The traditional reasons for the optional provisioning and exploitation of FlashCopy capability with GDPS/PPRC:

- Retaining DR readiness during PPRC resynchronization primary-to-secondary DASD. After a planned or unplanned PPRC suspension, having a write consistent FlashCopy image at the DR site improves DR readiness and capability and eliminates a potential SPOF.
- Resynchronization exposure on DASD without FO/FB[1]. During PPRC resynchronization ,the target volumes lose application write consistency when the updates are applied, irrespective of any write dependencies, leaving the solution with a single point of failure. The duration of the resynchronization is an important consideration in the justification for this provisioning. Before FO/FB, a resynchronization from SITE2 to SITE1 (after running application workload on SITE2 DASD) required a complete resynchronization and would be expected to be a lengthy operation. FO/FB has eliminated the need for volume-copy

1. Symmetrix Compatible PPRC supports FO/FB.

resynchronization, in this case, and reduced the justification for FlashCopy. FlashCopy would be initiated immediately prior to the invalidation of the PPRC secondary. When provisioned, it is mostly commonly provisioned at SITE1, given that failover operations is on SITE2 DASD.

- Retaining Disaster Recovery readiness during DR testing: those customers employing a GDPS/PPRC business continuity solution that calls for restart of workload (typically non-HyperSwap and longer distance) can test GDPS/PPRC recovery at SITE2 with a FlashCopy image and not interrupt production disaster-recovery operations. Provisioning a FlashCopy capability promotes DR testing and should improve RTO.
- Application usage for point-in-time copies.

Definition

See "GEOPLEX MIRROR" on page 105 for GDPS/PPRC GEOPARM specification of FlashCopy volume definitions, for both SITE1 and SITE2 FlashCopy capacity.

Operation

SCRIPT FlashCopy commands

The creation of a FlashCopy sessions employs the GDPS DASD FCESTABLISH keyword. Similarly, removal of FlashCopy sessions employs the FCWITHDRAW keyword.

It is a good SCRIPT coding practice to always preface a FCESTABLISH with DASD OFFLINE and DASD FCWITHDRAW, and never assume that volumes are offline, or that all earlier FlashCopy sessions have been withdrawn previously. Execution of the necessary DASD OFFLINE and DASD FCWITHDRAW are nearly instantaneous, and their inclusion helps to ensure errorless execution of the FlashCopy.

GDPS/PPRC FlashCopy panel mirroring operations commands are always NOCOPY.

With HyperSwap deployments

Although provisioning a GDPS/PPRC managed FlashCopy capability continues to be a recommended feature of GDPS/PPRC implementation with Symmetrix systems, FO/FB and HyperSwap dramatically reduce the justification for FlashCopy provisioning (of the capacity and microcode feature) in many implementations of GDPS/PPRC.

Remote Pair FlashCopy

By allowing HyperSwap to remain enabled during FlashCopy DASD subsystems, such as VMAX, that support Remote Pair FlashCopy improve the operational viability of FlashCopy employed in applications.

Symmetrix systems compatible feature licensing in GDPS/PPRC

In addition to other features, the following feature order numbers are typical of a GDPS/PPRC implementation. Table 5 lists the EMC features for implementing GDPS/PPRC.

Table 5 EMC features for GDPS/PPRC implementation

Feature Name	Symmetrix System	Required/ Optional
Compatible Peer	Primary and secondary Symmetrix	Required
Compatible HyperPAV	Primary and secondary Symmetrix DASD subsystems	Optional (but recommended)
Compatible Native Flash for Mainframe	Primary and secondary Symmetrix DASD subsystems	Frequently implemented for application support,operation in HyperSwap deployment is easier with Remote Pair FlashCopy support
FAST	Primary and secondary Symmetrix systems	Optional, but when employed on both the Pirimary and Secondary VMAX it maintains high system performance after a HyperSwap by transmission of FAST statistics

CFHINT considerations

CFHINT is an architectural technique to attempt to improve the recovery time objective (RTO) for some GDPS/PPRC deployments with high data-integrity requirements (PPRCFAILURE of STOP or COND) and assumes the restart of workloads with shared data in duplexed CFs. Other than support for CGROUP FREEZE, this feature is entirely dependent upon CFRM policy definitions and GDPS STOP management (through the SA BCPii feature).

The improvements to the recovery time objective are attempted by avoiding CF REBUILD, when workloads are restarted at SITE2.

Preconditions include:

- CFs are duplexed. GDPS attempts to keep CF duplexing in the same direction as PPRC, and PPRCFAILURE policy is STOP or COND
- A PPRCFAILURE policy of STOP or COND

Trigger event for PPRC FREEZE

- GDPS does a Freeze&Stop. Data consistency on DASD is assured by the FREEEZE. Data consistency between the CFs and DASD is assured by resetting all production systems.
- The synchronization of data in the CFs and secondary DASD can be achieved by RESET of the production systems during the FREEZE.
- GDPS intervenes during the restart of the production z/OS systems at SITE2 to avoid CF REBUILD of the SITE2 CFs improving the RTO.

Preservation of the data consistency in the CF is by no means guaranteed. Failure of the CF Hint feature does not presume a failure in the Compatible Peer MC feature or the Symmetrix system.

CF Hint is entirely dependent upon GDPS/PPRC operations, and does not depend upon Compatible Peer or Compatible Native Flash features.

GDPS/PPRC operations

This section contains the following information:

- "GDPS/PPRC mechanisms" on page 113
- "Panel operations (GDPS operator)" on page 114

GDPS/PPRC mechanisms

GDPS/PPRC operates through several mechanisms:

- GDPS Operator: By logging on to NetView, GDPS/PPRC provides an interface for manual panel-driven operations. As has been pointed out frequently in this section, avoidance of unintended consequences to operations of remote copy volume pairs and the remote copy links is only possible through GDPS/PPRC. GDPS also provides a web server interface as well.

  Note: As a measure of GDPS's management and control, even manual HMC actions to IPL and shutdown systems is counter indicated once GDPS/PPRC is installed and the systems are defined in GDPS Site Table. External actions initiate TAKEOVER actions by GDPS. Manual operations by Symmetrix inlines, SRDF/S directives, or PPRC directives to the remote copy components should not be performed without direction and informed consent of all responsible parties.

- System Status and Monitoring: Through a combination of sysplex communications, syslog message interception (MPF), MONITOR operations, and ENF, GDPS/PPRC constantly monitors the state of systems, sites, and remote copy mirroring, and initiates corrective actions or warnings. GDPS/PPRC has three monitors that are initiated either on an interval basis or in response to GDPS operator requests. Panel and readiness statuses are updated by initiation of the MONITORs.
- Autonomic Operations: GDPS/PPRC responds to external events to systems and remote copy status to automatically preserve data consistency and system availability, as directed by policy definitions (PPRCFAILURE and PRIMARYFAILURE).

- Changes to the policy, altering the autonomic response to failures, requires changing the GEOPARM settings, either through modification to the PDB or dynamically updating the "split freeze" definitions (PPRCFAILURE and PRIMARY FAILURE) in the panels.
- Unplanned Actions (TAKEOVER SCRIPTs): These scripts, run in NetView, are often presented to the z/OS operator as WTOR options[1] in response to triggering events and subsequent to the completion of GDPS/PPRC autonomic operations. TAKEOVER SCRIPTS are coded and retained in the PDB.
- Planned Actions (CONTROL and BATCH SCRIPTs): These scripts, run in NetView, are invoked either directly through GDPS/PPRC's panels (CONTROL SCRIPTS) or externally through NetView commands or z/OS MODIFY (F) command. CONTROL and BATCH scripts are coded and retained in the PDB.

GDPS operations are documented in the individual version's Installation and Customization guides.

Panel operations (GDPS operator)

GDPS/PPRC displays are *not* dynamic. GDPS/PPRC DASD Mirroring Status panel and Volume Status panel do not necessarily represent the current DASD mirroring status. It is recommended to operate GDPS panels with a current representation of remote copy status and refresh the screen status with the actual value of GDPS/XRC's Global variables:

- Use option "M" on the GDPS/PPRC Main panel to run MONITOR1 and MONITOR3 to validate the status.
- Force the refresh of status of GDPS/PPRC DASD entities on the GDPS mirroring screens by using function key 5 (F5).

1. This process is also known as the TAKEOVER prompt. After detection of a failure, and upon completion of autonomic operations, GDPS presents to the operator the GEO112E WTO and GEO113A WTOR, which describe the detected failure and provide the operator with the names of the available TAKEOVER scripts.

GDPS/PPRC DASD BATCH SCRIPT VPCEXIT2

BATCH SCRIPTs can be externally initiated to the GDPS operator through the VPCEXIT2 NetView command. One advantage of the BATCH SCRIPTs, over CONTROL and TAKEOVER SCRIPTS, is their ability to accept variable parameters. A good example of such a general purpose script is the BATCH DASD SCRIPT. It is almost always coded simply as

```
DASD='%1'
```

Where

%1 can be any valid DASD keyword specification.

It can be invoked by the NetView VPCEXIT2 command:

```
VPCEXIT2 nnn DASD <PARMS>
```

Or from the z/OS operator console:

```
F netview_proc,VPCEXIT2 nnn DASD <PARMS>
```

Where

- nnn is the expected duration of the script operation
- DASD is the name of the BATCH SCRIPT, in this case DASD
- <PARMS> such as “SWITCH HYPERSWAP RESYNCH”, no quotes no “< >”

The DASD BATCH SCRIPT is almost always implemented. It enables quick operator operations of SCRIPTed operations, and in the case of GDPS/PPRC, it enables command-type execution of planned HyperSwap.

Locating PPRC error messages within GDPS/PPRC

Many PPRC error messages are in the NetView LOG. Use the NetView “BR NETLOGA” to review the log on the GDPS K system (typically whichever system was acting as the master K system at the time of the incident in question).

Search NetView’s log for messages

This NetView tool is especially useful for reviewing complex GDPS operations. From the NetView operator application, issue BRLOG and fill in search values.

For example, a frequent issue of HyperSwap testing is the duration of the HyperSwap, whose various phases of operation are documented by GDPS messages, all with the character string “PHASE”, in the NetView log. Questions regarding phase duration and overall duration can be answered by searching on character string “PHASE”.

Issuing MVS system commands from NetView

NetView’s command prompt is a handy place to issue MVS system commands. Use the NetView command MVS to issue an MVS command:

```
MVS <any MVS command>
```

Example

```
MVS D R,L
MVS RO *ALL,D T
```

Help

GDPS/PPRC adds descriptive information to NetView’s HELPMSG command for GDPS/PPRC messages. From the NetView command:

```
HELPMSG GEOnnnn
```

GEO*nnnn* is the GDPS/PPRC message id.

GDPS/PPRC employment of alternate subchannel support with Symmetrix systems

EMC Symmetrix systems and Compatible Peer are completely compliant with alternate sub-channel deployment with GDPS. There is no control-unit microcode support required for System z alternate subchannel set support.

Note: There are known limitations for primary device definition in MSS1 that are dependent on the z/OS release level. Except for the previously-mentioned exclusions, PPRC primary and secondary volumes share the same device address excepting the high order 0,1, or 2, which indicates the sub-channel set in the z/OS device number.

Validating GDPS autonomic operations

Validation of the environment, especially GDPS/PPRC autonomic operations, is an important step in the delivery of EMC Compatible Peer and Symmetrix products in a GDPS/PPRC deployment[1].

There are a variety of ways to initiate both failure to mirror (triggering the PPRCFAILURE policy) and write I/O error (triggering the PRIMARYFAILURE policy). For instance, disrupting the FICON or FCP connectivity and causing a write to a PPRC primary volume will trigger an I/O error or mirroring failure . Fortunately, there are more convenient and generally accepted mechanisms to trigger these events, as discussed in this section:

"Unplanned FREEZE" on page 118

"Unplanned HyperSwap" on page 119

Unplanned FREEZE

To trigger an unplanned FREEZE by using a batch TSO job to CSUSPEND a PPRC pair in GDPS/PPRC's GEOPARM, the suspended pair must be in a FREEZE GROUP. The following JCL example demonstrates the use of a batch TMP to suspend a PPRC pair outside of GDPS control and trigger an unplanned GDPS/PPRC FREEZE. Validate that DASD mirroring status is OK (green), then submit the job, as shown in Figure 5 on page 119.

1. These mechanisms are employed by EMC QA, IBM Global Services GDPS/PPRC deployment, customers, and GDPS Certification process to validate FREEZE and HyperSwap autonomic operations. They are something of a litmus test for GDPS/PPRC implementation, configuration, and compliance, and as such are employed in every GDPS/PPRC implementation. As the DASD vendor in a GDPS/PPRC implementation, it is EMC's responsibility to propose these tests (if they have not been proposed by other parties involved with the installation).

```
//PPRCTSO  EXEC PGM=IKJEFT01
//SYSTSPRT  DD  SYSOUT=*
//SYSTSIN   DD  *
CSUSPEND DEVN(X'7100')                         -
   PRIM(X'A704' AANAK X'00' X'04')         -
     SEC(X'B704' AAMWY X'00' X'04')
```

Figure 5   Batch TMP to trigger an unplanned GDPS/PPRC FREEZE

In the above example, change the DEVN, SSIDs, VMAX serial numbers, and LCU IDs in accordance with a PPRC volume in your GDPS GEOPARM.

Again, if the PPRCFAILURE policy is STOP, then triggering an unplanned FREEZE directs GDPS/PPRC to suspend all mirroring and resets all operating production z/OS systems.

Unplanned HyperSwap

To trigger an unplanned HyperSwap, first validate that GDPS/PRPC is HyperSwap-ready, and then trigger an unplanned HyperSwap by using a z/OS system command to vary “offline force” a PPRC primary device in GDPS/PPRC’s GEOPARM. (Wait for a write).

As is the case with any unplanned HyperSwap, there are some risks triggering unplanned HyperSwap. Production z/OS systems that can not complete a HyperSwap will be reset by GDPS/PPRC. Additionally, it is possible that HyperSwap can take long enough to cause application disruption.

Testing of an unplanned (as well as a planned HyperSwap) should be undertaken only in a control environment, with proper change/control approval. Testing of an unplanned HyperSwap should only be undertaken after a prolonged and comprehensive testing program of planned HyperSwaps.

GDPS/PPRC networking topologies

This section includes the following information:

EMC’s role

Many factors determine the inter-site network provisioning and affect EMC’s role in the network’s architecture and procurement:

- Dependencies of GDPS on sysplex connectivity
- Availability requirements of the GEOPLEX policy, particularly PRIMARYFAILURE of SWAP
- Number of cross-site FICON links for normal I/O and PPRC operational control
- Number of FCP links for PPRC mirroring

Even though the required GDPS/PPRC sysplex connectivity is not within EMC’s realm of responsibility, by necessity, it dictates upon the solution network requirements that effectively limit the linkage options, mirroring distance, and directly affect the configuration of proposed Symmetrix units and the number of FICON ports. These considerations are not typical of many SRDF/S deployments (a consideration for some GDDR deployments), but they are almost always a primary concern for GDPS/PPRC deployments. Furthermore, these requirements profoundly affect the inter-site networking financial considerations and physical network deployment.

As the storage vendor in a GDPS/PPRC deployment, EMC’s role should be to configure Symmetrix solutions and mirroring components compliant with the overall networking requirements of the solution as a whole and with the understanding that the availability requirements dictate many aspects of network architecture, topology, and deployment.

GDPS topologies

GDPS topologies break down into three different categories depending on the GEOPLEX PRIMARYFAILURE policy, mirroring distance, and availability expectations:

- GDPS/PPRC in a BCRS configuration
- GDPS/PPRC not enabled for HyperSwap, PRIMARYFAILURE of GO or STOP
- GDPS/PPRC enabled for HyperSwap, PRIMARYFAILURE of SWAP

The differences in the topologies and their effect on the networking provisioning are discussed in the next sections.

Link budget

One additional topic in the role of a GDPS/PPRC storage vendor is EMC's role in development of the *link budget*. The link budget is the explicit or implicit step in a GDPS deployment where the inter-site link topology and provisioning are decided. The types of links, protocols, bandwidth, redundancy, distance, multisite workload, and the number of links of each type determine the networking requirements and physical deployment. To a large degree EMC's role is confined to the number of FCP and FICON links required and how GDPS/PPRC BCRS that effects the provisioning of the FCP and FICON components and linkage.

Inter-site sysplex connectivity is a complex topic depending upon many factors:

- Actual z/Series processors themselves
- Number and deployment of z/Series systems with systems in a multisite sysplex
- Sysplex topology (base or sysplex)
- Type of sysplex timing (ETR or STP)
- Maximum allowable latency difference between the diverse dark-fiber routing
- Degree of redundancy required by the customer

The links themselves are very specialized, but their minimum requirements dictate much of the inter-site networking deployment.

One important consideration is that depending on the exact z/Series architecture some of these links cannot employ channel extension. They require either direct connectivity between z/Series processors or connectivity through dark fiber with or without DWDMs. In addition, the cross-site sysplex connectivity imposes very strict rules on the qualified DWDM systems and cards.

GDPS/PPRC BCRS

The one GDPS/PPRC topology that does not require a sysplex at both sites, BCRS deployment is a DR solution. SITE2 can operate as a “cold site”. Free from the distance restraints of an active multisite sysplex, the inter-site distance is limited only by the maximum distance supported by the FCP and FICON linkage and write I/O performance considerations.

The limited requirements for cross site FICON connectivity reduce the need for FICON ports and provisioning for VMAX engines.

An active GDPS/PPRC K system is still required (it still has all the same isolation and connectivity requirements), but it operates at SITE1. There is a dormant K system deployed at SITE2 that will become the kernel of recovery operations, DASD recovery, production z/OS system restart, and workload restart at SITE2.

Only PRIMARYFAILURE of and GO or STOP. HyperSwap is NOT feasible (the sole GDPS K system’s local DASD is assumed to fail with the SWAP triggering event).

From a GDPS/PPRC perspective, this solution has very unique GDPS networking requirements:

- No cross-site sysplex linkage. SITE2 has no active system in the production sysplex.
- Mirroring linkage can employ any physical deployment consistent with the SRDF/S FCP RDF linkage and performance requirements of the z/OS system and applications (response time and network bandwidth).
- Requires very limited cross-site FICON connectivity to control PPRC operations and maintain the dormant K system.

Operational overview in the event of an actual DR reflects the lower expectations of availability due to the lack of an active GDPS/PPRC K presence at the recovery site.

- Manually IPL the recovery GDPS/PPRC K system in predefined, un-mirrored storage at SITE2 with a valid PDB and GEOPARM consistent with SITE1.
- CRECOVER the DASD at SITE2.
- IPL the recovery z/OS systems using either standard actions or CONTROL scripts.
- Expect elongated RTO due to the manual aspects of recovery operations.

Figure 6 illustrates a BCRS topology.

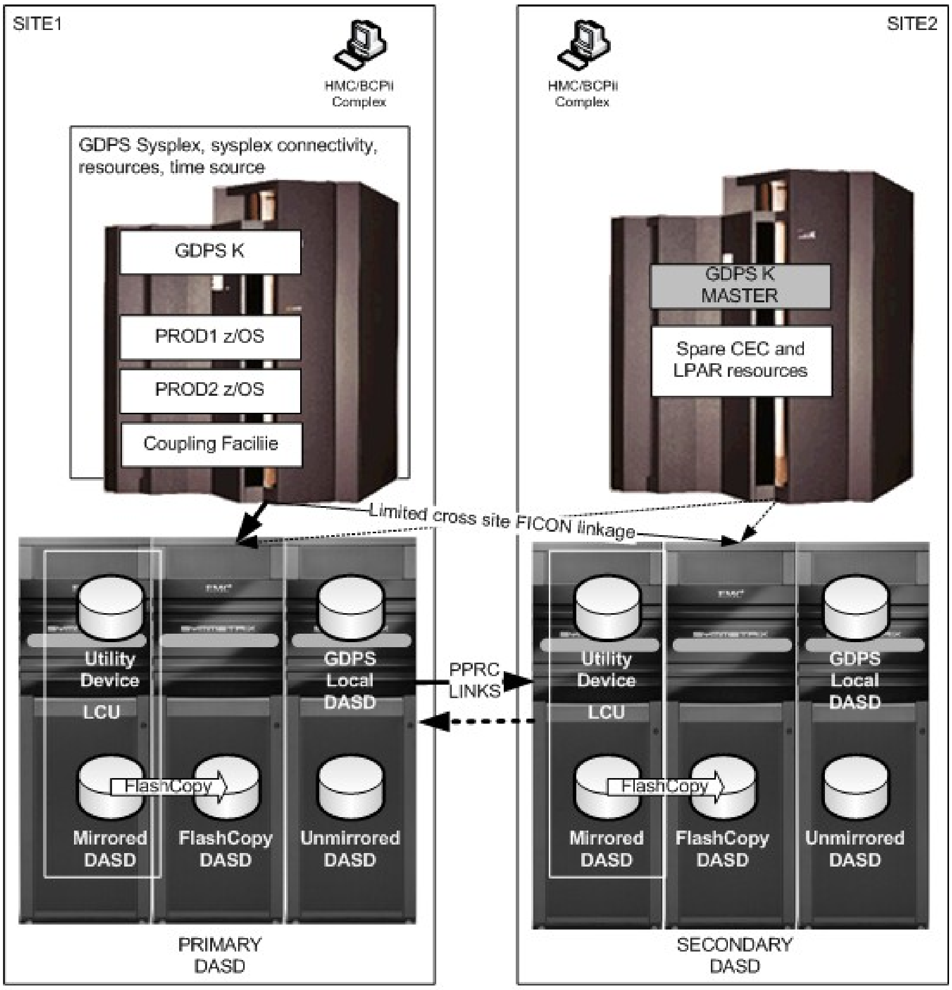


Figure 6 GDPS/PPRC BCRS architecture

GDPS/PPRC FREEZE and GO/STOP

This is the archetypical GDPS/PPRC deployment. Prior to HyperSwap deployments, this was the predominate topology. It consists of a multisite sysplex, with one or more K systems, and the Master K system deployed at SITE2. Workload is deployed with processing at only SITE1 (single-site workload) and production FICON connectivity is contained within a site (limited inter-site FICON connectivity for PPRC operational control and operational management).

In the event of a SITE1 failure, the K system at SITE2 offers a "TAKEOVER prompt" providing options to recover DASD, as well as systems and restart workload using TAKEOVER scripts at its disposal.

Linkage requirements:

- Cross-site sysplex consistent with the sysplex architecture and z/Series systems. Again, the sysplex protocols cannot undergo any protocol conversions, and these links are typically deployed over a DWDM and dark-fiber infrastructure.
- SRDF/S FCP linkage for Compatible Peer.
- Cross-site FICON for GDPS management of PPRC mirroring and K systems operations.

As in the case of BRS configuration above, the limited requirement for cross site FICON connectivity (non HyperSwap) should reduce the requirements for FICON ports and VMAX engines.

Having DWDMs simplifies the networking solution for the cross-site FCP and FICON connectivity. It does require EMC's active participation in the link budget and the DWDM card selection consistent with the bandwidth, redundancy requirements for the FCP and FICON links and the Symmetrix system.

Figure 7 illustrates a FREEZE and GO/STOP solution.

