GDPS® / Hitachi Virtual Storage Platform G1500/F1500 & 5000 series

Qualification Test

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GDPS / Hitachi Virtual Storage Platform Qualification Test

GDPS can work with IBM as well as other Equipment Manufacturer (OEM) disk vendors, as long as the vendor meets the required Metro Mirror functions. Hitachi, Ltd. has implemented these functions in its Hitachi Virtual Storage Platform™ (VSP) and this document describes the GDPS Metro Single Leg and Dual Leg qualification testing performed in the IBM GDPS Solution Test lab. Hitachi Virtual Storage Platform™ 5000 series were used for GDPS Metro Single Leg and G1500/F1500 for GDPS Metro Dual Leg. Additionally, this paper describes the GDPS Metro with HUR controlled by BCM test results.

Dec 9th, 2020

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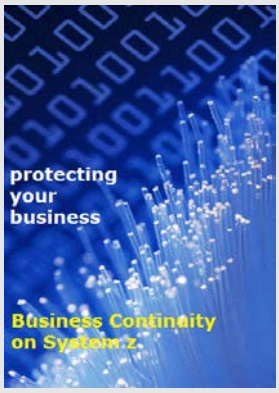
Executive Summary

In order to protect their businesses and IT investments, many customers have implemented one or a combination of the available GDPS solutions, enhancing the continuous availability characteristics and enabling automated, advanced disaster recovery for their business-critical applications. Each of the GDPS solutions are based upon a different advanced copy technology: Metro Mirror for GDPS Metro Single Leg as well as Dual Leg in case of Multi-Target Metro.



These non-proprietary remote copy architectures, implemented on IBM storage hardware, have also been supported by some enterprise storage vendors. This allows customers the flexibility to select the disk subsystems that best match their requirements and to mix and match disk subsystems from different storage vendors within the context of a single solution, GDPS, while retaining the investment they have made in the GDPS solution itself as well as in the skills to manage GDPS and the copy technology. To this end, IBM has established a GDPS Qualification Program to validate that an enterprise storage vendor's implementation of the advanced copy services architecture meets the GDPS requirements.

Hitachi, Ltd., as an enterprise storage vendor, has implemented the Metro Mirror Single Leg as well as Multi-Target Metro Mirror technologies on its disk subsystems. The Hitachi TagmasStore hardware was the first disk subsystem to be qualified under the GDPS Qualification Program for GDPS PPRC and GDPS XRC, then USP-V/VM and VSP and VSP 1000 hardware has been qualified; within this test session, the VSP 5000 has been qualified for Single Leg Metro Mirror and VSP G/F1500 has been qualified for Multi Target Metro Mirror.

Introduction

For many years now, IBM has been improving the quality of GDPS code delivery by conducting in-depth testing of both the functional aspects of the solution as well as its integration with various IBM products in a variety of configurations. The implementation of some of the IBM copy technologies by non-IBM manufacturers has introduced the need to validate the compatibility and interoperability of non-IBM equipment with GDPS®. To satisfy this requirement, IBM has launched a GDPS qualification test program for non-IBM vendors. The Hitachi disk subsystems, installed in the IBM GDPS Solution Test lab configuration, have been used during execution of the entire GDPS qualification test suite (contents of which are described later in this document). The results obtained and described in this document can be dependent on the various levels of the software, hardware and microcode involved and as such, do not reduce the need for customers to test their own configuration.

GDPS Overview

GDPS offers three different solutions based on the underlying mirroring technology:

- The GDPS solution, based on the IBM Metro Mirror copy technology (formerly known as Peer-to-Peer Remote Copy, PPRC), is referred to as **GDPS Metro Single Leg or GDPS Metro Hyperswap Manager**.
- The GDPS solution based on the Multi-Target Metro Mirror, is referred to as **GDPS Metro Dual Leg**.
- The GDPS solution based on the IBM Global Mirror copy technology is referred to as **GDPS Global GM**.

Only GDPS Metro Single Leg for VSP5000 and GDPS Metro Dual Leg for G/F1500 generation have been tested during this qualification test session. There was no testing for xDR nor zProxy features.

Metro Mirror (PPRC) is a hardware copy technology that synchronously mirrors data residing on a set of disk volumes, called the primary volumes, to secondary disk volumes typically in a secondary site, up to 303 fiber km away. The IBM Parallel Sysplex® clustering technology is designed to enable resource sharing, data sharing and dynamic workload balancing. When configured properly, enterprises can now dynamically manage workloads across multiple sites enabling them to achieve high levels of availability while using their resources effectively. The GDPS Metro solution builds on these high-availability technologies, providing autonomic functions and numerous automation facilities to facilitate continuous availability and effective, fast disaster recovery. The GDPS Metro HyperSwap™ function enables transparent switching from the primary METRO MIRROR disks to the secondary disks, extending Parallel Sysplex availability to the disk subsystem, providing continuous availability in the event of planned and/or unplanned disk outages. With the GDPS HyperSwap Manager solution, customers can enjoy the benefits of HyperSwap even if multiple sites are not available and the Parallel Sysplex is configured in one site. The GDPS Metro and GDPS HyperSwap Manager solutions are data-type independent. Furthermore, either solution can manage METRO MIRROR on behalf of Distributed Systems and can provide a consistent recovery point for z/OS and/or Open Systems data. This is especially important for multi-tier applications where both z/OS and Open Systems data is updated within a single unit-of-work. With the Multiplatform Resiliency for System z feature (referred as xDR in this document) all these capabilities are extended to any application hosted under any z/VM guest or Linux for z Systems®.

Multi-Target Metro mirror above all benefits of single leg Metro Mirror, extending its capability adding possibility to run 2 synchronous target devices from one source. Each replication leg is run independently and doesn't influence other leg capabilities like replication operation, freeze etc. In case of planned and/or unplanned event, primary devices may be Hyperswap to one of target devices. Quick delta resynch is managed by MTIR (Multi Target Increamental Resynch) function which is established automatically by GDPS.

Hitachi Virtual Storage Platform 5000 Series Overview

Hitachi Virtual Storage Platform 5000 series (VSP 5000) is the flagship high end storage from Hitachi. It is an advanced storage services platform which inherited functions and feature from his predecessor Hitachi Virtual Storage Platform F1500 (VSP F1500) and Hitachi Virtual Storage Platform G1500 (VSP G1500). VSP5000 series being very last generation from Hitachi does bring improvements in all areas Compared to VSP F1500 and VSP G1500 (which already does satisfy vast majority of data center requirements). Virtual Storage Platform 5000 series offers the scalability, performance, high availability and advanced storage functionality to satisfy all data center storage requirements for open systems and mainframe environments. In addition to its 3-D scaling architecture it features lower power and cooling requirements, high density packaging based on industry standard 19-inch racks, faster microprocessors, supports NVMe and MVMe SCM (these are not offered on VSP F1500/G1500), and the choice of disk drives types, including solid state disk (SSD), serial attached SCSI (SAS), Nearline SAS and Hitachi Accelerated Flash (FMD). Advanced architecture of the VSP 5000 series allows mixing NVMe and SAS Flash together in order to improve costs. This new storage platform provides an industry leading, reliable and highly available storage system for mainframes in IBM z/OS® environments. It is backed with a 100% data availability guarantee.

Hitachi Virtual Storage Platform 5000 series (as well as VSP G1500/F1500) can scale up to provide increased performance, capacity, throughput and connectivity. It can scale out by dynamically combining multiple units into a single logical system with shared resources. It can also scale deep by dynamically virtualizing new and existing external storage systems. This 3-D scaling means that Virtual Storage Platform 5000 series (like VSP G1500 and VSP F1500) can grow non-disruptively to meet changing needs within the data center. It minimizes outages to extend the platform and enhance functionality while providing flexibility in the configuration and choice of disk technology to meet the specific needs of each environment.

The deep scaling enabled by Hitachi controller-based storage virtualization available of both VSP 5000 series as well as VSP G1500/F1500, supports connectivity to external storage. This enables organizations to further extend the life of existing storage assets, including storage from a variety of other vendors. It also provides IBM mainframes the ability to connect to both enterprise and midrange storage platforms, some of which can be configured with lower cost nearline SAS or SATA drives. This virtualization of external storage can potentially extend the life of existing storage assets and reduce costs.

Hitachi Virtual Storage Platform 5500 series Specifications	
Architecture	Hitachi Accelerated Fabric
Max IOPs	21M
Max Fibre Bandwidth to Host	614.4GB/sec
Host Interfaces (maximum)	192 Fiber Channel: 32/16/8Gb/sec, 192 FICON: 16/8/4Gb/sec, 96 iSCSI: 10Gb/sec
Internal Raw Capacity	69.3PB
Internal and External Capacity	287PB
Hard Disk Drive Options	2.4TB 2.5” SAS, 14TB 3.5” NL-SAS
Flash Drive Options	960GB 2.5” SAS, 3.8TB 2.5” SAS, 7.6TB 2.5” SAS, 15TB 2.5” SAS, 30TB 2.5” SAS
Flash Module Drive (FMD) options	7TB & 14TB
NVMe Flash Drive Options	1.9TB 2.5” NVMe, 3.8TB 2.5” NVMe, 7.6TB 2.5” NVMe, 15TB 2.5” NVMe
NVMe SCM Flash Drive Option	375GB NVMe SCM
Minimum to Maximum Hard Drives	0-2,304 2.5”, 0-1,152 3.5”
Maximum Number of Flash Module drives (FMD)	576
Maximum Number NVMe Flash Drives	288
Maximum Number NVMe SCM Flash Drives	33
Back-End Disk Interface	12GB/sec SAS
RAID Configurations	RAID-1+0, RAID-5, RAID-6
Cache Options	256GB-6TB
Maximum LUNs	65,280
Volume Size	1 Cylinder-256TB
High Reliability	Redundant Power Supplies, fans, batteries
High Availability	N+1 Architecture, Controller Clustering

Figure 1 - VSP 5000 series Specifications

Hitachi Virtual Storage Platform F1500 & G1500 Specifications	
Architecture	HiStar-E network
Max IOPs	4M
Aggregate Bandwidth	896GB/sec
Host Interfaces (maximum)	192 Fiber Channel: 16/8/4Gb/sec, 176 FICON: 16/8/4Gb/sec, 192 Fiber Channel over Ethernet (FCoE): 10 10Gb/sec, 88 iSCSI: 10Gb/sec
Internal Raw Capacity	34.6PB
Internal and External Capacity	287PB
Hard Disk Drive Options	1.2TB 2.5" SAS, 1.8TB 2.5" SAS, 2.4TB 2.5" SAS, 4TB 3.5" NL-SAS, 6TB 3.5" NL-SAS
Flash Drive Options	1.9TB 2.5" SAS, 3.8TB 2.5" SAS, 7.6TB 2.5" SAS, 15TB 2.5" SAS
Flash Module Drive (FMD) options	3.8TB, 7TB & 14TB
Minimum to Maximum Hard Drives	0-2,304 2.5" and/or 0-1,152 3.5"
Maximum Number of Flash Module drives (FMD)	576
Maximum Number Flash Drives	384
Back-End Disk Interface	6GB/sec SAS
RAID Configurations	RAID-1+0, RAID-5, RAID-6
Cache Options	32GB-2TB
Maximum LUNs	65,280
Volume Size	1 Cylinder-256TB
High Reliability	Redundant Power Supplies, fans, batteries
High Availability	N+1 Architecture, Controller Clustering

Figure 2 - VSP F1500/G1500 Specifications

As companies extend business-critical applications on their mainframe servers, they also seek compatible high-capacity, high-performance storage to manage growing stores of data. For over 30 years, Hitachi Ltd. has provided mainframe technology to business and industry, including solutions for z/OS®, z/VM®, Linux® for z, and z/TPF®.

Hitachi Mainframe Software Portfolio

Hitachi has introduced many software innovations for mainframe storage such as Hitachi Universal Volume Manager, Dynamic Provisioning, Dynamic Tiering, Hitachi TrueCopy® synchronous remote replication, Hitachi Universal Replicator and Hitachi ShadowImage® software. Hitachi storage is compatible with:

- GDPS
- Multi Target Metro Mirror (MTMM - VSP F1500/G1500 currently)
- Virtual Machines (z/VM®)
- Transaction Processing Facility (z/TPF®)
- Remote Pair FlashCopy®
- zHPF multi track
- Sequential data striping
- Cache fast write (CFW) and DASD fast write (DFW)
- Enhanced dynamic cache management
- Extended count key data (ECKD) commands
- Multiple Allegiance
- Concurrent Copy (CC)
- Peer-to-Peer Remote Copy (PPRC)
- Extended Remote Copy (XRC)
- FlashCopy® and FlashCopy® Space Efficient
- Parallel Access Volume (PAV)
- Hyper Parallel Access Volume (HPAV)
- Super Parallel Access Volume (SPAV)
- Priority I/O queuing
- Red Hat Linux for IBM® S/390® and zSeries®
- SUSE Linux for IBM® S/390® and zSeries®
- zHyperWrite
- DB2® Castout Accelerator
- zHPF Extended Distance II
- FICON® Dynamic Routing
- FICON® Forward Error Correction
- Soft Fence
- Query Host Access

Mainframe expertise persists through the Hitachi portfolio of mainframe software solutions, which address data protection, disaster recovery, application availability, and data lifecycle management.

Qualification test description

The primary objective of this qualification testing was to validate the Hitachi Virtual Storage Platform 5000 usage within GDPS Metro Single Leg environment and Hitachi Virtual Storage Platform G1500/F1500™ usage within a GDPS Metro Dual Leg environment. Additionally both configuration were combined GDPS Metro solution with HUR controlled by BCM environment. Validating the VSP 5500/G1500 or GDPS code themselves was not specifically targeted. The scenarios specifically related to server management capabilities of GDPS were not included in the test case portfolio. Additionally, some performance measurements were performed on the HyperSwap and Freeze test cases only were it was necessary and applicable for GDPS configuration.

Note All the tests were conducted with the devices formatted in HDP (Hitachi Dynamic Provisioning) mode.

GDPS Metro Single Leg (SL) test – Hitachi VSP 5000

SYSTEM CONFIGURATION

The configuration used for this test was a GDPS Metro Single Leg with Multi-site workload. The objective of the exercise was to test the functionality of the VSP 5000 in a GDPS Metro SL environment, not to test performance (except for some HyperSwap test cases) or throughput. No attempt was made to optimize the configuration for throughput.

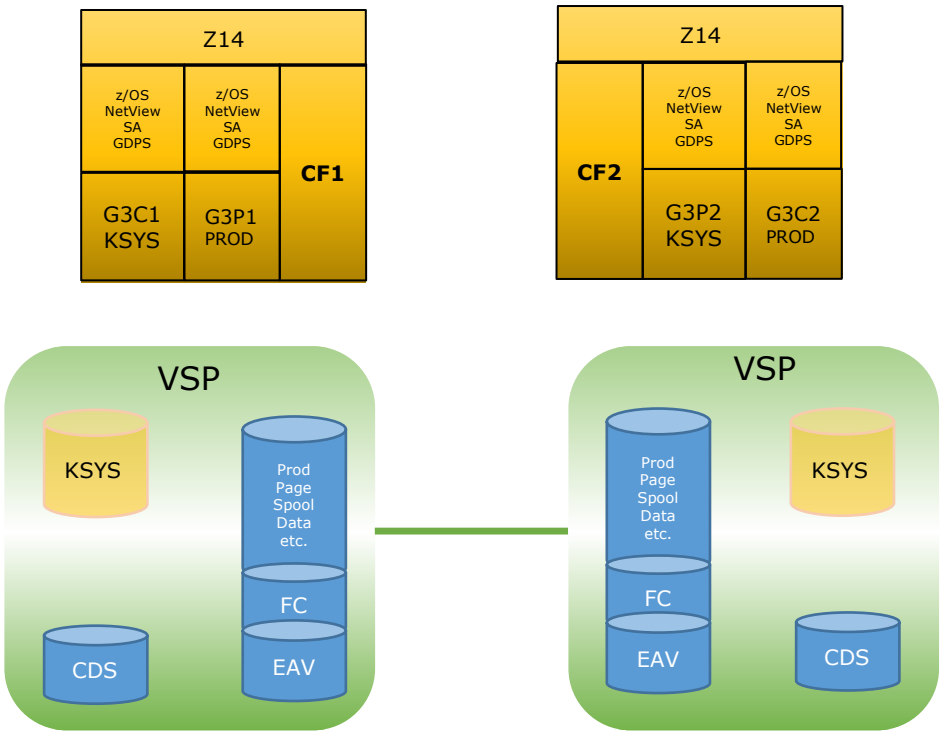


Figure 3 – GDPS Metro SL Multi -site workload configuration.

The Site 1 configuration is comprised of one coupling facility (CF1), an alternate GDPS Metro controlling system (G3C1) and 1 production system running z/OS (G3P1). In Site 2 there is the GDPS Metro controlling system (G3C2), 1 production system running z/OS (G3P2) and another coupling facility (CF2) and spare LPARs to host the Site 1 systems in case of need. The G3C1, G3C2, G3P1 and G3P2 systems are in the same "Parallel SYSPLEX". The Production systems run with their system and application data residing on the VSP 5000, while the Controlling systems were residing on non-mirrored LSS within the VSP 5000. All the production data, system and application, is Metro Mirrored to the secondary VSP 5000 disk subsystem. The "SYSPLEX" files (Couple Datasets – CDS) were allocated in the two sites but only the Logger CDS was mirrored.

Figure 4 shows the configuration used as viewed by the GDPS Metro Standard Actions page:

```
VPCPSTD1                    Standard Actions                          G3C2
Actions:  S Stop   R ReIPL    M odify      Q QryxDR       V SSI View
          L Load   X Reset    A Activate   D Deactivate   U Dump   T VMDUMP MGMT

                                          LPAR      IPLmode Auto L-addr Loadparm
_ SITE1          MOP1
_ G3C1       C   ACTIVE   NORMAL   S0502     RS1       YN    C000  C007G3M
_ G3P1           ACTIVE   NORMAL   S0504     RS1       YN    C100  C108G3M
_ CF31           MANUAL   NORMAL   S0501               NN
_ SITE2          PARIS
_ G3C2       C   MASTER   NORMAL   S0503     RS2       YN    D000  D007G3M
_ G3P2           ACTIVE   NORMAL   S0505     RS1       YN    C100  C108G3


1 CPC Ops  2 SSI Ops
Selection ===>
  F1=Help       F3=Return  F6=Roll                  F11=Right
```

Figure 1 – GDPS Metro SL system configuration

CODES LEVELS AND HARDWARE SETTINGS

- Hardware levels GDPS Metro Single Leg :
  - Storage : Hitachi Virtual Storage Platform 5100™ at code level 90-04-02.

    Hitachi VSP 5000 series has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS MM testing:

    114, 142, 459, 467, 484, 506, 598, 665, 784, 789, 790, 832, 867, 868, 872, 895, 896, 899, 976, 990, 995, 1005, 1022, 1061, 1068, 1086, 1099, 1115, 1169, 1175

    Mode 114: This mode allows the system to automatically change the direction of the METRO MIRROR links and allows dynamic port mode setting (RCP/LCP for serial, Initiator/RCU target for fiber-channel) through PPRC CESTPATH and CDELPATH commands. This mode is required in a GDPS MM environment.

    Mode 484: Displaying PPRC path QUERY information in the FC interface format. When using the IBM host functions (PPRC, GDPS etc.), mode 484 can be set for displaying the PPRC path QUERY information in the FC interface format. This mode is required in a GDPS MM environment.
  - Remote Site Storage : Hitachi Virtual Storage Platform F1500™ at code level 80-06-78.

    Hitachi VSP F1500 has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS MM testing:

    114, 142, 449, 467, 484, 506, 530, 598, 664, 665, 784, 867, 872, 895, 896, 976, 990, 1015, 1022, 1061, 1068, 1086, 1172

- Software levels:
  - z/OS V2.04 April 2020
  - Tivoli Netview for z/OS V6.R3
  - System Automation for z/OS V4.R1
  - GDPS Metro V4.R3.M2

Note Levels indicated here are those that were already installed in the GDPS lab and were not imposed by these qualification tests.

- GEOPLEX Options used in option XML file. All missing values are left as default.

OPTIONS	Defaulted	Default value	Value used
CONTROLLING SYSTEMS	NO	1	2
FCTIMEOUT	YES	5	20
FREEZESCOPE	YES	GROUP	GROUP
FRTIMEOUT	YES	01:00:00	01:00:00
MASTER	NO		G3C2 G3C1 G3P2 G3P1
PROCOPTS	YES	INTERNAL2	INTERNAL2
TOPOLOGY	NO		MM2SITE
MM2SITE	NO		HM(NO), MTFO(NO)

- Disk subsystem layout

Each HITACHI VSP 5000 was configured with 3390 devices across 19 LSS and all LSS have HyperPAV UCBs defined and all the volumes were defined as HDP (Hitachi thin provisioning devices):

- 1 LSS dedicated to the infrastructure devices (z/OS Production System disks)
- 4 LSS for data and work areas
- 4 LSS reserved for FlashCopy
- 4 LSS reserved for Space Efficient FlashCopy
- 6 LSS with 10 EAV Mod.100 each

The final disk layout is as follows:

VSP-A (5500) Site 1 S/N 30849 IP:

SSID		LCU	Mod.	UCB	PAV	Link
G3C1	A001	00	9	A000-A03F	A0C0-A0FF	98.11.82 F0.12.86
GDPCOM & CDS	A001	00	27	A040-A04F	A0C0-A0FF	98/99.11.82 F0/F1.12.86
Prod	A011	01	27	A100-A13F	A1C0-A1FF	98/99.11.83 F0/F1.12.88
Prim	A021	02	27	A200-A23F	A2C0-A2FF	98/99.11.9A F0/F1.12.8A
	A031	03	27	A300-A33F	A3C0-A3FF	98/99.11.9A F0/F1.12.8A
	A041	04	27	A400-A43F	A4C0-A4FF	98/99.11.9A F0/F1.12.8A
FC	A051	05	27	A500-A53F	A5C0-A5FF	98/99.11.9A F0/F1.12.8A
	A061	06	27	A600-A63F	A6C0-A6FF	98/99.11.9A F0/F1.12.8A
	A071	07	27	A700-A73F	A7C0-A7FF	98/99.11.9A F0/F1.12.8A
	A081	08	27	A800-A83F	A8C0-A8FF	98/99.11.9A F0/F1.12.8A
SEFC	A091	09	27	A900-A93F	A9C0-A9FF	98/99.11.9B F0/F1.12.63
	A0A1	0A	27	AA00-AA3F	AAC0-AAFF	98/99.11.9B F0/F1.12.63
	A0B1	0B	27	AB00-AB3F	ABC0-ABFF	98/99.11.9B F0/F1.12.63
	A0C1	0C	27	AC00-AC3F	ACC0-ACFF	98/99.11.9B F0/F1.12.63
EAV	A0D1	0D	100	AD00-AD09	ADC0-ADFF	98/99.11.9B F0/F1.12.63
	A0E1	0E	100	AE00-AE09	AEC0-AEFF	98/99.11.9B F0/F1.12.63
	A0F1	0F	100	AF00-AF09	AFC0-AFFF	98/99.11.9B F0/F1.12.63
	A101	10	100	E000-E009	E0C0-E0FF	98/99.11.9B F0/F1.12.63
	A111	11	100	E100-E109	E1C0-E1FF	98/99.11.9B F0/F1.12.63
	A121	12	100	E200-E209	E2C0-E2FF	98/99.11.9B F0/F1.12.63

VSP-B (5500) Site 2 S/N 30865 IP:

SSID		LCU	Mod.	UCB	PAV	LINK
G3C2	B002	00	27	B000-B01F	B0C0-B0FF	98.11.80 F0.12.80
	B002	00	9	B000-B03F	B0C0-B0FF	98.11.80 F0.12.80
CDS	B002	00	27	B040-B04F	B0C0-B0FF	98/99.11.80 F0/F1.12.80
Prod	B012	01	27	B100-B13F	B1C0-B1FF	98/99.11.81 F0/F1.12.81
Prim	B022	02	27	B200-B23F	B2C0-B2FF	98/99.11.98 F0/F1.12.98
	B032	03	27	B300-B33F	B3C0-B3FF	98/99.11.98 F0/F1.12.98
	B042	04	27	B400-B43F	B4C0-B4FF	98/99.11.98 F0/F1.12.98
FC	B052	05	27	B500-B53F	B5C0-B5FF	98/99.11.98 F0/F1.12.98
	B062	06	27	B600-B63F	B6C0-B6FF	98/99.11.98 F0/F1.12.98
	B072	07	27	B700-B73F	B7C0-B7FF	98/99.11.98 F0/F1.12.98
	B082	08	27	B800-B83F	B8C0-B8FF	98/99.11.98 F0/F1.12.98
SEFC	B092	09	27	B900-B93F	B9C0-B9FF	98/99.11.99 F0/F1.12.89
	B0A2	0A	27	BA00-BA3F	BAC0-BAFF	98/99.11.99 F0/F1.12.89
	B0B2	0B	27	BB00-BB3F	BBC0-BBFF	98/99.11.99 F0/F1.12.89
	B0C2	0C	27	BC00-BC3F	BCC0-BCFF	98/99.11.99 F0/F1.12.89
EAV	B0D2	0D	100	BD00-BD09	BDC0-BDFF	98/99.11.99 F0/F1.12.89
	B0E2	0E	100	BE00-BE09	BEC0-BEFF	98/99.11.99 F0/F1.12.89
	B0F2	0F	100	BF00-BF09	BFC0-BFFF	98/99.11.99 F0/F1.12.89
	B102	10	100	E300-E309	E3C0-E3FF	98/99.11.99 F0/F1.12.89
	B112	11	100	E400-E409	E4C0-E4FF	98/99.11.99 F0/F1.12.89
	B122	12	100	E500-E509	E5C0-E5FF	98/99.11.99 F0/F1.12.89

Figure 2 – Metro Mirror DASD layout

Under GDPS®, the Remote Copy page shows the following configuration:

```
VPCPQSTE  Mirroring Status: OK        Monitor2 Time:01:00:00          G3C2
          Primary Site: ATH.MOP1      Soft Fenced  NONE
 Actions: Q ueryPath Z QueryReverse V iew devices X ceptions D elpath E stpath
          S econdary
 Group: LEGACY.LEGACY      Type: CKD     Leg: RL1     Device Pairs:126
      Primary        ->      Secondary         PRI  -  SEC
   Serial LSS SSID          Serial LSS SSID    Util. Devices    Links    Pairs
_ 0030849 01 A011   ->    0030865 01 B012     0A13D - 0B13D      4/4       63
_ 0030849 02 A021   ->    0030865 02 B022     0A23F - 0B23F      4/4       63
_ 0030849 03 A031   ->    0030865 03 B032     0A23F - 0B33F      4/4       63
_ 0030849 04 A041   ->    0030865 04 B042     0A23F - 0B43F      4/4       63
_ 0030849 0D A0D1   ->    0030865 0D B0D2     0AD09 - 0BD09      4/4       9
_ 0030849 0E A0E1   ->    0030865 0E B0E2     0AE09 - 0BE09      4/4       9
_ 0030849 0F A0F1   ->    0030865 0F B0F2     0AF09 - 0BF09      4/4       9
_ 0030849 10 A101   ->    0030865 10 B102     0A309 - 0B309      4/4       9
_ 0030849 11 A111   ->    0030865 11 B112     0A409 - 0B409      4/4       9
_ 0030849 12 A121   ->    0030865 12 B122     0A509 - 0B509      4/4       9

1 Epair 2 Dpair 3 Suspend 4 Resynch 5 Monitor2 6 Q Paths 7 Epath 8 Dpath
11 Find
Selection ===>
  F1=Help   F3=Return    F6=Roll   F7=Up   F8=Down   F9=Toggle
```

Figure 3 - GDPS Metro SL LSS configuration

SCENARIOS CHECKED

All the test scenarios executed were "DASD-Oriented". Scenarios specifically geared towards "SYSPLEX" events or designed to test server management aspects of GDPS were removed.

A. Basic test:

- Use all GDPS Metro SL Remote copy options with the full configuration loaded.

```
VPCPQSH2  Mirroring Status: OK  Group: LEGACY.LEGACY     Type: CKD   G3C2
Actions:  D elpair  E stpair  S uspend  Y RecSec  R esynch  Q uery
          QO Query Online
Leg: RL1  Pair: 0022424 01 C013 -> 0023221 01 D014 Count: 63  Scope:  All
_ 0A100  0B100 DUP        _ 0A110  0B110 DUP        _ 0A120  0B120 DUP
_ 0A101  0D101 DUP        _ 0A111  0B111 DUP        _ 0A121  0B121 DUP
_ 0A102  0D102 DUP        _ 0A112  0B112 DUP        _ 0A122  0B122 DUP
_ 0A103  0D103 DUP        _ 0A113  0B113 DUP        _ 0A123  0B123 DUP
_ 0A104  0D104 DUP        _ 0A114  0B114 DUP        _ 0A124  0B124 DUP
_ 0A105  0D105 DUP        _ 0A115  0B115 DUP        _ 0A125  0B125 DUP
_ 0A106  0D106 DUP        _ 0A116  0B116 DUP        _ 0A126  0B126 DUP
_ 0A107  0D107 DUP        _ 0A117  0B117 DUP        _ 0A127  0B127 DUP
_ 0A108  0D108 DUP        _ 0A118  0B118 DUP        _ 0A128  0B128 DUP
_ 0A109  0D109 DUP        _ 0A119  0B119 DUP        _ 0A129  0B129 DUP
_ 0A10A  0D10A DUP        _ 0A11A  0B11A DUP        _ 0A12A  0B12A DUP
_ 0A10B  0D10B DUP        _ 0A11B  0B11B DUP        _ 0A12B  0B12B DUP
_ 0A10C  0D10C DUP        _ 0A11C  0B11C DUP        _ 0A12C  0B12C DUP
_ 0A10D  0D10D DUP        _ 0A11D  0B11D DUP        _ 0A12D  0B12D DUP
_ 0A10E  0D10E DUP        _ 0A11E  0B11E DUP        _ 0A12E  0B12E DUP
_ 0A10F  0D10F DUP        _ 0A11F  0B11F DUP        _ 0A12F  0B12F DUP
1 Estpair 2 Delpair 3 Suspend 4 Resynch 5 Query 6 RecSec 7 All 8 Exceptions
11 VOLSERs
Selection ===>
  F1=Help   F3=Return    F6=Roll   F7=Up   F8=Down   F9=Toggle   F10=CCA
```

Figure 4 - LSS volume list panel

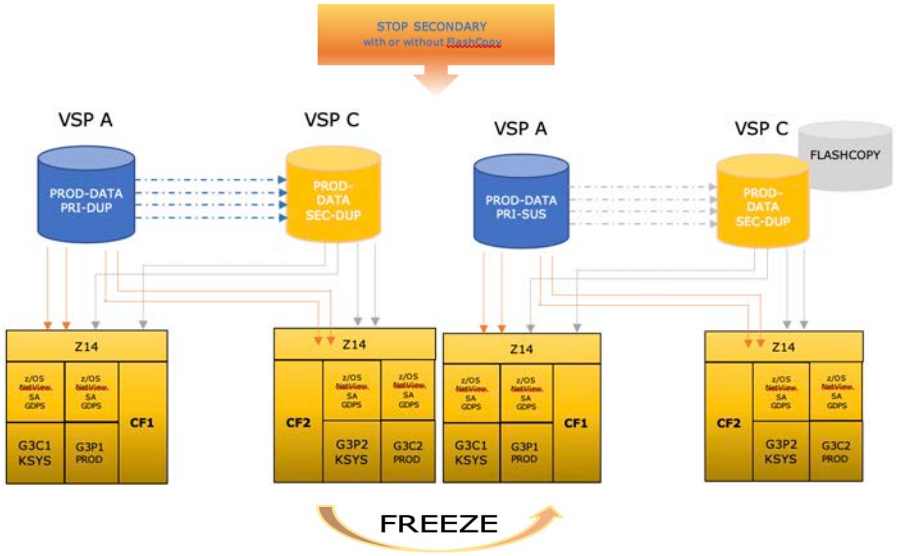
- Generate a variety of freeze events (Either through commands or via hardware event triggers).

Note

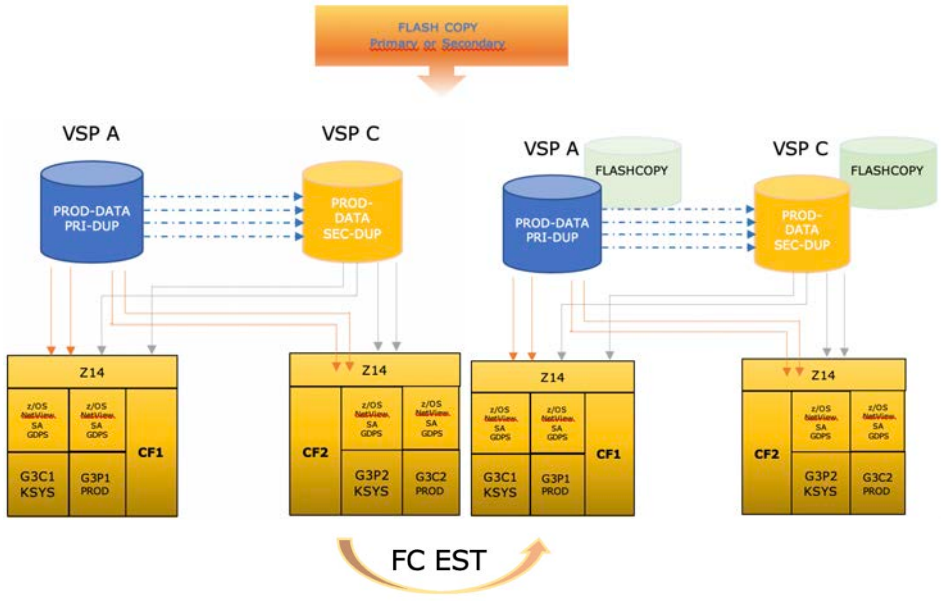
Alternate tests were performed using the different policy options available:
- PRIMARYFAILURE=SWAP,GO or SWAP,STOP
- PPRCFAILURE=GO or COND or STOP

B. Planned actions:

- Start and stop METRO MIRROR relationship with and without first taking a Flash Copy using scripts

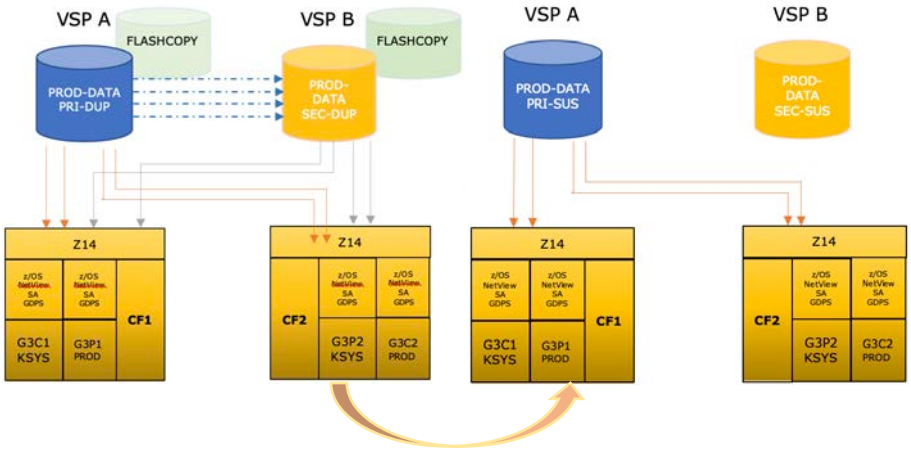


- Start and stop Flash Copy sessions for primary disks as well as for secondary disks.

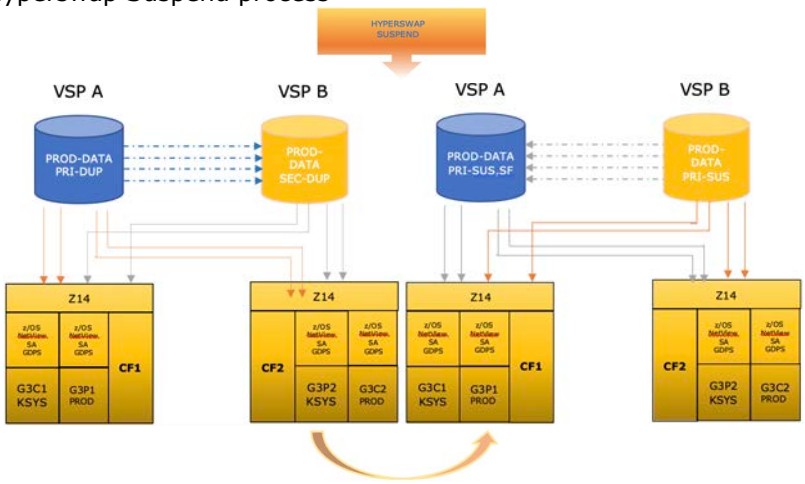


- Use all options of Flash Copy options: Nocopy, Copy, Incremental, and Nocopy2copy.
- Space Efficient volumes have been tested, as well as the Remote Pair Flash Copy function.
- Simulation of disruptive disk maintenance in Site 1 by restarting the production systems on the Site 2 disks and then returning back to Site 1.

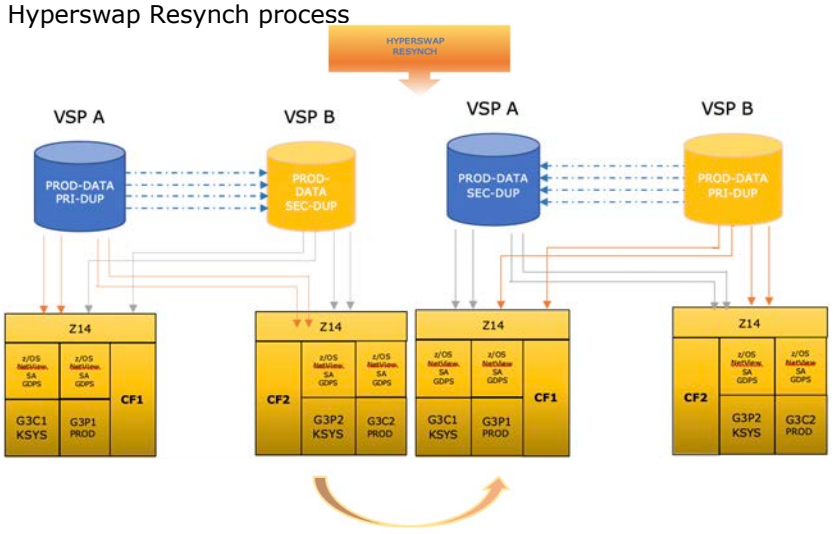
- Simulate disk maintenance in Site 2 and returning back to the normal configuration.



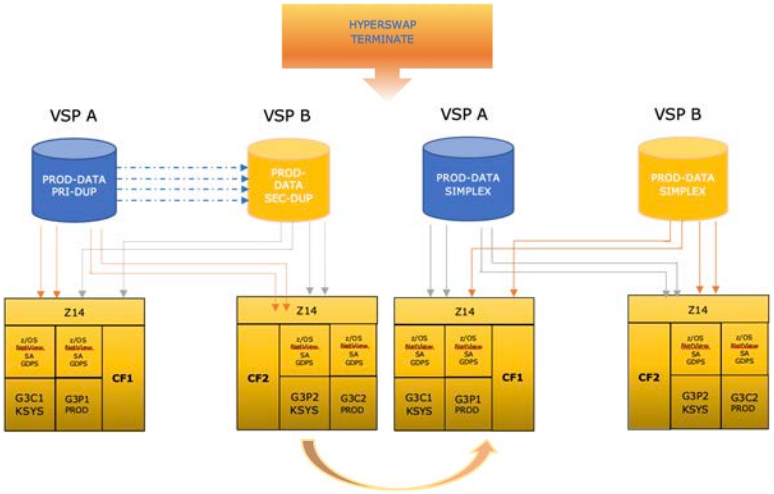
- Generate various GDPS Master Switches (checking update of the DASD variables).
- Swap Site 1 and Site 2 disks using all the available HyperSwap™ options: SUSPend, Resynch and Terminate.
  - Hyperswap Suspend process



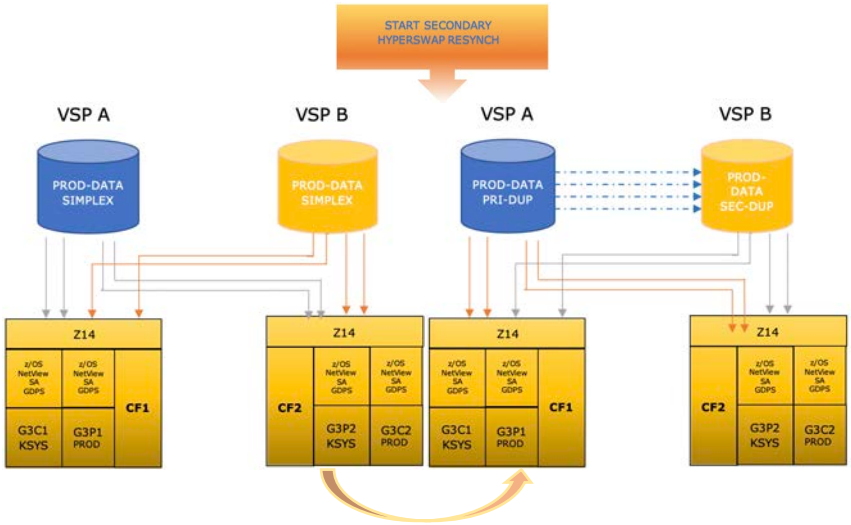
  - Hyperswap Resynch process



- Hyperswap Terminate process



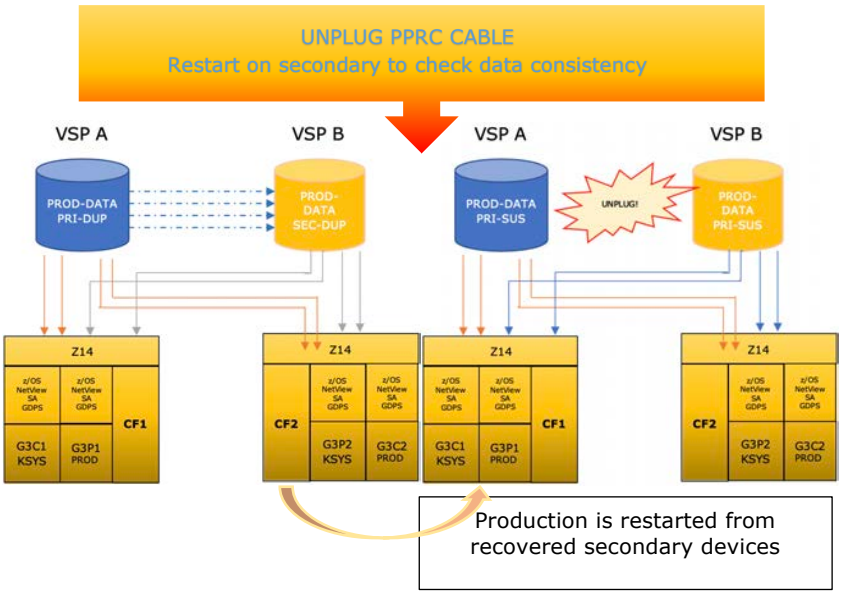
- In each case, return to the normal configuration by first restarting the METRO MIRROR relationship (if needed) and then running a HyperSwap™ Resynch.



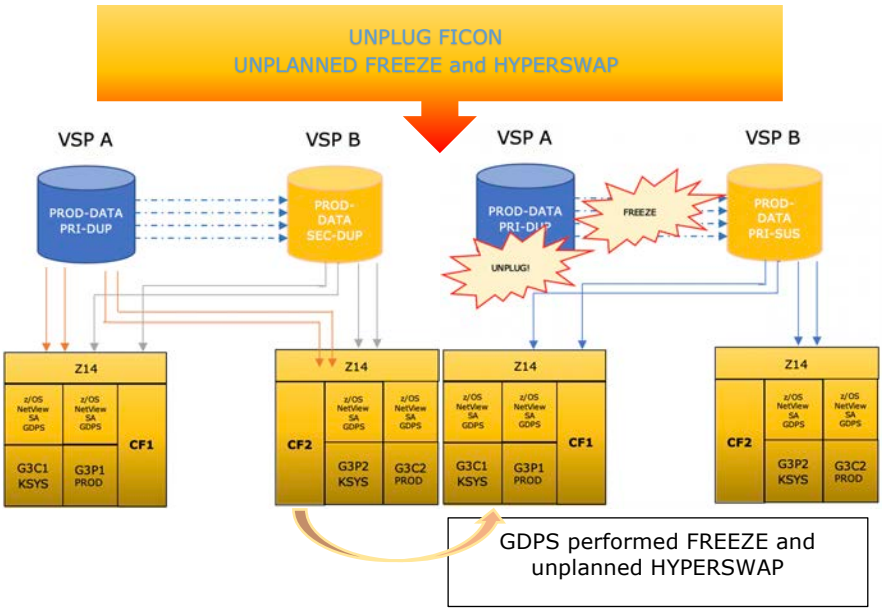
START SECONDARY is designed to handle all status of devices.
Hyperswap Resynch is used to return to normal situation

C. *Unplanned actions (Repeated for each of the PRIMARYFAILURE/PPRCFAILURE policy options):*

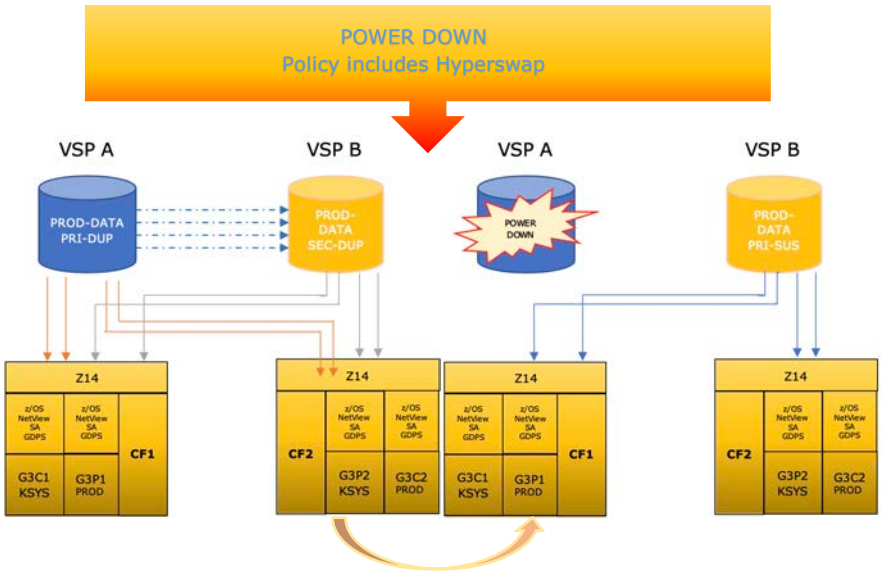
- Generate real loss of all METRO MIRROR links between the VSP 5000 in Site 1 and the VSP 5000 in Site 2. For Site 1 failure scenarios, restart the production systems on the recovered secondary disk in order to check data consistency.



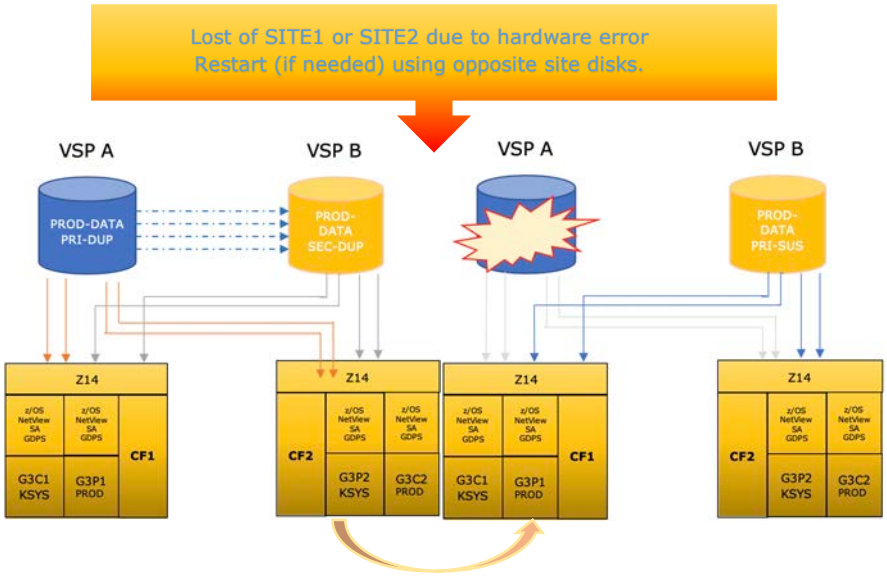
- Generate real loss of all host links between VSP 5000 in Site 1.



- Generate real loss of VSP 5000 in Site 1 or Site 2 with a Normal Power Off.



D. Disruptive tests (for PRIMARYFAILURE/PPRCFAILURE SWAP&GO, SWAP&STOP, SWAP&COND policy option and on each site):



- Generate real loss of VSP 5000 Site 1 or Site 2 with an emergency Power off
- Generate real loss of VSP 5000 Site 1 or Site 2 with an internal CU error
- Generate real loss of VSP 5000 Site 1 or Site 2 with an internal channel adapter error
- Generate real loss of VSP 5000 Site 1 or Site 2 with an internal physical device error

E. HyperSwap™ stress tests

- Run various planned HyperSwap™ tests in a CPU-constrained and memory-constrained environment.

F. HyperSwap™ Performances tests

- Run Freeze, HyperSwap™ Resynch, and HyperSwap™ SUSPEND, as well as unplanned HyperSwap™ in full configuration and take process timings.

GDPS Metro SL test results

All these scenarios were run successfully, and the results obtained were as expected. As the purpose of this qualification test session was primarily to verify the implementation of the advanced copy services architecture in the Hitachi hardware, only performance data for HyperSwap & Freeze process have been collected.

There is few limitations which were discovered during test period. Bellow we are describing those limitations (complete list of limitation you can find in qualification letter).

- Flashcopy SEQ number and VOLSER
  - SEQ number shows "00000000" value all the time.
  - VOLSER are showing "******" value all the time. FC are taken.
- GDPS_CHECK_SPOF indicates a potentially false single point of failure on PPRC links adapter. This item has to be manually checked.

Note

The following disk features implemented in GDPS Metro SL are not supported by the actual VSP 5000 microcode:
- XD mode copy processing (PPRC-XD Asynchronous protocol for initial copy and resynch)
- Summary Event Notification for PPRC Suspends (PPRCSUM)
- NDSS

GDPS Metro Dual Leg (DL) test – Hitachi VSP G1500/F1500

SYSTEM CONFIGURATION

The configuration used for this test was a GDPS Metro Dual Leg with Single-site workload. The objective of the exercise was to test the functionality of the VSP F1500 in a GDPS Metro Dual Leg environment, not to test performance (except for some HyperSwap test cases) or throughput. No attempt was made to optimize the configuration for throughput.