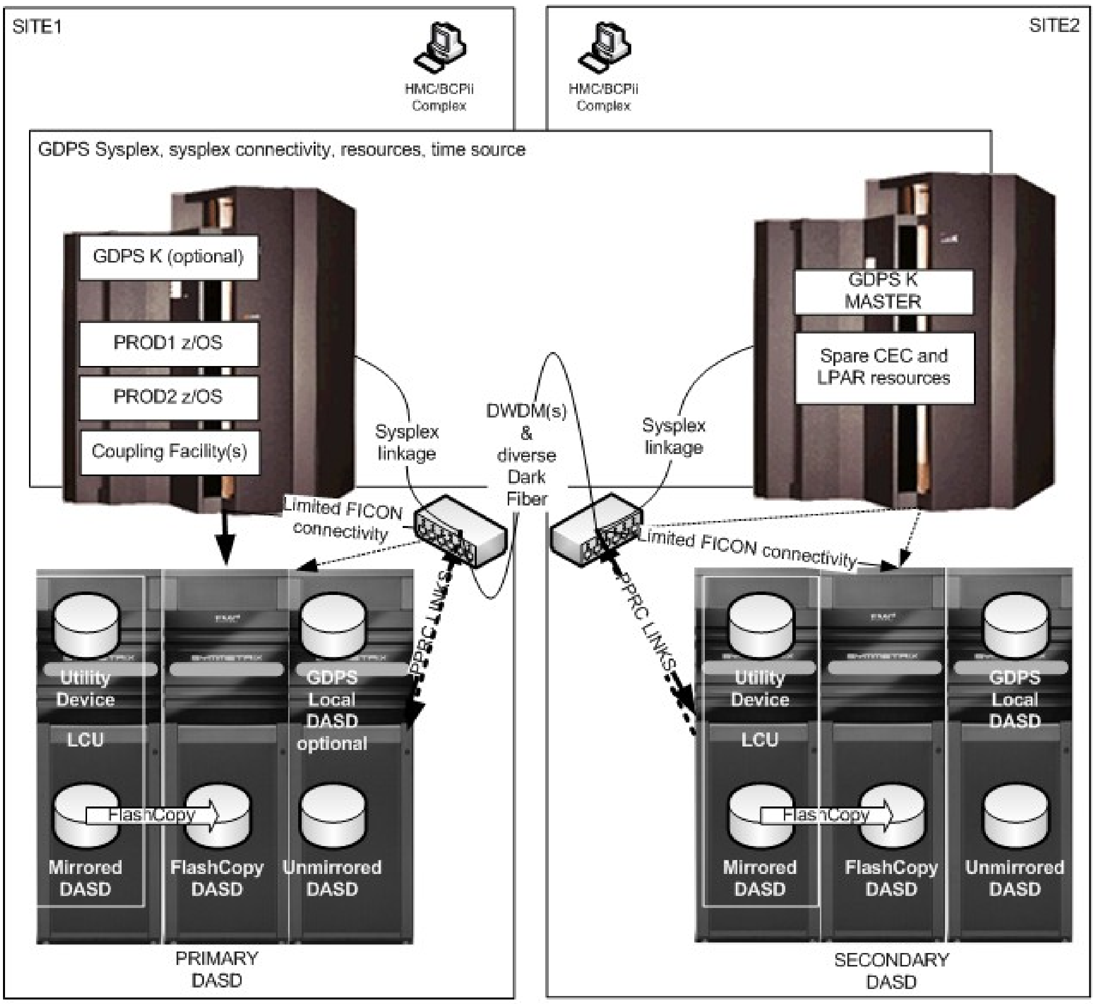


Figure 7 GDPS/PPRC FREEZE STOP/GO network provisioning with DWDM

This topology more closely resembles the illustration on "GDPS/PPRC components " on page 77 . Typically, all links employ the DWDM and dark-fiber network (even the TCP/IP and HMC network employing inter-site connectivity through the DWDMs).

GDPS/PPRC with HyperSwap

Inclusion of HyperSwap to a GDPS/PPRC creates an architecture resulting in a solution with higher expectations of availability and requires more cross-site links.

Additional availability expectations increase the linkage requirements and Symmetrix port requirements:

- Primary DASD cannot be assumed to be at any site. Production FICON connectivity must be provisioned with the same cross-site connectivity as local FICON connectivity.
- Cross-site DASD and local DASD connectivity should not share any common component that introduces a Single Point Of Failure (SPOF).
- Processing is not necessarily confined to one site in particular. It may be operating at both sites simultaneously. Local DASD and cross-site DASD should share similar performance, connectivity, and redundancy characteristics.

The expectation is that a HyperSwap operation is transparent to system and application workloads. In the event of a DASD subsystem failures, the paired Symmetrix system must provide adequate response times (all read and write I/O operations might have additional distance imposed latency). cross-site FICON DASD linkage, redundancy, and performance must be deployed and architected to achieve that expectation.

Linkage requirements:

- Cross-site sysplex consistent with the sysplex architecture and z/Series systems.
- SRDF/S linkage.
- Cross-site FICON connectivity consistent with the local FICON connectivity.

As is the case with STOP/GO policy, inclusion of the DWDMs simultaneously narrows the range of network deployment, but at the same time, simplifies the solution. With the enhanced availability expectations comes a greater role for EMC in determining the cross-site mirroring and FICON connectivity and enhanced participation in determining the link budget. Sysplex linkage's DWDM provisioning and qualification requirements dictate vendor, model, and card selection.

Figure 8 illustrates GDPS/PPRC with HyperSwap linkage.

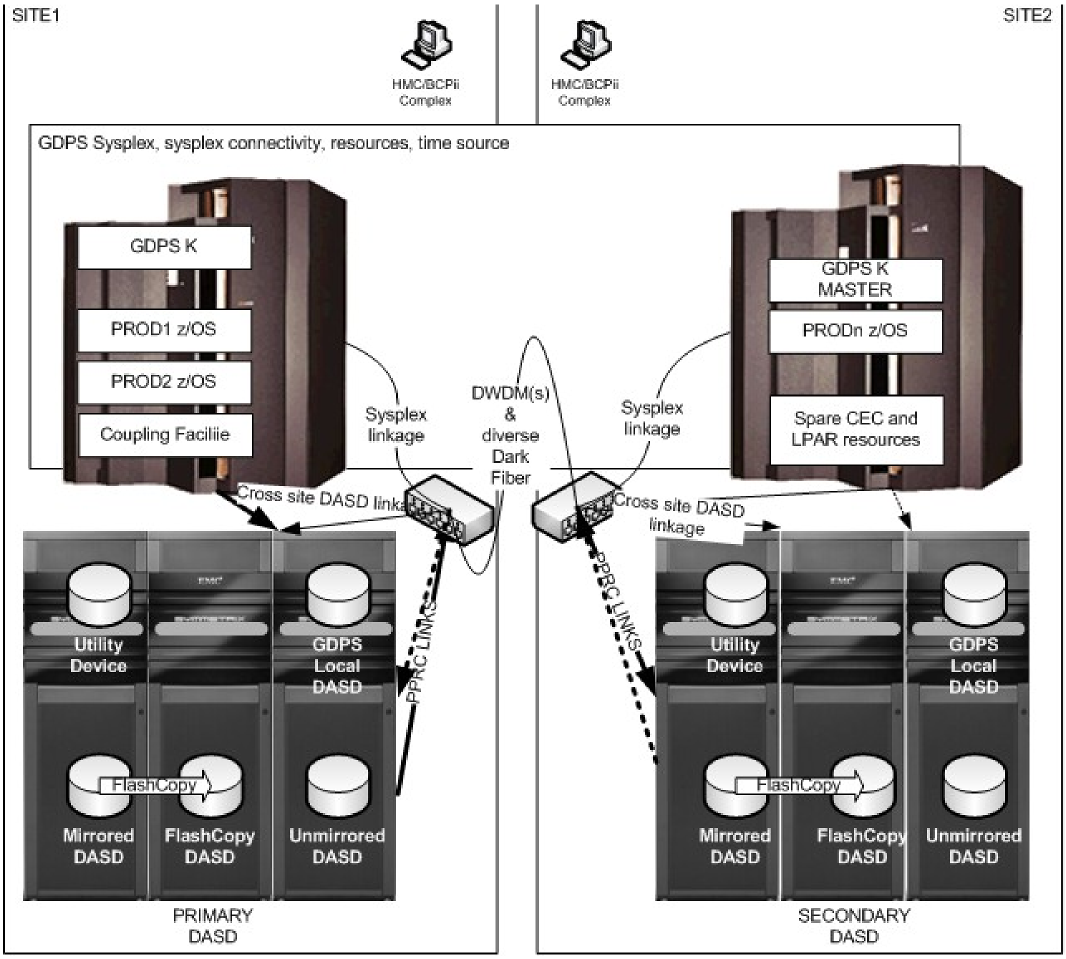


Figure 8 GDPS/PPRC with HyperSwap network

The most important differentiator are the number of links to support the cross-site FICON DASD access, which in turn supports transparent FICON access to DASD after a HyperSwap, as well as FICON connectivity required of potential multisite workload.

This requirement for higher availability results in increased FICON connectivity requirements that must be addressed by sufficient network connectivity, bandwidth and FICON ports.

5

Compatible Extended (XRC)

This chapter includes the following information on Compatible Extended (XRC), also known as z/OS Global Mirror:

Compatible Extended (XRC) overview

Compatible Extended (XRC) is a relatively new EMC Enginuity feature. Several additional feature enhancements in Enginuity 5875 have significantly improved the compatibility of this offering on Symmetrix systems, Incremental Resynchronization (IR) for GDPS/MzGM, and Enhanced Multi-Reader (MR).

The Extended Remote Copy Enhanced Multiple Reader feature is a performance feature and is typically employed by most XRC installations. The PPRC/XRC Incremental Resynchronization feature is required only in GDPS/MzGM when it is implemented with incremental resynchronization capability.

XRC is a remote copy solution, principally for z/OS implementations, but can also be used with z/VM guests capable of time stamping write I/Os. When properly sized and managed, XRC can deliver very low Recovery Time Objectives and scale to very large configurations with a single time consistency. Due to XRC's operational complexity, it is almost always managed with GDPS/XRC.

Features and components

Some of XRC's features and components include:

- Asynchronous remote copy solution, mirroring primary DASD, typically over significant geographic distances, to secondary DASD. When XRC is properly implemented, remote copy operations should impose a minimum of impact to an application's write I/O performance.
- XRC is a combination of hardware and software components. It requires specially licensed microcode features on the primary Symmetrix, cross-site channel connectivity, specially configured z/OS infrastructure, the System Data Mover components (SDM) at the recovery site, as well as secondary DASD, and frequently, a tertiary DASD capacity.
- XRC formation of dependent write consistency in the secondary DASD is based on time stamping of write I/Os when an application writes records. Each application write is time stamped by the host operating system (z/OS, z/VM, and

z/Linux guest under z/VM), and the writes to all the secondary volumes are applied in a manner that retains the time consistency of the initial writes (not necessarily in the same order).

- XRC can be used for business continuity solutions, typically for disaster recovery, as well as site migration. XRC can operate either in XRC mode or MIGRATION mode.
- Does not impose a manufacturer pairing requirement on primary and secondary volumes. Secondary volumes can be any compatible CKD device. The secondary volume must be of equal or greater capacity.
- XRC provides the primary remote copy component of GDPS/XRC implementations.
- XRC microcode is licensed, but the System Data Mover (SDM) is part of DFSMS distribution and is part of the z/OS operating system.[1]
- Remote Copy operation is provided by the System Data Mover (SDM) address space on a z/OS system. However, even a modest XRC implementation (a few TB) requires a notable configuration effort to create the SDM environment.
- XRC's SDM component requires significant processing power, but much of this requirement is zIIP processor capable.

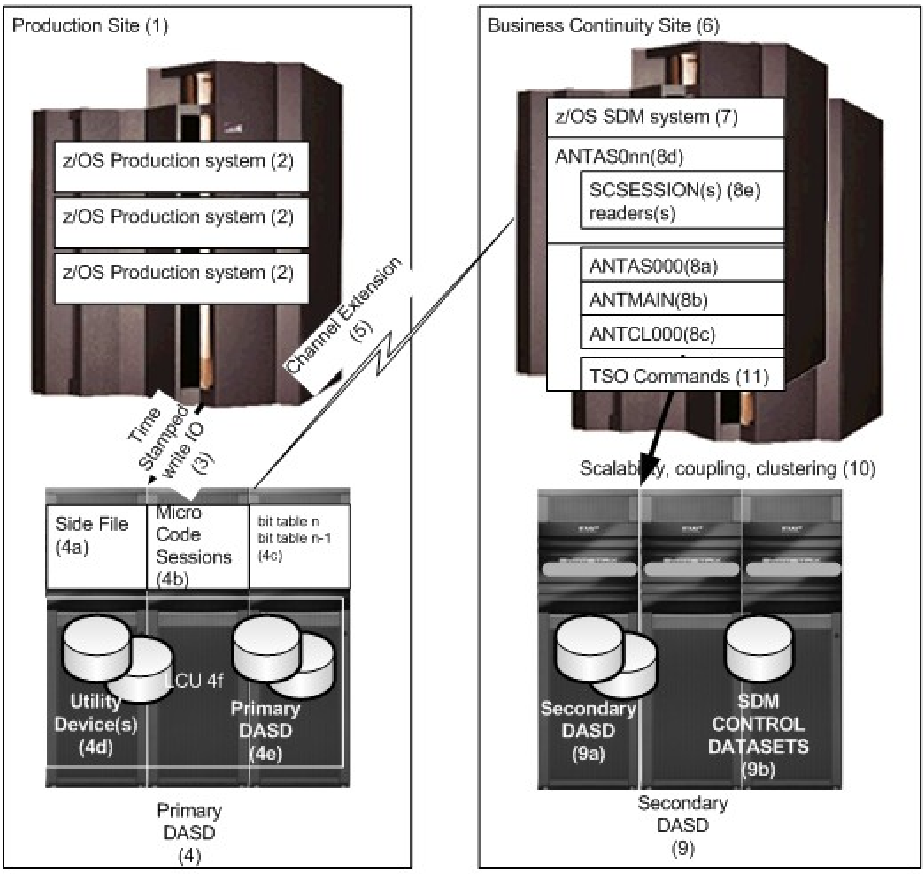
While it is possible to start XRC for remote copy by installing the functional microcode and starting the SDMs, stable world-class implementations are achieved only with extensive planning and monitoring of many components.

1. Significant operational components, such as GDPS/XRC and XPM, are licensed software.

XRC components

Figure 9 illustrates XRC components as typically configured in business continuity application.

Figure 9 XRC components



The following describe the components in Figure 9.

1. Production site: A complex of z/OS systems. A single time consistency requires that the production systems all share a common time source.

2. Production systems: z/OS or z/VM systems capable of time stamping write I/Os to primary XRC volumes.
3. Time-stamped I/O: Of production writes to primary volumes by the operating system to create.
4. primary DASD: A Symmetrix system running the XRC-licensed microcode. Primary DASD subsystems from different vendors can be configured into a single time consistency. The primary DASD is FICON connected to the z/OS resident SDM systems. VMAX systems employed as Primary XRC DASD only requires FICON connectivity. The SDM connectivity should only employ A ports and should not share these ports with production workload. VMAX employed as Primary XRC DASD requires no SRDF connectivity for XRC replication.
   a. Sidefile on primary queued cache structure to retain write updates until they are processed by the SDM. The sidefile is a cache resource independent of the LRU management of other cache resources. Each microcode session (4b) manages its own sidefile.
   b. XRC microcode sessions on the primary DASD subsystem manage the records retained in the sidefile and provide them to the SDM in response to the SDM's XRC read requests (Read Record Set CCWs). These microcode sessions are in a one-to-one relationship with reader tasks in the SDM.
   c. Resynchronization Bit Tables: The microcode sessions maintain two bit tables for every primary volume to enable resynchronization after planned and unplanned suspension. Tracking of updates to the primary DASD is constantly performed. On a specified basis, the older bit table is cleared out and becomes the current bit table. The previous bit table is retained for resynchronization. Bit tables are swapped under the direction of the SDM while a volume is duplexed. When the volume is suspended, this swapping ceases. When starting resynchronization (TSO COMMAND XADDPAIR SUSPENDED), the SDM's COPY tasks read a volumes's two bit tables, OR the two tables together, to determine which tracks must be read from the primary DASD. Next, the changed tracks are read to resynchronize the primary and secondary volume.

d. Utility devices for SDM readers on primary DASD LCUs service the read of record sets from the SDM's readers' sidefiles. XRC advanced features require "fixed" utility devices. Multiple utility devices should be created in each LCU in the Symmetrix Primary DASD subsystem. These volumes should be as small as possible (one cylinder) and must be dedicated to XRC operations. Fixed utility devices are not remotely copied.

e. Primary XRC volumes grouped into an SCSESSION (see 8e), must be in the same LCU. A primary volume belongs to one SCSESSION.

f. Primary LCU: The primary volumes and utility devices in a reader are bound to single LCU.

5. Channel extension architecture: FICON connectivity between the SDM z/OS system and the primary Symmetrix DASD subsystems. This can take many forms depending on network availability, distance and z/Series processor channels.

   a. Direct FICON, or FICON, DWDM, and dark fiber. Some applications with low tolerance for any synchronous mirroring write degradation employ XRC for DR at short distances. Some customers have acceptable FICON performance at distances up to 300 km (with repeaters).

   b. Symmetrix VMAX arrays and z/Series z/10 or later support Extended Distance FICON (EDF), combined with multi-reader feature to reduce the effect of IU pacing.

   c. Channel Extension hardware (also known as spoofing) consists of local and remote channel extenders to: 1) Alter the Read Record Set (RRS) channel programs to reduce latency and improve channel throughput; 2) Enable FICON protocol conversion to different network topologies, such as SONNET or GigE. Many customers employ XRC remote copy at continental distances continue to require Channel Extension hardware. XRC has been tested at half the circumference of the Earth using links over channel extension.

6. Business continuity site: Representative architecture of an XRC business continuity site.

7. z/OS systems to host the SDM address space(s), varying from 1 - 16 systems per CEC (LPAR restriction per CEC). These are typically z/OS systems dedicated to SDM operations. They run the SDMs during XRC mirroring and are generally abandoned during DR operations.

8. XRC address spaces and TCBs.

   a. ANTAS000 system address space: Used for communications between TSO and ANTAS0nn (SDM) address spaces.

   b. ANTMAIN: Point-in-time address space.

   c. ANTCL000 optional cluster address space: Used to manage time consistency when SDMs are clustered.

   d. ANTAS0nn SDM address space: A component of z/OS that manages the SCSESSIONs (s), up to 20 SDMs per z/OS.

   e. SCSESSIONS (also known as Readers): Group volumes within an LCU. Originally, an SCSESSION was a reader. However, with the introduction of Multi-Reader feature (Enhanced Readers) an SCSESSION can be composed of multiple readers (one base reader and multiple auxiliary readers). There can be up to 80 readers per SDM Address Space. However, for performance considerations an SDM should be limited to 40 readers, though 32 is recommended and enforced for multi-reader configurations.

9. Secondary DASD subsystem: DASD subsystems from any manufacturer. They do not require specialized microcode. They only require FICON connectivity and do not need to be provisioned with SRDF ports. Due to the intense write operations associated with the SDM JOURNAL Control Data Sets, VMAX as a secondary DASD subsystem is an excellent candidate for FAST provisioning.

   a. Secondary volumes: The same model density as primary volumes; however, they can be from any manufacture and do not require XRC microcode feature.

   b. System Data Mover (SDM) control data sets (CDS): The Journal, CONTROL, STATE, Master, and Cluster data sets. Note, that the correct configuration of the control data sets (which data sets, properly named and correctly allocated) must exist prior to starting XRC.

10. XRC Scalability: Provided by SDM clustering and SDM coupling. Thirteen SDMs are in a Cluster. Fourteen clusters (or SDMs) are coupled a MASTER.
11. TSO Commands: Command and control through TSO commands (or ASM API).

XRC planning overview checklist

This section provides a quick overview of the planning for an XRC implementation, from configuring the primary Symmetrix channel extension to the SDM and secondary DASD. Details are described in the discussion of the various components listed in Table 6.

Table 6 Feature requirements and compatibility features (page 1 of 2)

	Feature Requirements	Which compatibility features are required for the implementation
PRIMARY Symmetrix	Symmetrix Configuration	Enable the configuration for Compatible Extended operations.
	FICON Modules	How many FICON modules are required? SDM connectivity should be independent of production system I/O and using A ports. Unlike SRDF/A, Compatible Extended does not employ RDF ports for replication connectivity.
	LCU Design	XRC implementation architecture and peak performance is dependent upon the LCU design. (As a reminder, SCSESSIONS are bound to an LCU).
	XRC Utility Devices	Ensure that sufficient XRC utility devices are predefined in each LCU and that their definition is compliant with XRC operations.
	PAVs	Determine the PAV implementation. HyperPAVs are recommended. Static PAVs can be used and Dynamic PAVs should be avoided.
Channel Extended FICON	Comprehensive Bandwidth Study	Primary Symmetrix design must be consistent with the performance requirements determined by a comprehensive bandwidth analysis. Principally this would be the number of FICON channels required, the number of utility devices per LCU, and PAV requirements.
	Channel Extension Technology	Different channel extension technology has different performance characteristics. Validate that the channel extension technology and deployment are sufficient for the solution architecture and Symmetrix configuration. Symmetrix DASD supports Extended Distance FICON.

Table 6 Feature requirements and compatibility features (page 2 of 2)

SDM Architecture	z/OS Systems for SDMs	SDM systems are typically hosted on dedicated z/OS systems. In GDPS/XRC implementations these must be dedicated z/OS systems at the recovery site. The implementation architecture is highly dependent upon the IOCDS design.
	LPARs	SDM performance is highly dependent upon the z Architecture LPAR definitions: Memory, channel connectivity, and MIPs.
	FICON Connectivity	SDM address space requires FICON connectivity to the primary Symmetrix system.
	SDM control data sets	The SDM requires control data sets for operations. Optimal SDM operations and performance is highly dependent upon the correct allocation of these data sets. In addition to the aforementioned performance requirements, the SDM control data sets, particularly the journal data sets, have significant physical and performance storage requirements.
Secondary DASD	Feature Requirements	Ensure that the correct features are installed on the secondary DASD Symmetrix. Typically FlashCopy is enabled and sufficient capacity is provided as “tertiary” DASD for disaster recovery operations.
	Secondary Symmetrix	Ensure that the DASD subsystem is designed correctly as a recovery system. Typically, these systems have at least twice the capacity of the primary Symmetrix. Insure sufficient FICON connectivity for SDM write IO to XRC secondary volumes and JOURNAL data sets. The SDM will do approximately twice the write IO as primary DASD.
	Symmetrix configuration file Settings	Compatible Extended is not configured, but Compatible Native Flash is configured.
	Cabling	Insure that the SDM and recovery systems have the correct access to the z/OS volumes they require.
	Secondary DASD	The XRC secondary volumes and JOURNAL data sets volumes have unique VOLSER naming requirements. Secondary LCUs should resemble the primary LCUs.
	PAVs	For optimal performance, the SDM should use HyperPAVs for the secondary DASD.

XRC operations

This section contains the following information:

XRC operations overview

Once XRC mirroring is enabled (SDM address space is started and TSO commands are issued to relate primary volumes to secondary volumes), the operating system at the primary site begins to time stamp write I/Os to primary volumes. Large complexes of production systems require a common time source, such as a sysplex timer facility. XRC is an asynchronous mirroring technology. As soon as the write is retained in the Symmetrix's primary DASD subsystem's cache sidefile, the application is allowed to continue operations asynchronous to the mirroring operations.

In addition to the expected LRU cache management of the writes, a copy of each write and the time stamp of the write are retained by the Symmetrix microcode in a queued structure in the cache known as the sidefile. Normal cache retains only the most recent update of a record. The sidefile must retain all updates during the processing by XRC (from the time of the write until the SDM secures the write on secondary DASD).

At the secondary side, the SDM address space dispatches the readers to simultaneously read the records in the Symmetrix system's sidefile. Technically, the readers actually read the records (CCW is known as a Read Record Set) from the Symmetrix system's sidefile using the address of a utility device. Typically, utility devices are un-mirrored devices (also known as fixed utility devices).

Primary volumes within an LCU are grouped into several SCSESSIONs, belonging to one reader or multiple readers. The multiple reader feature is deployed either through the use of PAVs or multiple fixed utility devices. Historically, the reader is associated with one fixed utility device. An SCSESSION (sometimes called a reader) can only contain volumes in a single LCU (SSID).

Extended Remote copy data flow

1. Residuals (update writes) are accumulated in the sidefile. There are three mechanisms for dispatching the readers by the SDM to read those residuals:
   a. When a threshold is surpassed, the Compatible Extended microcode sends an interrupt to SDM (XRC PARMLIB threshold).
   b. If there were sufficient residuals after last read (XRC PARMLIB threshold), then the SDM immediately redispatches the readers.
   c. SDM is polling. (Set by XRC parmlib parameter SHADOW.ReadDelay, the default is 0.5 seconds.)
2. The SDM gets buffers for all the readers and dispatches all of its readers to perform read operations against the utility devices.
3. Once all the readers complete their read of record sets from the primary DASD sidefile, the records are put into the SDM's buffers as time groups. If there were sufficient residuals remaining after the last read, then redispatch the readers at step 2. Otherwise, wait for another interrupt or polling interval.
4. Using data from previous reads-in-time groups and time groups from recent reads, the SDM then composes consistency groups (CGs) from the time groups. A CG represents a slice of time that comprises all updates read by the readers. (Note: some readers may have no updates during that interval, but the CG is still valid.)
5. If this is an XRC SDM (not a MIGRATION SDM), the CG is then queued for write to a JOURNAL. Otherwise, for MIGRATION SDM, skip to step 8.
6. A JOURNAL task writes the CG to the next JOURNAL and updates the control data set.
7. If the SDM is COUPLED, the SDM then updates its JOURNAL time in the COUPLE data set, (Note that lacking a JOURNAL TIME, a migration SDM cannot participate in a COUPLED session.)