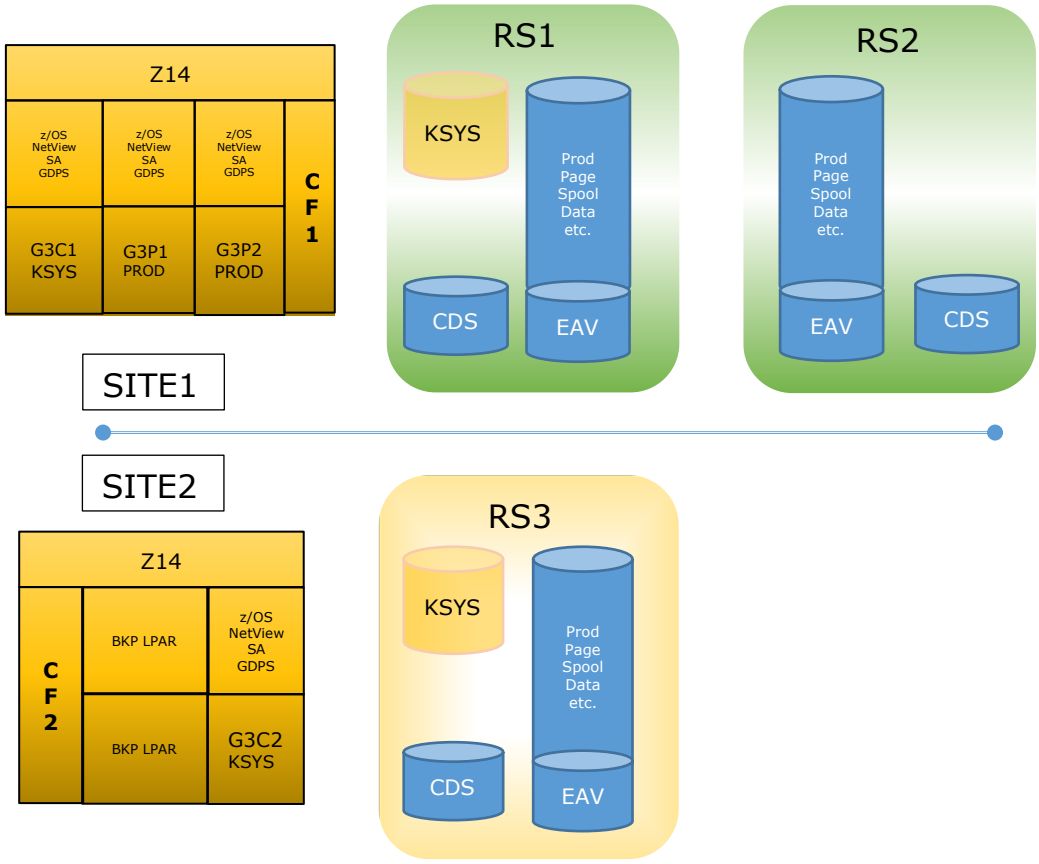


Figure 8 - GDPS Metro DL single site workload configuration.

The Site 1 configuration is comprised of one coupling facility (CF1), an alternate GDPS Metro controlling system (G3C1) and 2 production system running z/OS (G3P1, G3P2). In Site 2 there is the GDPS Metro controlling system (G3C2), another coupling facility (CF2) and spare LPARs to host the Site 1 systems in case of need. The G3C1, G3C2, G3P1 and G3P2 systems are in the same "Parallel SYSPLEX". The Production systems run with their system and application data residing on the VSP F1500, while the Controlling systems were residing on non-mirrored LSS within the VSP F1500 (RS1 for G3C1 and RS3 in G3C2). All the production data, system and application, is METRO MIRRORed using Multi-Target Metro Mirror technology to the secondary VSP F1500 disk subsystem (RS2). Additional replication leg is set between RS1 and third VSP F1500 disk subsystem (RS3). The "SYSPLEX" files (Couple Datasets - CDS) were allocated in

the three sites but only the Logger CDS was mirrored. Non mirrored CDSes are replicated by system. Flashcopy was not tested in this qualification for GDPS Metro DL, so there was no configuration for it in this environment.

Figure 9 shows the configuration used as viewed by the GDPS Metro Standard Actions page:

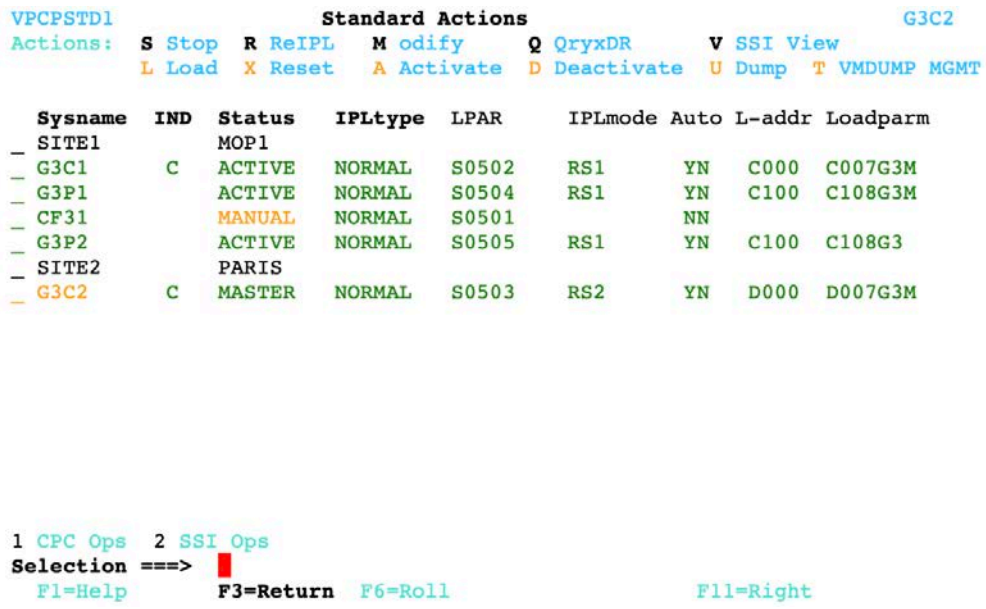


Figure 9 - GDPS Metro DL system configuration

CODES LEVELS AND HARDWARE SETTINGS

- Hardware levels GDPS Metro Dual Leg :
  - Storage : Hitachi Virtual Storage Platform F1500™ at code level 80-06-81.

    Hitachi VSP F1500 and G1x00 has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS MM testing:

    114, 142, 449, 467, 484, 506, 530, 598, 664, 665, 784, 867, 872, 895, 896, 976, 990, 995, 1005, 1015, 1022, 1050, 1061, 1068, 1086, 1099, 1172

    Mode 114: This mode allows the system to automatically change the direction of the PPRC links and allows dynamic port mode setting (RCP/LCP for serial, Initiator/RCU target for fiber-channel) through PPRC CESTPATH and CDELPATH commands. This mode is required in a GDPS MM environment.

    Mode 484: Displaying PPRC path QUERY information in the FC interface format. When using the IBM host functions (PPRC, GDPS etc.), mode

484 can be set for displaying the PPRC path QUERY information in the FC interface format. This mode is required in a GDPS MM environment.

- Remote Site Storage : Hitachi Virtual Storage Platform 5500™ at code level 90-04-02.

Hitachi VSP G/F1500 series has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS Metro DL testing:

114, 142, 459, 467, 484, 506, 598, 665, 784, 789, 790, 832, 867, 868, 872, 895, 896, 899, 976, 990, 995, 1005, 1022, 1061, 1068, 1086, 1099, 1115, 1169, 1175

- Software levels:
  - z/OS V2.04 April 2020
  - Tivoli Netview for z/OS V6.R3
  - System Automation for z/OS V4.R1
  - GDPS Metro V4.R3.M2

Note

Levels indicated here are those that were already installed in the GDPS lab and were not imposed by these qualification tests.

- GEOPLEX Options:

OPTIONS	Defaulted	Default value	Value used
CONTROLLING SYSTEMS	NO	1	2
FCTIMEOUT	YES	5	20
MASTER	NO		G3C2 G3C1 G3P2 G3P1
TOPOLOGY	NO		MM3SITE
MM3SITE	NO		MTFO(YES)

- Disk subsystem layout

  Each HITACHI VSP F1500 was configured with 3390 devices across 19 LSS and all LSS have HyperPAV UCBs defined and all the volumes were defined as HDP (Hitachi thin provisioning devices):

  - 1 LSS dedicated to the infrastructure devices (z/OS Production System disks)
  - 12 LSS for data and work areas
  - 6 LSS with 10 EAV Mod.100 each

Matrix bellow shows full configuration.

The final disk layout is as follows:

VSP-C (F1500) Site 1 S/N 22424 IP:

SSID		LCU	Mod.	UCB	PAV	LINK
G3C1	C003	00	9	C000-C03F	C0C0-C0FF	98.11.88 F0.12.0B
GDPCOM & CDS	C003	00	27	C040-C04F	C0C0-C0FF	98/99.11.88 F0/F1.12.0B
Prod	C013	01	27	C100-C13F	C1C0-C1FF	98/99.11.89 F0/F1.12.22
Prim	C023	02	27	C200-C23F	C2C0-C2FF	98/99.11.8A F0/F1.12.43
	C033	03	27	C300-C33F	C3C0-C3FF	98/99.11.8A F0/F1.12.43
	C043	04	27	C400-C43F	C4C0-C4FF	98/99.11.8A F0/F1.12.43
Prim	C053	05	3	C500-C53F	C5C0-C5FF	98/99.11.8A F0/F1.12.43
	C063	06	3	C600-C63F	C6C0-C6FF	98/99.11.8A F0/F1.12.43
	C073	07	3	C700-C73F	C7C0-C7FF	98/99.11.8A F0/F1.12.43
	C083	08	27	C800-C83F	C8C0-C8FF	98/99.11.8A F0/F1.12.43
Prim	C093	09	27	C900-C93F	C9C0-C9FF	98/99.11.A3 F0/F1.12.4A
	C0A3	0A	27	CA00-CA3F	CAC0-CAFF	98/99.11.A3 F0/F1.12.4A
	C0B3	0B	27	CB00-CB3F	CBC0-CBFF	98/99.11.A3 F0/F1.12.4A
	C0C3	0C	27	CC00-CC3F	CCC0-CCFF	98/99.11.A3 F0/F1.12.4A
EAV	C0D3	0D	100	CD00-C009	CDC0-CDFF	98/99.11.A3 F0/F1.12.4A
	C0E3	0E	3	CE00-CE09	CEC0-CEFF	98/99.11.A3 F0/F1.12.4A
	C0F3	0F	3	CF00-CF09	CFC0-CFFF	98/99.11.A3 F0/F1.12.4A
	C103	10	3	E600-E609	E6C0-E6FF	98/99.11.A3 F0/F1.12.4A
	C113	11	3	E700-E709	E7C0-E7FF	98/99.11.A3 F0/F1.12.4A
	C123	12	3	E800-E809	E8C0-E8FF	98/99.11.A3 F0/F1.12.4A

VSP-D (F1500) Site 2 S/N 23221 IP:

SSID		LCU	Mod.	UCB	PAV	LINK
G3C2	D004	00	27	D000-D01F	D0C0-D0FF	98.11.60 F0.12.10
	D004	00	9	D020-D03F	D0C0-D0FF	98.11.60 F0.12.10
CDS	D004	00	27	D040-D04F	D0C0-D0FF	98.11.60 F0.12.10
Prod	D014	01	27	D100-D13F	D1C0-D1FF	98/99.11.61 F0/F1.12.11
Prim	D024	02	27	D200-D23F	D2C0-D2FF	98/99.11.62 F0/F1.12.12
	D034	03	27	D300-D33F	D3C0-D3FF	98/99.11.62 F0/F1.12.12
	D044	04	27	D400-D43F	D4C0-D4FF	98/99.11.62 F0/F1.12.12
Prim	D054	05	3	D500-D53F	D5C0-D5FF	98/99.11.62 F0/F1.12.12
	D064	06	3	D600-D63F	D6C0-D6FF	98/99.11.62 F0/F1.12.12
	D074	07	3	D700-D73F	D7C0-D7FF	98/99.11.62 F0/F1.12.12
	D084	08	27	D800-D83F	D8C0-D8FF	98/99.11.62 F0/F1.12.12
Prim	D094	09	27	D900-D93F	D9C0-D9FF	98/99.11.63 F0/F1.12.13
	D0A4	0A	27	DA00-DA3F	DAC0-DAFF	98/99.11.63 F0/F1.12.13
	D0B4	0B	27	DB00-DB3F	DBC0-DBFF	98/99.11.63 F0/F1.12.13
	D0C4	0C	27	DC00-DC3F	DCC0-DCFF	98/99.11.63 F0/F1.12.13
EAV	D0D4	0D	100	DD00-DD09	DDC0-DDFF	98/99.11.63 F0/F1.12.13
	D0E4	0E	3	DE00-DE09	DEC0-DEFF	98/99.11.63 F0/F1.12.13
	D0F4	0F	3	DF00-DF09	DFC0-DFFF	98/99.11.63 F0/F1.12.13
	D104	10	3	E900-E909	E9C0-E9FF	98/99.11.63 F0/F1.12.13
	D114	11	3	EA00-EA09	EAC0-EAFF	98/99.11.63 F0/F1.12.13
	D124	12	3	EB00-EB09	EBC0-EBFF	98/99.11.63 F0/F1.12.13

VSP-E (F1500) Site 3 S/N 23223 IP:

SSID		LCU	Mod.	UCB	PAV	Link
	A001	00	9	A000-A03F	A0C0-A0FF	
CDS	A001	00	27	A040-A04F	A0C0-A0FF	98/99.11.82 F0/F1.12.86
Prod	A011	01	27	A100-A13F	A1C0-A1FF	98/99.11.83 F0/F1.12.88
Prim	A021	02	27	A200-A23F	A2C0-A2FF	98/99.11.9A F0/F1.12.8A
	A031	03	27	A300-A33F	A3C0-A3FF	98/99.11.9A F0/F1.12.8A
	A041	04	27	A400-A43F	A4C0-A4FF	98/99.11.9A F0/F1.12.8A
Prim	A051	05	3	A500-A53F	A5C0-A5FF	98/99.11.9A F0/F1.12.8A
	A061	06	3	A600-A63F	A6C0-A6FF	98/99.11.9A F0/F1.12.8A
	A071	07	3	A700-A73F	A7C0-A7FF	98/99.11.9A F0/F1.12.8A
	A081	08	27	A800-A83F	A8C0-A8FF	98/99.11.9A F0/F1.12.8A
Prim	A091	09	27	A900-A93F	A9C0-A9FF	98/99.11.9B F0/F1.12.63
	A0A1	0A	27	AA00-AA3F	AAC0-AAFF	98/99.11.9B F0/F1.12.63
	A0B1	0B	27	AB00-AB3F	ABC0-ABFF	98/99.11.9B F0/F1.12.63
	A0C1	0C	27	AC00-AC3F	ACC0-ACFF	98/99.11.9B F0/F1.12.63
EAV	A0D1	0D	100	AD00-AD09	ADC0-ADFF	98/99.11.9B F0/F1.12.63
	A0E1	0E	3	AE00-AE09	AEC0-AEFF	98/99.11.9B F0/F1.12.63
	A0F1	0F	3	AF00-AF09	AFC0-AFFF	98/99.11.9B F0/F1.12.63
	A101	10	3	E000-E009	E0C0-E0FF	98/99.11.9B F0/F1.12.63
	A111	11	3	E100-E109	E1C0-E1FF	98/99.11.9B F0/F1.12.63
	A121	12	3	E200-E209	E2C0-E2FF	98/99.11.9B F0/F1.12.63

Figure 10 – Metro Mirror Dual Leg DASD layout

Under GDPS®, the Remote Copy page shows the following configuration:

```
VPCPQSTE  Mirroring Status: OK       Monitor2 Time:11:20:34          G3C2
          Primary Site: ATH.MOP1     Soft Fenced  NONE
 Actions: Q ueryPath Z QueryReverse V iew devices X ceptions D elpath E stpath
          S econdary
 Group: LEGACY.LEGACY     Type: CKD    Leg: RL1    Device Pairs:277
      Primary       ->     Secondary        PRI  -  SEC
   Serial LSS SSID        Serial LSS SSID    Util. Devices    Links    Pairs
v  0022424 01 C013   ->   0023221 01 D014    0C13D - 0D13D     4/4      63
_  0022424 02 C023   ->   0023221 02 D024    0C23F - 0D23F     4/4      63
_  0022424 03 C033   ->   0023221 03 D034    0C33F - 0D33F     4/4      61
_  0022424 04 C043   ->   0023221 04 D044    0C43F - 0D43F     4/4      63
_  0022424 0D C0D3   ->   0023221 0D D0D4    0CD09 - 0DD09     4/4      9
_  0022424 0E C0E3   ->   0023221 0E D0E4    0CE09 - 0DE09     4/4      9
_  0022424 0F C0F3   ->   0023221 0F D0F4    0CF09 - 0DF09     4/4      9


1 Epair 2 Dpair 3 Suspend 4 Resynch 5 Monitor2 6 Q Paths 7 Epath 8 Dpath
11 Find
Selection ===>
  F1=Help   F3=Return    F6=Roll   F7=Up   F8=Down   F9=Toggle
```

Figure 11 - GDPS Metro DL LSS configuration

SCENARIOS CHECKED

All the test scenarios executed were "DASD-Oriented". Scenarios specifically geared towards "SYSPLEX" events or designed to test server management aspects of GDPS were removed.

A. Basic test:

- Use all GDPS Metro DL Remote copy options with the full configuration on both loaded legs.

```
VPCPQSTM     GDPS Metro     Replication Leg and Policy Status          G3C2

   Group: LEGACY.LEGACY      Type: CKD

   ------------ Replication Sites -----------
   RS1 Primary     RS2 -------     RS3 -------
   ATH.MOP1        ATH.MOP2        ATH.PARIS

   Actions:  V iew

   Replication     ----- Status ----   -------- Policy Specifications ---------
   Leg  Sites      HyperSwap  Mirror   PREFERRED     PRIMARYFAILURE   PPRCFAILURE
v  RL1  RS1-RS2    ENABLED    OK       PREF          SWAP,GO          GO
_  RL2  RS1-RS3    ENABLED    OK                     SWAP,GO          GO
_  RL3  RS2-RS3               MTIR                   SWAP,GO          GO



  1 Copyopt    2 Policy Mgmt    3 View Config/Freeze time
  5 Monitor2
Selection ===>
  F1=Help       F3=Return       F6=Roll
```

Figure 12 - GDPS Metro DL replication legs configuration

Bellow you can find screen from RL1 (Replication Leg1) device list.

```
VPCPQSH2  Mirroring Status: OK  Group: LEGACY.LEGACY      Type: CKD    G3C2
Actions:  D elpair  E stpair  S uspend  Y RecSec  R esynch  Q uery
          QO Query Online
Leg: RL1  Pair: 0022424 01 C013 -> 0023221 01 D014 Count: 63  Scope:  All
_ 0C100  0D100 DUP        _ 0C110  0D110 DUP        _ 0C120  0D120 DUP
_ 0C101  0D101 DUP        _ 0C111  0D111 DUP        _ 0C121  0D121 DUP
_ 0C102  0D102 DUP        _ 0C112  0D112 DUP        _ 0C122  0D122 DUP
_ 0C103  0D103 DUP        _ 0C113  0D113 DUP        _ 0C123  0D123 DUP
_ 0C104  0D104 DUP        _ 0C114  0D114 DUP        _ 0C124  0D124 DUP
_ 0C105  0D105 DUP        _ 0C115  0D115 DUP        _ 0C125  0D125 DUP
_ 0C106  0D106 DUP        _ 0C116  0D116 DUP        _ 0C126  0D126 DUP
_ 0C107  0D107 DUP        _ 0C117  0D117 DUP        _ 0C127  0D127 DUP
_ 0C108  0D108 DUP        _ 0C118  0D118 DUP        _ 0C128  0D128 DUP
_ 0C109  0D109 DUP        _ 0C119  0D119 DUP        _ 0C129  0D129 DUP
_ 0C10A  0D10A DUP        _ 0C11A  0D11A DUP        _ 0C12A  0D12A DUP
_ 0C10B  0D10B DUP        _ 0C11B  0D11B DUP        _ 0C12B  0D12B DUP
_ 0C10C  0D10C DUP        _ 0C11C  0D11C DUP        _ 0C12C  0D12C DUP
_ 0C10D  0D10D DUP        _ 0C11D  0D11D DUP        _ 0C12D  0D12D DUP
_ 0C10E  0D10E DUP        _ 0C11E  0D11E DUP        _ 0C12E  0D12E DUP
_ 0C10F  0D10F DUP        _ 0C11F  0D11F DUP        _ 0C12F  0D12F DUP
1 Estpair 2 Delpair 3 Suspend 4 Resynch 5 Query 6 RecSec 7 All 8 Exceptions
11 VOLSERs
Selection ===>
  F1=Help    F3=Return    F6=Roll    F7=Up    F8=Down    F9=Toggle  F10=CCA
```

Figure 13 - LSS volume list panel

- Generate a variety of freeze events (Either through commands or via hardware event triggers).

Note

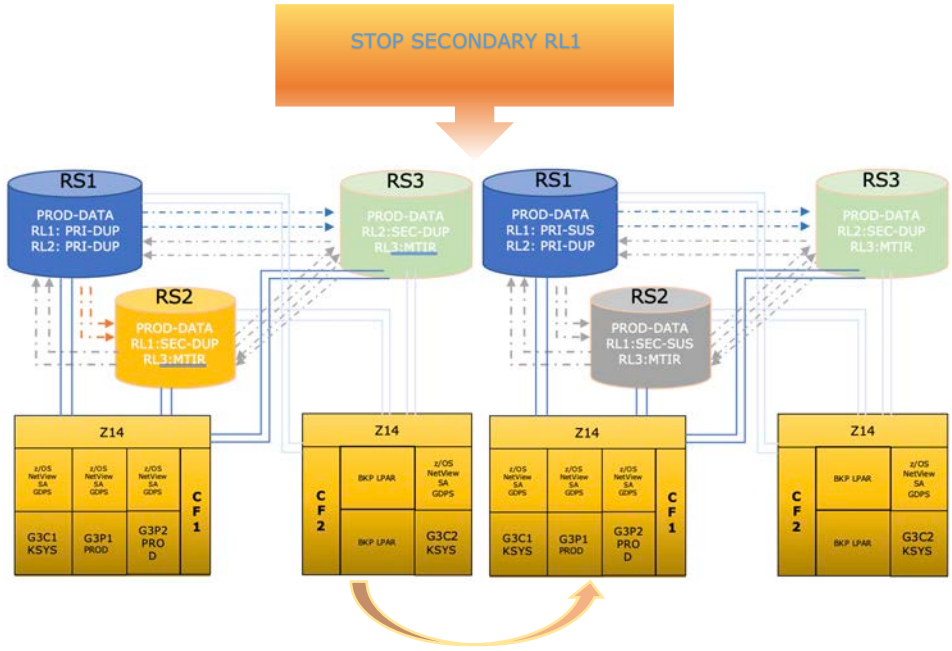
Alternate tests were performed using the different policy options available:
- PRIMARYFAILURE=SWAP,GO or SWAP,STOP
- PPRCFAILURE=GO or COND or STOP, CONDLAST, STOPLAST

Note

During tests of GDPS Metro Dual Leg with VSP F1500 using FlashCopy was not tested.

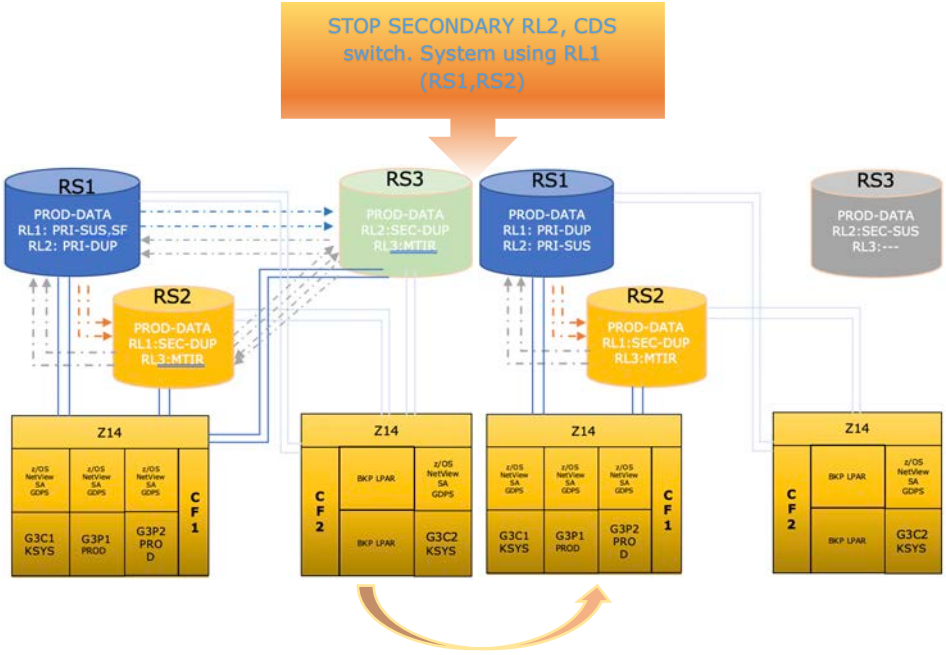
B. Planned actions:

- Start and stop PPRC relationship using scripts.