8. The SDM queues the CG for write to secondary volumes. The SDM:
   a. Combines possible CG.
   b. Eliminates unnecessary writes.
   c. Orders writes based on optimum write performance.
9. CG is written to the secondary DASD. All writes for CG must complete before secondary write subtask can start next CG write.
10. SDM updates secondary time in MASTER COUPLE data set.
11. Buffer is released.

SDM Remote copy operations

The SDM's READERs issue specialized Read Record Set (RRS) CCWs to the sessions utility devices (UD) to read the write records retained in the sidefile. The SDM also issues directives indicating when the data is secure at the remote site, and when the XRC Microcode session can delete the records from the sidefile.

XRC Copy operations

The SDM will direct COPY operations under two instances:

- During initial COPY, when XRC is directed by an XADDPAIR to remote copy, a primary, and a secondary volume, SDM reads tracks directly from the primary volume. (The primary volume must be online to SDM.) See description for XRC TSO command XADDPAIR.
- Incremental Copy is when XRC is directed by an XADDPAIR SUSPENDED command to resume suspended remote copy following a volume suspension. SDM calculates the tracks out of synch based on OR'd update (bit) tables on the primary DASD, and then reads the changed tracks directly from the primary DASD.

XRC's volume copy operations are considerably different than its remote copy operations.

- The CCWs are very different for COPY and REMOTE COPY operations. The copy tasks read data directly from the primary volumes, whereas readers remotely copy by reading update data from the sidefiles through the utility devices.
- The dispatchable operations are very different. Mirroring operations are performed by the reader subtask, and copy operations are performed by the copy tasks.
- The number and aggregation of copy tasks are controlled by their own parameters in the XRC PARMLIB. (See the discussion on XRC PARMLIB, SCSYNCH.) Remote Copy operational parameters are grouped into SHADOW section. Volume copy's parameters are grouped into VOLINIT section.

XRC MONITOR I/O

The SDM periodically reads statistical MONITOR data from the microcode sessions then retains that performance data in the SDM's STATE data set (MONITOR members). This information is principally used by XPM. (See "XRC Performance Monitor (XPM) " on page 187.) The MONITOR I/O is performed approximately once every 10 seconds and is an important diagnostic, performance, and operational aid.

XRC XADVANCE and XRECOVER operations

Normally the SDM is responsible for remote copy operations, initial copy, and resynchronization operations. But under two special cases, XADVANCE and XRECOVER, the SDM is restarted to provide special operations against the secondary DASD.

- XRECOVER restarts the SDM address space to ready the XRC secondary DASD for recovery operations. When restarted by XRECOVER, the SDM ensures dependent write consistency by applying all necessary consistency groups recorded in the control data sets (principally the JOURNALS). The SDM then relabels the XRC secondary volumes with the same VOLSERs as the XRC primary volumes. Under special conditions, the XRECOVER SDM can actually be started against the tertiary DASD (the FlashCopy targets). Doing so requires not only the use of special keyword parameters (ONLINE or TERTIARY), but also usually requires specific GRS settings to avoid conflicting operations between the XRECOVER SDM and ongoing SDM operations. This technique is typically employed by GDPS/XRC. XRECOVER's operations are recorded in the SYSLOG.

- XADVANCE shares some of the same functionality as XRECOVER. XADVANCE restarts the SDM address space to "advance" the secondary DASD to the most recent time possible, as permitted by the valid data in the SDM control data sets (principally CGs recorded in the JOURNALs). XADVANCE differs from XRECOVER in that it does not relabel the secondary DASD.

Host time-stamping requirements

Time-stamping of write I/Os is required (common time source) by the SDM to form time consistency and results in dependent write consistency. Assigning a time stamp to a write I/O is entirely the responsibility and operation of the production system at the primary site. Consequently, if the primary site's production workload spans multiple System z CECs and production systems (z/OS, z/VM) share the DASD and require application restart enforced by a single time consistency (sysplex operations), then the production systems must share the same system time (coordinated time network), typically implemented through STP (or legacy ETR sysplex timers).

Employment of the new SupressTimestamp XRC parameter on the SDM systems is highly recommended.

Description of XRC components

This section describes the following XRC components:

Symmetrix SIDEFILE

The XRC control unit sidefile is physically a cache resource, but dedicated for queued storage of write updates (also known as "residuals"). The size of the sidefile is mediated on VMAX by the cache allocation policy setting in the Symmetrix configuration file.

Managed differently than LRU cache, the XRC microcode sessions must retain a copy of every write (no folding of write I/Os, such as is the case with SRDF/A) until such time as the SDM indicates that the write has been secured at the secondary site.

If the number of residuals in the primary DASD exceeds user specified thresholds, then the XRC Compatibility microcode will employs one of two protection mechanisms for cache overrun on a primary volume depending on threshold settings and the device blocking or write pacing settings established for the volume pair.

Sidefile resource management

Over the years, several mechanisms have been implemented to avoid exhaustion of the sidefile resource and to determine what actions to take when the sidefile resources have become exhausted. There are specific limitations for the sidefile[1]:

- The space consumed by all sidefiles cannot exceed the Symmetrix cache allocation policy definition
- Residual count cannot exceed 128K per sidefile

If these resource limitations are exceeded, then XRC microcode sessions must cease operations and suspend. There have been several microcode features implemented to penalize sidefile cache users and restrict the use of sidefile resources: Device Blocking and the newer Write Pacing. In addition, there are now features that enable a more graceful shutdown of XRC operations that limit adverse effects on production DASD.

Device blocking

Device blocking was the original mechanism to reduce consumption of sidefile resources. If the number of residuals for a volume exceeds the device blocking threshold (XRC PARMLIB SHADOW.DeviceBlockingThreshold default 20), the microcode would issue a long busy for 500 ms every 1000 ms (1/2 second every one second) to all reads and writes as long as the residuals exceeded the threshold. As a mechanism for limiting the consumption of sidefile resources, it had many shortcomings[2] and has been supplanted by the write pacing feature[3].

The TSO XADDPAIR command parameter of DONOTBLOCK disables device blocking for a volume.

1. Values for 2107 implementation. 2105 implementation is 63K residuals.
2. Among the short comings, all reads and writes were penalized; using device busy increased IOSQ time for a device, which WLM attempts to rectify by assigning additional Dynamic PAVs.
3. Device blocking was likened to “slamming on the brakes.”

Write pacing

Write pacing is a newer feature designed to avoid exhaustion of sidefile resources by inhibiting discretionary workload through elongation of write I/O to that volume. It is a granular mechanism for specifying, by volume, the amount of write elongation to apply[1]. Write pacing should not be viewed as a mechanism to replace adequate network and SDM design. Rather, it is best employed to limit the consumption of sidefile resources by discretionary workload or as a means to ensure continued operations by XRC when the ability of the SDM to read residuals from the sidefile is extremely limited due to external events.

Operation

The XRC microcode injects disconnect time on write I/Os to a volume whose residuals have exceeded the write pacing threshold (or device blocking threshold if no write pacing threshold is uniquely specified). Adding disconnect time reduces the number of write I/Os an application can perform with the intent of reducing sidefile consumption by that workload.

Write pacing specification

Specification is by volume pair when the volumes are XADDPAIRed and on a 0 to 15 scale, the maximum degree of write elongation to apply. In addition to a new threshold specification (PARMLIB SHADOW.WrtPacingResidualCnt default 80), there is a default specification for write pacing (PARMLIB SHADOW.DfltWritePacingLvl default 0). To improve the reporting of write pacing, a value has been added that suppresses the reporting of write pacing (PARMLIB SHADOW.PacingReportThreshold default 10). Note that default level write pacing and volume write pacing can be set dynamically using the XSET command.

Suspend Instead of Long Busy (SUSLBUSY)

Initially, when the sidefile resources were exhausted, the microcode reacted by issuing an extended long busy condition, which would often result with production application and system stability issues. If the number of residuals exhausted the sidefile resources, the microcode would respond by issuing LONGBUSY to volumes in the LCU until the number of residuals was less 1K less than the exceeded threshold.

However, a recent enhancement to XRC enables the microcode sessions to simply suspend mirroring when sidefile resources are exhausted. Suspend Instead of Long Busy is enabled using the TSO

1. Write pacing is likened to “tapping on the brakes.”

XRC command XSET parameter SUSLBUSY (YES | NO), the default value is NO.[1] The XRC PARMLIB setting for SILB is SHADOW.SuspendOnLongBusy (YES|NO). In almost all environments, SUSLBUSY should be set to YES. This should be set prior to issuing any XADDPAIR commands.

READERTIMEOUT value

Correctly setting the READERTIMEOUT value in architectures employing channel extension technology is vitally important because the routers local to the primary DASD often do not report channel disconnect with networking problems[2]. Consequently, the microcode sessions in the PRIMARY DASD are unaware that the SDM is unable to read from the primary DASD. This can quickly lead to severe write pacing, as the residuals exceed the device blocking thresholds. READERTIMEOUT provides the microcode sessions a time limit to wait for read I/O from the sessions, after which they suspend.

The microcode sessions always maintains the current time out value, which is decremented by seconds when the SDM does not contact the microcode session and reset to the time out value each time the SDM contacts the microcode. Session suspension occurs when the time out value reaches zero. Since each reader has its own timer the microcode sessions suspend when their time out is exhausted and threshold is subsequently exceeded. In real world scenarios suspension occurs for some readers very quickly (at the reader time out) while others will suspend much later. Because the SDM is unable to communicate to the microcode sessions, it may or may not suspend.

Relevant settings:

```
XRC PARMLIB.SHADOW.DeviceBlockingThreshold(nn, 0-255,
default is 20, dynamic)

XRC PARMLIB.SHADOW.WritePacingResidualCnt (nn, 0-255,
default is 80, dynamic)

XRC PARMLIB.SHADOW.StorageControlTimeout
(00.00.00-18.00.00, default is set by CE)
```

1. When XSET SUSLBUSY is combined with SSID parameter, then the setting for the specified SSID is updated. Without an SSID setting, it applies to subsequently added SSIDs to that SDM. Review GDPS/XRC DASD MIRRORING SCREEN option XSET for GDPS support.
2. In normal FICON (and ESCON) connectivity, when the last path to a host is lost (the light goes out), the microcode will suspend the XRC sessions.

Volume pairs

XRC volume pairs consist of:

- Primary volume on a Symmetrix system with the licensed XRC compatibility feature. The primary volume "belongs" to a reader within an SDM for the life span of the remote copy pair.
- Secondary of equal or greater capacity on any 3390 compatible system (any vendor).

XRC volume pairs are created by the XADDPAIR TSO command or API directive.

Utility device

A utility device provides the device address for an SDM's reader to read record sets from the Symmetrix XRC sidefile. Utility devices are very tightly bound to a reader and LCU (SSID). They are an important design consideration for performance and continuous operation of XRC. Typically, the design of an LCU must accommodate a sufficient number of previously defined fixed utility devices for initial operations and should accommodate changes required to address operational and performance aspects. Additional requirements for utility devices can arise in response to address reader performance or SCSESSIONs that have different mirroring characteristics. (See different session types discussed in Chapter 7, "Three-Site Solution GDPS/MzGM.")

Each SCSESSION must have at least one utility device[1].

There are two types of utility devices:

Fixed: The reader issues reads for the SCSESSION to a particular utility device that was defined using the XADDPAIR command with secondary VOLSER of XRCUTL. The reader always uses the same real device address, hence "fixed" utility device.

Floating: The reader issues reads for the SCSESSION to any primary volume in its session without a reserve. If there is a reserve against the current utility volume, the SDM "floats" the utility device to another device in the SCSESSION.

1. Often casually referred to as "utility volume".

Originally, fixed utility devices could not have a reserve from production system (the SDM could not read through the reserve), but that restriction has been lifted. However, it is still a recommended practice for the utility devices to be undefined or offline to the production systems.

Floating utility devices are a newer feature than fixed utility devices, but fixed utility devices are more common than floating and are required by the most recent of XRC features, multi-reader and incremental resynchronization of GDPS/XRC. In these cases, it is important to set XRC parameters to require FIXED utility devices.

Floating utility devices are implicit. There is no XADDPAIR with the XRCUTL secondary VOLSER specification in an SCSESSION. In addition, unless fixed utility devices are required, when fixed utility devices are unavailable, the utility device can "float".

Important XRC PARMLIB settings controlling utility devices:

`XRC PARMLIB SHADOW.RequireUtility(YES|NO)`
(Default is YES. This is not a dynamic parameter.)

`XRC PARMLIB SHADOW.UtilityDevice (FIX|FLOAT)`
(Default is FIX.)

SCSESSION and readers

From the SDM's perspective, an SCSESSION is a group of volumes in an LCU that all share the same two-character session ID. Originally the reader, SCSESSION, and microcode session were linked on a one-to-one-to-one basis. Each reader was linked to its utility device. The SDM dispatched the reader to read record sets from the sidefile for the volumes in the SCSESSION. An SCSESSION and the microcode session is established when the first volume is defined using the two character SCSESSION_ID, either with:

- A fixed utility device with its secondary VOLSER of XRCUTL, or
- A floating utility device (used the first time a volume pair is defined with the SCSESSION_ID).

The reader uses the utility device to read record sets for write I/Os to the primary volumes from the session's sidefile.

Primary volumes are joined to an SCSESSION and microcode session when an XADDPAIR command is issued specifying the session's designated two-character SCSESSION_ID.

An SCSESSION or reader cannot span LCUs. Its volumes are all restricted to a single LCU. Readers with the same SCSESSION_IDs in different LCUs are in fact different SCSESSIONs.

Multi-readers

The multi-reader feature (enhanced readers) is a performance feature that enables the SDM to simultaneously perform multiple read record sets for a SCSESSION. Single readers can become a bottleneck in XRC performance due to the inherently longer latency and greater response times in reading the residuals from the sidefile than the local applications writing to the sidefile. This can cause residuals to build up in the sidefile in readers with volumes servicing many writes, increasing the recovery point objective and negatively impacting the stability of the solution. In addition, it is more difficult to balance and tune workloads using single-reader sessions. Multi-readers enable much larger SCSESSIONs, with more volumes and reduce the amount of manual tuning required.

Instead of one sidefile and one microcode session, the SCSESSION has as many sidefiles as it has multiple sessions. The writes to an XRC primary device are spread over the multiple sidefiles, enabling the SDM to issue multiple read record sets simultaneously to each microcode session.

Symmetrix multi-reader sessions have one primary session and up to thirteen auxiliary sessions, for a total of fourteen sessions. Most customers employ a default of three or four readers per SCSESSION, with some performance sensitive readers employing more. SCSESSIONs with multi-readers enjoy a nearly linear improvement as readers are added, until the links become saturated or residuals in the sidefiles become zero. As the number of readers increases, the SDM can offload the number of residuals much more effectively.

The first utility device must be a fixed utility device(s). Auxiliary sessions can have fixed utility devices or PAV aliases. HyperPAVs or static PAVs for the utility device are recommended. Dynamic PAVs are not recommended.

Note: The maximum number of readers in an SDM is reduced with multiple readers. Normally with single readers, SCSESSIONS per SDM should be limited to 40. With multi-readers enabled, the number of SCSESSIONS is restricted to 32 per SDM.

Important XRC parameters managing enhanced readers:

`XRC PARMLIB SHADOW.AllowEnhancedReader(YES|NO)`
Enables the SDM to employ enhanced readers. Note the default setting of NO disallows the use of multi-readers.

`XRC PARMLIB SHADOW.NumberReaderTask ((scsn,#tasks),…)`
The number of tasks supporting each SCSESSION IDs. Specification of a default value for all SCSESSIONs is specified by (*,n), where n is the number of multi-readers. If multiple fixed utility devices (XRCUTL volumes) are defined for a SCSESSION, then the reader uses all the fixed utility devices.

`XRC PARMLIB SHADOW.MAXTotalReaderTasks(32-80)`
80 if AllowEnhancedReader(NO). 32 if AllowEnhancedReader (YES). However, for performance reasons, the number of readers/SDM should never exceed 40 in an SDM.

`XRC PARMLIB SHADOW.RequireUtility(YES|NO)`
Should always be specified as YES. Specification of YES requires the use of fixed utility devices.

`XRC PARMLIB SHADOW.UtilityDevice(FLOAT|FIX)`
Enables the floating utility feature. It should always be specified as FIX.

Copy operations

Copy operations is a distinct operation within the SDM address space and is mediated by several XRC parameters. Copy tasks read the tracks directly from the primary DASD and write directly to the secondary volumes. Copy tasks are invoked dynamically, initially as a result of XADDPAIR of volume pairs or after suspension of remote copy, as a result of "XADDPAIR SUSPENDED". Initial copy provides several operational modes (FULLCOPY, NOCOPY, and QUICKCOPY), but the safest is FULLCOPY, which copies all tracks ever used but puts no reserve on the volume's VTOC. [1]

1. QUICKCOPY only copies tracks currently allocated but it must hold a reserve on the VTOC, which is counter indicated in channel extension architectures. Reserves are not well tolerated by production sysplex systems and completely contrary to the implementation requirements of HyperSwap implementations. NOCOPY is never recommended.

The total number of COPY tasks is mediated by several XRC parameters and the total number of LCUs:

XRC PARMLIB VOLINIT.MaxNumberInitializations(0-45). (Default is 4.)

XRC PARMLIB VOLINIT.InitializationsPerPrimary(0-45. (Default is 2.)

XRC PARMLIB VOLINIT.InitializationsPerSecondary(0-45). (Default is 2.)

The number of copy tasks can also be dynamically managed by the TSO command XSET subparameter SYNCH and SCSYNCH. Default copy task values are frequently considered insufficient.

System Data Mover (SDM) address space

The SDM address space provides remote copy services between primary and secondary volumes. This includes inventory management of volume pairs, reading updates from primary DASD Symmetrix system, ensuring dependent write consistency on the secondary DASD volumes and recovery services.

There are a number of important considerations for sizing the SDM and the z/OS system and LPAR within which it must operates.

SDM (re)Start Modes

The SDM operates under a variety of other purposes:

- Started with the XSTART TSO COMMAND (or API), the SDM manages the mirroring operations, reading record sets from primary DASD, forming consistency groups, and updating the secondary DASD in a manner to retain dependent write consistency. The SDM also performs many of XRC TSO command directives.
- Started with XRECOVER, the SDM recovers the secondary DASD by ensuring that all consistency groups in the JOURNAL data sets are rewritten to secondary DASD. If the SDM was coupled, the XRECOVER operation determines the maximum JOURNAL time of all the coupled SDMs and applies the residuals up to the maximum JOURNAL time. The SDM also relabels all the secondary with primary volsers.
- Started with XADVANCE, the SDM performs similar operations of the XRECOVER, but does not relabel the secondary volsers.

- In a clustered SDM environment, one SDM address space per z/OS system operates as the cluster address space coupling the SDMs on that z/OS system.

The SDM address spaces system task names are all of the form ANTAS0nn (nn: 01-15). The SDM address space can be identified with a particular XRC SDM_ID through the XSTATUS TSO command.

SDM operations

In addition to employing readers to read residuals from the sidefile of the primary Symmetrix system, the SDM provides other services:

- Initial full copy and incremental resynchronization copy (after suspension using bit tables) of tracks from primary XRC volumes to secondary XRC volumes.
- Management of the resynchronization bit tables on the primary Symmetrix system.
- Periodic capture of performance data from the primary DASD subsystem and retention in control data set.
- Management of the volume pair status and remote copy, adding volume pairs, deleting volume pairs, suspending remote copy of volume pairs.
- Formation of consistency groups, managing the write of CG to JOURNAL data sets, control data sets (when required), and scheduling the CG writes to secondary DASD.
- Notification to primary DASD microcode sessions when residuals have been secured on secondary DASD and sidefile resources can be released.

SDM session types

An SDM can operate in one of two SESSIONTYPES:

- XRC is the normal mode of remote copy operations for disaster recovery services. XRC operates in recovery mode utilizing control data sets (JOURNAL DSs and CONTROL DS) to guarantee dependent write consistency of the secondary volumes.
- MIGRATE mode is employed for data migration or volume remote copy when dependent write consistency is not required. This mode of operation is often utilized to manage the production system's infrastructure volumes.

Due to the nature of its work, an XRC SDM (as opposed to a MIGRATION type SDM) is required to perform efficiently. A typical

SDM requires at least 1.5 to 1.6 GB of virtual memory, the vast bulk of which must be in buffers that should not page.

SDM buffers and memory requirements

The number of buffers represents the amount of virtual memory available to an SDM's operations. As such, the buffers represent an important sizing, performance, and capacity resource. The buffer capacity and usage is controlled by several parameters in the STORAGE category, many of which have insufficient default values and should be reviewed for more appropriate specification. The size of a buffer is 60 KB.

XRC PARMLIB STORAGE.BuffersPerStorageControl(100-25,000). (Default is 576.)

XRC PARMLIB STORAGE.PermanentFixedPages(0-9,999).

XRC PARMLIB STORAGE.ReleaseFixedPages(YES | NO). (Default is NO.)

XRC PARMLIB STORAGE.TotalBuffers(100-999999). (Default is 25,000.)

XRC PARMLIB STORAGE.IODataAreas(100-9999). (Default is 256.)

Buffer capacity is a critical resource. The SDM will slow down reader dispatching (reader pacing) if the number of available buffers drops below a threshold. Reader pacing usually results in a prompt build up of residuals on the Symmetrix primary DASD and an increased probability of write pacing. In addition, it might also lead to the SDM stalling, XRC suspension, and abnormal termination of the SDM address space.

It is important to ensure the z/OS system is properly configured for sufficient private area and paging space to accommodate all the SDMs intended for that z/OS system.

Likewise, ensure that the LPAR itself is defined with sufficient real memory to support the z/OS system and all SDM address spaces. A single SDM requires about 1.5 GB of virtual memory. The z/OS system must be able to satisfy the virtual memory requirements for all SDMs that run on that system.

Review the *Advanced Copy Services* manual "Planning for Extended Remote Copy" chapter, for guidance on real and virtual storage requirements for the SDM and the z/OS system.

System zResources

Optimal SDM performance is highly dependent upon the physical resources dedicated to its operation in the LPAR definition.

The LPAR must have sufficient real memory to support all SDMs that run in the z/OS system in that LPAR. Typically, that is 1.5 GB of real memory for each SDM, in addition to the real memory requirements of the z/OS system itself.

The LPAR requires FICON channel extension to the primary DASD, with sufficient bandwidth to read the updates from the primary Symmetrix DASD subsystem. The SDM also requires sufficient connectivity to the secondary DASD. The SDM is required to do approximately double the write workload as the production systems. (CGs are recorded in the JOURNAL data sets and then the updates are written to the secondary DASD.)

The SDM can use ZIIP specialty engines, if they are available to the LPAR and enabled in the XRC PARMLIB.

z/OS SDM systems

Typically, the z/OS systems employed for the SDMs are dedicated systems, with unique system generation, availability goals, and operational goals then typical production systems. Almost always they reside at the remote site, especially when operated over geographically significant distances and for disaster recovery purposes[1].

While SDM z/OS systems are often cloned from production systems, they have very different configurations:

- Virtual memory is designed for the large SDM address spaces.
- SDM z/OS systems are not general purpose systems dedicated performance of the SDM address spaces.
- From a licensing standpoint, they are usually cost justified as single-purpose DR systems.

1. Channel Extension technology for XRC is engineered for efficient operation when pulling the Read Record Sets. It is extremely inefficient pushing the individual updates to secondary volumes.

- I/O gen requirements are very different. Typically, both primary and secondary DASD and control data sets are genned as available and online to the SDM systems. Any FlashCopy tertiary DASD is typically offline to the SDM z/OS systems[1]. Turn off reserves and disable SMF recording of DASD statistics, especially when the solution employs channel extender technology. A reserve from the SDM system can hang production systems if the reserve is coincident with a link failure. Guidelines for SMF recording and reserve/release issues are documented in the *DFSMS Extended Remote Copy Reference Information for Advanced Users*.
- SDM z/OS systems are intended for 7X24X365 unattended operations.