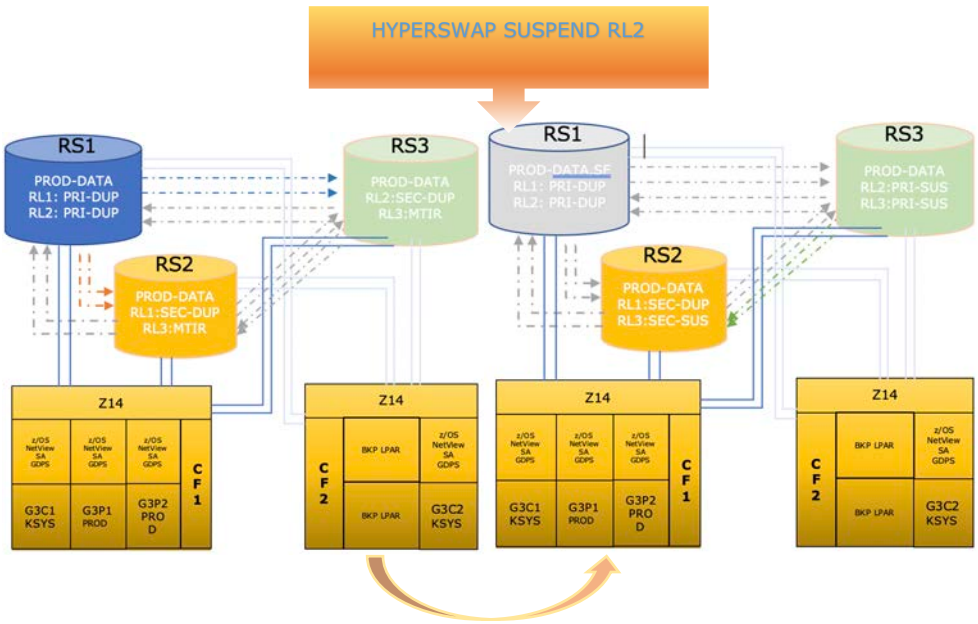


- Circle switch over using Hyperswap where PRIMARY DASD were in RS1->RS2->RS3 was performed in both direction.
- Simulation of non-disruptive disk maintenance in Site 1 by switching to RS1->RS2, as well as RS1->RS3 was made. Restarting the production systems from RS2 and RS3 was tested on this occasion.

- Simulate disk maintenance in Site 2 and returning back to the normal configuration.



- Generate various GDPS Master Switches (checking update of the DASD variables).
- Swap RS1 and RS2 disks using HyperSwap™ SUSPend.



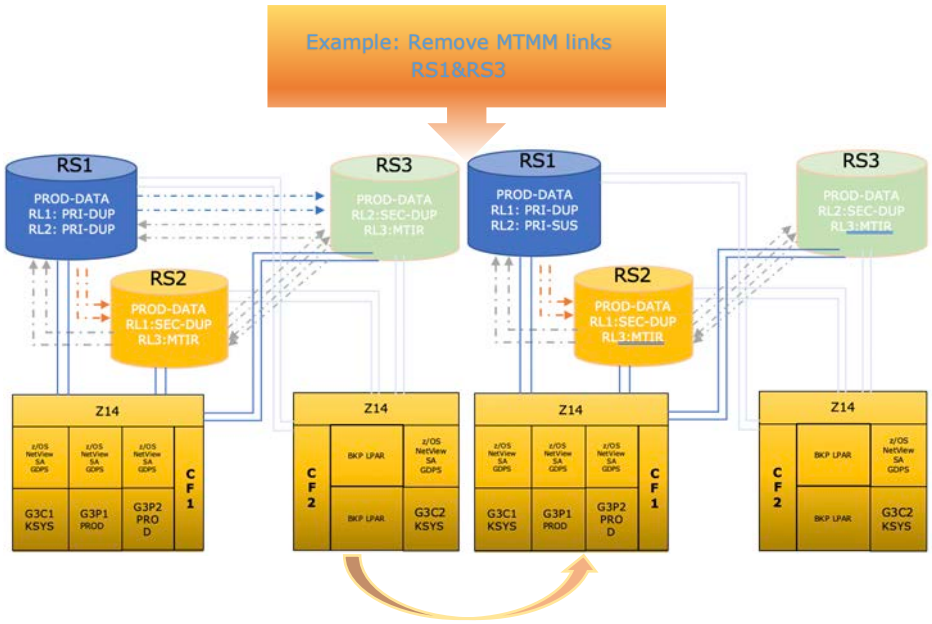
In each case, return to the normal configuration by first restarting the PPRC relationship on both legs and then running a HyperSwap™ Suspend.

Note

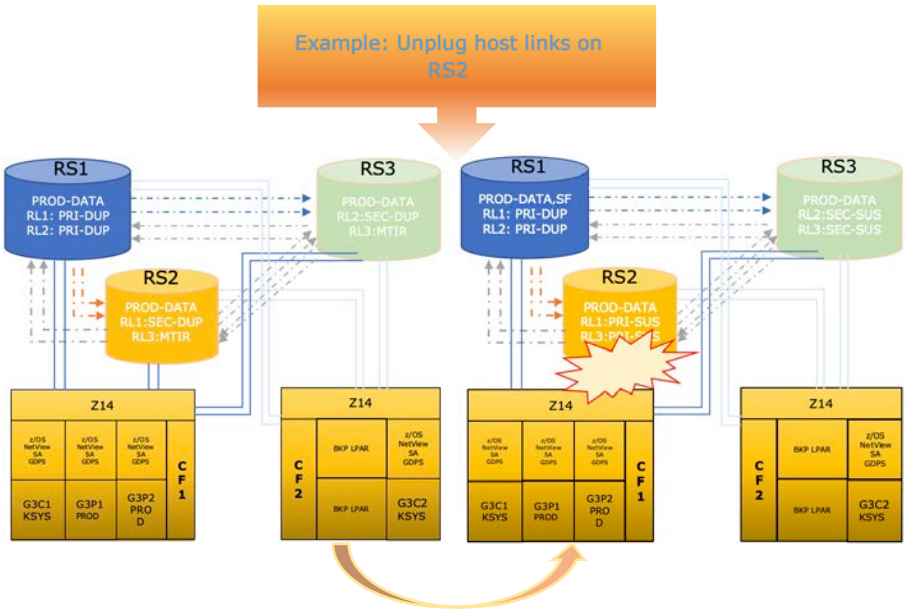
Hitachi VSP G/F1500 MTMM implementation of MTIR function resulting in full copy being perform every time when leg is getting request for replication. More information is included in test result part of this white paper.

C. Unplanned actions (PRIMARYFAILURE/PPRCFAILURE policy options SWAP/GO, SWAP/STOP, SWAP&STOP/COND, SWAP&STOP/STOPLAST, SWAP&STOP/CONDLAST):

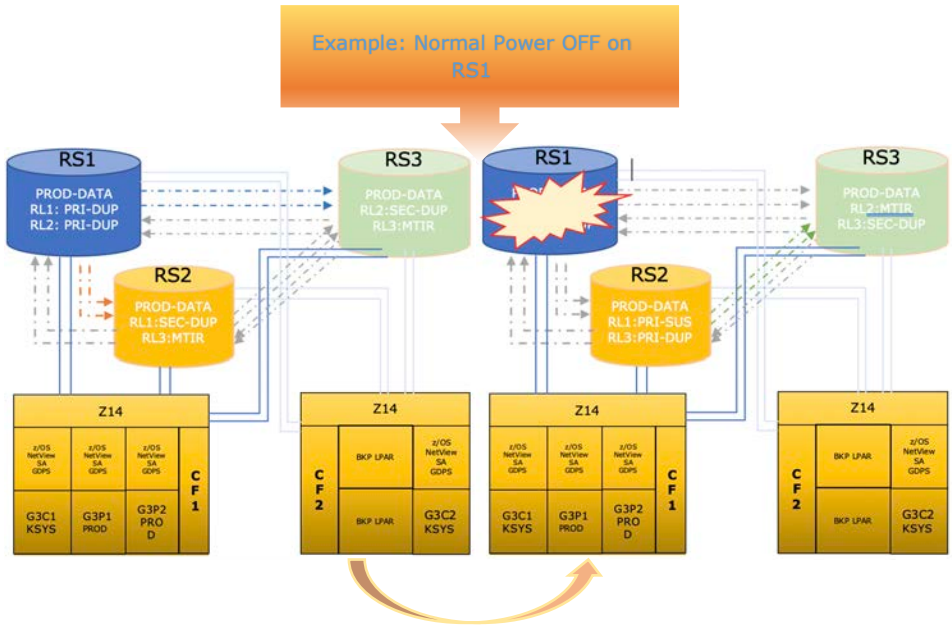
- Generate real loss of all PPRC links on each leg between the VSP F1500 in Replication Leg 1 and the VSP F1500 in Replication Site2, as well as VSP F1500 in RS1 and VSP F1500 in RS3. For Site 1 failure scenarios, restart the production systems on the recovered secondary disk in order to check data consistency.



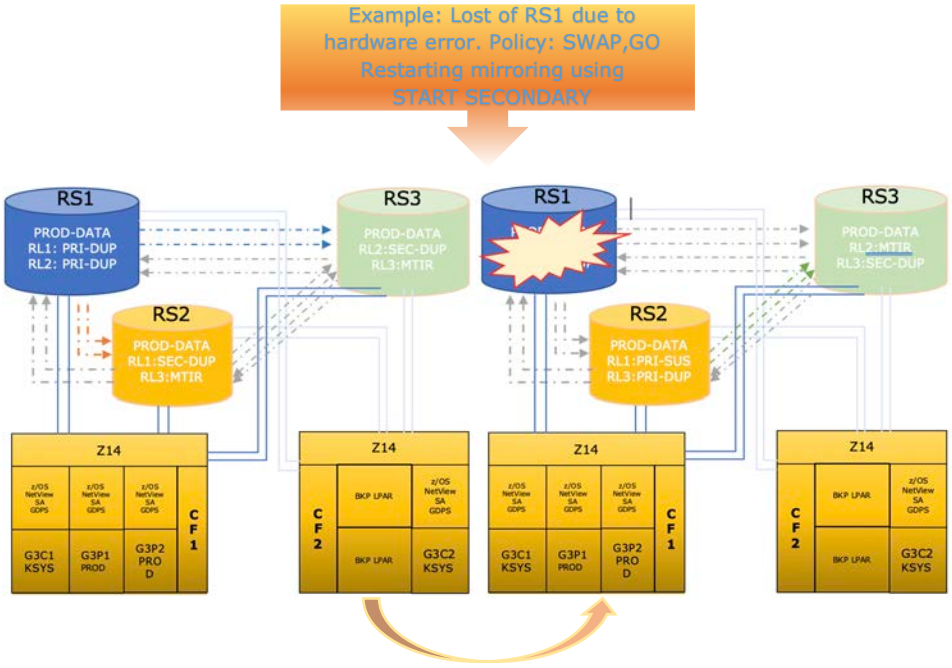
- Generate real loss of all host and PPRC links between VSP F1500 in Site 1 and VSP F1500 in Site 2.



- Generate real loss of VSP F1500 in RS1, RS2 and RS3 with a Normal Power Off.



D. Disruptive tests (PRIMARYFAILURE/PPRCFAILURE policy options SWAP/GO, SWAP/STOP, SWAP&STOP/COND, SWAP&STOP/STOPLAST, SWAP&STOP/CONDLAST on each site):



- Generate real loss of VSP F1500 RS1, RS2 and RS3 with an emergency Power off
- Generate real loss of VSP F1500 RS1, RS2 and RS3S with an internal channel adapter error
- Generate real loss of VSP G1000 RS1, RS2 and RS3 with an internal physical device error

GDPS Metro DL test results

All these scenarios were run successfully. Some results obtained from these tests rise consideration which customers have to take on their own. We are presenting test results bellow.

MTIR

IBM provides Multi Target Incremental Resynch feature as a part of MTMM replication. It is setup as third leg of MTMM replication.

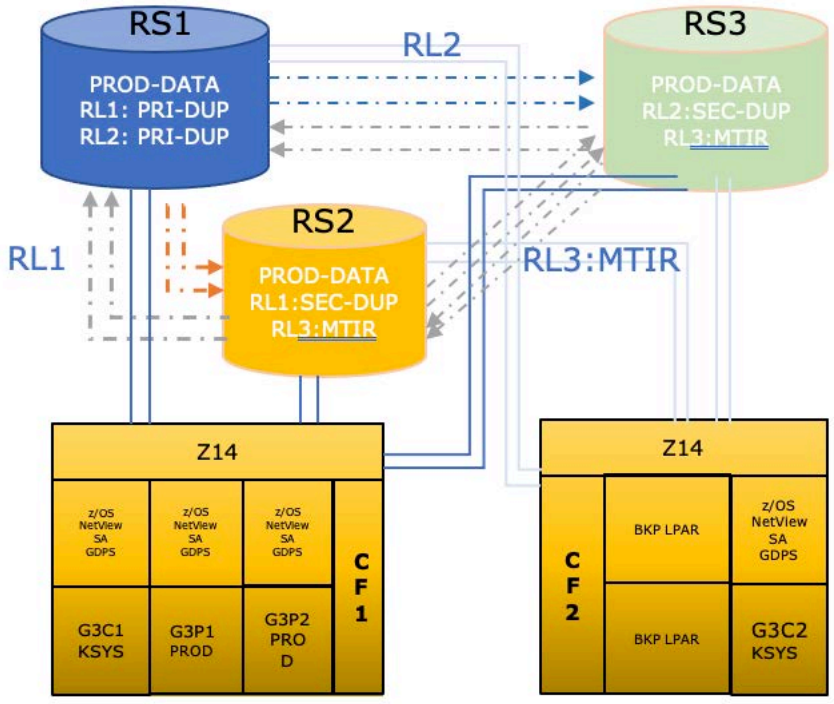
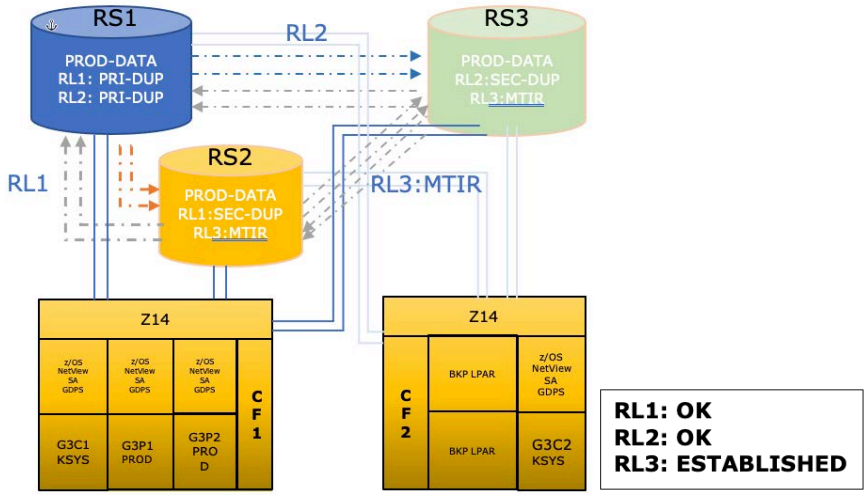


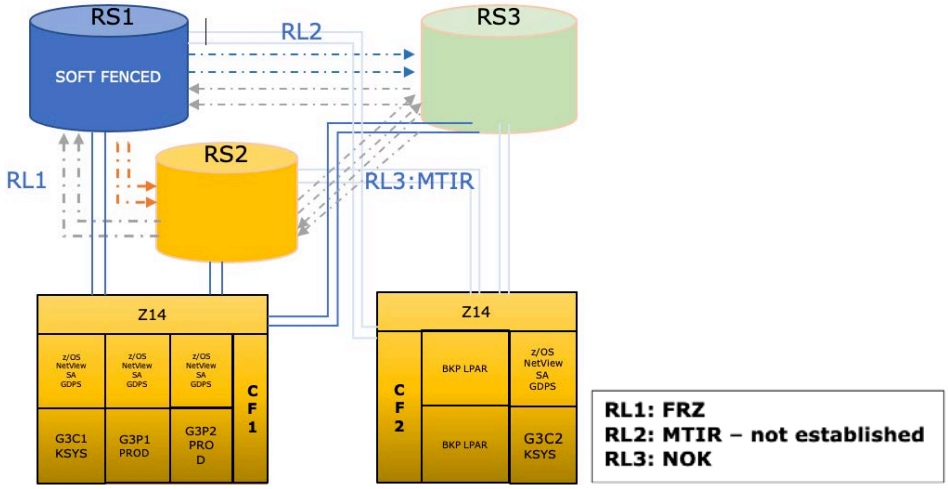
Figure 14 MTMM Setup of Replication Leg 3 for MTIR

It provides possibility to quickly resynch other leg in case of failure primary disks. Although Hitachi provide MTIR setup, and leg is established properly, use of MTIR leg resulted in full copy being performed every time. Bellow we provide example scenario with unplanned Hyperswap being performed using SETIOS HYPERSWAP command. Preferred Leg for Hyperswap was set on RL1.

Step0. Normal operation.



Step1. Issue command for unplanned Hyperswap over preferred leg (RL1)



After Hyperswap and failover of RS2 to become primary, RS1 devices being soft fenced for protection. RL1 (RS2->RS1) is being correctly freezed. Restarting replication on RL1 result in delta resynch using failback capability. RL3 which was established as MTIR leg, reports status NOK instead of FRZ. Start of replication on this leg resulted in full copy being performed.

UNIDIRECTIONAL LINKS

Hitachi VSP G/F1500 provided unidirectional FCP links for replication. To secure correct operation with Multi-Target Metro Mirror we provided separate links in each direction. This was represented in our GEOPARM configuration which we present bellow.

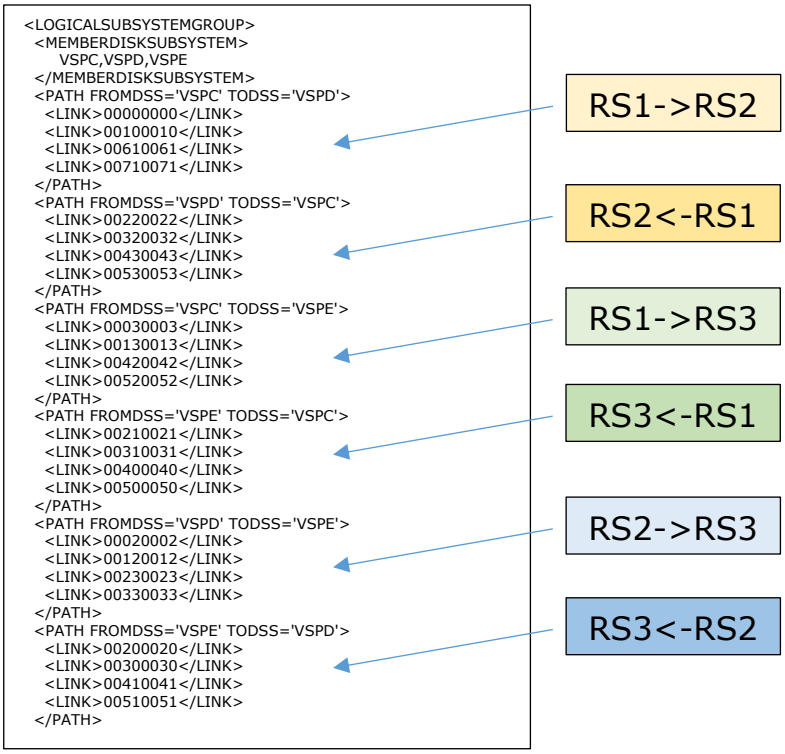


Figure 15. GEOPARM used in GDPS Metro DL for PATH definition

HEALTHCHECK

GDPS_CHECK_SPOF indicates a potentially false single point of failure on PPRC links adapter. This item has to be manually examined.

PSETCHAR – SET PPRC CHARACTERISTICS COMMAND

Although there was no Flashcopy tests during GDPS Metro DL qualification tests, Hitachi made a statement that RPFC is not supported in MTMM configuration at this time. GDPS by default setup a preferred RPFC leg. This results in SDF warning being issued about PSETCHAR command.

```
------------------------------------------------------------ Trace Entries -----------------
Time        Text
13:22:02  PSETCHAR 0C104 C01301 0022424 04 D01401 0023221 04 RESET      (13:22:02.272826)
13:22:02  PSETCHAR 0C204 RC=7944 REAS=00000014 (13:22:02.271652)
13:22:02  PSETCHAR 0C104 RC=7944 REAS=00000014 (13:22:02.272826)
```

Figure 16. SDF Trace entries with PSETCHAR warnings

Change of Preferred Hyperswap leg is connected with RPFC being set. To remove RPFC and connected with it PSETCHAR warning messages on SDF, DASD config is necessary to be performed. Before beginning config process, additional option has to be checked in panel C.D

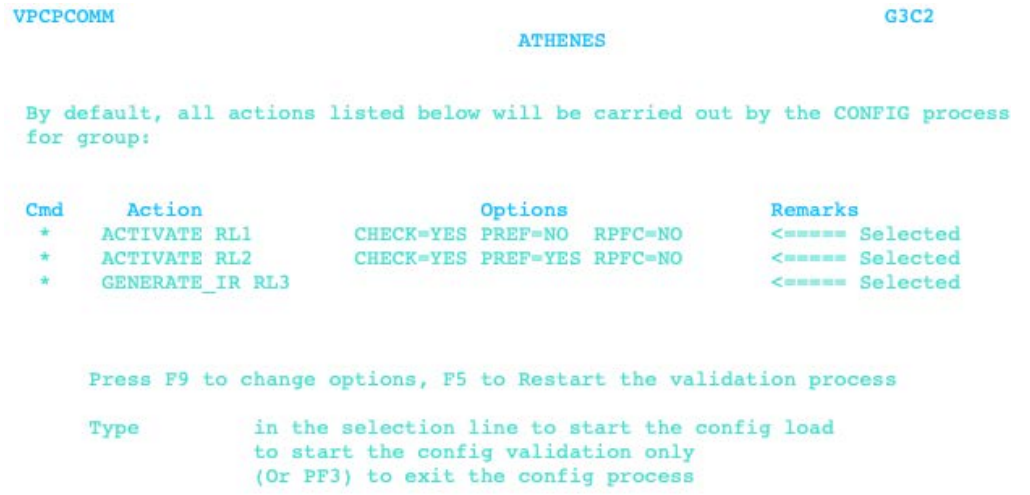


Figure 17. VPCPCOMM (Option C.D) panel

Press PF9 to change option and change RPFC to NO on all legs (as shown on figure 15). You can also set Preferred Hyperswap Leg over here if necessary.

Note

The following disk features implemented in GDPS Metro DL are not supported by the actual VSP G/F1500 microcode:
- XD mode copy processing (PPRC-XD Asynchronous protocol for initial copy and resynch)
- Summary Event Notification for PPRC Suspends (PPRCSUM)
- Non disruptive Set State
- Multi Target Incremental Resynch
- RPFC

GDPS Metro SL with HUR controlled by BCM test

SYSTEM CONFIGURATION

The configuration used for this test was a three site BC/DR solution: GDPS Metro SL Multi-site workload was configured for the BC between the two metropolitan distance sites, while BCM (Hitachi Business Continuity Manager) was configured to take care of the HUR (Hitachi Universal Replication) at longer distance. The objective of the exercise was to test the functionality of the VSP 5500 in a mixed synchronous Metro Mirror (controlled by GDPS Metro SL) and HUR (controlled by BCM) configuration. No attempt was made to optimize the configuration for throughput.

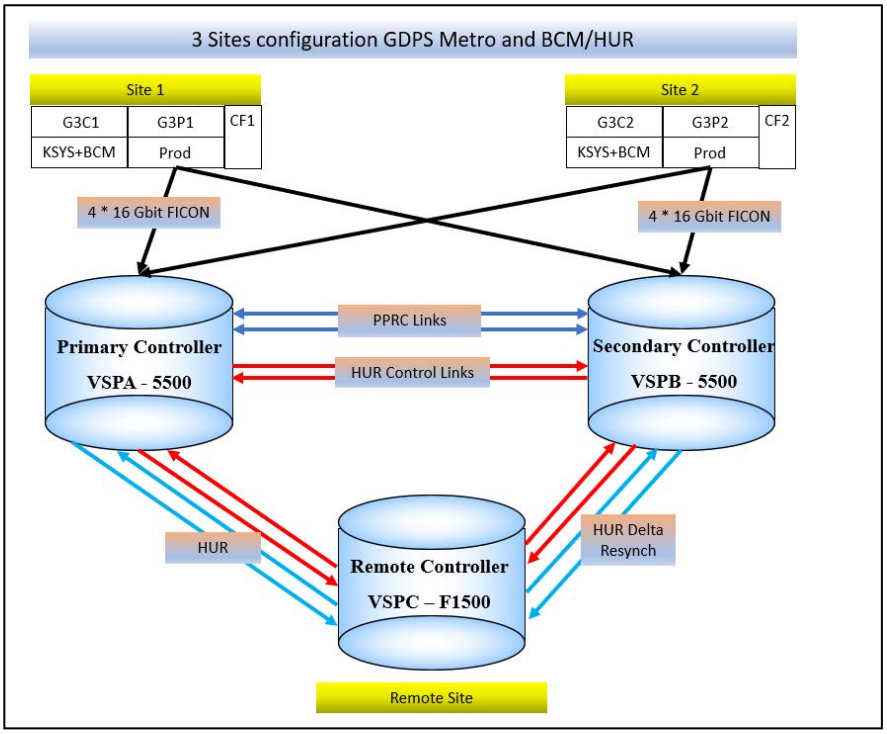


Figure 18 – Three sites GDPS Metro SL with BCM/HUR configuration

The Site 1 configuration is comprised of one Coupling facility (CF1), 1 production systems running z/OS (G3P1) and 1 GDPS Metro SL Controlling system (G3C1), which runs the BCM software. In Site 2 there is the GDPS Metro SL Controlling system (G3C2) that also hosts the BCM software, another Coupling facility (CF2) and the other production system running z/OS (G3P2). The G3C1, G3C2, G3P1 and G3P2 systems are in the same "Parallel SYSPLEX". In Site Remote there is one single system running in monoplex, and spare LPARs to host the production Parallel Sysplex when IPLed in recovery. All the data resides on the VSP 5500. All the production data, system and application, is PPRCed to the secondary VSP 5500 disk subsystem, and at the same time it's replicated asynchronously to the third site with the Hitachi UR (Universal Replicator). The "SYSPLEX" files (Couple Datasets - CDS) were allocated in

Site 1 and Site 2 disks, only the Logger CDS was mirrored. HUR makes use of "journal files" that are formatted on every VSP 5500 disk subsystems in Open mode; they are not known to the z/OS systems.