SDM sizing

Sizing the SDM system depends upon several issues, including the write workload, number of volumes, and number of readers. Typical 'rules of thumb' follow:

- 1500 to 1800 volumes or 3 TB to 5 TB
- 40 readers without multi-reader
- 32 readers with multi-reader

SDM scalability

A single SDM implements its own dependent write consistency through the formation of consistency groups and by controlling the sequential writes of the consistency groups to the secondary DASD.

IMPORTANT

A single SDM puts severe constraints on the scalability of an XRC solution and is insufficient for modern environments, where solutions of hundreds of terabytes are required.

1. GDPS/XRC and GDPS MzGM impose additional I/O GEN requirements for the GDPS SDM systems and K system.

XRC has addressed scalability though the technology of SDM coupling and its adjunct technology SDM clustering. Coupled XRC is sometimes referred to as CXRC.

In addition to the software enablement of SDM coupling and SDM clustering, proper sizing of the z/OS systems that run the SDMs is very important. Fully defined SDMs need approximately 2 GB address spaces, and much of that private storage must be fixed. Consequently, adequate and effective scalability depends on SDM z/OS systems with large virtual space running in LPARs with sufficient real memory and processor MIPs.

Coupling of SDMs does not force the SDMs to actively maintain point-in-time consistency. Coupling enforces a maximum JOURNAL time (also known as maximum RECOIVERY time) between the SDMs enabling XRECOVER to recreate dependent write consistency by moving slower SDMs forward in time based on consistency group data in the JOURNALs.

SDM Coupling, Coupled XRC (CXRC)

This is the oldest coupling technique. Originally it allowed up to 14 SDMs to form a mutually self-managed time consistency. (No SDM was allowed to write a consistency group to its secondary volumes ahead of (more recently) than the JOURNALed consistency group time of another SDM.)

SDM coupling was introduced with two significant capabilities:

- The maximum number of SDMs in a z/OS was increased from one to five (address spaces ANTAS0nn).
- Up to 14 SDMs could couple themselves in a Master Couple data set to interlock and self-manage a joint recoverable consistency.

JOURNAL and SECONDARY times for each SDM are retained in the Master Couple data set. The Master data set is a one cylinder data set (one track is reserved for mutual use and each SDM has use of one track).

When a system is initially coupled into a Master session [1] it is unlikely that it is interlocked with the already existing coupled members. Interlock is also synonymous with a joint consistency time, or as it is also sometimes expressed, max journal time.

1. In actuality, the “Master Session” does not exist. Coupled SDMs maintain a state of interlock on their own.

A joint consistency time is necessary and sufficient for XRECOVER to create data consistency between coupled SDMs.

Two TOD values are important to the interlocking of an SDM. The JOURNAL TOD (the TOD of the consistency group most recently written to the JOURNAL, effectively the exposure time) and the secondary TOD (the TOD of the consistency group most recently written to the secondary DASD, effectively the delay time). An SDM is interlocked when its JOURNAL time is more recent (newer) than the secondary times for all other interlocked SDMs.

Alternatively, an SDM cannot interlock if it has written CGs to secondary DASD more recently than any other SDM's JOURNAL time. The interlock condition allows XRECOVER to resolve time differences when it rewrites all valid consistency groups in the SDMs' JOURNAL data sets[1]. XRECOVER of coupled SDMs relies upon the fact that data on the secondary DASD can be moved forward in time based on consistency groups s in the JOURNAL, but it is impossible to erase data hardened to the secondary DASD.

However, the structure of coupling technology had inherent scalability limitations (maximum of 14 SDMs). Consequently, XRC scalability has been extended through the newer feature SDM clustering based on z/OS systems.

SDM Clustering

SDM Clustering is enabled by three major enhancements to CXRC:

- The maximum number of SDMs address spaces in a single z/OS system has been increased from 5 to 20.
- A new CLUSTER SDM (name ANTCL000) has been introduced to manage the consistency time for SDMs running in the same z/OS system.

1. Secondary DASD volumes are inherently inconsistent during normal Remote Copy. The write order of consistency groups on secondary volumes is based on time stamping, but the write order within a consistency group is not performed in time stamp order (folding of duplicate writes is performed a priori). Furthermore, the individual SDMs make no attempt to write consistency groups to secondary based on other SDMs writes to secondary DASD. It is up to XRECOVER to resolve all intermediate inconsistencies by rewriting all valid consistency groups in the SDM JOURNALs up to the maximum JOURNAL time in the COUPLE data set.

- To couple to a master data set, SDMs on the same z/OS system either cluster and then couple or couple directly. However, if there is a cluster SDM defined on a z/OS system, then an SDM must employ clustering in order to couple.

Up to fourteen SDM address spaces on an SDM z/OS system can now be clustered. A cluster consists of one CLUSTER SDM (address space ANTCL000) and thirteen XRC SDM address spaces (address spaces ANTAS0nn). The CLUSTER SDM coordinates the consistency time of the thirteen XRC SDMs and manages the cluster's joint consistency time in the MASTER COUPLE data set. The individual JOURNAL and SECONDARY consistency times for the XRC SDMs are retained in the CLUSTER data set, which is a one-cylinder data set. The CLUSTER SDM records the individual SDM consistency times in its CLUSTER data set.

Thus, the maximum attainable scalability for clustering of a single time consistency is 182 SDMs (14 CLUSTERs/MASTER * 13 SDMs/CLUSTER). While it is difficult to put an exact number on this, potentially that would be 182 * 32 LCUs (32 SCSESSIONs/SDM recommended with multi-readers), or about 5376 LCUs (SSIDs), performance considerations notwithstanding.

Clustering SDMs is mediated by two XRC parameters:

- XRC PARMLIB.STARTUP.ClusterMSession(sys_name MSESSIONID)
- XRC PARMLIB.STARTUP.ClusterName(sys_name CLUSTERID)

XRC parameters

The importance of the XRC parameters with regards to sizing, tailoring, operations, and tuning should not be underestimated. Many of these parameter settings have co-dependences, not only with GDPS parameters, XRC control files, and SDM definition, but also with Symmetrix configuration file settings.

Detailed information regarding the XRC PARMLIBs and the parameters can be found in the Advanced Copy Services manual.

Parameter name convention

This manual employs an open type nomenclature[1] for the XRC parameter names. XRC PARMLIB members employ a hierarchy of major sections BITMAP, MONITOR, SHADOW, STARTUP, STORAGE, and VOLINIT, and within each major section its parameters. Within this manual when a parameter is referenced, it will include a reference to its MAJOR section. That format is:

```
Major_SECTION_name.parameter
```

Significant XRC parameters

There are significant XRC parameters that should be specified in XRC large XRC implementations, and includes to avoid using the defaulted values. In addition, VMAX arrays and the Compatible Extended feature have different optimum operational characteristics than other manufacturer's DASD subsystems. This would be reflected in different tuning values for VMAX arrays. Some of the recommendations, listed in Table 7 on page 162, result from testing with VMAX, some are recognized as best of breed recommendations in large XRC implementations for business continuity solutions.

1. An editorial style sheet.

Table 7 XRC PARMLIB recommendations (page 1 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Bitmap	ChangedTracks	0-99999	7500	How many updates to the a primary volume before directing a swap of the primary volume's bitmaps. Default value contributes to extended resynchronization time (potentially as many as 2 * 7500 tracks per volume). Reduce significantly to improve resynchronization time. EMC has determined that relying upon a low bitmap. ChangedTrack, as low as 600-1000 tracks, without adverse effects. Resynchronization duration is the same for all volumes with limited overhead.	To manage the bit table, EMC has determined that Compatible Extended can rely upon a low BITMAP.ChangedTracks, as low as 600-1000 tracks, without adverse effects. Resynchronization duration is effectively the same for all volumes with limited overhead. All volumes will have some tracks to resynchronize with an absolute limit.
	DelayTime	00.00.03-18.00.00	00.30.00	How frequently to swap primary volumes' bitmap while volume is synchronized. Default value contributes to extended resynchronization time. Reduce significantly to improve resynchronization time. Many sites employ DelayTime setting of 00.03.00 to 00.05.00 (3 to 5 minutes) without adverse effects. Resynchronization is very quick for all but the busiest volumes.	

Table 7 XRC PARMLIB recommendations (page 2 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Monitor	MonitorOutput	ON|OFF	OFF	Controls monitor statistical recording to the STATE data set MONITOR members. Recommended setting is ON; ON is required if XPM is installed.	
Shadow	AllowEnhancedReader	YES | NO	NO	Support for Enhanced Readers, required for multi-reader support. Also, specify SHADOW.UtilityDevice(FIX) and SHADOW.RequireUtility(YES),	
	DeviceBlockingThreshold	0-255	20	Keep default, recommend controlling sidefile resource utilization with write pacing, instead of device blocking SHADOW.DfltWritePacingLvl,	
	MaxBytesTransfered	0,60000 to 9999999	512500		The maximum number of bytes written to secondary DASD. EMC has tested this up to 4M,
	MaxTracksRead	1 to 246	64		Number of RRS (read record set) commands that areissuedinasingle channel program. Maximum value can be 246 (but you can specify 1 to 255, all values >246 are treated as 246). Should be set to at least 124.

Table 7 XRC PARMLIB recommendations (page 3 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Shadow (cont.)	MaxTotalReaderTasks	32-80	80 or 32	The total number of readers (both base and auxiliary) allowed in an SDM address space. If AllowEnhancedReader(NO), then default is 80. If AllowEnhancedReader(YES), then default is 32. Set AllowEnhancedReader(YES) and use default of 32. If not using enhanced readers, then the practical limit is 40. If more than 40 readers are required, create a new SDM, balance the readers and COUPLE. Ensure there is sufficient real and virtual memory to support a new SDM address space in the z/OS system.	
	NumberReaderTasks	(id,n) Id: session id or "*" n: 0:14	(*,0)	Specifies whether auxiliary readers are to be used and their numbers by SCSESSION or by default. Note that this parameter corresponds to the number of MR sessions in a SCSESSION, and by reserving 2 for system use on Symmetrix, the maximum number of tasks is reduced by 2. However, in practice the number of MR rarely exceeds 5.	Symmetrix systems support up to 14 sessions (typically, 1 primary and up to 13 auxiliary tasks).

Table 7 XRC PARMLIB recommendations (page 4 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Shadow (cont.)	PavVolumes	1-9	1	Number of parallel write I/O tasks to be used for writes to a secondary volume when PavByteThreshold is exceeded. Performance problems on secondary volumes can impact XRC performance enough to cause write pacing. Recommendation is to employ HPAV on secondary volumes. PavVolume setting of 3 is usually sufficient.	
	ResidualLefttoRead	1-500	128	Number of residuals remaining in a sidefile that directs the SDM to immediately dispatch the readers to reread the residuals, rather than waiting for an attention interrupt or the read delay.	
	ReadDelay	100-5000	100		Duration of the reader polling interval in milliseconds. Symmetrix systems have been stress tested at 100 to 200 resulting in lower average RPO (less than 1 second). Lower ReadDelay results in more aggressive operation by the SDM and can potentially reduce average RPO, but can also increase the MIPs used under low-activity periods.

Table 7 XRC PARMLIB recommendations (page 5 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Shadow (cont.)	StorageControlTimeout	00.00.00 - 18.00.00	CE-defined default for Symmetrix array	Establish site default value based on consulting with the customer, especially in implementations employing FICON channel extension with protocol conversion. Note this is set on an LCU-by-LCU basis upon the creation of the first microcode session in the LCU. Parmlib variable only establishes time out value for new LCUs, not existing ones. To update time out on existing LCUs, use the XRC TSO command XSET with the TIMEOUT parameter.	
	SuspendOnLongBusy	YES|NO	NO	Suspend instead of long busy, unless otherwise indicated, set to YES. This is not dynamic for existing sessions. Use XSET SUSLBUSY for existing XRC sessions.	
	WritePacingResidualCnt	0-255	80	Threshold for initiation of write pacing. This value is multiplied by 64 to determine target residual threshold by volume to begin write pacing. This setting has performance and Recovery Time Implications. Consult with the customer. Note the relationship with VOLINIT.HaltThreshold.	

Table 7 XRC PARMLIB recommendations (page 6 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Startup	STARTUPzIIPEnabled	YES|NO	NO	If SDM processor has ZIIP processors, then the recommendation is to employ zIIPEnabled(YES).	
	SuppressTimeStamp	YES|NO	NO	Direct DFSMS to suppress time-stamping from THIS system. Use this parameter on the SDM system(s) to ensure that the SDM system (s) do not inadvertently update the microcode time on the primary Symmetrix system. Default setting on SDM systems can enable inadvertent updates to time and make it difficult for the SDM to form Consistency Groups.	
Storage	BuffersPerStorageControl	100-25000	576	Default is usually inadequate for most large XRC implementations. Set to 25000.	
	PermanentFixedPages	0-9999	8	Default is too low for most large XRC implementations. It can be set up to 9999.	
	TotalBuffers	100-999999	25000	Most significant SDM employ the maximum of 25,000. Specification has a direct effect on the amount of virtual and real memory required by the z/OS system and LPAR.	

Table 7 XRC PARMLIB recommendations (page 7 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Volinit	InitializationsPerPrimary	0-45	2	The number of copy tasks per primary LCU. Two is usually too low and increases initial copy and resynchronization timing. But too many cop tasks can cause over initiation issues. Four to six is usually sufficient. Monitor resynchronization and increase dynamically with XSET SCSYNCH	
	InitializationsPerSecondary	0-45	2	This has the same issue as InitializationsPerPrimary. Set to the same value.	
	I/ODataAreas	100 to 9999	256	Real Storage Allocation for the SDM channel programs. Settings for this parameter should be based on the number of volume pairs in the session. See Advanced Copy Services Guide for settings.	
	HaltThreshold	0-65535	5120	Keep higher than write pacing threshold, which has a more effective mechanism for managing residuals.	
	MaxNumberInitializations	0-45	4	Total number of COPY tasks. Specify an adequate number given the settings for InitializationsPerPrimary and InitializationsPerSecondary. Can dynamically reset with XSET SYNCH.	

Table 7 XRC PARMLIB recommendations (page 8 of 8)

	Parameter	Range Value	Default	Recommendation	VMAX-specific Recommendations
Volinit (cont.)	TracksPerRead	0-15	3	This has the same value as TracksPerRead.	
	SecondaryDeviceRange		(nnnn-nnnn)	No default. Consider employing SecondaryDeviceRange or SecondaryVolserPattern to protect primary DASD.	
	SecondaryVolserPattern	VOLSER pattern)	NONE	Employ a good naming standard for secondary VOLSERs to protect primary DASD and specify this pattern.	
Flags	IGNORE_INTERRUPTS	OFF	ON|OFF		Setting to ON can reduce the MIPs and likely overhead on VMAX arrays. Aggressive settings on read delay and residuals left to read reduce the need for the SDM to be interrupted. EMC recommends setting IGNORE_INTERRUPTS to ON

In addition to the XRC PARMLIB recommendations, anecdotal evidence from stress tests suggests that Symmetrix system's Compatible Extended performs more effectively when the number of sidefiles per SSID is limited.

XRC PARMLIB hierarchy

For more information about the XRC PARMLIB hierarchy and search order, refer to the *DFSMS Advanced Copy Services Guide*, “Administering your extended remote copy environment” section. Given the scale of modern DASD subsystems, in most cases of multi-vendor deployments, an SDM would likely only administer a single DASD subsystem. Consequently, differences in parameters specific to Symmetrix systems can be easily resolved by providing

XRC PARMLIB members specific to those SDMs managing Symmetrix systems.

XRC PARMLIB members

There are explicit and implicit rules regarding the search order an SDM employs in locating the parameter libraries and their members.

SYS1.PARMLIB(ANTXIN00)

When the SDM is started, it searches the z/OS system PARMLIB concatenation for the ANTXIN00 member. Typically the ANTXIN00 members supply global naming parameters (NAMES.Hlq, NAMES.MHlq, STARTUP.Parmlib, and STARTUP.Global) used for establishing the naming standards for XRC and SDMs' control data sets. Foremost amongst the data sets name standards are those SDM PARMLIBs with the operational parameters through the STARTUP.Hlq and STARTUP.MHlq parameters. Parameter specifications in the ANTXIN00 are usually confined to the STARTUP category.

The NAME parameters can only be specified in the ANTXIN00 member.

Hlq.XRC.PARMLIB(global | ALL)

The ALL and global members (indentified by the STARTUP.Global parameter) typically supply the enterprise's default parameter settings for all SDMs.

Hlq.XRC.PARMLIB(SDMid)

SDMid members typically provide override parameter settings for individual SDMs. The SDM's name is associated with the member name.

XSET PARMLIB member

The XSET PARMLIB command can be used to refresh an SDM's parameters.

XRC control data sets

Depending on the SESSIONTYPE, an SDM will potentially allocate different data sets. A SDM of SESSIONTYPE MIGRATE will only require a STATE data set. An SDM of SESSIONTYPE XRC will at least allocate its control data set and as many JOURNAL data sets as exist.

State data set

The State data set retains the operational definition and domain of an SDM. It should be allocated as a PDSE. The State data set retains the status of all volume pairs. The SDM stores MONITOR performance information in special members. It retains information regarding the CLUSTERED and COUPLED status of an SDM. Cluster SDMs require their own State data set.

Control data set

The control data set identifies valid consistency groups in the JOURNAL files. It is required by SESSIONTYPE of XRC, but not used by SESSIONTYPE MIGRATE.

Journal data sets

There are between two to sixteen data sets principally used for journaling consistency groups (CGs) prior to writing the records in the CG to the secondary DASD (defined in multiples of 2). XRECOVER operations also exploit the JOURNALs as part of recovery operations by reading all valid CGs in the JOURNAL data sets and re-writing their records to secondary DASD.

The JOURNAL data sets are very performance sensitive. All data written to primary volumes is recorded in the form of consistency groups in the JOURNAL data sets. As much I/O goes to an SDM's JOURNAL data sets' volumes as is written to all primary volumes and almost as much as to all secondary volumes. Placement of these z/OS volumes and their physical definition in the secondary Symmetrix subsystem can have profound performance impact. Sizing of secondary Symmetrix DASD subsystem must account for the doubling of write I/O.

Pairs of JOURNAL data sets are generally allocated as DFSMS stripped data sets. See the *Advanced Copy Services* manual for details on the preferred allocation methodology. Performance problems on the JOURNAL data sets can quickly cause operational issues in the SDM and even affect the degree of write pacing on production volumes and adversely affect production and the stability of the solution.

Most serious XRC implementations employ a minimum of eight JOURNAL data sets and of those implementations, the majority use sixteen JOURNAL data sets. If a SDM is unable to write a consistency group (because all the space is exhausted by CGs awaiting write to secondary), then the SDM will ABEND.

Journals are required by SDMs of sessiontype XRC, but not required of SESSIONTYPE MIGRATE.

Cluster data set

The Cluster data set is employed by the SDM address space CLUSTER SESSION (ANTCLnnn) to maintain the joint consistency time information for the clustered SDMs. The CLUSTER SESSION maintains the time consistency information for the member SDMs in a cluster.

Cluster State data sets

Retains XRC monitor data for all the CLUSTERED SDMs in a cluster. It is used by XPM for reporting.

Master Couple data sets

This is used by coupled SDMs to manage their recoverable consistency. With traditional coupling, the SDMs themselves manage their own time consistency by comparing the recorded maximum JOURNAL and SECONDARY DASD consistency times of the other SDMs. In a clustered environment, the CLUSTER SDM address space manages the consistency times of its constituent SDMs and updates the CLUSTER data set. The COUPLE data set must be on a volume accessible by all coupled SDMs or their CLUSTER SDM.

Performance for the COUPLE data set is moderately critical. It is typically isolated on a volume of its own and should never share a volume with a JOURNAL data set.

The COUPLE data set is allocated in a single extent of one cylinder, with no secondary extents. Each SDM takes a single track for recording its information.

Performance considerations for XRC control data sets

Consider the following:

The JOURNAL data sets should be SMS striped.

- MOD-3 volumes are recommended for the journals. Typically, there will be enough cache slots so the entire volume fits in the cache, and device Write Pending limit is never reached with a MOD-3.
- The I/O should be sequential on the journals, so RAID-5 7+1 should be sufficient protection.
- Optimal performance should be achieved by intermixing the JOURNAL secondary volumes across all physical disks. This is most easily achieved using one disk group, with all secondary volumes and control data sets striped across all DAs and disks.
- In a configuration with multiple secondary/tertiary DASD subsystems, consider staggering an SDM's SECONDARY volumes and JOURNALs over multiple DASD subsystems to avoid “doubling up” a hot spot.
- On TIERED frames, the FC disks are recommended. EFD can also be used, but avoid SATA.

XRC TSO commands

Table 8 provides a brief description of XRC TSO commands.

Table 8 XRC commands (page 1 of 2)

Command	Purpose	SDM status
XADDPAIR	Several uses: • Identifies the pair(s) of primary and secondary volumes (by VOLSER). Note the discussion on GDPS/XRC GEOPARM. Puts the volume pair on the COPY queue for initial copy. • Identifies which SCSESSION primary volumes reside (which reader). • Identifies REAL utility devices. (Their definition is not remotely copied.) • Restarts mirroring for suspended volumes (XADDPAIR … SUSPENDED) by putting the volume pairs on the COPY queue.	Up
XADVANCE	Used when the SDM is down to read the valid consistency groups in the JOURNAL data set and write them to the secondary DASD. Not frequently employed.	Down
XCOUPLE	Several uses: • Couples SDMs or CLUSTERs to the MASTER COUPLE data set when the SDM is up. • Uncouples SDM from the MASTER couple data set when SDM is up. • Removes an SDM from the MASTER data set if the SDM is not available (PURGE).	Either up or down depending on the function
XDELPAIR	Deletes the relationship between an XRC pair. Subsequent resumption of mirroring between the pair requires an XADDPAIR and initial copy.	Up
XEND	Ends the SDM environment for an SDM. Rarely employed.	Down
XQUERY	Several query functions on SDM, VOLUMEs, SCSESSIONs, parameter specifications	
XRECOVER	Restarts the SDM to recover the secondary DASD (or tertiary DASD), making those volumes available for normal z/OS operations (such as disaster recovery operations), and ensuring that the data on all volumes is time consistent. Its exact operation depends on the XRC operational mode when the SDM last executed as well as whether the SDM was XENDed. In DR operations (XRC mode[1]) it: • Restarts the SDM address space. • Reads valid consistency groups retained in the JOURNAL data sets . • Rewrites all the valid consistency groups on the apparent secondary DASD[2]. • Relabels the secondary volumes with their primary VOLSERs. The recovery SDM address space either uses the secondary volume addresses retained in the STATE data set or uses the volumes found ONLINE, when directed to use the XRECOVER ONLINE keyword. (This is the typical process employed by GDPS/XRC implementations.)	Down

Table 8 XRC commands (page 2 of 2)

Command	Purpose	SDM status
XSET	Change session parameters. This became of lesser importance with the implementation of XRC PARMLIBs. Many PARMLIB settings are still not dynamic, requiring the employment of XSET for to affect those changes.	
XSTART	Starts the SDM with the assigned SDM name, HLQ, ERRORLEVEL and SESSIONTYPE (MIGRATE or XRC). The SDM then (re)allocates the predefined control data sets.	
XSTATUS	Query the SDM status. It is primarily employed by automation systems managing SDMs.	
XSUSPEND	Suspend the SDM or volume(s) pairs.	

1. MIGRATION mode has no JOURNAL data set(s), hence no rewrite of the valid consistency groups (steps 2 and 3).
2. See discussion on using tertiary DASD in GDPS/XRC.

XRC commands are described in the *Advanced Copy Services Guide*.

Ordering XRC MC features for XRC implementations

In addition to other Management Class (MC) features required, Table 9 lists feature order numbers typical of an XRC implementation:

Table 9 MC products for XRC implementation

Feature Name	Symmetrix System	Model Numbers	Required/Optional
Compatible Extended	Primary Symmetrix DASD Subsystems	CMPEXT	Required
Compatible HyperPAV	Primary Symmetrix DASD Subsystems	SYM-HYPERPAV	Optional (but recommended)
Compatible HyperPAV	Secondary Symmetrix DASD Subsystems	SYM-HYPERPAV	Optional (but recommended)
Compatible Native Flash for Mainframe	Secondary Symmetrix DASD Subsystems	CMPNFLASH	Optional, but typically required in GDPS/XRC implementations

Note: Only the primary Symmetrix DASD subsystem requires XRC feature licensing. It is not required on the secondary Symmetrix DASD subsystem. However, XRC is almost always implemented with a tertiary DASD capacity at the DR site that is implemented with DASD capacity and Compatible Native Flash.

Designing an EMC XRC solution for z/OS

The following information is included in this section:

Implementation

The following sections discuss implementation:

Considerations for implementing a new solution

XRC must be sized for peak business workload. It is imperative that XRC sizing studies employ data (typically SMF/RMF) that reflects peak business workload.

There are many components to XRC, and a sizing study should address all components:

- Number of I/Os per second: Affects not only bandwidth but also SDM sizing and MIP requirements .
- Blocksizes of I/Os: Affects not only bandwidth but also SDM MIP requirements (data in small blocks requires more processing power than the same amount of data in large blocks).
- Peak write (to a volume): XRC must be sized for peak requirement component by component. Failure to account for even a single volume's mirroring requirements can adversely affect the solution's stability.
- Sidefile size: Failure to adequately size the cache requirement effects the maximum RPO and stability of the solution.
- Utility Devices: Number per LCU on primary DASD.

- Bandwidth: A major cost component, initial costs and ongoing costs, often a stability issue.
- FICON connectivity: The geographic distance between the DSM and the primary DASD within the limitations of FICON (over dark fiber) or channel extension technology must be employed.
- Connectivity redundancy: Network components fail and mirroring solutions often suffer the most during partial network failure.
- FICON ports for mirroring: Isolated from production work.
- Geographic separation and network latency: Hops add to latency, marginally increasing RPO, but also increasing the cache requirement, and reducing the effectiveness of readers.
- z/OS systems: For the SDMs, must be designed for the number of SDM address spaces, and they often require specific SYS1.PARMLIB system set up.
- GDPS/XRC requirements: K z/OS system, SDM z/OS system(s), and require sysplex enablement of the SDMs and K systems.
- z/Series MIPs: ZIIP engines requirements. SDMs can use ZIIP specialty processors for much of their processing requirements.
- Real memory: Dedicated to the LPARs for SDM’s z/OS system. It must be adequately sized. Paging for the SDMs should be minimized.
- The virtual memory sizing: For the SDM z/OS systems and SDM buffers, the z/OS system must have adequate virtual memory for all the SDMs active.
- SDM address spaces: The number, configuration, and performance of SDM address spaces.
- Readers: Each primary LCU requires at least one reader. Performance considerations for individual volumes often require readers dedicated to particular volumes and workloads. An SDM should not have more than 40 readers. When multi-readers are employed, the number of readers per SDM should be limited to 32. Combine MR with HyperPAV definitions.
- PAVs (HyperPAVs): Highly recommended on secondary DASD, and requires enablement through XRC PARMLIB settings.
- SDM’s control data sets must be allocated according the type of SDM:

  - STATE DS: One for each SDM, regardless of the SDM type.
  - CONTROL DS: One for each XRC SDM.
  - JOURNAL DS: The JOURNAL data sets must perform as much write I/O as the primary volumes. Allocation of these data sets for performance and adequately sized is required. two to sixteen for each SDM for XRC type.
- SDMsSystem control data sets:
  - PARMLIBs: The SDM attempts to allocate the local XRC PARMLIB data set, depending on setting in the SYS1.PARMLIB settings. This data set and parameters should be allocated, and the PARMs should be established prior to starting the mirroring operations.
  - CLUSTER DS: One for each z/OS systems if SDM clustering is employed.
  - CLUSTER STATE DS: One for each z/OS system if SDM clustering is employed.
  - COUPLE or MASTER DS: One for each time consistency if SDMs are coupled.
- Writes to secondary DASD: Secondary DASD subsystems experience twice as much write I/O as the primary DASD subsystems (writes to XRC secondary volumes and JOURNAL data sets). Use of PAVs is specified in the XRC PARMLIB and is highly recommended.
- Reverse site switch: Are there requirements for a return to the production site after a disaster declaration?
- Secondary VOLSERS: A good naming standard for the secondary VOLSERs is recommended.
- Considerations for FlashCopy capacity: Capacity, usage, performance and access.

XRC sizing

Because of the architecture of XRC, it is not uncommon to actually have to size XRC based on the maximum of two business operations peaks: the maximum number of I/Os per second (small blocksize many I/Os), and the maximum amount of data (large blocksize and many I/Os per second). This is frequently encountered when XRC is deployed in the financial industry, where the daytime online

workload (small block size, many I/Os) is very different than the workload exhibited during offline processing (larger block sizes and sequential type I/O). In addition, an effective study depends on the minimum SMF interval possible. Large intervals often average out workload, masking short duration peaks that on their own can seriously impact XRC operations.

Because XRC employs so many resources, XRC sizing is more than bandwidth sizing.[1] Failure to adequately size any one component can adversely affect XRC performance, not only increasing XRC's Exposure Time (RPO), but also impacting production write response time through XRC imposed write pacing, and ultimately the stability of the solution if XRC exhausts sidefile capacity.

When the SDM is unable to match application write rate, exhaustion of critical resources will happen very quickly, much quicker than typical operational response times. Either SDM buffers or sidefile can quickly become exhausted, leading quickly to SDM suspension.

FlashCopy deployment can also exhibit a detrimental operational effect on XRC performance and an awareness of XRC and FlashCopy interaction is also critical.

Considerations for supplementing an existing solution

An SDM can manage SCSESSIONs with different vendors (primary DASD). But given the size of modern DASD subsystems and possible conflicts in optimal XRC PARMLIB settings, this is unlikely.

Moving volumes under XRC (and changing VOLSERs) is supported (TDMF operations).

Sidefile specification

To address the surge in non Data Slot usage in the cache, Enginuity 5875 micro code introduces the new cache allocation policies called default and replication sidefile. A Symmetrix system employed as a primary XRC DASD subsystem must have the cache allocation policy set to "Replication_Policy".

Symmetrix configuration file specifications

In a GDPS MzGM implementation these configuration file settings must be enabled for all DASD subsystems that can be primary XRC DASD. Insure that your EMC field representative thoroughly checks these settings for correctness via Symmetrix service interface.

1. The best tool for performing XRC SDM sizing studies is RMFMAGIC, sold by Intellimagic B.V.

subsystems. In addition, the SDM has specific PAV requirements, see "XRC exploitation of PAVs" on page 183.

As is the case with Compatible PEER, the configuration file settings and configuration of the primary and secondary Symmetrix systems must be compliant with Compatible Extended.

Table 10 Symmetrix Configuration File Settings for XRC enablement

Name	Value	Description
CKD->XRC_flags->Enable XRC	Check Box	Check box to enable Compatible Extended
CKD->XRC->flags->XRC Never Timeout	Check Box	Leave as unchecked
CKD->XRC_flags->XRC Floating Utility Device	Check Box	From a compatibility standpoint enable this feature but disable its usage through the SDM utility deivce definitions and XRC parmlib specifications
CKD->PPRC/XRC Incremental Resync	YES I NO	This feature must be enabled in GDPS/MzGM implementations employing the incremental resynchronization. Refer to "GDPS MzGM and XRC incremental re-synchronization" on page 218 for a description of the optional feature and when to enable this BINFILE setting.

Name	Value	Description
CKD->impl_fix_part->Multi Reader XRC	1:14	This is the maximum number of microcode sessions for an SDM SCSESSION. The first session is the base session, additional auxiliary sessions are enabled by increasing this value. See "SCSESSION and readers" on page 150.
CKD->XRC timeout value	0:FFFF	AKA Dead Reader Timer, This counter begins to decrement once the device blocking threshold has been exceeded by residuals in the side file. A MC session will suspend itself if this counter gets to zero. This parameter is of importance in implementations employing channel extension technology 0 is the default of 120 seconds.
Memory->Cache Allocation Policy	Replication_Policy Snap Default	Set to Replication_Policy on VMAX with primary XRC volumes.

Linkage and channel extension connectivity

SDM requires System z FICON connectivity to the primary DASD. However, one form or another of channel extension technology is often employed, due to the geographically significant distances encountered between the SDM systems and the primary DASD. The technology employed in the SDM's FICON channel extension is significantly different than those technologies employed in equivalent SRDF/A's RDF connectivity, and rarely can the SDM exploit the same network architecture and components without significant modification.

There are many considerations in the channel connectivity to consider:

- Distance and latency
- Physical network protocols

- FICON pathing
- Network linkage components (FICON channel extension routers or DWDM)
- Protocol conversion technology
- Typically, converting FICON protocol to some physical network protocol, such as GIG/E or SONNET
- Performance requirements
- Cost
- While networking costs have historically trended downward, XRC's networking costs are very important considerations and must be addressed early in the solution consideration

The following are typical with increased distances and latency times:

- Direct FICON over DWDMs and dark fiber and multi-Reader
- Extended Distance FICON and multi-Reader
- Channel extenders

FICON linkage requirements

Use FICON modules on the primary Symmetrix system for the SDM's connectivity. Guidelines include:

- On VMAX arrays, use A ports before using the B ports.
- Configuring all logical ports into the A port is generally preferred.
- Do not configure two paths to the same LCU on the A and B ports of the same director.
- For XRC readers (SDM access), use the B port if no others are available.

Typical mainframe workloads will saturate the VMAX FICON module around 7000 IOPS. Average workloads do not exceed 3500 IOPS. Peaks should not exceed 5500 IOPs. Check with performance engineering on using these numbers. However, these guidelines may need to be reduced *considerably* if peaks are occurring within batch or backup windows, due to larger average I/Os.

Note: The utilization of the second port of a FICON module does not increase the total workload of the module, and results in slightly higher overall response times. Avoid saturating the module and impact production workload on the A port because of SDM access through B ports.

XRC exploitation of PAVs

PAVs (particularly HyperPAVs) are indicated in several aspects of SDM operation. Many of these are not automatically exploited, and require mediation through XRC settings and definitions. Consequently, for optimal operational performance HPAV specifications in the configuration file must correspond to the intended XRC operational requirements and plans.

Incorrect definition of PAVs in the configuration file, or their absence, may seriously degrade the SDM's performance. In addition, HPAVs must be activated on the SDM system to the primary DASD in order for multi-reader to perform effectively using PAVs (as opposed to readers that use multiple fixed utility devices, which do not employ PAVs).

Table 11 lists information for PAV enablement.

Table 11 PAV enablement (page 1 of 2)

DASD Category	Enablement	XRC PARMLIB Setting	PAV type
Secondary DASD	Enables the SDM to simultaneously issue multiple writes in a CG to a secondary volume. Exploitation is mediated by two parameters. When write I/O in a CG for a secondary device > PavByteThreshold, then SDM will use PAVs count in PavVolume to issue simultaneous writes to secondary volume.	SHADOW.PavByteThreshold Range (60000-9999999) default 512500 SHADOW.PavVolumes Range (1-9) default 1 Delays at secondary DASDs, which are not associated with FlashCopy background operations might indicate the need for increasing PavVolume setting.	HyperPAVs are recommended. but static can be employed with additional management coordinated with the production PAV definition of primary volume. Dynamic PAVs are counter-indicated.

Table 11 PAV enablement (page 2 of 2)

DASD Category	Enablement	XRC PARMLIB Setting	PAV type
Primary DASD fixed utility device	Enables multiple readers to issue RRS against a single fixed utility device in an SCSESSION. Reduces the need for multiple fixed utility devices in a single SCSESSION.	SHADOW.NumberReaderTasks Range (0-16) Default (*,0). Note, however, that it is overridden by number of fixed XRCUTL defined in SCSESSION. Excessive accumulation of residuals associated with given readers, leading to increased EXPOSURE TIME or exhaustion of SIDEFILE resources,. Suspension might indicate the need for multi-reader or increasing the NumberReaderTasks Another indicator is excessive I/O time by a reader in relation to the XPM MONITOR interval time. Generally speaking, if a reader's I/O time is observed exceeding half of the MONITOR interval time, itis often regarded as sufficient evidence that additional auxiliary readers are added to the session.	HyperPAVs are recommended. Static can be employed with management. Dynamic PAVs are counter-indicated.

Note: HPAVs are recommended for both primary and secondary DASD.

JOURNALs are DFSMS STRIPED and the SDM does not make use of HPAVs writing to the JOURNALs.

Diagnostics: MODIFY ANTAS000 commands

The MODIFY ANTAS000 commands provide diagnostic services for display and operation of the XRC microcode sessions (including Compatible Extended sessions on Symmetrix systems and the SDMs. The diagnostic information they provide overlaps INLINE displays of the microcode sessions. Compatible Extended feature operation complies with these directives and queries.

Commands apply to XRC, FlashCopy, and Concurrent Copy sessions

Table 12 provides a brief description of the functions of the ANTAS000 commands:

Table 12 ANTAS000 command functions

CREFESH	Restarts the CLUSTER session's address space on a z/OS system.
DELBMAP	Deletes all the bitmaps in the SDM (old-fashioned) planned outage.
DUMP	Dumps the SDM address space (see important note on following page).
DVCDATA	Lists the Storage Control Sessions for a device.
IGNORE_INTERRUPTS	Requests SDM ignore low and high attention interrupts from MC.
LISTDVCS	Lists all devices that are part of a storage control session.
LISTSESS	Lists the storage control sessions operating in a storage control.
PATHS	Reports the channel path and associated path group ids for a device.
RESTART	Restarts an SDM.
SCDATA	Reports the detailed status of a session on a primary storage control.
SCTRAP	Enables /disables problem determination and aids on storage control.
STATESAVE	Diagnostic tool.
SUSSSESS	Suspends microcode sessions (the big red switch).
TERMSESS	Terminates microcode sessions.
XENDDUMP	SDM diagnostic tool.
XRCTRAP	SDM diagnostic tool.

IMPORTANT

These commands can directly affect operations of the microcode sessions and the SDM. Always exercise caution in their use. Incorrect usage can result in session suspension, possible termination of the SDM, or termination of Remote Copy necessitating complete reinitialization and initial copy of volume pairs.

Operation and parameters are documented in the *Advanced Copy Services Guide, Appendix A*.

XRC Performance Monitor (XPM)

A monitoring, tuning, and problem determination for XRC, XPM[1] runs at the DR site alongside XRC.

XPM is probably the most important tool for managing XRC operations. A separately chargeable license by IBM, it is almost always a part of XRC engagements. XPM Real Time Monitor is frequently used in an operational setting to monitor XRC operations on a real time basis. Its mirroring status display is usually preferred over GDPS/XRC's remote copy status display.

XPM uses the MONITOR data in the State data sets.

Components include:

- Real-time monitor (under ISPF) with critical and warning thresholds
- Background component to copy MONITOR data into history data sets (batch job)
- History monitor to review operation in the history data sets (under ISPF)
- Batch Exception monitor to issue warning messages when operational and performance thresholds are exceeded

Note: Invocation is very site- and configuration-dependent. XPM is usually invoked though an ISPF option, but not always. Operation requires knowledge of the SDM names, naming standards, and XPM operations.

Initial problem determination of XRC issues often starts by reviewing XPM historical data to isolate failure.

1. Originally, a closely held set of utilities, XPM was subsequently released as product.

6

GDPS/XRC

This chapter includes the following information on GDPS/XRC:

GDPS/XRC overview

GDPS/XRC is a business-continuity solution designed to deliver disaster-recovery solutions using XRC for long-distance remote copy. In addition, a FlashCopy capability is almost always configured and operationally employed at the recovery site to provide a testable and resilient solution and retain a viable recovery image during resynchronization.

GDPS/XRC requires significant manual setup of the XRC mirroring prior to beginning of operations. The SDMs must be ready to start up prior to starting them under GDPS/XRC control. Manual validation of the XRC and FlashCopy components prior to attempting operational control through GDPS is often performed.

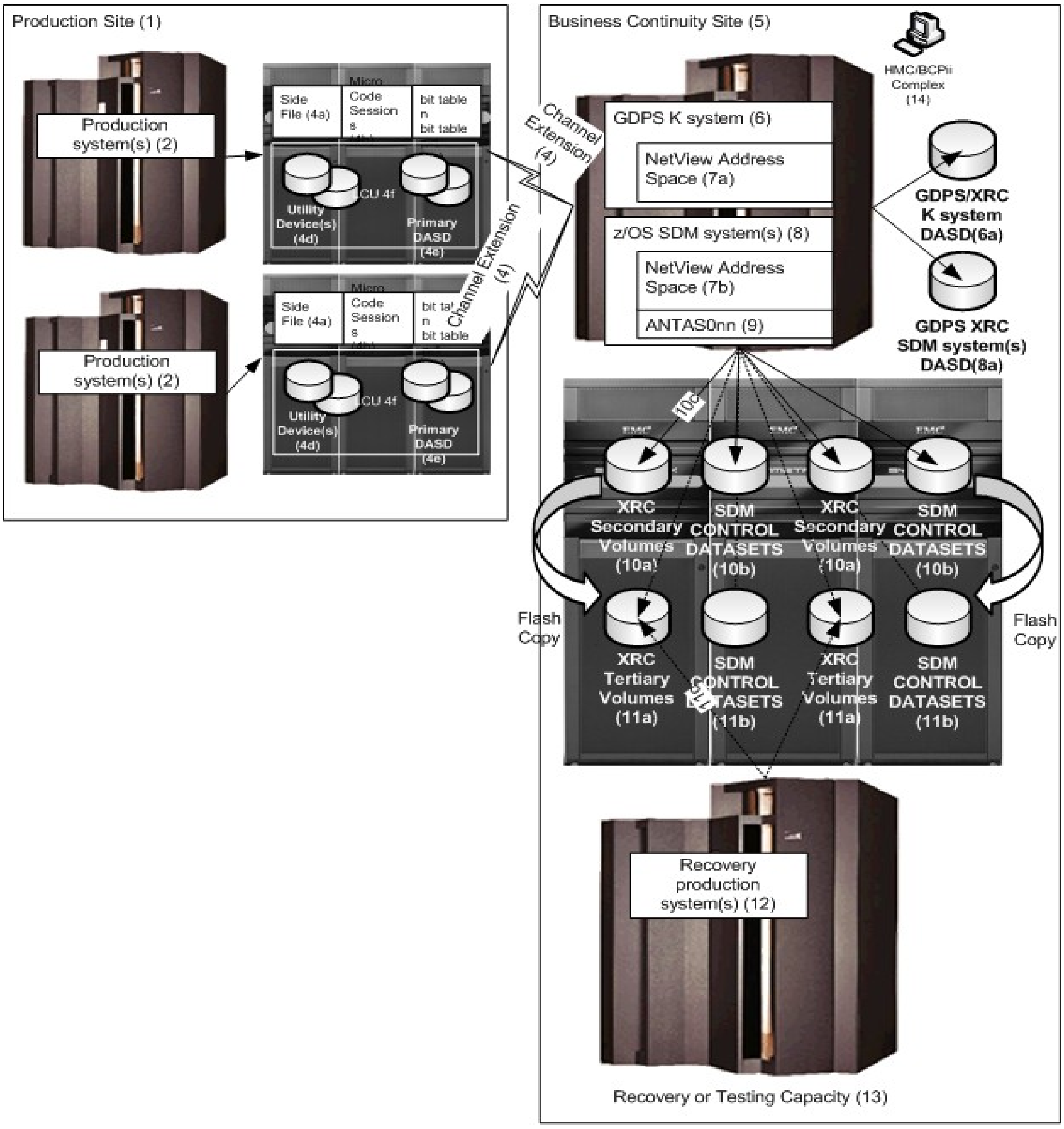
GDPS/XRC features and operations

- GDPS/XRC consists of a GDPSplex at a recovery site, a GDPS K system, and a variable number of z/OS SDM systems running the SDMs.
- GDPS/XRC runs as an application in the NetView address space. Operations of GDPS/XRC requires NetView operator logon to NetView and access the GDPS application.
- Can manage multiple independent time consistencies by enabling multiple MASTER sessions.
- Can direct independent testing and restart of recovery systems.
- GDPS/XRC is not as particular about external operations as GDPS/PPRC. Unlike GDPS/PPRC, which FREEZEs mirroring if a volume pair is suspended outside GDPS/PPRC, GDPS/XRC allows external operations against volume mirroring.

GDPS/XRC components

Figure 10 on page 190 illustrates the major components of a GDPS/XRC deployment.

Figure 10 GDPS/XRC components



Major GDPS/XRC components

Not all of these components are germane to EMC's products, roles, and responsibilities in a GDPS/XRC implementation, but have been included to provide a more comprehensive overview.

1. **Production Site:** GDPS/XRC has no presence at the production site.

2. **Production System(s):** GDPS/XRC has no awareness of the number of z/OS systems at the production site. In fact, it has no actual awareness of even the number of systems (might be inferred through the number of systems to recover).
3. **Primary DASD(s):** Primary XRC DASD is defined in the GEOXPARM. Note this example illustrates a GDPS/XRC complex of multiple time consistencies (multiple MASTER sessions managed independently).
4. **Channel Connectivity:** XRC's channel-extended FICON.
5. **Business Continuance Site:** A physically remote site for disaster recovery.
6. **GDPS/XRC K system:** The controlling system at the recovery site. Together, the GDPS K system and the SDM z/OS systems compose a unique sysplex. In most environments the GDPS/XRC K system actually performs the XRC recovery operations. In most implementations, there is only a single GDPS/XRC K system.
   a. **GDPS/XRC K system DASD:** The local system DASD for the GDPS/K system. Note that it is extremely important to avoid any potential duplicate VOLSERs of the production systems' DASD VOLSERs. Not only would it make it difficult to bring the intended production volumes online to the SDMs, but if the SDM used these volumes as primary XRC volumes, the logical integrity of the recovery set of DASD could be critically impaired.

IMPORTANT

This is not a casual warning. GDPS's GEOXPARM definitions are device-addressing based, but XRC XADDPAIR is VOLSER based. When a CONFIG is loaded, GDPS resolves the intended XRC pairings based on the VOLSERs found at the device addresses specified in the GEOXPARM. If subsequent to that operation a local device with the same VOLSER as a production system was ONLINE to an SDM when an XADDPAIR directive was issued, then that unintended local volume is established as the primary volume and its contents are remotely copied to the secondary volume. If that volume was perhaps a critical volume, an ICF CATALOG for instance, the catalog structure of the recovery environment would be corrupted by the local version.

IMPORTANT

Resist simply cloning the production systems' system volumes in order to create the GDPS/XRC systems environment. The issue is not simply strange SDM consistency behavior due to difference in the GMT time of the different locations and the inconvenience of the SDM system being presented with duplicate VOLSERs, the very integrity of the recovery can be at stake.

7. **NetView address space (GDPS/XRC):** GDPS runs in the NetView address space. Operation of GDPS/XRC requires logging on to NetView and running GDPS in your operator session. Most scripts run on the GDPS/XRC K system.

8. **z/OS SDM systems:** The z/OS systems that run the XRC SDMs. Typically, massive z/OS systems running in very large LPARs. In addition to running the SDM address space,s, these systems actually perform the FlashCopy operations. They need access to the primary DASD, secondary DASD, and tertiary DASD.

   a. **GDPS/XRC SDM system DASD:** The local system DASD for the SDM z/OS systems. Note that it is extremely important to avoid any potential duplicate VOLSERs of the production systems' DASD VOLSERs. Not only would it make it difficult to bring the intended production volumes online to the SDMs, but if the SDM used these volumes as primary XRC volumes, the logical integrity of the recovery set of DASD could be critically impaired.

9. **SDM address spaces (ANTAS0nn):** These system address spaces are the SDMs. GDPS/XRC can support multiple MASTER Sessions all with their own SDMs.

10. **GDPS Secondary DASD:** With FlashCopy capacity, the secondary DASD is more than just the XRC secondary volumes. It includes the XRC secondary volumes and SDM infrastructural volumes. Note that there can be multiple instances of 10a and 10b.

    Note: Typically these DASD subsystems are more than twice the size of the production DASD subsystems and require FlashCopy licensing. With regard to performance, they must be capable of twice the write operations as the production DASD, while simultaneously completing FlashCopy and DR testing. These systems must be configured accordingly. Advise customers of their performance requirements, and avoid redeploying older, outdated DASD subsystems in this role.

    a. **XRC SECONDARY volumes:** The volumes used by the SDMs for mirroring operations. If FlashCopy is employed, these volumes are only used for mirroring never for recovery.

    b. **SDM control data sets:** The SDM control data sets, JOURNAL, STATE, CONTROL, CLUSTER, and MASTER. If FlashCopy is employed these data sets are FlashCopy sources to the tertiary control data sets employed by the recovery operations.