CODES LEVELS AND HARDWARE SETTINGS

- Storage : Hitachi Virtual Storage Platform 5500™ at code level 90-04-02.

  Hitachi VSP 5000 series has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS MM testing:

  114, 142, 459, 467, 484, 506, 598, 665, 784, 789, 790, 832, 867, 868, 872, 895, 896, 899, 976, 990, 995, 1005, 1022, 1061, 1068, 1086, 1099, 1115, 1169, 1175

  Mode 114: This mode allows the system to automatically change the direction of the METRO MIRROR links and allows dynamic port mode setting (RCP/LCP for serial, Initiator/RCU target for fiber-channel) through PPRC CESTPATH and CDELPATH commands. This mode is required in a GDPS MM environment.

  Mode 484: Displaying PPRC path QUERY information in the FC interface format. When using the IBM host functions (PPRC, GDPS etc.), mode 484 can be set for displaying the PPRC path QUERY information in the FC interface format. This mode is required in a GDPS MM environment.

- Remote Site Storage : Hitachi Virtual Storage Platform F1500™ at code level 80-06-78.

  Hitachi VSP F1500 has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS MM testing:

  114, 142, 449, 467, 484, 506, 530, 598, 664, 665, 784, 867, 872, 895, 896, 976, 990, 1015, 1022, 1061, 1068, 1086, 1172

- Software levels:
  - z/OS V2.04 April 2020
  - Tivoli Netview for z/OS V6.R3
  - System Automation for z/OS V4.R1
  - GDPS Metro V4.R3.M2
  - Hitachi BCM 9.2

Note *Levels indicated here are those that were already installed in the GDPS lab and were not imposed by these qualification tests.*

- GEOPLEX Options used in option XML file. All missing values are left as default.

OPTIONS	Defaulted	Default value	Value used
CONTROLLING SYSTEMS	NO	1	2
FCTIMEOUT	YES	5	20
FREEZESCOPE	YES	GROUP	GROUP
FRTIMEOUT	YES	01:00:00	01:00:00
MASTER	NO		G3C2 G3C1 G3P2 G3P1
PROCOPTS	YES	INTERNAL2	INTERNAL2
TOPOLOGY	NO		MM2SITE
MM2SITE	NO		HM(NO), MTFO(YES)

- Disk subsystem layout

Each HITACHI VSP 5000 was configured with 3390 devices across 19 LSS and all LSS have HyperPAV UCBs defined and all the volumes were defined as HDP (Hitachi thin provisioning devices):

- 1 LSS dedicated to the infrastructure devices (z/OS Production System disks)
- 4 LSS for data and work areas
- 4 LSS reserved for FlashCopy
- 4 LSS reserved for Space Efficient FlashCopy
- 6 LSS with 10 EAV Mod.100 each; first three LSSes are for data and next three were for FlashCopy

The final disk layout is as follows:

VSP-A (5500) Site 1 S/N 30849 IP: 10.3.98.1

SSID		LCU	Mod.	UCB	PAV	Link
G3C1	A001	00	9	A000-A03F	A0C0-A0FF	98.11.82 F0.12.86
GDPCOM & CDS	A001	00	27	A040-A04F	A0C0-A0FF	98/99.11.82 F0/F1.12.86
Prod	A011	01	27	A100-A13F	A1C0-A1FF	98/99.11.83 F0/F1.12.88
Prim	A021	02	27	A200-A23F	A2C0-A2FF	98/99.11.9A F0/F1.12.8A
	A031	03	27	A300-A33F	A3C0-A3FF	98/99.11.9A F0/F1.12.8A
	A041	04	27	A400-A43F	A4C0-A4FF	98/99.11.9A F0/F1.12.8A
FC	A051	05	27	A500-A53F	A5C0-A5FF	98/99.11.9A F0/F1.12.8A
	A061	06	27	A600-A63F	A6C0-A6FF	98/99.11.9A F0/F1.12.8A
	A071	07	27	A700-A73F	A7C0-A7FF	98/99.11.9A F0/F1.12.8A
	A081	08	27	A800-A83F	A8C0-A8FF	98/99.11.9A F0/F1.12.8A
SEFC	A091	09	27	A900-A93F	A9C0-A9FF	98/99.11.9B F0/F1.12.63
	A0A1	0A	27	AA00-AA3F	AAC0-AAFF	98/99.11.9B F0/F1.12.63
	A0B1	0B	27	AB00-AB3F	ABC0-ABFF	98/99.11.9B F0/F1.12.63
	A0C1	0C	27	AC00-AC3F	ACC0-ACFF	98/99.11.9B F0/F1.12.63
EAV	A0D1	0D	100	AD00-AD09	ADC0-ADFF	98/99.11.9B F0/F1.12.63
	A0E1	0E	100	AE00-AE09	AEC0-AEFF	98/99.11.9B F0/F1.12.63
	A0F1	0F	100	AF00-AF09	AFC0-AFFF	98/99.11.9B F0/F1.12.63
	A101	10	100	E000-E009	E0C0-E0FF	98/99.11.9B F0/F1.12.63
	A111	11	100	E100-E109	E1C0-E1FF	98/99.11.9B F0/F1.12.63
	A121	12	100	E200-E209	E2C0-E2FF	98/99.11.9B F0/F1.12.63

VSP-B (5500) Site 2 S/N 30865 IP: 10.3.98.2

SSID		LCU	Mod.	UCB	PAV	LINK
G3C2	B002	00	27	B000-B01F	B0C0-B0FF	98.11.80 F0.12.80
	B002	00	9	B000-B03F	B0C0-B0FF	98.11.80 F0.12.80
CDS	B002	00	27	B040-B04F	B0C0-B0FF	98/99.11.80 F0/F1.12.80
Prod	B012	01	27	B100-B13F	B1C0-B1FF	98/99.11.81 F0/F1.12.81
Prim	B022	02	27	B200-B23F	B2C0-B2FF	98/99.11.98 F0/F1.12.98
	B032	03	27	B300-B33F	B3C0-B3FF	98/99.11.98 F0/F1.12.98
	B042	04	27	B400-B43F	B4C0-B4FF	98/99.11.98 F0/F1.12.98
FC	B052	05	27	B500-B53F	B5C0-B5FF	98/99.11.98 F0/F1.12.98
	B062	06	27	B600-B63F	B6C0-B6FF	98/99.11.98 F0/F1.12.98
	B072	07	27	B700-B73F	B7C0-B7FF	98/99.11.98 F0/F1.12.98
	B082	08	27	B800-B83F	B8C0-B8FF	98/99.11.98 F0/F1.12.98
SEFC	B092	09	27	B900-B93F	B9C0-B9FF	98/99.11.99 F0/F1.12.89
	B0A2	0A	27	BA00-BA3F	BAC0-BAFF	98/99.11.99 F0/F1.12.89
	B0B2	0B	27	BB00-BB3F	BBC0-BBFF	98/99.11.99 F0/F1.12.89
	B0C2	0C	27	BC00-BC3F	BCC0-BCFF	98/99.11.99 F0/F1.12.89
EAV	B0D2	0D	100	BD00-BD09	BDC0-BDFF	98/99.11.99 F0/F1.12.89
	B0E2	0E	100	BE00-BE09	BEC0-BEFF	98/99.11.99 F0/F1.12.89
	B0F2	0F	100	BF00-BF09	BFC0-BFFF	98/99.11.99 F0/F1.12.89
	B102	10	100	E300-E309	E3C0-E3FF	98/99.11.99 F0/F1.12.89
	B112	11	100	E400-E409	E4C0-E4FF	98/99.11.99 F0/F1.12.89
	B122	12	100	E500-E509	E5C0-E5FF	98/99.11.99 F0/F1.12.89

Figure 19 – Metro Mirror DASD layout

Under GDPS®, the Remote Copy page shows the following configuration:

```
VPCPQSTE  Mirroring Status: OK        Monitor2 Time:01:00:00          G3C2
          Primary Site: ATH.MOP1      Soft Fenced  NONE
 Actions: Q ueryPath Z QueryReverse V iew devices X ceptions D elpath E stpath
          S econdary
 Group: LEGACY.LEGACY      Type: CKD     Leg: RL1     Device Pairs:126
      Primary       ->     Secondary         PRI  -  SEC
  Serial LSS SSID        Serial LSS SSID    Util. Devices    Links    Pairs
_ 0030849 01 A011   ->  0030865 01 B012    0A13D - 0B13D     4/4       63
_ 0030849 02 A021   ->  0030865 02 B022    0A23F - 0B23F     4/4       63
_ 0030849 03 A031   ->  0030865 03 B032    0A23F - 0B33F     4/4       63
_ 0030849 04 A041   ->  0030865 04 B042    0A23F - 0B43F     4/4       63
_ 0030849 0D A0D1   ->  0030865 0D B0D2    0AD09 - 0BD09     4/4       9
_ 0030849 0E A0E1   ->  0030865 0E B0E2    0AE09 - 0BE09     4/4       9
_ 0030849 0F A0F1   ->  0030865 0F B0F2    0AF09 - 0BF09     4/4       9
_ 0030849 10 A101   ->  0030865 10 B102    0A309 - 0B309     4/4       9
_ 0030849 11 A111   ->  0030865 11 B112    0A409 - 0B409     4/4       9
_ 0030849 12 A121   ->  0030865 12 B122    0A509 - 0B509     4/4       9



1 Epair 2 Dpair 3 Suspend 4 Resynch 5 Monitor2 6 Q Paths 7 Epath 8 Dpath
11 Find
Selection ===>
  F1=Help   F3=Return    F6=Roll   F7=Up   F8=Down   F9=Toggle
```

Figure 20 - GDPS Metro SL LSS configuration

SCENARIOS CHECKED

All the test scenarios executed were "DASD-Oriented". Scenarios specifically geared towards "SYSPLEX" events or designed to test server management aspects of GDPS were removed.

G. *Basic test:*

- Use all GDPS Metro SL Remote copy options with the full configuration loaded.

```
VPCPQSH2  Mirroring Status: OK  Group: LEGACY.LEGACY     Type: CKD   G3C2
Actions:  D elpair  E stpair  S uspend  Y RecSec  R esynch  Q uery
          QO Query Online
Leg: RL1  Pair: 0022424 01 C013 -> 0023221 01 D014 Count: 63  Scope:  All
_ 0A100  0B100 DUP        _ 0A110  0B110 DUP        _ 0A120  0B120 DUP
_ 0A101  0D101 DUP        _ 0A111  0B111 DUP        _ 0A121  0B121 DUP
_ 0A102  0D102 DUP        _ 0A112  0B112 DUP        _ 0A122  0B122 DUP
_ 0A103  0D103 DUP        _ 0A113  0B113 DUP        _ 0A123  0B123 DUP
_ 0A104  0D104 DUP        _ 0A114  0B114 DUP        _ 0A124  0B124 DUP
_ 0A105  0D105 DUP        _ 0A115  0B115 DUP        _ 0A125  0B125 DUP
_ 0A106  0D106 DUP        _ 0A116  0B116 DUP        _ 0A126  0B126 DUP
_ 0A107  0D107 DUP        _ 0A117  0B117 DUP        _ 0A127  0B127 DUP
_ 0A108  0D108 DUP        _ 0A118  0B118 DUP        _ 0A128  0B128 DUP
_ 0A109  0D109 DUP        _ 0A119  0B119 DUP        _ 0A129  0B129 DUP
_ 0A10A  0D10A DUP        _ 0A11A  0B11A DUP        _ 0A12A  0B12A DUP
_ 0A10B  0D10B DUP        _ 0A11B  0B11B DUP        _ 0A12B  0B12B DUP
_ 0A10C  0D10C DUP        _ 0A11C  0B11C DUP        _ 0A12C  0B12C DUP
_ 0A10D  0D10D DUP        _ 0A11D  0B11D DUP        _ 0A12D  0B12D DUP
_ 0A10E  0D10E DUP        _ 0A11E  0B11E DUP        _ 0A12E  0B12E DUP
_ 0A10F  0D10F DUP        _ 0A11F  0B11F DUP        _ 0A12F  0B12F DUP
1 Estpair 2 Delpair 3 Suspend 4 Resynch 5 Query 6 RecSec 7 All 8 Exceptions
11 VOLSERs
Selection ===>
  F1=Help   F3=Return    F6=Roll   F7=Up   F8=Down   F9=Toggle  F10=CCA
```

Figure 21 - LSS volume list panel

- Generate a variety of freeze events (Either through commands or via hardware event triggers).

Note Alternate tests were performed using the different policy options available:
- **PRIMARYFAILURE=SWAP,GO or SWAP,STOP**
- **PPRCFAILURE=GO or COND or STOP**

Under BCM, the Manage Copy Groups panel shows the two available Copy Groups:

- HUR.S1TORM representing the HUR from Site 1 to Site Remote disks with multiple consistency groups
- HUR.S2TORM representing the HUR Delta Resynch ready from Site 2 to Site Remote disks with extended consistency groups enabled

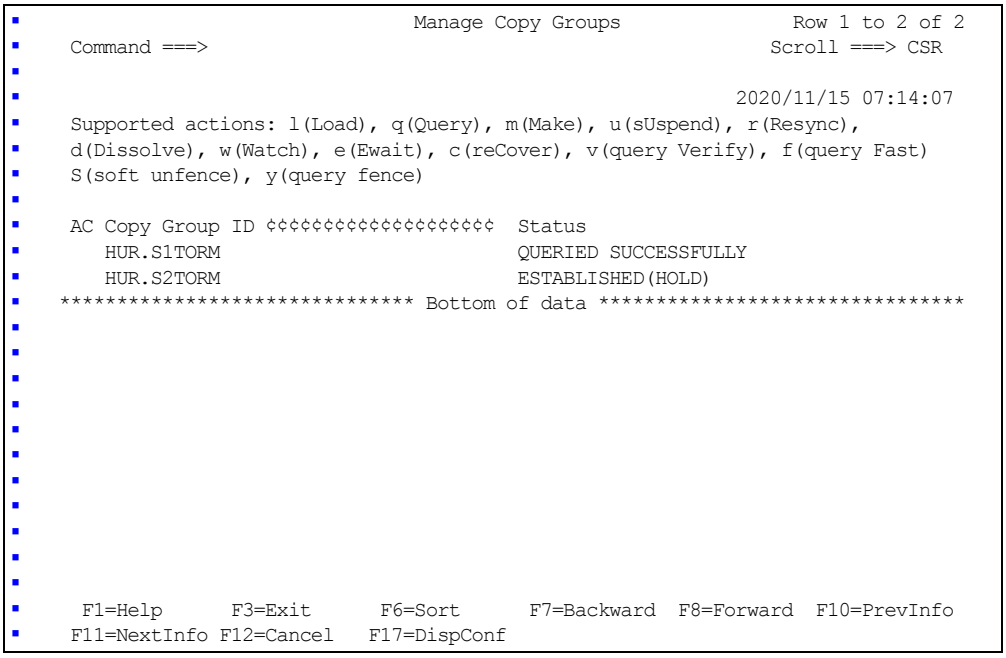


Figure 22 – BCM Manage Copy Groups panel

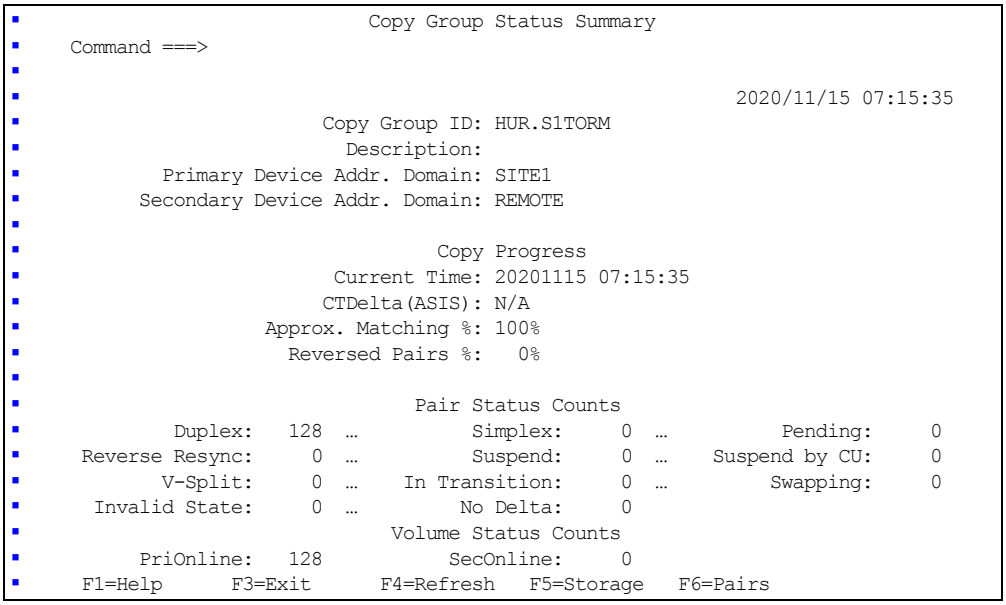


Figure 23 – BCM Query a Copy Groups panel

Under BCM, the Copy Group panel for HUR.S1TORM shows all of the HUR pairs available and their status, a Query gives more details on any single pair.

```
                              Copy Group Pair Status          Row 62 to 70 of 128
   Command ===>                                                Scroll ===> CSR

                                                            2020/11/15 07:16:32
   Supported actions: q(Qrydev), m(Make), u(sUspend), r(Resync), d(Dissolve),
   c(reCover), p(query Path)

   Copy Group ID . . : HUR.S1TORM
   Description . . . :
   Status Time . . . : 20201115 07:15:35

       C/T ID          Match CT Delta            Pri  E     Sec  E AC Result
   AC     sub State    Rate% DDD HH:MM:SS VOLSER Devn X Dir Devn X Action   RC
       00 00  DUPLEX   100                       A13D -  >  C13D -
       00 00  DUPLEX   100                       A13E -  >  C13E -
       00 00  DUPLEX   100                       A13F -  >  C13F -
       01 01  DUPLEX   100                       A200 -  >  C200 -
       01 01  DUPLEX   100                       A201 -  >  C201 -
       01 01  DUPLEX   100                       A202 -  >  C202 -
       01 01  DUPLEX   100                       A203 -  >  C203 -
       01 01  DUPLEX   100                       A204 -  >  C204 -
       01 01  DUPLEX   100                       A205 -  >  C205 -
    F1=Help      F3=Exit      F4=Refresh   F6=Sort      F7=Backward  F8=Forward
```

Figure 24 – BCM Query pairs Copy Groups panel

```
                          Volume Query Information (UR)          Row 1 to 2 of 2
   Command ===>                                                 Scroll ===> CSR

                                                            2020/11/15 07:17:32
   Copy Group ID . . . . . . . . . : HUR.S1TORM
   Copy Type(in Configuration): UR    Copy Type(from Storage): UR
   ---------- Primary Volume ----------     --------- Secondary Volume ---------
   SN    SSID CU CCA DEVN  Status       Dir  SN    SSID CU CCA DEVN  Status
   30849 A021 02 3D  A23D* DUPLEX (02)   >   22424 C023 02 3D  C23D* DUPLEX (02)

   Consistency Time (GMT) : 20201115 06:17:32.894068
                  (LOCAL) : 20201115 07:17:32.894068
   EXCTG ID (F,R): 0 , N/A (in Configuration) 0 , N/A (from Storage System)
   EXCTG(F-R): active(0,0) - N/A(N,0)
   C/T  ID  ERROR LVL  TIMER TYPE(F-R)  PROT MODE  Path ID
   00   00  GROUP      SYSTEM - SYSTEM  PROTECT    00
   01   01  GROUP      SYSTEM - SYSTEM  PROTECT    00
   Other CopyPair Information
              ------ Primary/Secondary ------       ------ Pair Volume ------
   Type C/T ID     SN    DEVN  Status         Dir   SN     SSID  CU  CCA  DEVN
   TC          Pri 30849 A23D* DUPLEX (02)     >    30865  B022  02  3D   N/A
   UR   00  00 Sec 22424 C23D- HOLD (70)       <    30865  B022  02  3D   N/A
   ****************************** Bottom of data ******************************

    F1=Help      F3=Exit      F4=Refresh   F7=Backward  F8=Forward
```

Figure 25 – BCM Volume Query Information Panel

SCENARIOS CHECKED

All the test scenarios executed were "DASD-Oriented".

A. *Regression Test:*

- Basic GDPS Metro SL testing to verify there are no unexpected impacts due to HUR; use all GDPS Metro SL Remote copy options with the full configuration loaded
  - Add / Delete pairs
  - Suspend / Resynch pairs
  - Stop / Start secondary
  - Managing FlashCopy
  - Changing the Config (add/delete LSS from the GEOPARM)
  - run MON I, II and III

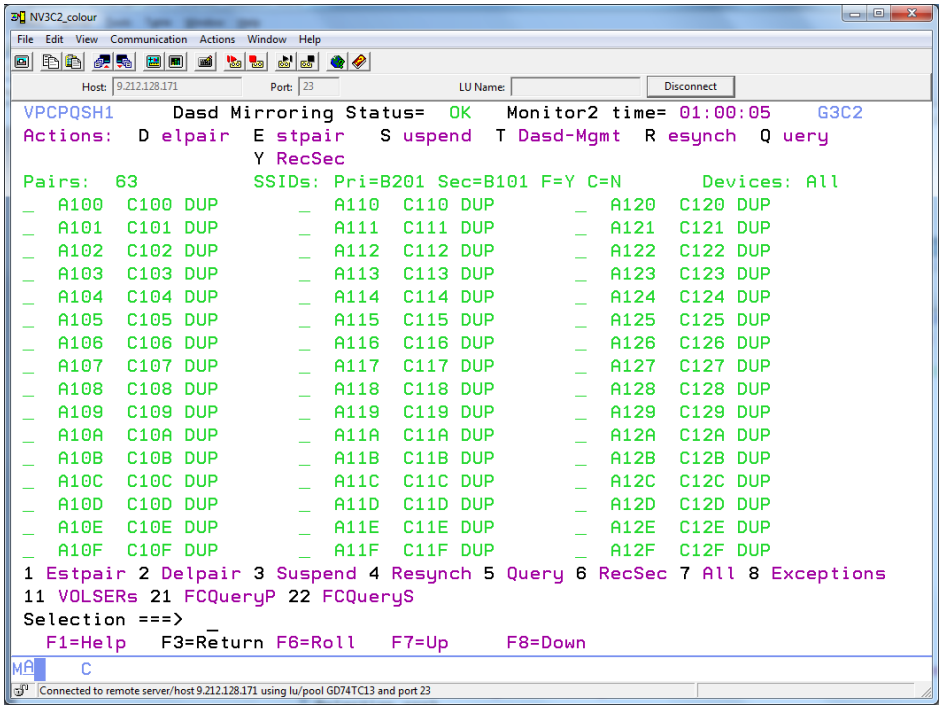


Figure 26 - LSS volume list panel

Note *All the tests, Regression, Planned Actions, and Unplanned Actions, were performed using the following policy option:*
- PRIMARYFAILURE= SWAP,GO
- PPRCFAILURE= GO
Note *During the HUR initial copy time window HyperSwap is enabled, but if a PPRC pair is suspended, in order to resync it one need to suspend HUR initial copy, resync PPRC pairs and resume HUR initial copy.*

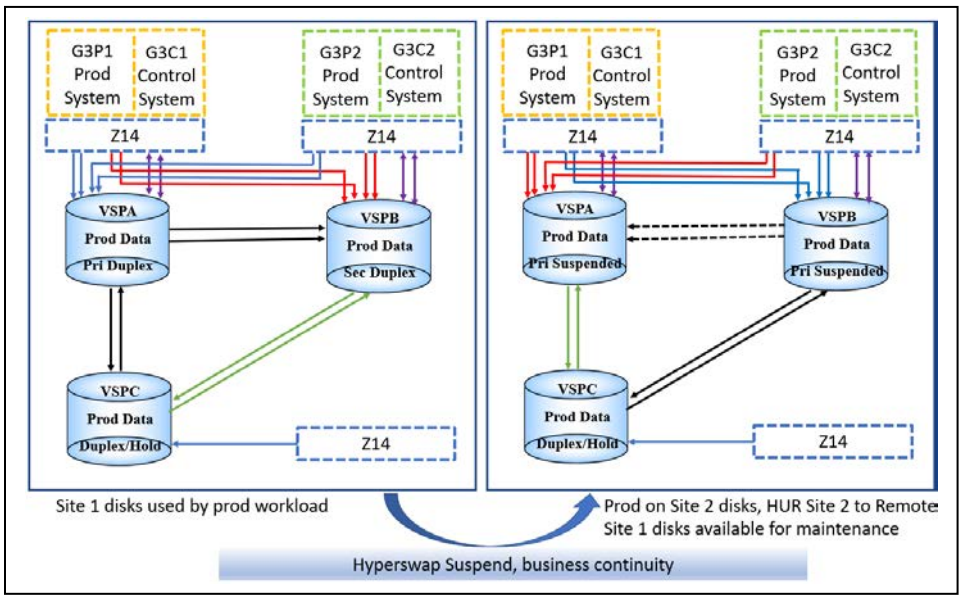
B. *Planned actions:*

- Site 1 disks maintenance.
  - Simulation of disruptive disk maintenance in Site 1 by the following steps. Stopping the application workload was not required.
  - Suspend Purge HUR 'Site 1 to Remote).
  - Planned Hyperswap (Site 1 to Site 2).
  - Delta Resync Site 2 to Remote).
  - Perform P site maintenance. (Power cycle the DKC in the P site)
  - Start Secondary after Primary recovered.