11. **GDPS Tertiary DASD:** With FlashCopy (and almost all GDPS/XRC implementations employ tertiary DASD), this is the DASD component used in the recovery operations. It is the DASD recovered for DR testing, and the DASD intended for use by actual DR operations. To recover from the tertiary DASD a complete set of XRC secondary volumes and XRC control data sets must be FlashCopied.

    a. **XRC Tertiary DASD:** The FlashCopy targets and DASD XRECOVERed by the GDPS/XRC K system.

    b. **SDM control data sets:** The FlashCopy targets and control data sets used by the GDPS/XRC K system for XRECOVER.

12. **Recovery production systems:** z/OS systems used for recovery operations. They should have access to only the tertiary DASD.

13. **Recovery or testing capacity:** Sufficient definition (LPARs) capacity, connectivity, and performance to run production DR operations.
14. **BCPii infrastructure:** Interfaces and components, HMCs, SEs, and TCP/IP connectivity.

GDPS/XRC systems and DASD components

The component architecture of GDPS/XRC is very different than GDPS/PPRC. GDPS/XRC employs sysplex technology at the DR site to improve the operations of XRC's SDMs, but it is not dependent upon sysplex technology to achieve data consistency, as required by GDPS/PPRC. Nor does GDPS/XRC monitor the production z/OS systems availability to detect possible disasters.[1]

Production systems/production sysplexs

GDPS/XRC makes no requirements on the production systems and production sysplexes. A GDPS/XRC implementation can actually service the disaster-recovery requirements for multiple production systems and sysplexes. Through its support for multiple master sessions, GDPS/XRC has the ability to independently manage multiple time consistencies. Production systems are not required to be in a sysplex.

GDPS/XRC sysplex

GDPS/XRC is implemented through a unique sysplex at the DR site, whose only purpose is to run the SDMs and provide recovery services. The systems that compose the GDPS/XRC sysplex (also known as GDPSplex), are not members of the production sysplex, nor are they members of the recovered sysplex at the DR site. Unlike GDPS/PPRC, GDPS/XRC requires no cross-site sysplex connectivity. GDPS/XRC at the recovery site has no awareness of the system or DASD awareness at the production sites[2]. GDPS/XRC runs as a NetView application on the GDPS/XRC K system and the GDPS/XRC SDM z/OS systems.

The GDPS/XRC K and SDM z/OS systems are identified through the NetView GDPS/XRC site table entries (refer to the IBM GDPS/XRC Installation and Customization Guide) and the installation of

1. Unlike GDDR SRDF/A and GDDR STAR remote C systems which do monitor the availability of the C systems at the production site and will initiate DR operations in the event of an apparent disaster event at the production sites.
2. GDPS/MzGM does introduce some limited inter-site communications and interoperability.

GDPS/XRC on those systems. SDMs are associated to SDM z/OS systems through GEOPARM SESSION statements.

IMPORTANT

Make sure that the production volumes are not written to by the systems (K and SDM systems) of the GDPS/XRC sysplex. The GDPS/XRC sysplex runs off of a different time source than the production systems. If write access by the GDPS/XRC sysplex to the production volumes is discovered, then timestamps should be turned off in the XRC PARMLIB.

GDPS K system

The GDPS/XRC K system provides centralized command and control functionality, including:

- Runs the GDPS/XRC scripts.
- Directs XRC and FlashCopy operations on the SDM z/OS systems.
- Controls of the SDM systems.
- Usually performs XRC XRECOVER operations.
- Interfaces to BCPii for restart of production workload and reconfiguration of processors.

GDPS/XRC SDM systems

GDPS uses the SDM systems for a variety of purposes. They are specially-generated systems running GDPS/XRC.

- The SDM z/OS systems host the XRC SDM address spaces.
- NetView on the SDM z/OS systems controls FlashCopy.
- Can perform BCPii operations against the GDPS/XRC K system.

GDPS/XRC DASD

The policy of remote copy relationships of two or three volumes in XRC and FlashCopy relationships defined through the GDPS/XRC GEOXPARM.

Successful GDPS/XRC implementation requires that only certain systems have access to particular DASD components through their z/OS IO GENs. These requirements are detailed in the *GDPS/XRC Installation and Customization Guide*.

Note: GDPS/MzGM changes some of the naming standards of the GDPS/XRC and GDPS/PPRC DASD[1].

GDPS/XRC system packs (local DASD)

These are system volumes for the GDPS/XRC K and z/OS SDM systems and are not the source or target of remote copy relationships. Access is typically limited to the GDPS/XRC K and SDM z/OS systems. Avoid duplicate VOLSERs with production DASD.

GDPS/XRC primary DASD

Typically, there are two classes of XRC primary volumes:

- Actively remote copied: These are kept in sync with XRC secondary DASD.
- Copyonce primary volumes: Infrastructure volumes, such as page volumes and work volumes, which provide infrastructure for the recovered systems but provide no valuable data for the restart of work.

The GDPS/XRC primary DASD must be accessible by the production systems and GDPS/XRC SDM z/OS systems. The primary DASD should not be accessed by the GDPS/XRC K system, and care must be taken to ensure that the recovered systems have no unintended access to these volumes[2].

GDPS/XRC secondary DASD

As a concept, the GDPS/XRC secondary DASD is not simply the XRC secondary volumes. GDPS/XRC definitions and operations extend beyond the traditional XRC secondary volume domain. The GDPS/XRC secondary DASD consists of:

- XRC secondary volumes: FlashCopy source to the recovered set of DASD.
- XRC's SDM control data sets: FlashCopysource to the XRECOVER SDM on the GDPS/XRC K system.

These two components of DASD are treated as a cohesive unit by many of the GDPS/XRC operations.

1. The GPDS/PPRC SITE1 DASD becomes SITEA DASD, SITE2 DASD becomes SITEB DASD, the GDPS/XRC secondary DASD becomes SITEC DASD, and the GDPS/XRC tertiary DASD becomes the SITEF DASD.
2. Employ an IOCDS that limits the recovery systems to only tertiary DASD addresses.

Access to the GDPS/XRC secondary DASD is required by the SDM z/OS systems. This is not true of the active production systems, nor of the recovered production systems, and very limited access by the GDPS/XRC K system[1].

GDPS/XRC tertiary DASD

FlashCopy targets of the GDPS/XRC secondary DASD. It is used for the recovery operations by both DR testing and actual DR (must be in the same Symmetrix DASD subsystem as the secondary DASD).

it permits access by the K system and recovered production systems. (The recovered production systems do not require access to the tertiary DASD that are the FlashCopy targets of the XRC SDM control data sets.

1. Depending on residency and operation of XPM, the GDPS/XRC K system may require access to the volumes with the STATE control data sets.

GDPS/XRC GEOXPARM mirroring defined

The XRC and FlashCopy copy relationships and XRC's SDM components are defined in the GDPS/XRC GEOXPARM data set, which is allocated to GDPS/XRC NetView (technically only on the GDPS K system).

Coding rules for the GEOXPARM are documented in the *GDPS/XRC Installation and Customization Guide*.

GDPS/MzGM adds additional parameter specifications. Zero Suspend FlashCopy also adds additional parameter specifications to identify the volumes with SDM control data sets.

In most implementations, the GDPS provider (IBM Global Services) designs the SDM architecture, and therefore is responsible for coding GDPS's GEOXPARM. However, some of this responsibility might be shifted to EMC as the storage vendor in specific implementations. Should that be the case, the SDM architecture described by the GEOXPARM will require updates to many of the GDPS/XRC CONTROL scripts for SDM operation, disaster-recovery testing, and actual disaster-recovery operations. The scope of EMC's responsibility would expand significantly.

The SDM components are somewhat hierarchical in nature, and that is reflected in the statements and their interrelationships in the GEOXPARM data set. Primary volumes belong to a reader. Readers operate within an SDM. SDMs couple to master sessions either directly, or through, a cluster. That hierarchy is reflected in the GEOXPARM's statements.

Locating XRC error messages with GDPS/XRC

GDPS/XRC retains error messages in a variety of locations depending on the component in question:

- SDF for error messages from GDPS/XRC SCRIPT execution.
- NetView LOG for CONFIG errors.
- NetView LOG on K system for XRECOVER errors.
- NetView LOG on SDM systems for XRC errors, FlashCopy and device directives (VARY ONLINE/OFFLINE).
- z/OS system logs for XRC, FlashCopy, and device directives.

Locating XRC XRECOVER report

XRECOVER operations creates a recovery report for each SDM. Since XRECOVER is typically executed on the GDPS/XRC K system, they are retained in the K system's NetView log.

NetView operations

GDPS panels resemble ISPF panels, but NetView operations require a NetView USERID, password, and knowledge of the GDPS/XRC NetView VTAM APPLID.

Getting to GDPS from NetView operator console

1. Log on to NetView on the K system (3270 application).
2. Issue GDPS from the NetView command prompt (wait for the "***" status).

Browse NetView's log

From command line issue "BR netloga" .

Search NetView's log for messages

Issuing MVS System Commands from NetView

NetView's command prompt is a handy place to issue MVS System Commands. Use the NetView command MVS to submit an MVS command:

MVS <*any mvs system command*>

Example MVS D R,L

7

Three-Site Solution GDPS/MzGM

This chapter includes the following information on GDPS/MzGM, a three-site solution:

GDPS/MzGM overview

GDPS MzGM is one of two three-site GDPS offerings[1]. MzGM is a combination of a GDPS/XRC infrastructure and one or more GDPS/PPRC[1] infrastructures.

MzGM can be implemented as three physical sites, but it is frequently implemented as three logical sites within two physical sites. The two GDPS/PPRC sites implemented as two logical sites within one physical site where HyperSwap is implemented, principally to eliminate primary DASD's Single Point of Failure (SPOF).

There are significant changes in the functionality of GDPS/XRC, as well as some changes to GDPS/PPRC:

- Limitations to HyperSwap operations.
- Changes in terminology of DASD by site designation and usage.
- Optionally employing Incremental Resynchronization (IR) after HyperSwap to eliminate complete resynchronization.
- New GDPS/XRC SCRIPT directives to manage incremental resynchronization.
- GDPS/XRC queries primary volumes to determine PPRC mirroring relationships.
- Formalization of multiple GDPS/PPRC to one GDPS/XRCNew SDM session types unique to GDPS/MzGM architectures to support the primary DASD architecture mirroring on top of XRC session types:
  - MZGM: GDPS session type for most volumes. These volumes are replicated by both PPRC and XRC. These volumes are capable of HyperSwap and XRC IR.
  - MIGMZGM: GDPS session type for infrastructural volumes, continuously remote copy by PPRC, but not continuously remotely copied by XRC (example: page data set volumes).
- XRC: GDPS session for volumes remotely copied by XRC, but not remotely copied by PPRC (example: sysplex couple data sets).

1. The other three-site GDPS solution, GDPS/MGM, is a combination of GDPS/Global Mirror and GDPS/PPRC. Global Mirror is not a supported compatibility remote copy technology. Consequently, GDPS/MGM is not supported on EMC Symmetrix technology.

- MIGRATE, non PPRC, not continuously mirrored by XRC. It is also referred to as “COPYONCE”.
- Additional coupling (CXRC) requirements for MZGM and XRC sessiontype.

Implemented through changes in the microcode licensing, GDPS licensing, GEOPARM coding, and new GEOPLEX policy (THREESITE and FRZ parameter).

GDPS/XRC supports the SDM mode of HYPER-PPRC

- SDM is aware of the GDPS/PPRC and GDPS/XRC relationships
- Supports incremental resync of the new primary DASD after HyperSwap
- Manages the DASD-A/DASD-B/DASD-C relationship
- Additional symmetry requirements of the DASD-A and DASD-B SCSESSIONs. (See recommendations on mixing IR and nonIR SCSESSIONS within an LCU.)

MzGM architecture

Figure 11 illustrates a simple MzGM's architectural components.

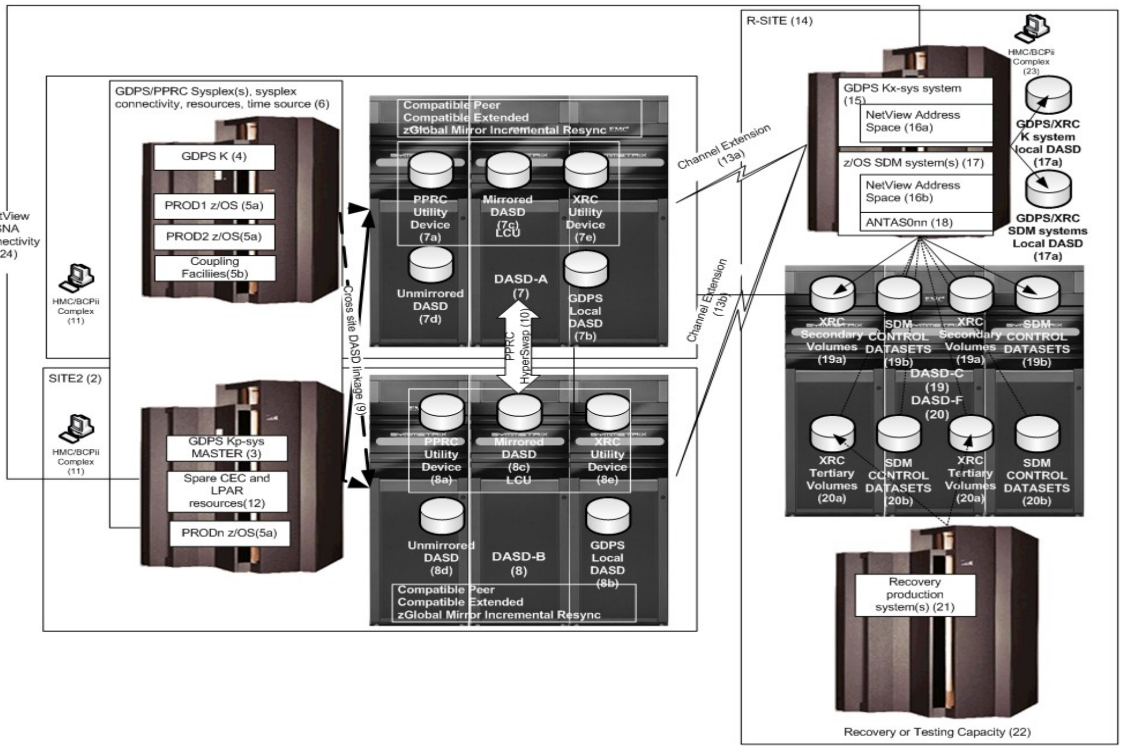


Figure 11 GDPS/MzGM architectural components

Of the major GDPS/PPRC components, not all are germane to EMC's roles and responsibilities in a GDPS/PPRC implementation, but have been included:

1. **SITE1:** The inventory of physical resources defined as residing at SITE1, including DASD, systems, processors.
2. **SITE2:** The inventory of physical resources defined as residing at SITE2.

3. **GDPS Kp-sys Master K:** In addition to the requirements and operations as the GDPS/PPRC K Master system, this system also establishes an operational relationship with a GDPS/XRC Kx-sys.

4. Other **GDPS K systems**: Two GDPS/PPRC systems are required (especially if HyperSwap is intended in the architecture).

5. **Production systems**: Usually the production systems are local to one site, but architectures with higher levels of availability do not restrict application systems to one site:

   a. z/OS systems in the sysplex.

   b. Coupling facilities used in the sysplex.

6. **GDPS/PPRC sysplex(s)**: GDPS/PPRC must reside in a sysplex, and GDPS/PRPC can only be in one sysplex. Multiple sysplexes require multiple instances of GDPS/PPRC infrastructures. However, in GDPS/MzGM configuration, the GDPS/XRC can manage multiple GDPS/PPRCs.

7. **DASD-A:** Traditionally thought of as the primary PPRC DASD, HyperSwap enables an agnostic approach to the situational locality of "primary" PPRC DASD and primary XRC DASD. GDPS/MzGM is always a concurrent mirroring topology[1], the GDPS/PPRC primary and the GDPS/XRC primary volumes reside at the same site.[2] This DASD subsystem has all the XRC microcode components of sessions, sidefiles, and bitmaps.

   a. GDPS/PPRC utility devices for PPRC operations by K systems technically can share usage of XRC utility devices (see 7e, 8e), but typically the utility devices are dedicated.

   b. GDPS local DASD: The DASD used by the GDPS/PPRC K system; not remotely replicated; unused by other systems.

   c. Remote Copy DASD, PPRC, and XRC primary volumes. For HyperSwap, all volumes used by applications and systems must be PPRC primary volumes in duplex state. Most volumes are continually replicated by XRC, but some

1. Unlike GDDR STAR, which can be designed in a concurrent topology or cascaded topology, GDPS/MzGM must always operate in a concurrent topology.
2. Some volumes not in PPRC relationships are in XRC relationships.

volumes, such as page and temporary volumes, need only occasional XRC replication to establish the infrastructure requirements for recovery systems.

   d. Non-PPRCd DASD: Typically the sysplex data sets are usually replicated by XRC on an occasional basis (like 7c).

   e. XRC utility devices: MzGM requires XRC utility devices in both DASD-A and DASD-B.

8. **DASD-B:** Normally unavailable, this DASD must be able to operate as the primary PPRC and primary XRC, subsequent to a HyperSwap. After a GDSP/PPRC HyperSwap and GDPS/XRC XSWAP PERFORM, this DASD becomes the primary PPRC suspended and XRC primary. It has all the XRC components of sessions, sidefiles and bit maps.

   a. GDPS/PPRC utility devices.

   b. GDPS local DASD used by the GDPS/PPRC K system.

   c. DASD replicated by PPRC and XRC.

   d. DASD not replicated by PPRC and usually remote copied on occasional basis by XRC.

   e. XRC utility devices.

9. **PPRC cross-site DASD connectivity**: Performance, redundancy, and bandwidth suitable for HyperSwap operations.

10. **PPRC linkage.**

11. **BCPii** interfaces and components: HMCs, SEs, TCP/IP. connectivity

12. **Spare CEC and LPAR:** Resources required and capacity on standby

13. **Channel connectivity:** SDM's FICON connectivity to primary XRC DASD subsystems. Note that HyperSwap and Incremental Resynchronization require simultaneous access by the SDM to both DASD-A and DASD-B. The architecture and the deployment of the physical network components depend on the business-continuity requirements of SITE1/SITE2. If SITE1/SITE2 share a single physical site, and HyperSwap is implemented merely to eliminate the DASD SPOF, then the need for redundant physical components for FICON access to DASD-A and DASD-B are lessened. If there is geographically significant distance between SITE1 and SITE2, significant enough that the business-continuity

expectations are that a mutual failure of SITE1 and SITE2 are not expected, then the need for redundant networking components increases.

a. Connectivity to DASD-A.

b. Connectivity to DASD-B.

14. **R-Site Business Continuance Site**: Physically, the site of GDPS/XRC at a remote site.

15. **GDPS/XRC Kx-sys:** Establishes relationships with one or more GDPS/PPRC Kp-sys. As is the case with simple GDPS/XRC, the GDPS/XRC K system is responsible for the XRECOVER of the tertiary DASD, and therefore requires access to the DASD-C and DASD-F.

    a. **GDPS/XRC K system DASD:** The local system DASD for the GDPS/K system. Note that it is extremely important to avoid any potential duplicate VOLSERs of the production systems' DASD VOLSERs. Not only would it make it difficult to put online any intended production primary XRC volumes with the same VOLSER to the SDMs, but the logical integrity of the recovery set of DASD could be critically impaired if the SDM used these volumes as primary XRC volumes.

16. **NetView address space (GDPS/XRC):** GDPS runs in the NetView address space. Operation of GDPS/XRC requires logging on to NetView and running GDPS in your operator session.

17. **z/OS SDM systems:** The z/OS systems that run the XRC SDMs. These are massive z/OS systems running in very large LPARs. In addition to running the SDM address spaces, these systems actually perform the FlashCopy operations. They need access to the primary DASD, secondary DASD, and the tertiary DASD (DASD-A, DASD-B, DASD-C, and DASD-F).

    a. **GDPS/XRC SDM system DASD:** The local system DASD for the SDM z/OS systems. Note that it is extremely important to avoid any potential duplicate VOLSERs of the production systems' DASD VOLSERs. Not only would it make it difficult to put online to the SDMs any intended production volumes with the same VOLSER, if the SDM used these volumes as primary XRC volumes, the logical integrity of the recovery set of DASD could be critically impaired.

18. **SDM address spaces (ANTAS0nn):** The SDMs. GDPS/XRC can support multiple master sessions all with their own SDMs.

19. **DASD-C:** GDPS/XRC secondary DASD (with FlashCopy capacity the secondary DASD is more than just the XRC secondary volumes). Just as in simple GDPS/XRC, the relationship between DASD-C and DASD-F is based on FlashCopy source and target. DASD-C and DASD-F must be in the same Symmetrix. Because MzGM can support multiple GDPS/PPRC to single GDPS/XRC, there can be multiple independent instances of 21a and 21b.

    a. **XRC SECONDARY volumes:** The volumes used by the SDMs for mirroring operations. If FlashCopy is employed, these volumes are only used for mirroring and never for recovery.

    b. **SDM control data sets:** The SDM control data sets, JOURNAL, STATE, CONTROL, CLUSTER, and MASTER. If FlashCopy is employed (and it always is), these data sets are FlashCopy sources to the "tertiary" control data sets employed by the recovery operations.

20. **DASD-F GDPS/XRC tertiary DASD:** This is the DASD component used in the DR recovery operations. It is the DASD recovered for DR testing, and the DASD intended for use by actual DR operations. To recover from the DASD-F, a complete set of XRC secondary volumes and XRC control data sets must be FlashCopyed from DASD-C.

    a. **XRC Tertiary DASD:** The FlashCopy targets and DASD XRECOVER operation employed by the GDPS/XRC K system.

    b. **SDM control data sets:** The FlashCopy targets and control data sets used by the GDPS/XRC K system for XRECOVER.

21. **Recovery production systems:** z/OS systems used for recovery operations. They should have access to only the DASD-F and only the XRC tertiary DASD. (FlashCopy targets of the XRC secondary volumes.)

22. **Recovery or testing capacity:** Sufficient definition (LPARs) capacity, connectivity, and performance to run production DR operations.

23. **BCPii infrastructure:** Interfaces and components, HMCs, SEs, and TCP/IP connectivity.

24. **NetView SNA connectivity:** Connectivity between the GDPS/XRC K system and each of the GDPS/PPRC infrastructures. (A single GDPS/XRC can be in a MzGM relationship with multiple GDPS/PPRCs.)

Terminology in GDPS MzGM

With so many versions of the DASD and GDPS z/OS systems, a new naming convention has been adopted with GDSP/MzGM infrastructure.

- DASD-A: The DASD at GDPS/PPRC Site 1. PPRC mirrored with DASD-B volumes.
- DASD-B: The DASD at GDPS/PPRC Site 2. PPRC mirrored with DASD-A volumes.
- DASD-C: The DASD at GDPS/XRC site. Traditionally, the GDPS/XRC secondary and FlashCopy sources to the DASD-F, coexists with the DASD-F in the same Symmetrix frame.
- DASD-F: The DASD at GDPS/XRC site. Traditionally, the GDPS/XRC tertiary and the FlashCopy targets for the DASD-C coexists with the DASD-C in the same Symmetrix frame.
- Kp-sys: The GDPS/PPRC K systems.
- Kx-sys: The GDPS/XRC K system.

Symmetrix system compatible feature licensing in GDPS MzGM

In addition to other features, Table 13 lists feature order numbers that are typical of an MzGM implementation.

Table 13 MC features for GDPS MzGM implementation

Feature Name	Symmetrix System	Required/Optional
Compatible Peer	Primary Symmetrix DASD Subsystems DASD-A, DASD-B	Required
Compatible Extended	Primary Symmetrix DASD Subsystem(s) DASD-A, DASD-B[1]	Required
Incremental Re-synchronization	Primary Symmetrix DASD Subsystems DASD-A, DASD-B	Only required for GDPS/MzGM implementations, and only when the implementation operates with Incremental Resynchronization (typically employed in MzGM)
Compatible HyperPAV	Primary Symmetrix DASD Subsystems DASD-A, DASD-B	Optional (but recommended)
Compatible HyperPAV	Secondary Symmetrix DASD Subsystems DASD-C/F	Optional (but recommended)
Compatible Native Flash for Mainframe	Secondary Symmetrix DASD Subsystems DASD-C/F, occasionally on DASD-A and DASD-B	Technically optional, but typically required in GDPS/XRC implementations. Occasionally employed in the GDPS/PPRC DASD Subsystems

1. Reverse site swap, planned return from SITE3 to SITE1 or SITE2 requires licensing of Compatible Extended feature on DASD-C/F.

GDPS MzGM and XRC incremental re-synchronization

One of the key enabling technologies of MzGM is XRC incremental re-synchronization on the Symmetrix system. XRC suspends after a HyperSwap when the previous PPRC secondary volumes become primary PPRC (suspended) volumes. In order to maintain disaster-recovery preparedness, XRC must resume operations quickly and avoid a complete re-synchronization with the new XRC primary volumes[1]. GDPS MzGM can be implemented without incremental re-synchronization, but MzGM is rarely implemented without incremental re-synchronization.

Note: GDPS/XRC identifies the HyperSwap volume relationships by querying the current XRC primary/PPRC primary to identify if the volume is in a PPRC mirroring relationship and the PPRC secondary and potential XRC primary.

There is no native XRC Incremental Re-synchronization capability. There are no TSO commands. Incremental Re-synchronization is a GDPS/MzGM-only capability and can only be implemented on DASD subsystems managed by GDPS/MzGM.

Incremental resynchronization feature

GDPS MzGM implementations with incremental resynchronization must have the additional licensed microcode feature of EMC® Compatible Global Mirror Incremental Resync. In addition, the incremental re-synchronization configuration setting must be enabled in the configuration files of all Symmetrix DASD subsystems acting as primary XRC DASD. See “Symmetrix Configuration File Settings for XRC enablement” on page 180 to enable Symmetrix configuration file setting.

Managing incremental resynchronization XRC sessions

In an MzGM implementation, the SDM maintains sessions in both the primary DASD-A and DASD-B through the XRC utility devices on both DASD subsystems. However, only the sessions in one of the

1. A PPRC secondary cannot function as XRC primary, see Table 1, “Allowable Compatible Extended copy combinations,” on page 31.

DASD subsystems can actively transfer data at any given time. And after an unplanned HyperSwap, a volume that thinks it is still in an XRC session cannot become a PPRC secondary volume. Consequently, after planned and unplanned HyperSwaps, some activities are required on the GDPS/XRC system to restart both XRC and PPRC.

After a planned or unplanned HyperSwap of the GDPS/PPRC DASD (for instance, DASD-A to DASD-B), GDPS/XRC must reestablish the XRC relationship with the microcode sessions on the DASD-B and start remote copy from DASD-B to DASD-C.

Following an unplanned HyperSwap, there is the potential for unsuspended sessions on the former primary PPRC/primary XRC volumes. Prior to restarting PPRC, these sessions (after resolving the HyperSwap trigger), must be cleaned up from the GDPS/XRC system. GDPS SCRIPT keywords exist for resolving the unsuspended XRC sessions on the Symmetrix system. Only then can GDPS/PPRC restart PPRC remote copy between the DASD-A and DASD-B Symmetrix DASD subsystems.

8

Compatible Native Flash for Mainframe

This chapter includes the following information on Compatible Native Flash (FlashCopy) for Mainframe:

Compatible Native Flash for Mainframe overview

Compatible Native Flash for Mainframe is a compatible implementation of FlashCopy contained entirely within the Enginuity microcode. It depends upon no external interfaces to emulate FlashCopy operations.

FlashCopy is employed in a number of ways by customers for production applications and imbedded into system applications to create point-in-time copies of volumes and data sets.

A number of applications use it, including DFSMSdss, DFSMShsm, TSO commands, ICKDSF, the ANTRQST interface ,as well as many third-party products.

Additionally, it can play a pivotal role in a GDPS deployment, depending upon the customer’s business availability requirements and the GDPS operation. Employing Compatible Native Flash enables EMC DASD to efficiently interface with these applications.

Employing Compatible Native Flash for Mainframe enables Symmetrix system deployment in solutions where EMC Native point-in-time CLONE and BCV solutions lack the compatibility and ease of use of other DASD vendors. In the case of GDPS, FlashCopy enables EMC Symmetrix DASD subsystems to fully integrate with GDPS GEOPARM FlashCopy relationships, FlashCopy panel operations, and FlashCopy SCRIPT directives.

Description of operation

FlashCopy is a copy relationship between two volumes in a single Symmetrix DASD subsystem[1]. A microcode session manages the images of the two volumes (source volume and the image of the target volume) and the copy operation.

1. Early versions of IBM FlashCopy limited the volume relationship to volumes within a single LCU. This restriction no longer exists, but in some environments its legacy can still be encountered.

Departures from IBM's solution

Consider the following departures listed in this section.

Supported FlashCopy functions

Not all FlashCopy features are supported. Notably, FBA devices, Inband FlashCopy, the imbedded FlashCopy in Global Mirror, and Space Efficient FlashCopy are not supported. Although Space Efficient FlashCopy is not supported, an equivalent capability is provided by defining the target devices to a thin pool and using the NOCOPY option.

Symmetrix split considerations

Volumes involved in a FlashCopy relationship must be contained within the same Symmetrix split.

A Symmetrix split is defined as a virtual frame located within the Symmetrix physical configuration. At the time of this writing, up to 16 splits can currently be defined via configuration tools within each Symmetrix VMAX physical frame.

FlashCopy components

This section briefly describes FlashCopy components.

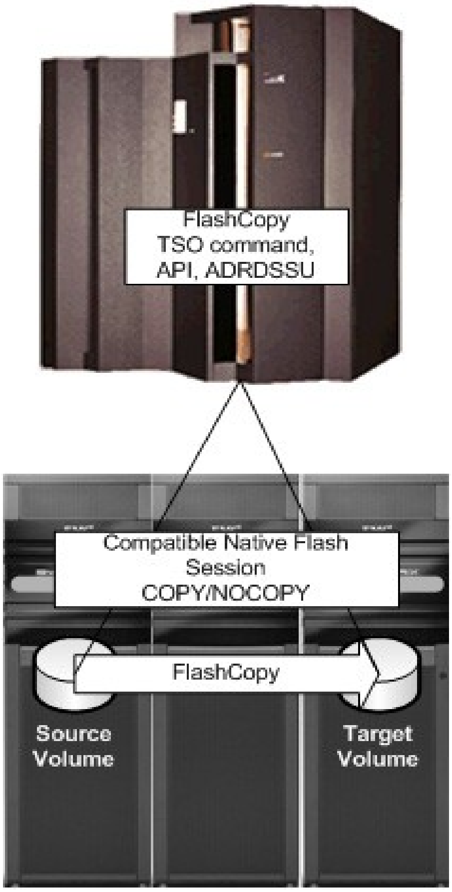


Figure 12 FlashCopy Components

Source volume

Source volumes are typically ONLINE, especially in a GDPS implementation.

Target volume

Target volumes are typically OFFLINE to all systems at FlashCopy initiation.

The target and source volume must be in the same Symmetrix DASD subsystem and same subsystem split.

The target volume must be of equal or greater capacity than the source volume.

FlashCopy session

A microcode FlashCopy session is created by a FlashCopy FCESTABLISH directive. It immediately establishes the relationship between the volumes and enables normal access to the volumes. Depending on the mode of operation, tracks may be copied in the background or not, and sessions may have finite duration (FlashCopy COPY) or indeterminate duration (FlashCopy NOCOPY).

Typically, a FlashCopy session must be withdrawn before another can be established. It is not uncommon to find logic in GDPS scripts that ensures that FlashCopy sessions are withdrawn prior to their intended establishment.

FlashCopy modes of operation

Traditional FlashCopy is a point-in-time copy. When the FlashCopy is initiated, a session starts on DASD subsystem and its function is to establish the perception that there are immediately two copies of the data. It manages the access to the two versions of the data (the source and target volumes) and copies the tracks from the source volume to the target volume. There are two modes of operation. A FlashCopy COPY operation copies the tracks in the background until there are two physically complete copies of the data. A FlashCopy NOCOPY operation copies only the tracks required to preserve the perception that there are two distinct copies of data.

In the case of GDPS/XRC, the instantiation of the tertiary DASD for DR testing may be accomplished with a FlashCopy NOCOPY, but actual DR should employ a FlashCopy COPY.

The following modes of operation are briefly described in this section:

"FlashCopy COPY" on page 225

"FlashCopy NOCOPY" on page 226

"FlashCopy INCREMENTAL" on page 226

FlashCopy COPY

A FlashCopy COPY session copies all tracks from the source to the target volume. When all source tracks are copied to the target volume, the session ends. When the copy operation is complete the target volume is a physically complete copy.

While the source volume is being copied, reads to the target volume can be satisfied either from the source volume or the target volume, depending on whether the track has been copied.

Writes to the source volume get special handling depending upon whether the track being updated has already been copied to the FlashCopy target volume. If the track has already been copied by FlashCopy, then the write to the target volume is processed unabated. However, if the track has not been copied, before the source track can be updated the microcode session must read the track from the source, write the track to the target, and then update the source. This operation can significantly increase write I/O response time and degrade performance. This is known as *delay on first write*.

Reads to the source volume are unaffected by the FlashCopy relationship. Writes to the target volume are unaffected, except when the track has not yet been copied from the source. In that case, a background copy is performed, and the target write is then allowed to proceed.

FlashCopy NOCOPY

A FlashCopy NOCOPY session copies tracks only when an initial update to the source volume track dictates that the track must first be read from the source. It writes the track to the target volume, and then allows the write to the source volume. As in the case of FlashCopy COPY delay on first write, this operation can significantly impact production write performance. However, unlike the COPY mode, there exists no background copy task, so the FlashCopy session persists until such time as all the tracks are updated or the FlashCopy session is withdrawn by a FCWITHDR directive.

FlashCopy NOCOPY can be converted to COPY by a NOCOPY2COPY directive.

FlashCopy INCREMENTAL

FlashCopy INCREMENTAL can be thought of as a combination of an initial FlashCopy COPY to create a full copy and subsequent incremental FlashCopy operations to copy only the changed tracks since the previous FlashCopy.

FlashCopy Consistency Groups

Compatible Native FlashCopy supports FlashCopy consistency groups. This feature enables the creation of write dependent consistent sets of FlashCopy target volumes through application directed formation of FlashCopy operations utilizing the FCESTABLISH ACTION(FREEZE) operand to queisce application updates. The typical operation is

1. Issue FlashCopy FCESTABLISH with the FREEZE option to create a FlashCopy consistency group. This simultaneously performs three operations: 1) it starts the FlashCopy sessions between the source and target, 2) the FlashCopy source volumes are put in "long busy" to suspend updates to the source volume and 3) the FlashCopy consistency timer starts.
2. Some set of operations to create, this can include normal FlashCopy operations.
3. Issue FlashCopy FCWITHDRAW with THAW to cancel the freeze to the primary volumes. This special form of the FCWITHDRAW only removes the "long busy" and does not cancel the FlashCopy session between the FlashCopy source and target. If a THAW is not issued before the FlashCopy consistency timer expires the consistency group thaws.

Review the section Symmetrix system configuration file settings 230 for Symmetrix Configuration file settings that manage FlashCopy Freeze.

Difference with PPRC CGROUP

FlashCopy consistency bears some commonality with PPRC CGROUP operations but has important differences.

- The PPRC CGROUP affects writes to all the volume pairs in the LCU. FlashCopy Freeze/Thaw only prevents write operations to the FlashCopy source volume by putting up long busy on that volume only.
- FlashCopy Freeze shares the same time setting as PPRC CGROUP’s timer. But each FlashCopy freeze source volume has its own timer.
- FlashCopy CGROUPs are application based and bounded by application operation.

- Multiple FREEZEs can be issued for volumes in a single LCU, but a single FCWITHDRAW THAW to a FlashCopy session thaws all FlashCopy source volumes in "long busy".

FlashCopy Consistency Group

The FlashCopy session established with a FCESTABLISH ACTION (FREEZE)

FlashCopy Freeze

FlashCopy freeze is established using the optional ACTION parameter on the FCESTABLISH command. It results in a long busy on the source volume. The freeze is removed by a subsequent FCWITHDR ACTION(THAW) or expiration of the freeze by the PPRC/FlashCopy Consistency Timer.

FlashCopy Thaw

FlashCopy thaw is accomplished using the optional ACTION parameter on the FCWITHDR command. It removes the long busy on all source volumes in that source volume LCU. If the PPRC/FlashCopy Consistency Timer expires it only removes the freeze on the source volume.

FlashCopy TSO commands

Table 14 lists FlashCopy TSO commands.

Table 14 FlashCopy commands

TSO command	Purpose	Primary volume	Secondary volume
FCESTABL	Establishes FlashCopy session between a pair of volumes	ONLINE	OFFLINE
FCQUERY	Query the FlashCopy status		
FCWITHDR	Withdraws a FlashCopy session		

Symmetrix system configuration file settings

The following are options in the Symmetrix configuration file to enable Compatible Native Flash:

Table 15 Symmetrix Configuration File Settings for FlashCopy enablement

Name	Value	Description
CKD->impl_fix_part->PPRC/ FlashCopy consistency	YES I No	YES is required for enablement of FlashCopy consistency Groups with FlashCopy freeze/thaw. This is required for employment of zero suspend FlashCopy technology with XRC.
CKD->impl_fix_part->PPRC/ FlashCopy consistency timer	0:65535 seconds	Sets the maximum duration of a freeze before subsystem automatically raises the long busy on the freeze volumes. 180 seconds is the default when 0 is specified. Note that this time should always be greater than the zero suspend FlashCopy timeout parameter (Z parameter) setting.
CKD->Enable FlashCopy	YES I NO	Specify YES to enable FlashCopy
CKD->Enable Remote FlashCopy	YES I NO	Specify YES to enable Remote Pair FlashCopy feature

FlashCopy with GDPS/PPRC deployment

FlashCopy has a long history of employment with GDPS/PPRC. Traditionally as a mechanism to address single points of failure during re-synchronization and testing. More recently FlashCopy operations have been enhanced to support application requirements without adversely affecting HyperSwap capability through the Remote Pair FlashCopy capability.

GDPS Managed FlashCopy

See Section "FlashCopy with GDPS/PPRC" on page 108 for details on GDPS/PPRC managed FlashCopy.

Remote Pair FlashCopy

Previously creating application based FlashCopy pairs of PPRC primary and PPRC secondary volumes were problematic, especially in GDPS/PPRC implementations with HyperSwap for several reasons. The problem is especially noticeable for application based FlashCopy of primary/secondary volumes and not GDPS/PPRC managed FlashCopy. A central expectation is that the invitation of a FlashCopy between primary PPRC volumes at SITE1 initiate a similar relationship between secondary PPRC volumes at SITE2.

1. Create and manage the FlashCopy session simultaneously between primary volumes and their secondary volumes.
2. Maintain PPRC duplex status between PPRC pairs allowing HyperSwap to remain enabled.
3. FlashCopy replication is independent of PPRC linkage.

The new feature support on Symmetrix Remote Pair FlashCopy addresses many of these concerns.

The following diagram illustrates the relationship between the PPRC and FlashCopy relationships between a pair of PPRC volumes.

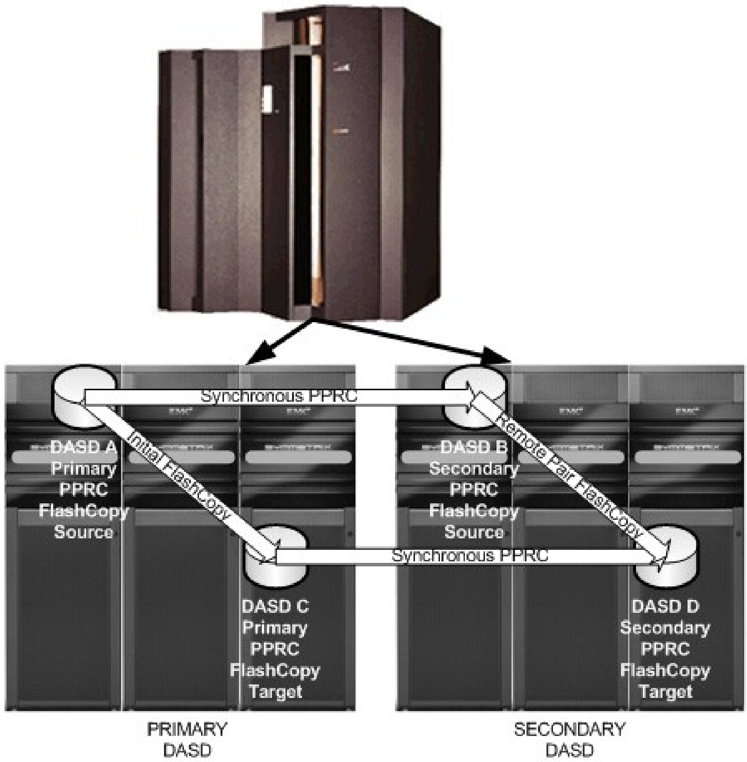


Figure 13 Remote Pair FlashCopy Relationships

Where:

- DASD A and B are in a PPRC relationship and duplexed
- DASD C and B are in a PPRC relationship and duplexed
- When the initial FlashCopy session is established between DASD A and DASD C another FlashCopy (the Remote Pair) session is established between DASD B and DASD D.
- FlashCopy sessions can be COPY, NOCOPY and converted from NOCOPY2COPY

FlashCopy Considerations with XRC and GDPS/XRC deployment

To recover from a tertiary DASD component, all the XRC DASD (secondary volumes and XRC control data sets) must be flashed in a time consistent manner. While some other techniques have been published for manual recovery of XRC on FlashCopy, the following techniques are the most widely adopted.

This section includes the following information:

"Traditional DR testing without Zero Suspend FlashCopy" on page 233

"DR Testing with Zero Suspend FlashCopy" on page 233

"Recovery for actual DR" on page 235

"Additional FlashCopy considerations " on page 236

"FlashCopy and XRC performance concerns during DR testing" on page 237

Traditional DR testing without Zero Suspend FlashCopy

Traditionally, this is accomplished either using TSO commands or a GDPS/XRC SCRIPT to::

- Ensure tertiary DASD is offline to all systems
- Withdraw any old FlashCopy sessions
- XSUSPEND XRC
- FlashCopy all secondary DASD to the tertiary DASD
- STARTSECONDARY to restart XRC mirroring
- XRC XRECOVER the tertiary DASD from the GDPS K system
- Wait for XRC to duplex
- Start up DR test workload

DR Testing with Zero Suspend FlashCopy

More recently IBM has delivered a Zero Suspend FlashCopy[1] utility and for XRC to enable the creation of a test copy of recovered DASD without requiring the suspension of the XRC SDMs. Zero Suspend FlashCopy is technically not an XRC feature. Rather, it is a specific use of FlashCopy FREEZE/THAW technology in an XRC environment using the Zero Suspend FlashCopy batch JCL operation or GDPS/XRC SCRIPT FC0SUSPEND operand.

Employing GDPS/XRC's FC0SUSPEND SCRIPT command also requires updating the GEOXPARM FC0type specification on XRC statements.

Compatible Native Flash provides transparent definition and operation of Zero Suspend FlashCopy.

Zero Suspend FlashCopy technology does depend upon some XRC SDM internal operations, and not all operations are immediately obvious:

- By using FlashCopy freeze/thaw feature it prevents writes of an SDM's Consistency Groups to the SDM's Control data set and in doing so stop the recording of the SDM's Consistency Groups to the JOURNAL data sets. These volumes containing the SDM Control data sets must be identified in the XRC GEOPARM settings.
- Once FlashCopy sessions have been initiated for all the freeze volumes, Zero Suspend FlashCopy performs a FlashCopy of all XRC secondary volumes and SDM control data sets (including Journal data sets) to the tertiary volumes. No time consistency of the secondary DASD is assumed, and writes of consistency groups queued for write to the secondary DASD continue unabated without any regard for consistency.
- Once FlashCopy sessions have been initiated for all the SDM control data sets and all secondary/tertiary volumes, the zero suspend FlashCopy utility thaws the freeze on the SDM Control data set volume(s).
- Later, normal SDM XRECOVER operations directed against the tertiary DASD (target volumes of the Zero Suspend FlashCopy) reads all valid XRC Consistency Groups from the tertiary JOURNALs and then rewrite these CGs to the tertiary DASD. Consequently, any inconsistencies of write dependencies that resulted from the Zero Suspend FlashCopy operations are overwritten by consistent data during normal XRECOVER operations.

1. Zero Suspend FlashCopy was originally delivered as a batch program and can still be used as such outside of GDPS/XRC operations.

The SCRIPT pseudo-code for a DR testing:

- Optionally withdraw any existing FlashCopy sessions or use the Zero Suspend FlashCopy operand.
- Make sure that the tertiary DASD is offline on all systems
- FC0SUSPEND XRC (optionally employ FCWITHDR operand)
- Put the tertiary DASD online to the K system
- XRC XRECOVER the tertiary DASD from the GDPS K system
- Start up DR test workload

Zero suspend FlashCopy not only reduces the number of steps required for DR testing, but it also eliminates XRC suspension, preserving duplex status for all remote copy pairs.

Recovery for actual DR

"Test the way you run; run the way you test."

XRC has no failover/failback capability. In addition, testing with GDPS/XRC usually employs tertiary DASD, which results in the use of tertiary DASD as the recovery DASD during failover, leaving the secondary DASD as a gold copy.

Actual disaster-recovery operations

Pseudo-code for a script to perform actual DR recovery:

- Shut down the SDM z/OS systems
- Withdraw any existing FlashCopy sessions
- FlashCopy all secondary to tertiary DASD (note that the withdraw and FlashCopy operations can be combined if the GDPS/XRC Zero Suspend FlashCopy script command is employed).
- XRC XRECOVER the tertiary DASD from the K system
- Restart the production workload

Always ensure that the FlashCopy session creating the tertiary DASD is a FlashCopy COPY (either by specifying the FCESTABLISH with COPY, or subsequently, with a NOCOPY2COPY option). The integrity of the recovered DASD is entirely dependent upon the operation of the FlashCopy microcode session. If those sessions are eliminated by a FCWITHDR, then all data updated since the beginning of the disaster recovery operation would be lost. An actual

DR would not experience delay on first write SDM impact to the secondary DASD. Consequently, performance concerns are lessened.

Additional FlashCopy considerations

- Additional details for these scripting techniques when operating XRC through GDPS/XRC can be found in the *GDPS/XRC Installation and Customization Guide*. Review these guidelines prior to implementation. In consideration of brevity, a considerable number of storage management operations to vary offline/online and FlashCopy clean up have been removed.
- Recovery techniques employing GDPS/XRC tertiary DASD requires specific GRS updates that can be found in the GDPS/XRC Guide and must be employed. An XRC XRECOVER actually restarts the SDM address space. The SDM protects itself from multiple instances through ENQ/DEQ of resources based on the SDM name, which under normal circumstances would prevent XRECOVER operations on the GDPS K system during normal XRC operations by the SDM on the SDM z/OS system (all GDPS/XRC systems being in a sysplex). However, through modification of the GRSRNL specifications, it is possible to change the SDM's ENQ/DEQ from GLOBAL to LOCAL. With the recognition that GDPS SCRIPT operations provide operational control of the SDM and manage the resource control equivalence to ENQ/DEQ.
- Recovery from tertiary DASD requires that FlashCopy targets must be defined for all XRC secondary volumes, as well as all XRC control data set volumes. This requires special definition of tertiary volumes for the control data sets in the XRC GEOPARM. The SDM control data sets must be on these volumes.
- Zero Suspend FlashCopy requires additional GEOXPARM specifications to prevent updates on the control data sets through FlashCopy FREEZE.
- Documented in the GDPS Installation Guide are very specific recommendations on the IOCDS definitions for SDM systems, GDPS K systems, and the recovery systems. GDPS Operations, GDPS Scripting, and recovery operations have specific expectations regarding device access.

- Use good coding techniques to ensure that the FlashCopy and XRECOVER scripts work successfully. The scripts should assume nothing about the initial conditions. Add initialization logic to the SCRIPTs to ensure that the tertiary volumes are offline to all systems, and FCWITHDRAW all FlashCopy sessions.