Note

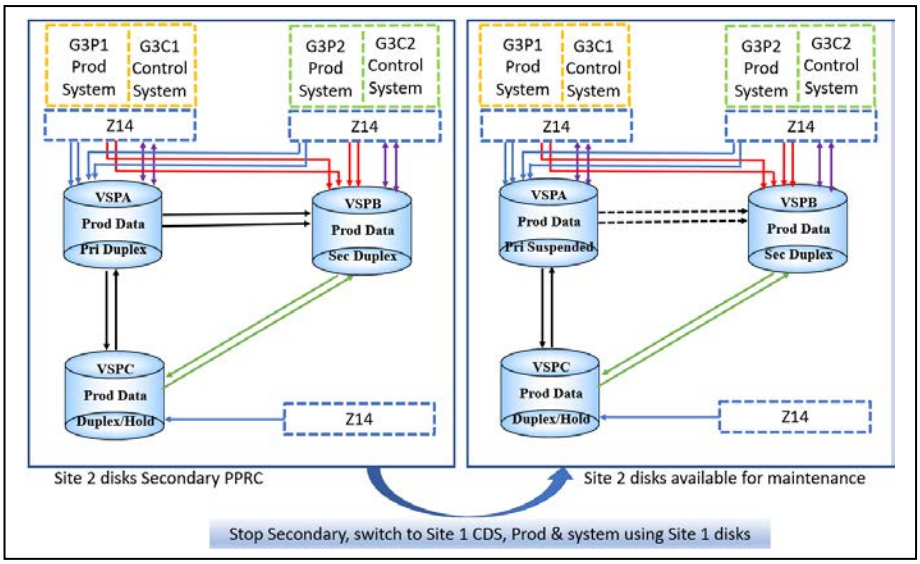
HyperSwap Resynch is not allowed in a three sites configuration

---



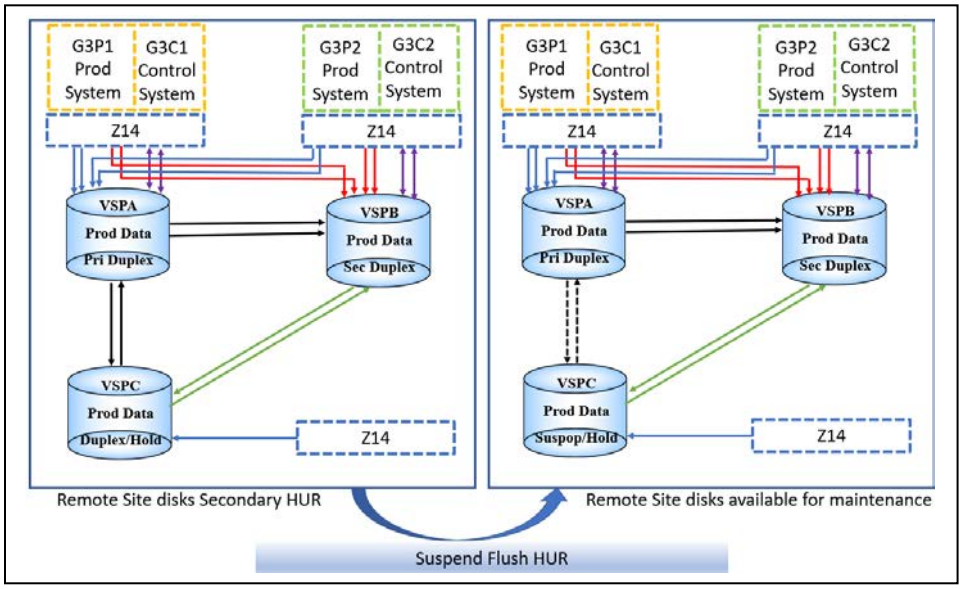
Returning back to Site 1 disks using the same procedure (without power cycle) used to move workload from site 1 to site 2. Stopping the workload was not required.

- Site 2 disks maintenance.
  Simulation of disruptive disk maintenance in Site 2 by suspending the PPRC replica from Site 1 to Site 2 disks. No impact on the application systems running on Site 1 disks and on the HUR replica from Site 1 to Site Remote disks.



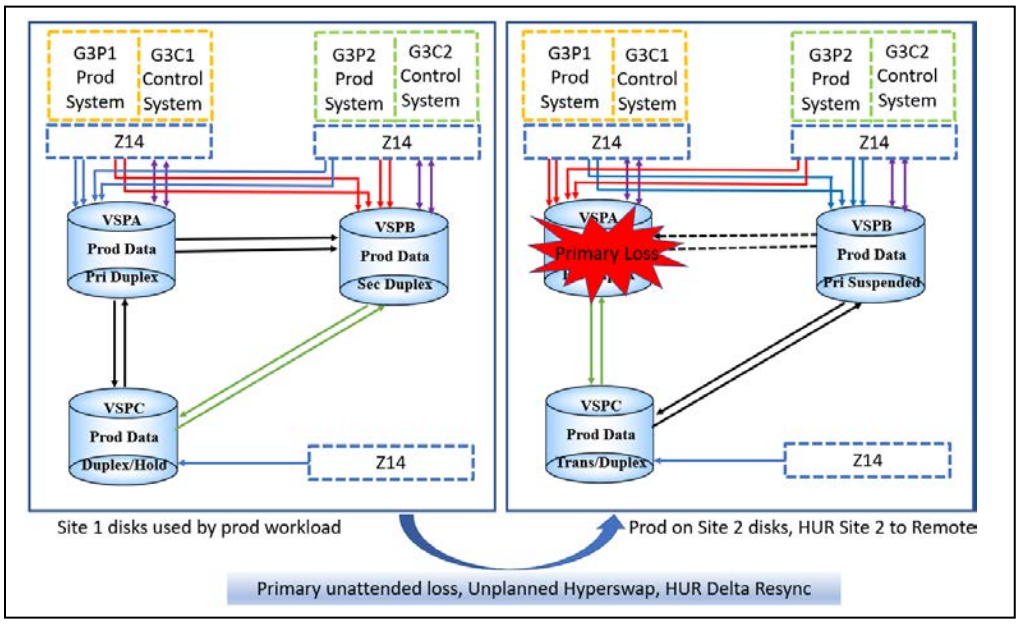
Back to normal resynching Site 1 to Site 2 disks with a Start Secondary from GDPS Metro SL.

- Site Remote disks maintenance.
  Simulation of disruptive disk maintenance in Site Remote by suspending the HUR replica from Site 1 to Site Remote disks (Suspend Flush). No impact on the application systems running on Site 1 disks and on the PPRC replica from Site 1 to Site 2 disks.



Back to normal resynching the HUR from Site 1 to Site Remote disks.

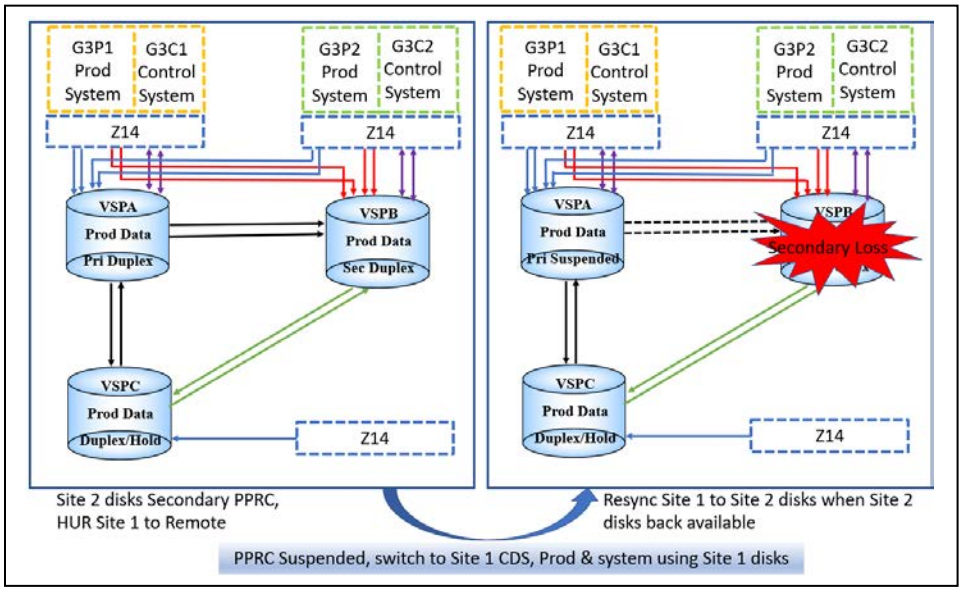
- ***Unplanned actions:***
- Site 1 disks failure.
  - Simulation of disk failure in Site 1 by the following steps. Stopping the application workload was not required.
  - Unplanned Hyperswap.
  - Suspend Purge HUR Site 1 to Remote.
  - Delta Resync Site 2 to Remote.
  - Start Secondary Site 2 to Site 1 when issue fixed on Site 1.



Returning back to Site 1 after Site 2 to Site 1 disks are Duplex (after GDPS Metro SL Start Secondary command has been issued) using the same procedure used to '**Site 1 disks maintenance'**. Stopping the workload was not required.

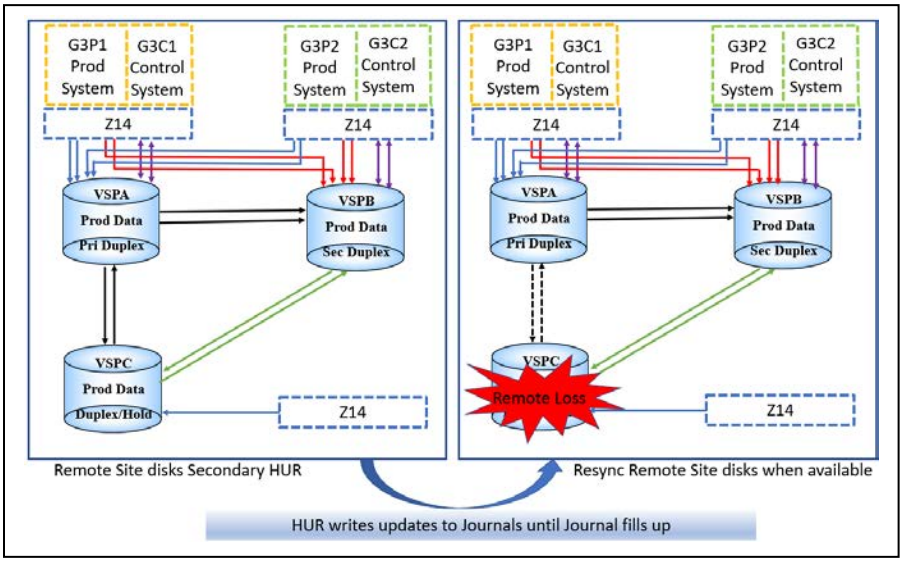
- Site 2 disk failure.

The PPRC replica from Site 1 to Site 2 disks is suspended. No impact on the application systems running on Site 1 disks and on the HUR replica from Site 1 to Site Remote disks.



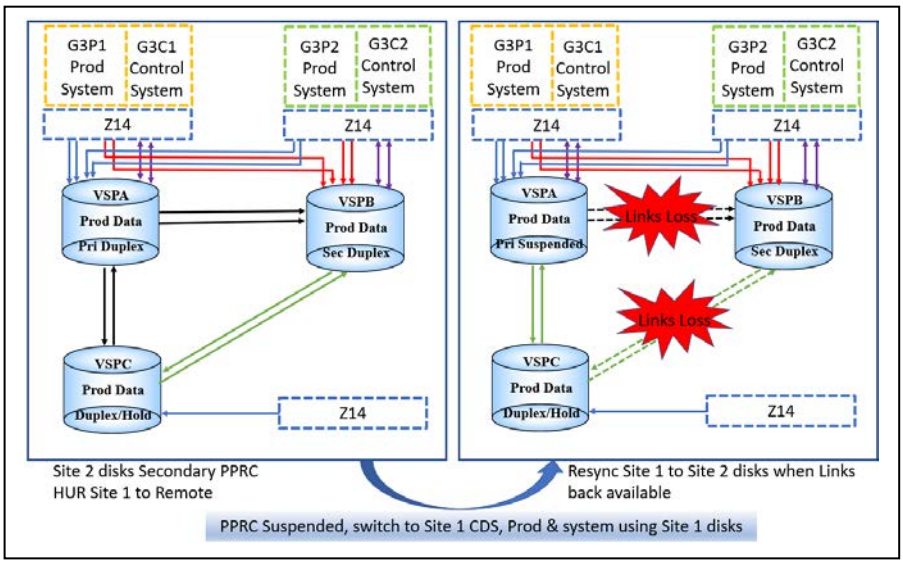
Returning to normal with a GDPS Metro SL Start Secondary to resynch Site 1 to Site 2 disks.

- Site Remote disks failure.
  The HUR continues writing to the Site 1 journal until it fills up, then eventually goes in track mode using bitmap. No impact on the application systems running on Site 1 disks and on the PPRC replica from Site 1 to Site 2 disks.



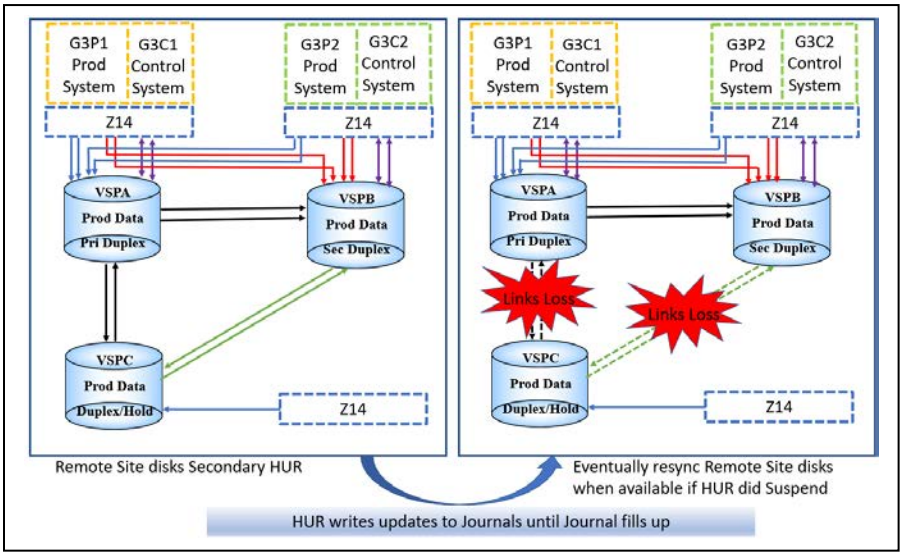
Returning to normal: when Site Remote disk is back available the HUR Copy Group from Site 1 to Site Remote appears as SUSPENDED-CU, from BCM in Site 1 resynch HUR Site 1 to Site Remote disks and wait for them to be back DUPLEX.

- Site 1 to Site 2 PPRC and DR (Delta Resynch) links failure.
  The PPRC replica from Site 1 to Site 2 disks is suspended. No impact on the application systems running on Site 1 disks and on the HUR replica from Site 1 to Site Remote disks.



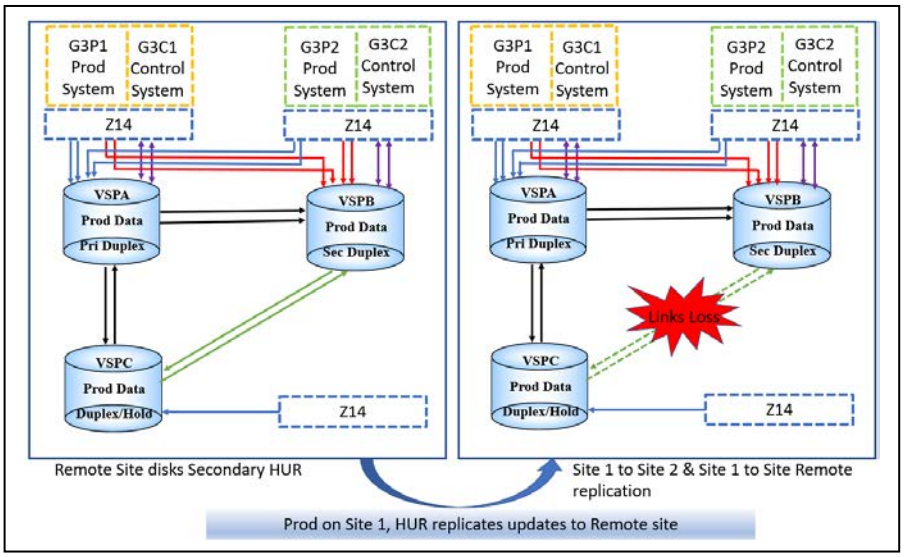
- Returning to normal with a GDPS Metro SL Start Secondary to resynch Site 1 to Site 2 disks.
  The scenario is similar to the Site 2 disks failure.

- Site 1 to Site Remote HUR and DR links failure.
  The HUR continues writing to the Site 1 journal until it fills up, then eventually goes in track mode; no impact on the application systems running on Site 1 disks and on the PPRC replica from Site 1 to Site 2 disks.



- Returning to normal without or with a BCM resynch (should journal being full and HUR did suspend) of the HUR from Site 1 to Site Remote disks. The scenario is similar to the Site Remote disks failure.

- Site 2 to Site Remote HUR links failure.
  No impact on the application systems running on Site 1 disks, on the PPRC replica from Site 1 to Site 2 disks, nor on the HUR replica from Site1 to Site Remote disks. When the links are back to normal the configuration will be back capable of a Delta Resynch in case of Site 1 disk failure.



GDPS Metro SL with HUR controlled by BCM test results

All the scenarios described have been successfully run, all the data resynchronizations were incremental. All the tests were performed with a single consistency group. In addition, the planned Hyperswap scenarios were also performed with extended consistency groups (EXCTG).

GDPS Metro DL with HUR controlled by BCM test

SYSTEM CONFIGURATION

The configuration used for this test was a four site BC/DR solution: GDPS Metro DL Single-site workload was configured for the BC between the two metropolitan distance sites, while BCM (Hitachi Business Continuity Manager) was configured to take care of the HUR (Hitachi Universal Replication) at longer distance. The objective of the exercise was to test the functionality of the VSP F1500 in a mixed synchronous PPRC (controlled by GDPS Metro DL) and HUR (controlled by BCM) configuration. No attempt was made to optimize the configuration for throughput.

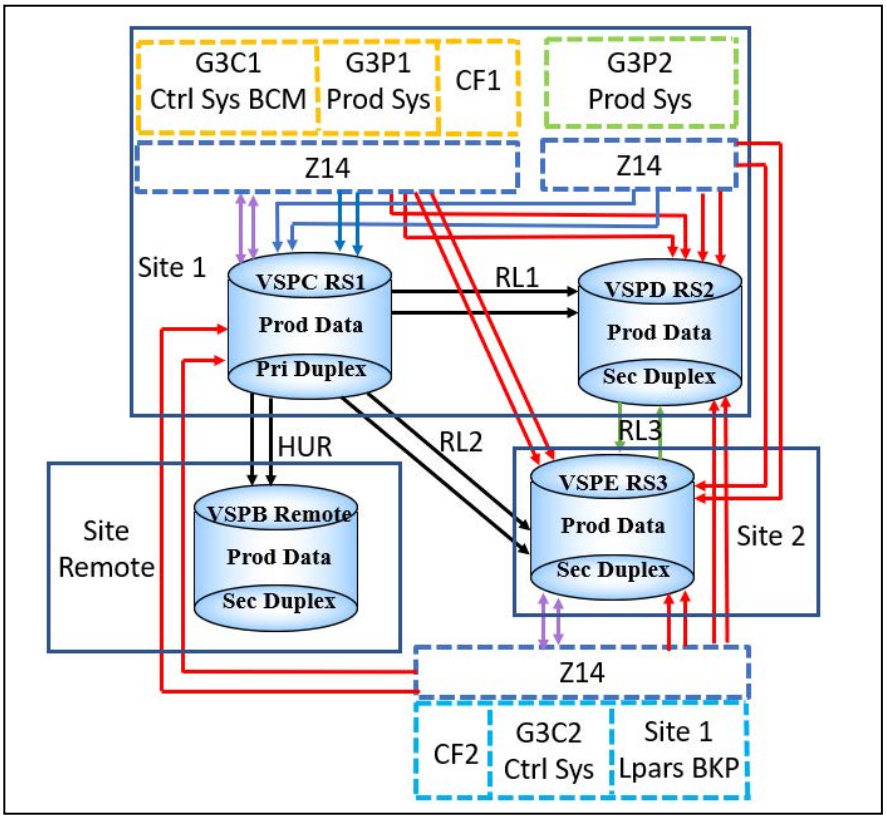


Figure 27 – Three sites GDPS Metro DL with BCM/HUR configuration

The Site 1 configuration is comprised of one coupling facility (CF1), an alternate GDPS Metro DL controlling system (G3C1) and 2 production system running z/OS (G3P1, G3P2). In Site 2 there is the GDPS Metro controlling system (G3C2), another coupling facility (CF2) and spare LPARs to host the Site 1 systems in case of need. The G3C1, G3C2, G3P1 and G3P2 systems are in the same "Parallel SYSPLEX". The Production systems run with their system and application data residing on the VSP F1500, while the Controlling systems were residing on non-mirrored LSS within the VSP F1500 (RS1). All the production data, system and application, is METRO MIRRORed using Multi-Target Metro Mirror technology to the secondary VSP F1500 disk subsystem (RS2). Additional replication leg is set between RS1 and third VSP F1500 disk subsystem (RS3). The "SYSPLEX" files (Couple Datasets - CDS) were allocated in the three sites but only the Logger CDS was mirrored. Non mirrored CDSes are replicated by system. Flashcopy was not tested in this qualification so there was no configuration for it in this environment. All the production data, system and application, is PPRCed to the two secondary VSP F1500 disk subsystem, and at the same time it's replicated asynchronously to the third site with the Hitachi UR (Universal Replicator) to a VSP 5500. The "SYSPLEX" files (Couple Datasets - CDS) were allocated in Site 1, Site 2 and Site 3 disks, only the Logger CDS was mirrored. HUR makes use of "journal files" that are formatted on site 1 VSP F1500 disk subsystems and remote VSP 5500 disk subsystem in Open mode; they are not known to the z/OS systems.

CODES LEVELS AND HARDWARE SETTINGS

- Storage Site 1/2/3: Hitachi Virtual Storage Platform F1500 at code level 80-06-81.

  Hitachi VSP F1500 has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS MM testing:

  114, 142, 449, 467, 484, 506, 530, 598, 664, 665, 784, 867, 872, 895, 896, 976, 990, 995, 1005, 1015, 1022, 1050, 1061, 1068, 1086, 1099, 1172

  Mode 114: This mode allows the system to automatically change the direction of the METRO MIRROR links and allows dynamic port mode setting (RCP/LCP for serial, Initiator/RCU target for fiber-channel) through PPRC CESTPATH and CDELPATH commands. This mode is required in a GDPS MM environment.

  Mode 484: Displaying PPRC path QUERY information in the FC interface format. When using the IBM host functions (PPRC, GDPS etc.), mode 484 can be set for displaying the PPRC path QUERY information in the FC interface format. This mode is required in a GDPS MM environment.

- Storage Remote : Hitachi Virtual Storage Platform 5500™ at code level 90-04-02.

Hitachi VSP 5000 series has various options which may be set depending on the environment in which it is used. The following system options were set for the GDPS MM testing:

114, 114, 142, 459, 467, 484, 506, 598, 665, 784, 789, 790, 832, 867, 868, 872, 895, 896, 899, 976, 990, 995, 1005, 1022, 1061, 1068, 1086, 1099, 1115, 1169, 1175

- Software levels:
  - z/OS V2.04 April 2020
  - Tivoli Netview for z/OS V6.R3
  - System Automation for z/OS V4.R1
  - GDPS Metro V4.R3.M2
  - Hitachi BCM 9.3

Note

Levels indicated here are those that were already installed in the GDPS lab and were not imposed by these qualification tests.

- GEOPLEX Options used in option XML file. All missing values are left as default.

OPTIONS	Defaulted	Default value	Value used
CONTROLLING SYSTEMS	NO	1	2
FCTIMEOUT	YES	5	20
FREEZESCOPE	YES	GROUP	GROUP
FRTIMEOUT	YES	01:00:00	01:00:00
MASTER	NO		G3C2 G3C1 G3P2 G3P1
PROCOPTS	YES	INTERNAL2	INTERNAL2
TOPOLOGY	NO		MM3SITE
MM2SITE	NO		MTFO(YES)

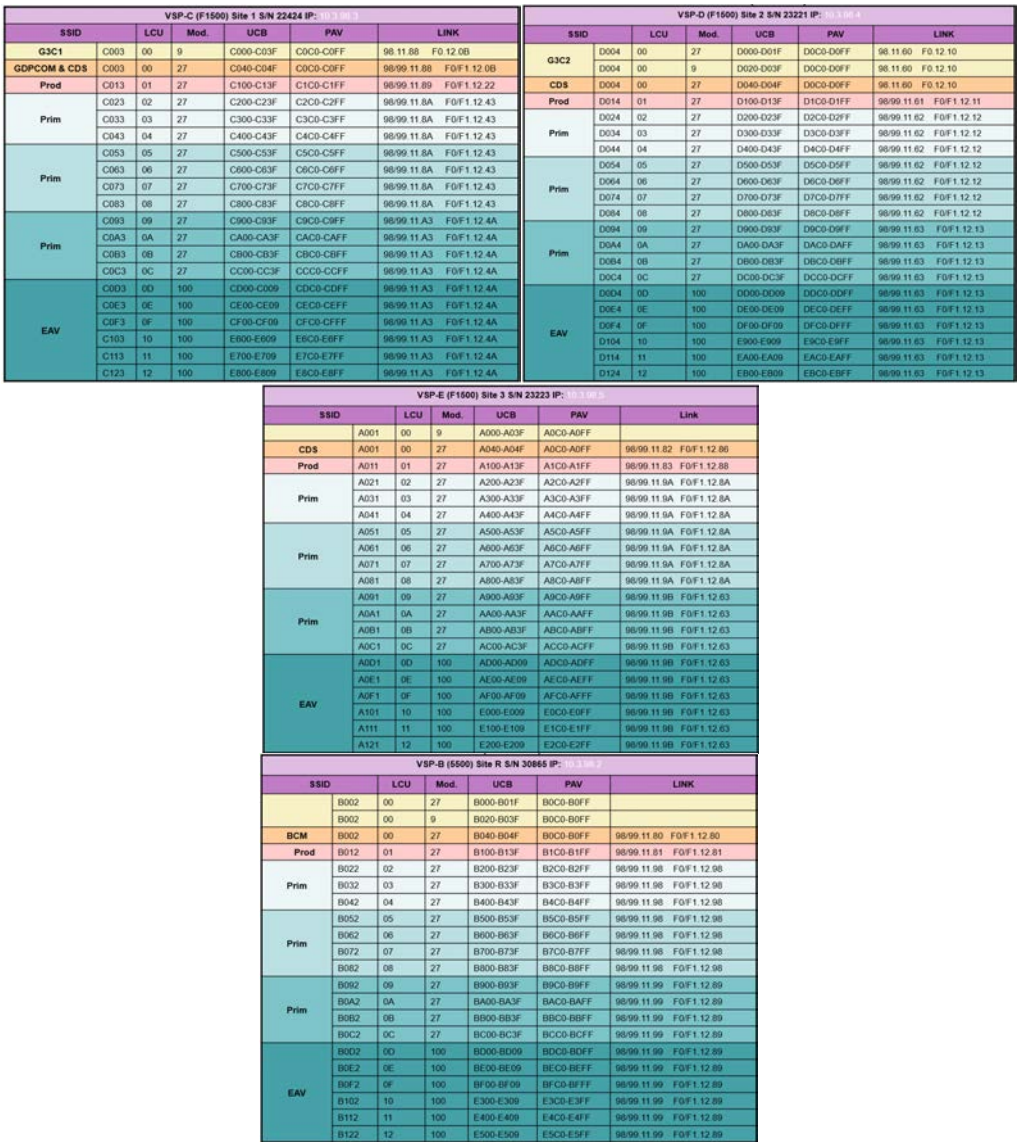
- Disk subsystem layout

Each HITACHI VSP F1500 was configured with 3390 devices across 19 LSS and all LSS have HyperPAV UCBs defined and all the volumes were defined as HDP (Hitachi thin provisioning devices):

  - 1 LSS dedicated to the infrastructure devices (z/OS Production System disks)

- 12 LSS for data and work areas
- 6 LSS with 10 EAV Mod.100 each

The final disk layout is as follows:



VSP-C (F1500) Site 1 S/N 22424 IP:

SSID		LCU	Mod.	UCB	PAV	LINK
G3C1	C003	00	9	C000-C03F	C0C0-C0FF	98.11.88 F0.12.0B
GDPCOM & CDS	C003	00	27	C040-C04F	C0C0-C0FF	98/99.11.88 F0/F1.12.0B
Prod	C013	01	27	C100-C13F	C1C0-C1FF	98/99.11.89 F0/F1.12.22
Prim	C023	02	27	C200-C23F	C2C0-C2FF	98/99.11.8A F0/F1.12.43
	C033	03	27	C300-C33F	C3C0-C3FF	98/99.11.8A F0/F1.12.43
	C043	04	27	C400-C43F	C4C0-C4FF	98/99.11.8A F0/F1.12.43
Prim	C053	05	27	C500-C53F	C5C0-C5FF	98/99.11.8A F0/F1.12.43
	C063	06	27	C600-C63F	C6C0-C6FF	98/99.11.8A F0/F1.12.43
	C073	07	27	C700-C73F	C7C0-C7FF	98/99.11.8A F0/F1.12.43
	C083	08	27	C800-C83F	C8C0-C8FF	98/99.11.8A F0/F1.12.43
Prim	C093	09	27	C900-C93F	C9C0-C9FF	98/99.11.A3 F0/F1.12.4A
	C0A3	0A	27	CA00-CA3F	CAC0-CAFF	98/99.11.A3 F0/F1.12.4A
	C0B3	0B	27	CB00-CB3F	CBC0-CBFF	98/99.11.A3 F0/F1.12.4A
	C0C3	0C	27	CC00-CC3F	CCC0-CCFF	98/99.11.A3 F0/F1.12.4A
EAV	C0D3	0D	100	CD00-C009	CDC0-CDFF	98/99.11.A3 F0/F1.12.4A
	C0E3	0E	100	CE00-CE09	CEC0-CEFF	98/99.11.A3 F0/F1.12.4A
	C0F3	0F	100	CF00-CF09	CFC0-CFFF	98/99.11.A3 F0/F1.12.4A
	C103	10	100	E600-E609	E6C0-E6FF	98/99.11.A3 F0/F1.12.4A
	C113	11	100	E700-E709	E7C0-E7FF	98/99.11.A3 F0/F1.12.4A
	C123	12	100	E800-E809	E8C0-E8FF	98/99.11.A3 F0/F1.12.4A

VSP-D (F1500) Site 2 S/N 23221 IP:

SSID		LCU	Mod.	UCB	PAV	LINK
G3C2	D004	00	27	D000-D01F	D0C0-D0FF	98.11.60 F0.12.10
	D004	00	9	D020-D03F	D0C0-D0FF	98.11.60 F0.12.10
CDS	D004	00	27	D040-D04F	D0C0-D0FF	98.11.60 F0.12.10
Prod	D014	01	27	D100-D13F	D1C0-D1FF	98/99.11.61 F0/F1.12.11
Prim	D024	02	27	D200-D23F	D2C0-D2FF	98/99.11.62 F0/F1.12.12
	D034	03	27	D300-D33F	D3C0-D3FF	98/99.11.62 F0/F1.12.12
	D044	04	27	D400-D43F	D4C0-D4FF	98/99.11.62 F0/F1.12.12
Prim	D054	05	27	D500-D53F	D5C0-D5FF	98/99.11.62 F0/F1.12.12
	D064	06	27	D600-D63F	D6C0-D6FF	98/99.11.62 F0/F1.12.12
	D074	07	27	D700-D73F	D7C0-D7FF	98/99.11.62 F0/F1.12.12
	D084	08	27	D800-D83F	D8C0-D8FF	98/99.11.62 F0/F1.12.12
Prim	D094	09	27	D900-D93F	D9C0-D9FF	98/99.11.63 F0/F1.12.13
	D0A4	0A	27	DA00-DA3F	DAC0-DAFF	98/99.11.63 F0/F1.12.13
	D0B4	0B	27	DB00-DB3F	DBC0-DBFF	98/99.11.63 F0/F1.12.13
	D0C4	0C	27	DC00-DC3F	DCC0-DCFF	98/99.11.63 F0/F1.12.13
EAV	D0D4	0D	100	DD00-DD09	DDC0-DDFF	98/99.11.63 F0/F1.12.13
	D0E4	0E	100	DE00-DE09	DEC0-DEFF	98/99.11.63 F0/F1.12.13
	D0F4	0F	100	DF00-DF09	DFC0-DFFF	98/99.11.63 F0/F1.12.13
	D104	10	100	E900-E909	E9C0-E9FF	98/99.11.63 F0/F1.12.13
	D114	11	100	EA00-EA09	EAC0-EAFF	98/99.11.63 F0/F1.12.13
	D124	12	100	EB00-EB09	EBC0-EBFF	98/99.11.63 F0/F1.12.13

VSP-E (F1500) Site 3 S/N 23223 IP:

SSID		LCU	Mod.	UCB	PAV	Link
	A001	00	9	A000-A03F	A0C0-A0FF	
CDS	A001	00	27	A040-A04F	A0C0-A0FF	98/99.11.82 F0/F1.12.86
Prod	A011	01	27	A100-A13F	A1C0-A1FF	98/99.11.83 F0/F1.12.88
Prim	A021	02	27	A200-A23F	A2C0-A2FF	98/99.11.9A F0/F1.12.8A
	A031	03	27	A300-A33F	A3C0-A3FF	98/99.11.9A F0/F1.12.8A
	A041	04	27	A400-A43F	A4C0-A4FF	98/99.11.9A F0/F1.12.8A
Prim	A051	05	27	A500-A53F	A5C0-A5FF	98/99.11.9A F0/F1.12.8A
	A061	06	27	A600-A63F	A6C0-A6FF	98/99.11.9A F0/F1.12.8A
	A071	07	27	A700-A73F	A7C0-A7FF	98/99.11.9A F0/F1.12.8A
	A081	08	27	A800-A83F	A8C0-A8FF	98/99.11.9A F0/F1.12.8A
Prim	A091	09	27	A900-A93F	A9C0-A9FF	98/99.11.9B F0/F1.12.63
	A0A1	0A	27	AA00-AA3F	AAC0-AAFF	98/99.11.9B F0/F1.12.63
	A0B1	0B	27	AB00-AB3F	ABC0-ABFF	98/99.11.9B F0/F1.12.63
	A0C1	0C	27	AC00-AC3F	ACC0-ACFF	98/99.11.9B F0/F1.12.63
EAV	A0D1	0D	100	AD00-AD09	ADC0-ADFF	98/99.11.9B F0/F1.12.63
	A0E1	0E	100	AE00-AE09	AEC0-AEFF	98/99.11.9B F0/F1.12.63
	A0F1	0F	100	AF00-AF09	AFC0-AFFF	98/99.11.9B F0/F1.12.63
	A101	10	100	E000-E009	E0C0-E0FF	98/99.11.9B F0/F1.12.63
	A111	11	100	E100-E109	E1C0-E1FF	98/99.11.9B F0/F1.12.63
	A121	12	100	E200-E209	E2C0-E2FF	98/99.11.9B F0/F1.12.63

VSP-B (5500) Site R S/N 30865 IP:

SSID		LCU	Mod.	UCB	PAV	LINK
	B002	00	27	B000-B01F	B0C0-B0FF	
	B002	00	9	B020-B03F	B0C0-B0FF	
BCM	B002	00	27	B040-B04F	B0C0-B0FF	98/99.11.80 F0/F1.12.80
Prod	B012	01	27	B100-B13F	B1C0-B1FF	98/99.11.81 F0/F1.12.81
Prim	B022	02	27	B200-B23F	B2C0-B2FF	98/99.11.98 F0/F1.12.98
	B032	03	27	B300-B33F	B3C0-B3FF	98/99.11.98 F0/F1.12.98
	B042	04	27	B400-B43F	B4C0-B4FF	98/99.11.98 F0/F1.12.98
Prim	B052	05	27	B500-B53F	B5C0-B5FF	98/99.11.98 F0/F1.12.98
	B062	06	27	B600-B63F	B6C0-B6FF	98/99.11.98 F0/F1.12.98
	B072	07	27	B700-B73F	B7C0-B7FF	98/99.11.98 F0/F1.12.98
	B082	08	27	B800-B83F	B8C0-B8FF	98/99.11.98 F0/F1.12.98
Prim	B092	09	27	B900-B93F	B9C0-B9FF	98/99.11.99 F0/F1.12.89
	B0A2	0A	27	BA00-BA3F	BAC0-BAFF	98/99.11.99 F0/F1.12.89
	B0B2	0B	27	BB00-BB3F	BBC0-BBFF	98/99.11.99 F0/F1.12.89
	B0C2	0C	27	BC00-BC3F	BCC0-BCFF	98/99.11.99 F0/F1.12.89
EAV	B0D2	0D	100	BD00-BD09	BDC0-BDFF	98/99.11.99 F0/F1.12.89
	B0E2	0E	100	BE00-BE09	BEC0-BEFF	98/99.11.99 F0/F1.12.89
	B0F2	0F	100	BF00-BF09	BFC0-BFFF	98/99.11.99 F0/F1.12.89
	B102	10	100	E300-E309	E3C0-E3FF	98/99.11.99 F0/F1.12.89
	B112	11	100	E400-E409	E4C0-E4FF	98/99.11.99 F0/F1.12.89
	B122	12	100	E500-E509	E5C0-E5FF	98/99.11.99 F0/F1.12.89

Figure 28 – Multi Target Metro Mirror DASD layout

Under GDPS®, the Standard Actions panel shows the following configuration about the MTMM configuration, it has no knowledge of the remote Site Remote systems.

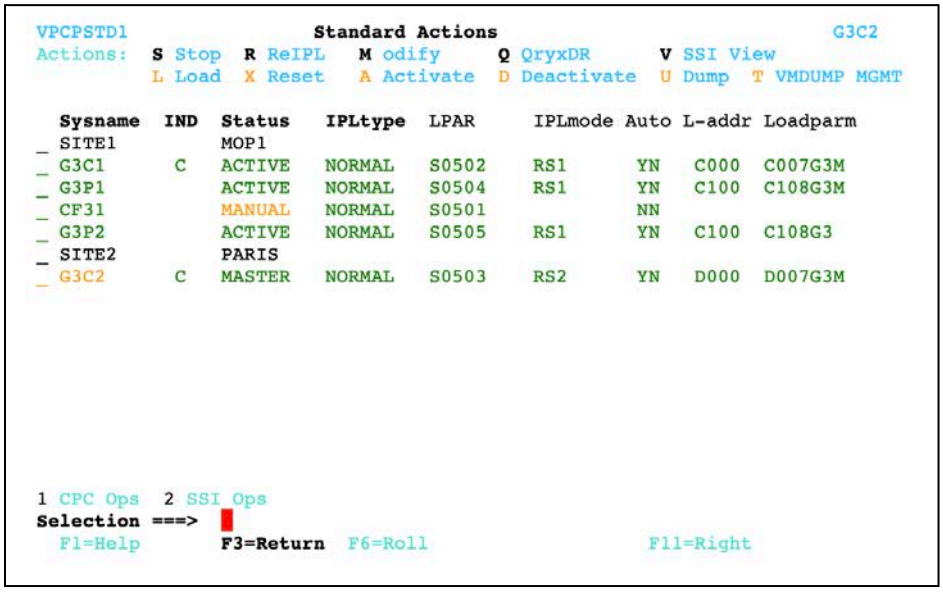


Figure 29 – GDPS Remote Copy panel

Under GDPS®, the Remote Copy panel shows exactly the same LSS configuration as reported on Figure 6 for the GDPS Metro DL test, again there is no any knowledge from GDPS perspective about the HUR replica.

Under BCM, the Manage Copy Groups panel shows the four available Copy Groups:

- TEST representing the HUR from Site 1 to Site Remote disks with extended consistency group

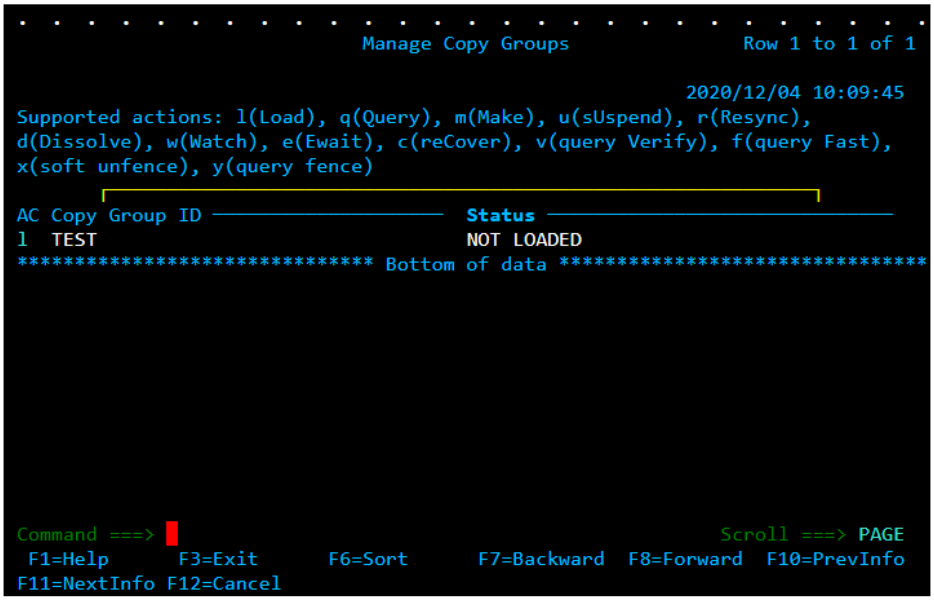


Figure 30 – BCM Manage Copy Groups panel

Under BCM, the Copy Group panel for TEST shows all of the HUR pairs available and their status, a Query gives more details on any single pair.

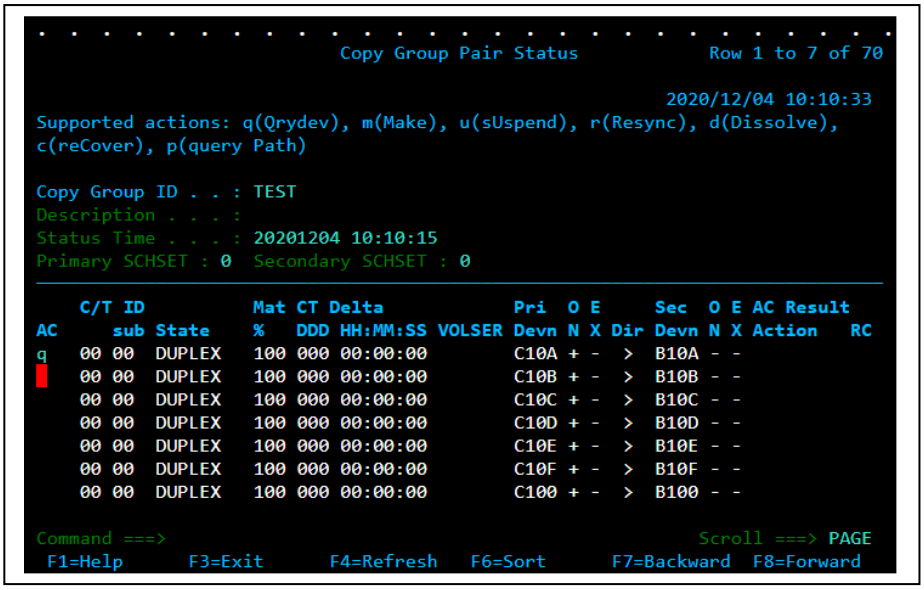


Figure 31 – BCM Copy Group Pair Status Panel

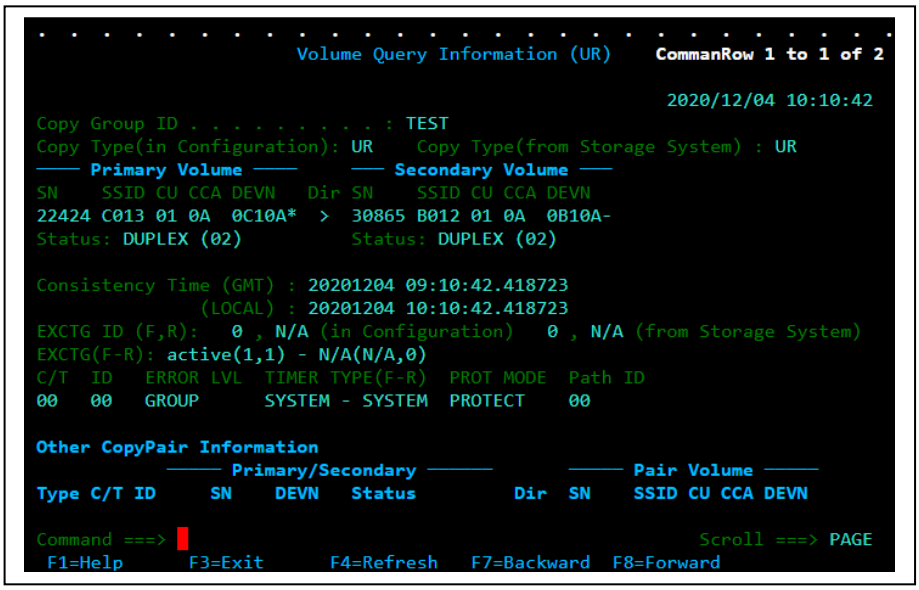


Figure 32 – BCM Volume Query Information Panel

SCENARIOS CHECKED

All the test scenarios executed were "DASD-Oriented".