FlashCopy and XRC performance concerns during DR testing

FlashCopy is frequently invoked as traditional FlashCopy COPY during DR testing. As intellectually appealing as NOCOPY appears on first consideration, operational experience with XRC shows it is somewhat counter-indicated. FlashCopy operates quickly because the FlashCopy initially establishes a session between the source and target volumes, and tracks are subsequently copied. If FlashCopy is invoked with the COPY option, the microcode sessions copy all the tracks from the source volume to target volume as a background operation. If FlashCopy is invoked with the NOCOPY option the microcode sessions only copy tracks as needed. Compatible Native Flash copies updated tracks on first write, that is, a write to the source volume of a track not as yet copied to the target forces an immediate copy[1], with some elongation of the I/O operation. Delay on first write has performance implications during DR testing by significantly slowing the SDM's writes to secondary volumes, and to a lesser extent, writes to the control data sets. Write operations against the tertiary DASD are significantly impacted, particularly to the XRC secondary volumes where a consistency group may contain multiple write updates to a single volume.

As each write is potentially impacted by the delay, all the writes of a consistency group (writes to consistency groups must complete serially) can be significantly delayed. Not infrequently, CG write performance to the secondary DASD can impact entire SDM operations, causing CGs to queue for write to secondary, exhausting the z/OS buffers in the SDM. This results in reader pacing as the readers' access to buffers is limited and allows residuals to accumulate on the Symmetrix sidefile. This results in write pacing,

1. The FlashCopy microcode session must read the referenced track from the source track (GDPS/XRC secondary DASD volume), write it to the target track (GDPS/XRC tertiary DASD volume), and then allow the write to the source volume, with significant penalty to the read or write I/O operation (almost always a write operation against the XRC secondary DASD).

elongation of RPO, and under the worst of conditions, suspension of the SDM as the sidefile resources are exhausted.

A

PPRC PATHing and Linkage Address

This appendix contains the following information:

Link parameters

Linkage format used in the TSO CESTPATH commands, ICKDSF PPRCOPY ESTPATH commands, and GEOPARM LINK statements are unique to EMC Symmetrix systems. Despite actually employing Fiber Channel protocol and technology, one must employ an ESCON type of path address as the link parameter[1]. The port numbering scheme is unique to Symmetrix systems.

Link parameters for VMAX 20K and 40K

The link parameters (also frequently documented as linkaddr) of the CESTPATH (ICKDSF PPRCOPY, and GEOPARM MIRROR), describes the pathing over the physical linkage between a primary LCU and secondary LCU by establishing which physical paths are employed for mirroring by volumes in the LCUs. In native PPRC, the pathing between LCUs is defined through the CESTPATH command. Additionally, CGROUP operations are also established for the mirrored volumes. In GDPS's GEOPARM definitions, the linkaddr of the SITE1 and SITE2 statements in the GEOPLEX LINKS section performs the same function. A PPRC path between two LCUs has between one and eight physical links.

A link parameter is composed of four fields (eight hex digits: AABBCCDD), where

- AA: Is two hex digits of the sending side (PRIMARY DASD) SRDF director (00-7F). See Table 16 on page 241.
- BB: Is two hex digits of the receiving side (SECONDARY DASD) SRDF director (00-7F). See Table 16 on page 241.
- CC: Is two hex digits of the SRDF DEVICE GROUP (X'00'-X'3F'), which are set in the configuration file.
- DD: Is two hex digits of the sending LCU IMAGE (X'00'-X'7F') (LCU) that are established in IOGEN.

1. WWNN is not supported .

Table 16 Symmetrix PPRC link parameter director map hex lookup

	Dir [a]	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Model[b]	PROC																
VMAX	H	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
	G	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
	F	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
	E	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
DMX	D	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
	C	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
	B	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
	A	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F

a. Relative to 1, note that HOST COMPONENT reports director slots relative to 0.

b. Note that DMX has only four processor interfaces on a director and VMAX have eight processor interface

For example, if a physical link connects director slot 5 processor B to director slot 6 processor C, and the SRDF GROUP is x 03 in CU image 00, then the linkaddr is: 14250300. This is repeated for as many physical links exist and are required to describe the pathing between two LCUs. (Compatible Peer's emulation of PPRC's logical paths works best when the links for a SRDF GROUP as defined in the Symmetrix configuration file are in agreement with PPRC's CESTPATH definition.) The pathing is repeated for as many LCU pairs as required. Note that the physical links between LCU pairs are usually shared by as many LCUs pairs as required.

Good sources of information for the GEOPARM-specific Symmetrix hardware and Configuration File settings are the ProcGEN II report and CheckUpgrade.dat report.

The RDF_Directors, and which SRDF_Groups use those directors, are found in CheckUpgrade.dat. The directors can be confirmed by reviewing the "Director and Memory Layout" section in the ProcGen II report. The RA ports are the SRDF links.

Defining PPRC PATHs with ICKDSF

When using ICKDSF to manage Compatible Peer on VMAX systems, use the LINK parameter with EMC-specific link specifications instead of the FCPPATH and WWNN parameters.

For example:

```
  PPRCOPY ESTPATH UNIT(1C00) AON -
     PRI(X'2960',AAGAG)         -
     SEC(X'2971',AAFTR)         -
     LSS(X'00',X'01')           -
LINK(X'46460001',X'47470001',X'56560001',X'57570001')
```

Link Parameters for VMAX3 and VMAX All Flash

Due to the enhanced port architecture of Symmetrix VMAX3 system technology, the Link Address for these systems is not only remains unique, but must be unique to even legacy Symmetrix system Link Address syntax.

The format of the Link Address requires information related to port numbering as well as SRDF director numbering. It also requires the current (or planned) SRDF Group number, which is allowed to be different at each side but for ease of manageability is typically the same at each side. For each Link Address the Symmetrix director, port, and SRDF Group information relating to the system at each side of the SRDF connection is required.

Note: In order to support Hyperswap and failover/failback, Link Address' describing PPRC paths in both directions should be provided and coded in advance

In order to support PPRC via SRDF connection from VMAX3 to legacy VMAX1-2, the format of the Link Address is now divided into two halves. The first (two byte) half describes the SRDF connection for the primary side system and the second (two byte) half describes the SRDF connection for the secondary side system.

Internal parameter definitions no longer always fall into whole digit definitions. Rather, the two bytes describing each half of the SRDF connection for the Link Address have bit level significance. For each Symmetrix system type participating in an SRDF relationship with a VMAX3, the breakdown is as follows:

VMAX3:

4 bits for SRDF board (up to 16 boards, 0-F)

1 bit pad

5 bits for SRDF port

6 bits for this side SRDF Group number (00 – 3F hex, zero based)

VMAX 20K, 40K:

1 byte for SRDF director (see Table 15)

2 bits pad

6 bits for this side SRDF Group number (00 – 3F hex, zero based)

Your EMC Field Representative has access to tools that will define proper Link Address parameters for your installation. As well, your EMC Field Service Representative has access to tools that will create, modify, or delete SRDF Groups if no EMC SRDF software is employed at your site. SRDF Groups are no longer configured with the Symmetrix configuration file with Symmetrix VMAX3 systems.

One major advantage to this new format is that the secondary CU image number is no longer required. As such, many less Link Address' need to be defined overall where multiple LCUs are defined within each Symmetrix participating in the SRDF connection.

Prior to creating SRDF Groups and PPRC paths between VMAX3 and VMAX1-2 systems, each system must be running the appropriate Enginuity level providing support. Consult with your EMC Field Service Representative for more detail.

B

EMC's Role as a GDPS Storage Vendor

This appendix contains the following information:

New GDPS deployment

EMC does not license or sell GDPS. EMC's role in a GDPS implementation is as a storage vendor. Even in that limited role EMC must still understand the customer's business-continuity requirements and the architectural requirements of intended GDPS deployment topology:

- Which products are being deployed, such as GDPS/PPRC, GDPS/HM, or GDPS MzGM?
- What are the autonomic policies for FREEZE and SWAP?
- What is the operational topology?
- What are the business-continuity expectations and how will GDPS be implemented and operated to achieve those goals?
- What are the appropriate features, such as Compatible PEER (PPRC) and possibly Native z/OS Flash (FlashCopy)?

Participation as a designated storage vendor in GDPS Deployment Workshops (often part of GDPS implementation by IBM Global Services,) should be anticipated. This is usually a detailed project planning session with the customer and GDPS implementation teams. As the storage vendor, EMC commits to project deliverables and comments on the following topics:

- Storage solution design, licensing, and implementation consistent with customer's requirements (primary DASD, secondary DASD, FlashCopy deployment when required).
- Required compatible licensing components for the architecture (Compatible PEER, Compatible z/OS Flash).
- Performance recommendations and cabling requirements.
- Storage deployment activities.
- Symmetrix Configuration settings to enable Compatible Peer and Compatible Native Clone.
- Enginuity microcode maintenance levels.
- Understand and provide consulting services for HCD definition for the production, GDPS K systems, and recovery systems consistent with the operation of GDPS.
- Possible data migration strategies with z/OS Migrator or equivalent product.

- Consulting on GEOPARM definitions, volume specifications, and linkaddr definitions.
- LCU design, including GDPS/PPRC Utility Volume designation.
- Construction of non-PPRC storage resources (K systems and non mirrored storage).
- Participate in development of GDPS remote copy SCRIPTs.
- Participate in testing activities.
- In HyperSwap implementations, planned and unplanned activities to validate HyperSwap timing and its effect on application stability.

Supplementing an existing GDPS implementation

Because GDPS is a licensed offering and not a product, storage augmentations of existing GDPS deployments are often undertaken without IBM Global Services' direct involvement. Typically, the customer is more experienced than an initial GDPS deployment, but lacking IBM Global Services' direct involvement, more responsibility and direction might be expected from EMC.

Before proposing a configuration, understand the existing GDPS deployment and the requirements for our implementation. Scope out not only the hardware and microcode requirements, but also the services component and any potential changes in the customer's business-continuity requirements or operations.

- Configuration and licensing of solutions consistent with existing GDPS goals and conventions employed by the customer.
- Performance consulting and validation.
- Storage deployment activities.
- Symmetrix configuration settings for Compatible Peer and Compatible Native Flash.
- Cabling.
- Understand and provide consulting services for HCD definition.
- Possible data migration with products consistent with GDPS operations and continuous availability.
- Participate in solution testing.
- In HyperSwap implementations, participate in timing validation.

C

Sample GEOPARM (GEOXPARM)

This appendix contains the following information:

Overview

Sample GDPS/PPRC and GDPS/XRC GEOPARMs are included for illustration purposes only and would require extensive modification at an actual customer implementation.

Note the differences in GEOPARM syntax between GDPS/PPRC and GDPS/XRC.

GDPS/PPRC GEOPARM

The following is an example of an actual GDPS/PPRC GEOPARM for Compatible Peer on a VMAX array.

```
GEOPLEX LINKS
*************************************************************************
* Note the unique linkaddr composition indicative of EMC VMAX
* Physical links are shared among all the LCU pairs, ports 38 into 38,
* 28 into 28, 18 into 18, 08 into 08, 39 into 39, 29, into 29, 19
* into 19, 09 into 09.
* Note the SITE1 to SITE2 symmetry (indicative of HyperSwap
* Note how the LCU pairs increase through the SITEn statements
* Note as well the “NE” specification consistent with EMC Symmetrix
* protocol definition.
* Note the convention for GEOPARM SITE1/SITE2 statement continuation
*
*************************************************************************

SITE1='2E41,2D41,Y,NE,38380001,28280001,18180001,08080001,39390001,C'
      29290001,19190001,09090001’
SITE2='2D41,2E41,Y,NE,38380001,28280001,18180001,08080001,39390001,C'
      29290001,19190001,09090001’
SITE1='2E42,2D42,Y,NE,38380002,28280002,18180002,08080002,39390002,C'
      29290002,19190002,09090002’
SITE2='2D42,2E42,Y,NE,38380002,28280002,18180002,08080002,39390002,C'
      29290002,19190002,09090002’
SITE1='2E43,2D43,Y,NE,38380003,28280003,18180003,08080003,39390003,C'
      29290003,19190003,09090003’
SITE2='2D43,2E43,Y,NE,38380003,28280003,18180003,08080003,39390003,C'
      29290003,19190003,09090003’
SITE1='2E44,2D44,Y,NE,38380004,28280004,18180004,08080004,39390004,C'
      29290004,19190004,09090004’
SITE2='2D44,2E44,Y,NE,38380004,28280004,18180004,08080004,39390004,C'
      29290004,19190004,09090004’
SITE1='2E45,2D45,Y,NE,38380005,28280005,18180005,08080005,39390005,C'
      29290005,19190005,09090005’
SITE2='2D45,2E45,Y,NE,38380005,28280005,18180005,08080005,39390005,C'
      29290005,19190005,09090005’
SITE1=‘2E46,2D46,Y,NE,38380006,28280006,18180006,08080006,39390006,C'
      29290006,19190006,09090006’
SITE2='2D46,2E46,Y,NE,38380006,28280006,18180006,08080006,39390006,C'
      29290006,19190006,09090006’
SITE1=‘2E47,2D47,Y,NE,38380007,28280007,18180007,08080007,39390007,C'
      29290007,19190007,09090007’
SITE2='2D47,2E47,Y,NE,38380007,28280007,18180007,08080007,39390007,C'
      29290007,19190007,09090007’
SITE1=‘2E48,2D48,Y,NE,38380008,28280008,18180008,08080008,39390008,C
      29290008,19190008,09090008’
SITE2='2D48,2E48,Y,NE,38380008,28280008,18180008,08080008,39390008,C'
      29290008,19190008,09090008’
```

```
SITE1='2E49,2D49,Y,NE,38380009,28280009,18180009,08080009,39390009,C'
      29290009,19190009,09090009'
SITE2='2D49,2E49,Y,NE,38380009,28280009,18180009,08080009,39390009,C'
      29290009,19190009,09090009'
SITE1='2E4A,2D4A,Y,NE,3838000A,2828000A,1818000A,0808000A,3939000A,C'
      2929000A,1919000A,0909000A'
SITE2='2D4A,2E4A,Y,NE,3838000A,2828000A,1818000A,0808000A,3939000A,C'
      2929000A,1919000A,0909000A'
SITE1='2E4B,2D4B,Y,NE,3838000B,2828000B,1818000B,0808000B,3939000B,C'
      2929000B,1919000B,0909000B'
SITE2='2D4B,2E4B,Y,NE,3838000B,2828000B,1818000B,0808000B,3939000B,C'
      2929000B,1919000B,0909000B'
SITE1='2E4C,2D4C,Y,NE,3838000C,2828000C,1818000C,0808000C,3939000C,C'
      2929000C,1919000C,0909000C'
SITE2='2D4C,2E4C,Y,NE,3838000C,2828000C,1818000C,0808000C,3939000C,C'
      2929000C,1919000C,0909000C'
SITE1='2E4D,2D4D,Y,NE,3838000D,2828000D,1818000D,0808000D,3939000D,C'
      2929000D,1919000D,0909000D'
SITE2='2D4D,2E4D,Y,NE,3838000D,2828000D,1818000D,0808000D,3939000D,C'
      2929000D,1919000D,0909000D'
SITE1='2E4E,2D4E,Y,NE,3838000E,2828000E,1818000E,0808000E,3939000E,C'
      2929000E,1919000E,0909000E'
SITE2='2D4E,2E4E,Y,NE,3838000E,2828000E,1818000E,0808000E,3939000E,C'
      2929000E,1919000E,0909000E'
SITE1='2E4F,2D4F,Y,NE,3838000F,2828000F,1818000F,0808000F,3939000F,C'
      2929000F,1919000F,0909000F'
SITE2='2D4F,2E4F,Y,NE,3838000F,2828000F,1818000F,0808000F,3939000F,C'
      2929000F,1919000F,0909000F'
GEOPLEX MIRROR
***********************************************************************
* PPRCSSID and PPRC statements for LCU pairing and volume definition
* Note how this implementation, HyperSwap enabled, doesn't require
* FlashCopy capability
***********************************************************************

PPRCSSID='2E40,2D40'
PPRC='2E40,2D40,109,N'
PPRCSSID='2E41,2D41'
PPRC='2E41,2D41,109,N'
PPRCSSID='2E42,2D42'
PPRC='2E42,2D42,109,N'
PPRCSSID='2E43,2D43'
PPRC='2E43,2D43,109,N'
PPRCSSID='2E44,2D44'
PPRC='2E44,2D44,109,N'
PPRCSSID='2E45,2D45'
PPRC='2E45,2D45,109,N'
PPRCSSID='2E46,2D46'
PPRC='2E46,2D46,109,N'
PPRCSSID='2E47,2D47'
PPRC='2E47,2D47,109,N'
PPRCSSID='2E48,2D48'
```

```
PPRC='2E48,2D48,109,N'
PPRCSSID='2E49,2D49'
PPRC='2E49,2D49,109,N'
PPRCSSID='2E4A,2D4A'
PPRC='2E4A,2D4A,109,N'
PPRCSSID='2E4B,2D4B'
PPRC='2E4B,2D4B,109,N'
PPRCSSID='2E4C,2D4C'
PPRC='2E4C,2D4C,109,N'
PPRCSSID='2E4D,2D4D'
PPRC='2E4D,2D4D,109,N'
PPRCSSID='2E4E,2D4E'
PPRC='2E4E,2D4E,109,N'
PPRCSSID='2E4F,2D4F'
PPRC='2E4F,2D4F,109,N'
*************************************************************************
* NONSHARED section, the GDPS/PPRC UTILITY DEVICES, 1 per LCU
*************************************************************************
GEOPLEX NONSHARE
NONSHARE='3169'
NONSHARE='D169'
NONSHARE='3269'
NONSHARE='D269'
NONSHARE='3369'
NONSHARE='D369'
NONSHARE='3469'
NONSHARE='D469'
NONSHARE='3569'
NONSHARE='D569'
NONSHARE='3669'
NONSHARE='D669'
NONSHARE='3769'
NONSHARE='D769'
NONSHARE='3869'
NONSHARE='D869'
NONSHARE='3969'
NONSHARE='D969'
NONSHARE='3A69'
NONSHARE='DA69'
NONSHARE='3B69'
NONSHARE='DB69'
NONSHARE='3C69'
NONSHARE='DC69'
NONSHARE='3D69'
NONSHARE='DD69'
NONSHARE='3E69'
NONSHARE='DE69'
NONSHARE='3F69'
NONSHARE='DF69'
```

D

GDPS/PPRC Support Matrix

This appendix contains the following information:

Support matrix

The following support matrix details GDPS/PPRC support to be found in EMC Compatible Peer and Compatible Native Flash for GDPS/PPRCV3.9 as documented by IBM.

Table 17 Support Matrix (page 1 of 3)

	GDPS requirement	Support in Compatible MC feature
Base GDPS/ PPRC FREE	All disk subsystems that will be managed by GDPS/PPRC must support the PPRC CGROUP(Y) definition and CGROUP FREEZE. This function is also known as the GDPS FREEZE/RUN architecture.	Supported by Compatible Peer.
GDPS/PPRC FlashCopy	FlashCopy across different LSSs in the same disk subsystem.	Supported by Compatible Native Flas.h
	GDPS support for FlashCopy NOCOPY-to-COPY conversion requires that the disk subsystems housing the FlashCopy source/target devices support FlashCopy NOCOPY-to-COPY conversion.	Supported by Compatible Native Flash.
	GDPS Persistent/Incremental FlashCopy support requires that the disk subsystems housing the FlashCopy source/target devices support Persistent/Incremental FlashCopy.	Supported by Compatible Native Flash.
	GDPS allows data set-level FlashCopy target devices to be PPRC primary devices. This capability requires that any disk subsystem housing the FlashCopy source/target devices supports data set-level FlashCopy as well as FlashCopy onto a PPRC primary.	On Compatible Native Flash roadmap.
	Preserve Mirror Function requires that disk subsystems housing the subject FlashCopy source and target devices support Remote Pair FlashCopy.	Compatible Native Flash supports Remote Pair FlashCopy
	GDPS support of Space Efficient FlashCopy requires that the disk subsystems housing the FlashCopy source/target devices support the FlashCopy Space Efficient capability.	Compatible Native Flash does not support FlashCopy SE functionality. An equivalent capability is provided by defining the FlashCopy target devices in a thin pool and use FlashCopy NOCOPY.
erSwap	GDPS/PPRC HyperSwap requires that all disk subsystems managed by GDPS are HyperSwap-capable. HyperSwap-capable disk subsystems are subsystems that support the Extended CQUERY function.	Supported by Compatible Peer.

Table 17 Support Matrix (page 2 of 3)

	GDPS requirement	Support in Compatible MC feature
PPRC support	GDPS transparently exploits the PPRC Failover capability when executing the DASD='RECOVER' and ODASD='RECOVER' script statements if it is supported on the disk subsystems. All disk subsystems in your GDPS configuration, both in Site1 and in Site2, must support PPRC failover/failback in order for GDPS to exploit this capability.	PPRC failover/failback is provided by Compatible Peer.
	The IBM System z9 provides the MIDAW facility on ESCON and FICON channels which can improve I/O performance and I/O throughput, especially on faster FICON channels. GDPS MONITOR1 checks whether PPRC devices pairs are composed of MIDAW-enabled or MIDAW-disabled pairs.	MIDAW feature is supported by Symmetrix FICON adapters.
	Disk subsystems connected by FCP PPRC links must support PPRC over Fibre Channel links.	Supported by Compatible Peer use of FC SRDF links.
	GDPS Open LUN management support requires that the disk subsystems managed by GDPS support Open PPRC, management of Open PPRC via CKD device addresses, and support Open PPRC SNMP alerts.	Compatible Peer does not support FBA PPRC.
	All GDPS-managed disk subsystems must support Global Copy (PPRC-XD) to benefit from the low impact initial copy/resynch capability added to the DASD='START SECONDARY' script statement.	PPRC XD is supported by Compatible Peer.
	If you exploit GDPS Open LUN management to manage PPRC for FB disks on behalf of distributed systems, all of the disks, both CKD and FB, must support Global Copy in order for GDPS to exploit this capability. This is true also for a FREEZESCOPE=GROUP configuration. If either the CKD or the FB group is not Global Copy-capable, the entire configuration is marked as not supporting Global Copy.	Compatible Peer does not support FBA PPRC.
	Concurrent Copy cleanup by the DASD START SECONDARY CCTERM script statement requires that the disk storage subsystems have microcode that supports the force option of the Concurrent Copy session termination channel command. This is essential to allow centralized cleanup, even in cases where the owning host system is not operational, or in cases where the session has lost its path group association entirely.	Contact your EMC representative regarding support for Concurrent Copy Force.
	Enhanced Freeze&Stop Conditional processing for reducing the impact of false freezes requires that all disk subsystems, including the disk subsystems for any Open LUN devices in the GDPS configuration, support Query Storage Controller Status. You might also see this being referred to as the configuration supporting reduced false freeze capability. Note that this capability is only provided when running with the PPRCFAILURE policy specification. It is not available if you are running with the old, FREEZE policy specification.	Compatible Peer supports Query Storage Controller Status and VMAX are detectable as Reduced False Freeze Capable.

Table 17 Support Matrix (page 3 of 3)

	GDPS requirement	Support in Compatible MC feature
DS8K Synergy Package 2	GDPS proactive unplanned HyperSwap, in response to acute health events in the disk subsystem requires that the disk subsystems in the GDPS configuration support the Storage Controller Health Message function. In a mixed configuration, only those disk subsystems with this capability raise the necessary attention message to trigger a proactive HyperSwap. For failures of other disk subsystems that do not support this feature, HyperSwap should trigger only after a host I/O from a GDPS system is impacted. Also note that the proactive unplanned HyperSwap trigger is only enabled when running with the PRIMARYFAILURE policy specification. It is not available when you are running with the old FREEZE policy specification.	We believe VMAX arrays and Compatible Peer support of the Storage Controller Health Message is unwarranted at this time. The two ENF 64 return codes that GDPS employs for HyperSwap triggers have no analogous meaning in VMAX architecture.
	Freeze triggering based on LSS summary notification of PPRC suspend events requires that the disk subsystems in the GDPS configuration support the Summary Event Notification for PPRC Suspends (PPRCSUM) function. Configurations with a mixture of disk subsystems that do and do not support PPRCSUM are supported.	Summary Event notification is not supported by Compatible Peer.