B. Regression Test:

- Basic GDPS Metro DL testing to verify there are no unexpected impacts due to HUR; use all GDPS Metro DL Remote copy options with the full configuration loaded
    - Add / Delete pairs
    - Suspend / Resynch pairs
    - Stop / Start secondary
    - Managing FlashCopy
    - Changing the Config (add/delete LSS from the GEOPARM)
    - run MON I, II and III

```
VPCPQSH2  Mirroring Status: OK  Group: LEGACY.LEGACY     Type: CKD   G3C2
Actions:  D elpair  E stpair  S uspend  Y RecSec  R esynch  Q uery
          QO Query Online
Leg: RL2  Pair: 0022424 02 C023 -> 0023221 06 D064 Count: 63  Scope:  All
_ 0C200  0D600 DUP          _ 0C210  0D610 DUP          _ 0C220  0D620 DUP
_ 0C201  0D601 DUP          _ 0C211  0D611 DUP          _ 0C221  0D621 DUP
_ 0C202  0D602 DUP          _ 0C212  0D612 DUP          _ 0C222  0D622 DUP
_ 0C203  0D603 DUP          _ 0C213  0D613 DUP          _ 0C223  0D623 DUP
_ 0C204  0D604 DUP          _ 0C214  0D614 DUP          _ 0C224  0D624 DUP
_ 0C205  0D605 DUP          _ 0C215  0D615 DUP          _ 0C225  0D625 DUP
_ 0C206  0D606 DUP          _ 0C216  0D616 DUP          _ 0C226  0D626 DUP
_ 0C207  0D607 DUP          _ 0C217  0D617 DUP          _ 0C227  0D627 DUP
_ 0C208  0D608 DUP          _ 0C218  0D618 DUP          _ 0C228  0D628 DUP
_ 0C209  0D609 DUP          _ 0C219  0D619 DUP          _ 0C229  0D629 DUP
_ 0C20A  0D60A DUP          _ 0C21A  0D61A DUP          _ 0C22A  0D62A DUP
_ 0C20B  0D60B DUP          _ 0C21B  0D61B DUP          _ 0C22B  0D62B DUP
_ 0C20C  0D60C DUP          _ 0C21C  0D61C DUP          _ 0C22C  0D62C DUP
_ 0C20D  0D60D DUP          _ 0C21D  0D61D DUP          _ 0C22D  0D62D DUP
_ 0C20E  0D60E DUP          _ 0C21E  0D61E DUP          _ 0C22E  0D62E DUP
_ 0C20F  0D60F DUP          _ 0C21F  0D61F DUP          _ 0C22F  0D62F DUP
1 Estpair 2 Delpair 3 Suspend 4 Resynch 5 Query 6 RecSec 7 All 8 Exceptions
11 VOLSERs
Selection ===>
  F1=Help   F3=Return   F6=Roll   F7=Up   F8=Down   F9=Toggle   F10=CCA
```

Figure 33 - LSS volume list panel

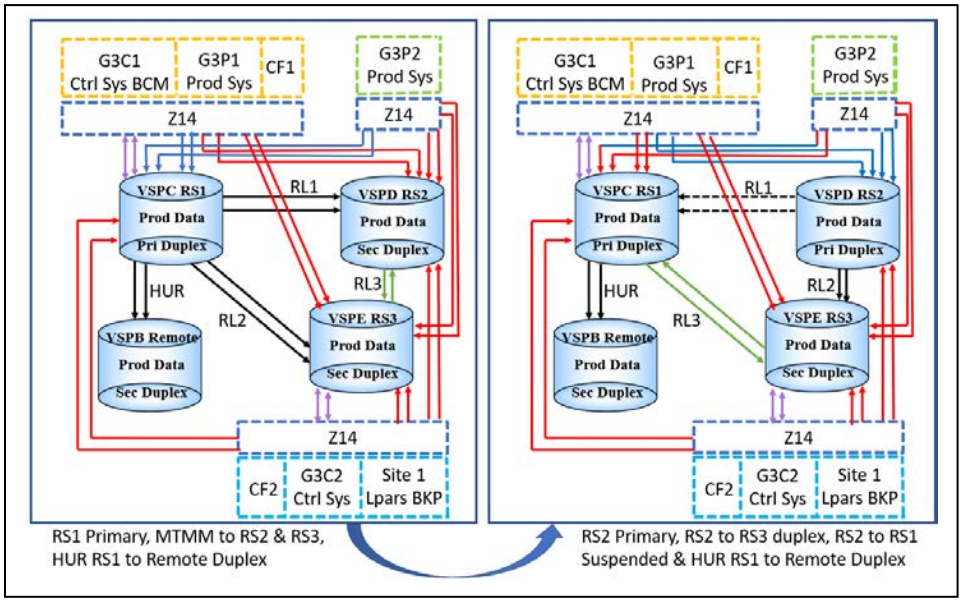
Note

All the tests, Regression, Planned Actions, and Unplanned Actions, were performed using the following policy option:
- PRIMARYFAILURE= SWAP,GO
- PPRCFAILURE= GO
***Note** During the HUR initial copy time window HyperSwap is enabled, but if a PPRC pair is suspended, in order to resynch one needs to suspend HUR initial copy, resync PPRC pair(s) and resume HUR initial copy.*

C. *Planned actions:*

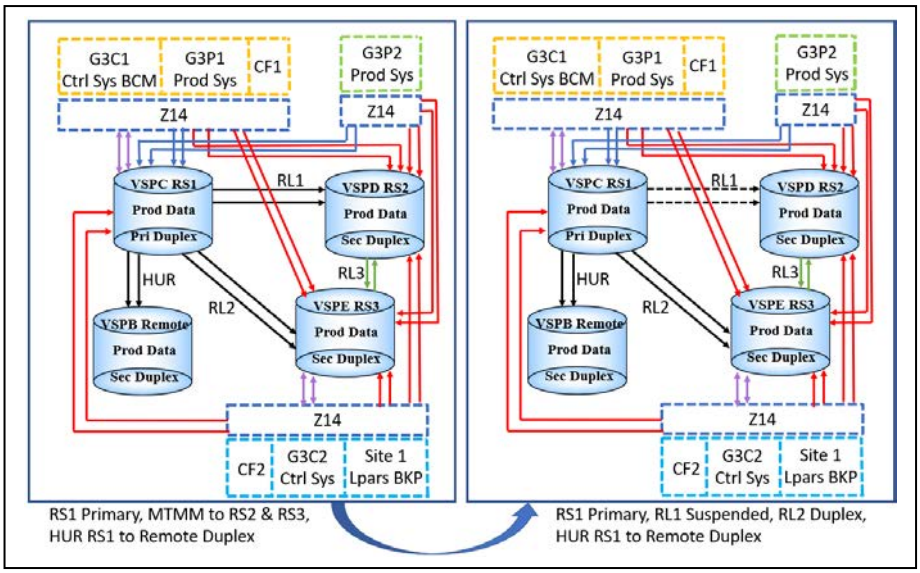
- RS1 disks maintenance.
  - Simulation of disruptive disk maintenance of RS1 by the following steps. Stopping the application workload was not required.
  - Suspend Purge HUR.
  - Planned Hyperswap RS1 to RS2.
  - Delta Resync.
  - Perform P site maintenance. (Power cycle the DKC in the P site)
  - Start Secondary after Primary recovered.

Note *HyperSwap Resynch is not allowed in a three sites configuration.*



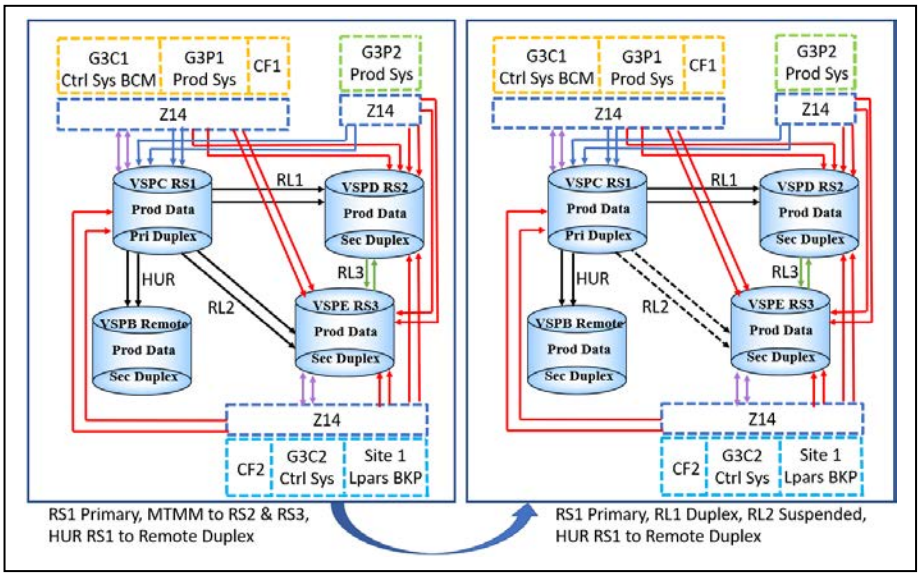
Returning back to RS1 disks using the same procedure (without power cycle) used to move workload from RS1 to RS2. Stopping the workload was not required. Please note that HUR need to be resynced as Start Secondary from RS2 to RS1 does suspend HUR.

- RS2 disks maintenance.
  Simulation of disruptive disk maintenance of RS2 by suspending the PPRC replica from RS1 to RS2 disks. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS3, and on HUR replica from RS1 to Site Remote disks.



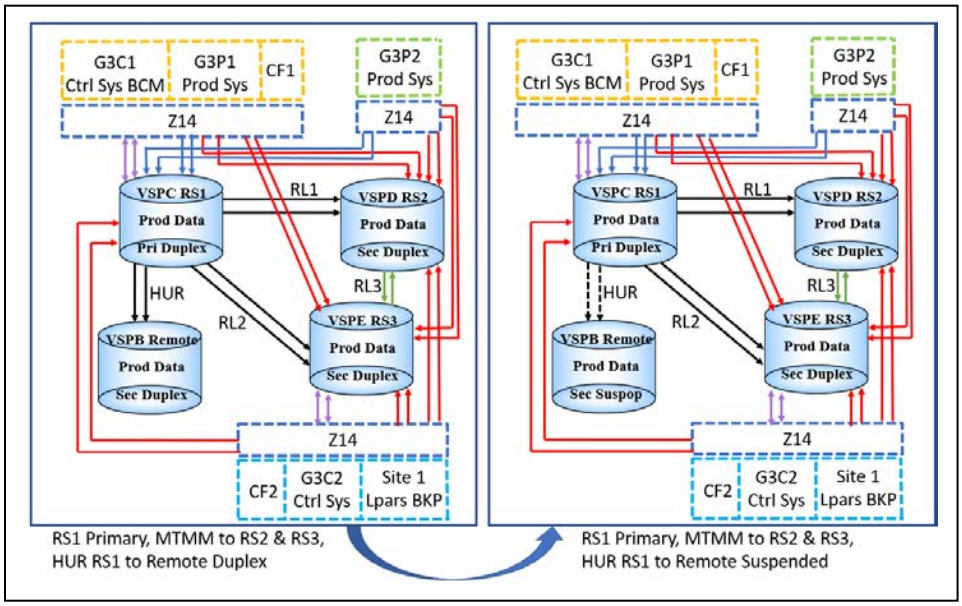
Back to normal resynching RS1 to RS2 disks with a Start Secondary RL1.

- RS3 disks maintenance.
  Simulation of disruptive disk maintenance RS3 by suspending the PPRC replica from RS1 to RS3 disks. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2, and on HUR replica from RS1 to Site Remote disks.



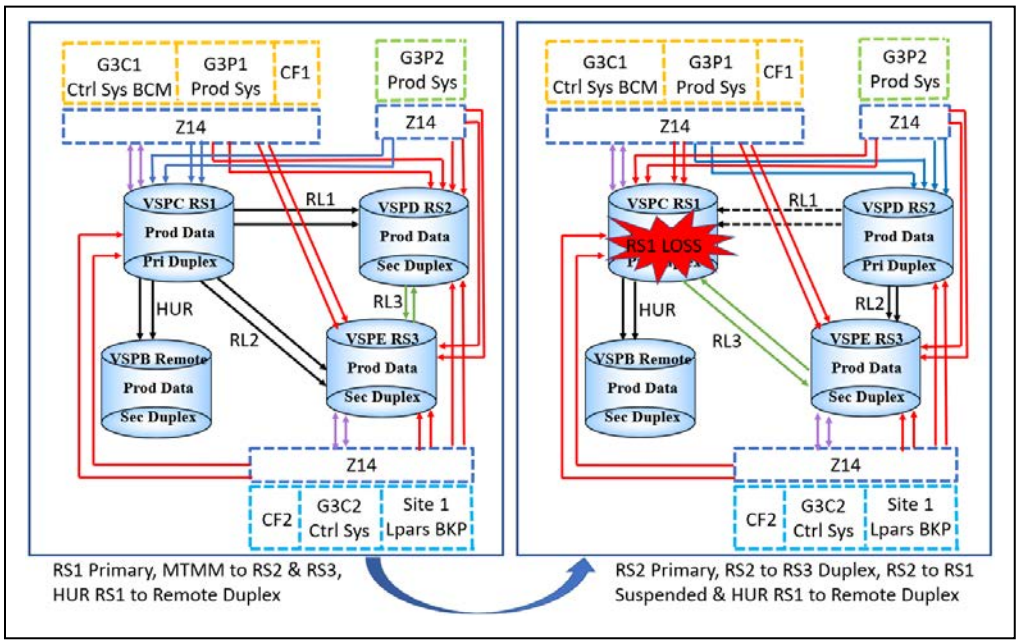
Back to normal resynching RS1 to RS3 disks with a Start Secondary from GDPS.

- Site Remote disks maintenance.
  Simulation of disruptive disk maintenance in Site Remote by suspending the HUR replica from RS1 to Site Remote disks (Suspend Flush). No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2 disks, and on the PPRC replica from RS1 to RS3 disks.



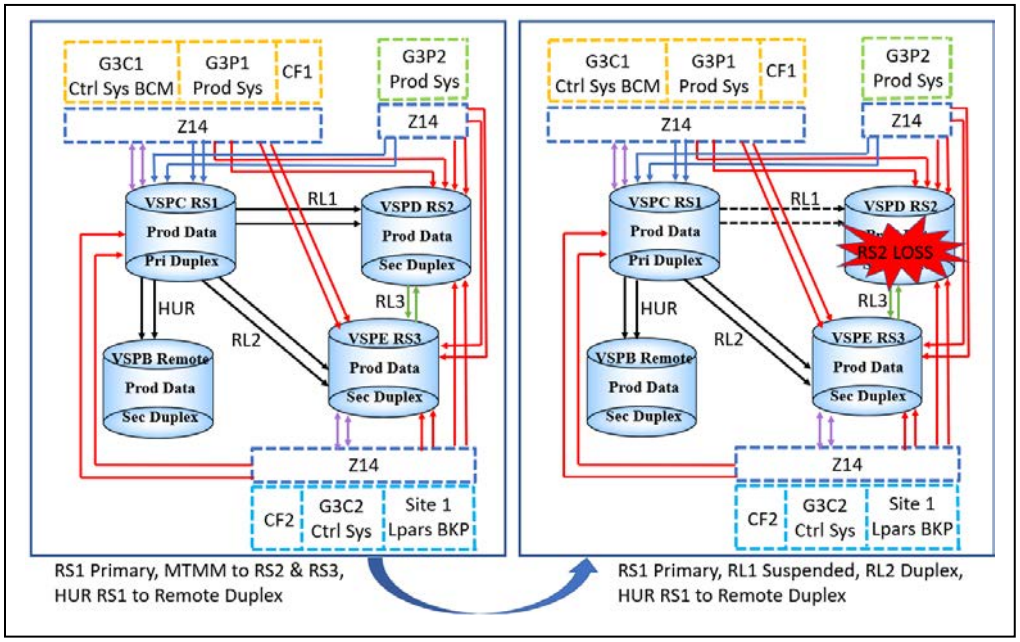
Back to normal resynching the HUR from RS1 to Site Remote disks.

- ***Unplanned actions:***
- RS1 outage.
  - Simulation of RS1 failure by unattended power off. Stopping the application workload was not required.
  - Unplanned Hyperswap.
  - Suspend Purge HUR.
  - Delta Resync.
  - Start Secondary.



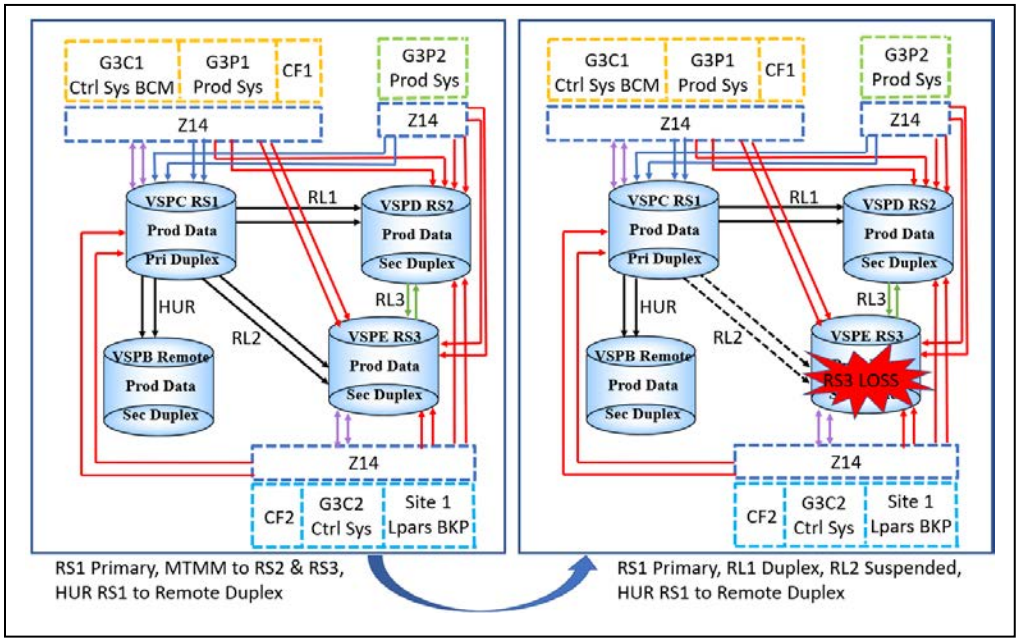
Returning back to RS1 after resynching RS2 to RS1 disks (GDPS Start Secondary) using the same procedure used to '**RS1 disks maintenance'**. Stopping the workload was not required. Pleas note that resync of PPRC will cause suspend of HUR RS1 to Remote, one will need to resynch HUR after RL1 is Duplex.

- RS2 outage.
- Simulation of RS2 failure by unattended power off. Stopping the application workload was not required.
- The PPRC replica from RS1 to RS2 disks is suspended. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS3, and on the HUR replica from RS1 to Site Remote disks.



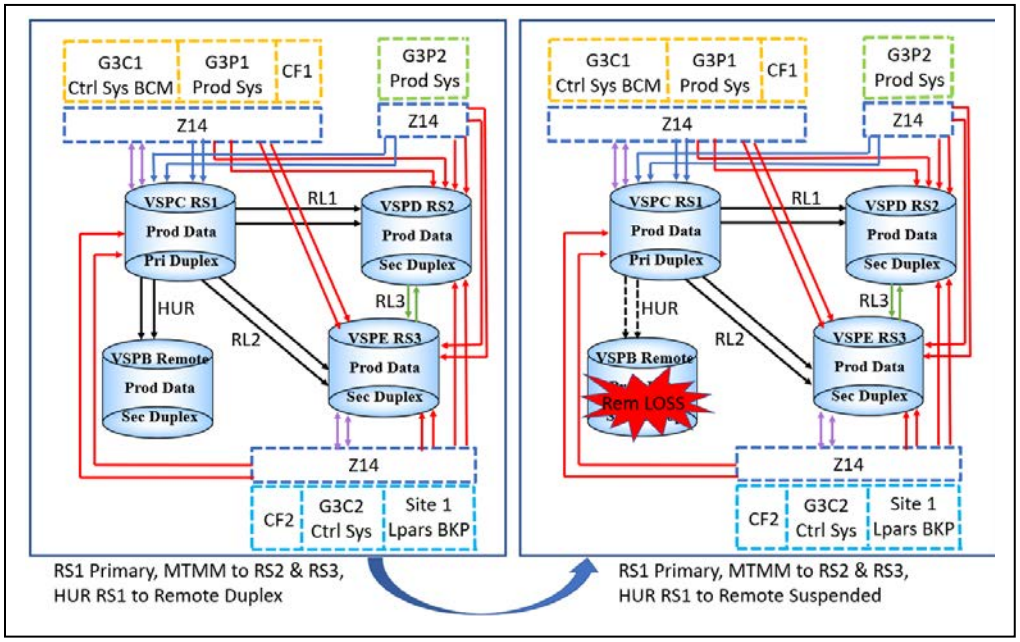
Returning back after resynching RS1 to RS2 disks (GDPS Start Secondary) using the same procedure used to '**RS2 disks maintenance'**. Stopping the workload was not required.

- RS3 disks outage.
- Simulation of RS3 failure by unattended power off. Stopping the application workload was not required.
- The PPRC replica from RS1 to RS3 disks is suspended. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2, and on the HUR replica from RS1 to Site Remote disks.



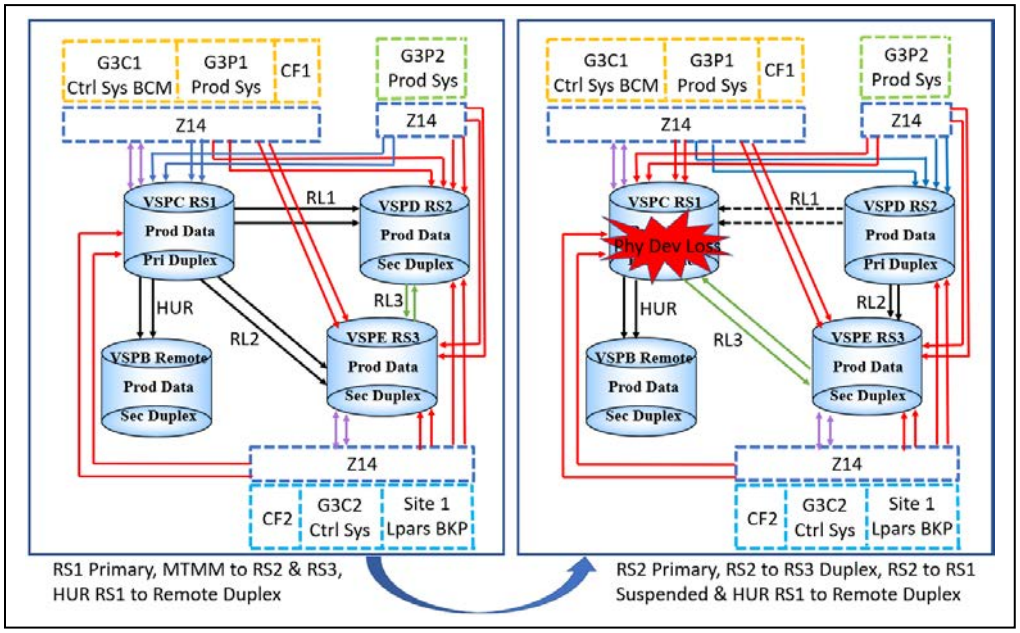
Returning back after resynching RS1 to RS3 disks (GDPS Start Secondary) using the same procedure used to '**RS3 disks maintenance'**. Stopping the workload was not required.

- Site Remote disks outage.
- Simulation of disk failure in Site Remote by unattended power off. Stopping the application workload was not required.
- The HUR replica from RS1 to Site Remote disks is not active. No impact on the application systems running on RS1 disks, on the PPRC replica SRS1 to RS2, and on the PPRC replica RS1 to RS3.



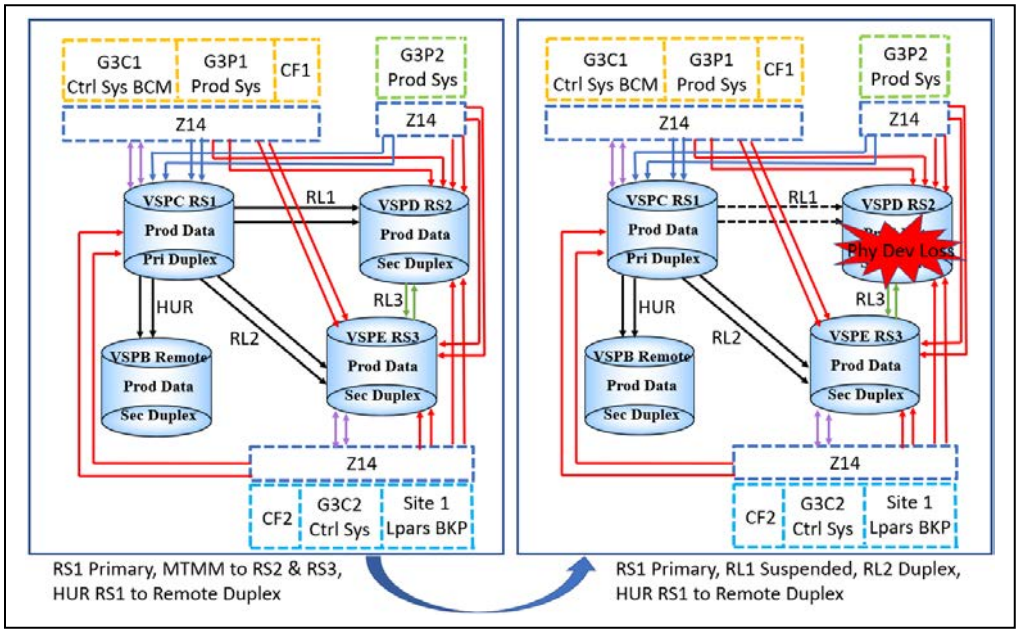
Returning back after resynching HUR Site 1 RS1 to Site Remote disks using the same procedure used to '**Site Remote disks maintenance'**. Stopping the workload was not required.

- RS1 disks failure.
  - Simulation of RS1 disk failure by losing one parity group in the Pool. Stopping the application workload was not required.
  - Unplanned Hyperswap.
  - Suspend Purge HUR.
  - Start Secondary.



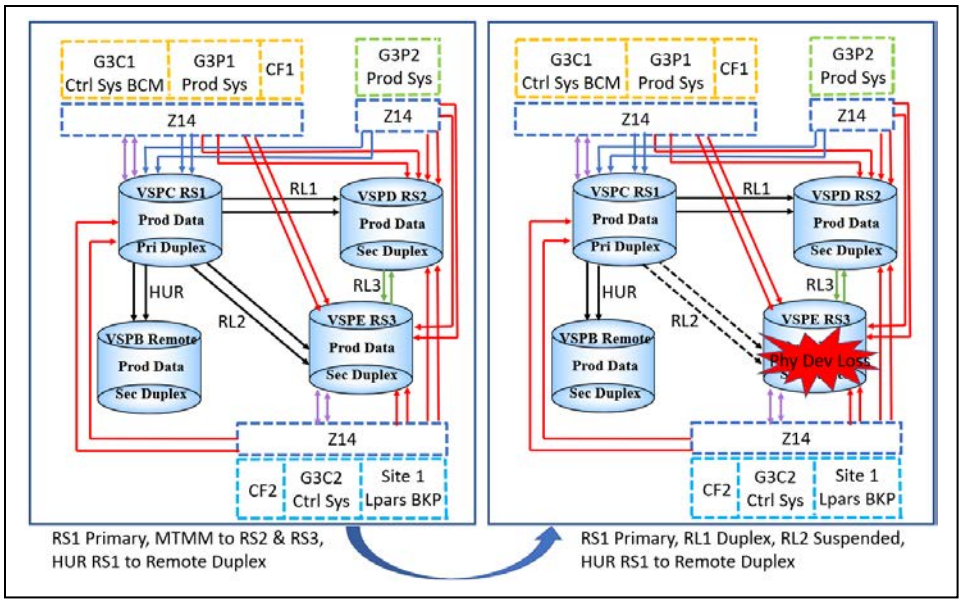
Returning back to RS1 after resynching RS2 to RS1 disks (GDPS Metro DL Start Secondary) using the same procedure used to '**RS1 disks maintenance'**. Stopping the workload was not required. Pleas note that resync of PPRC will cause suspend of HUR RS1 to Remote, one will need to resynch HUR after RL1 is Duplex.

- SRS2 disks failure.
- Simulation of RS2 failure by losing one parity group in the Pool. Stopping the application workload was not required.
- The PPRC replica from RS1 to RS2 disks is suspended. No impact on the application systems running on RS1 disks, on the PPRC replica SRS1 to RS3, and on the HUR replica from RS1 to Site Remote disks.



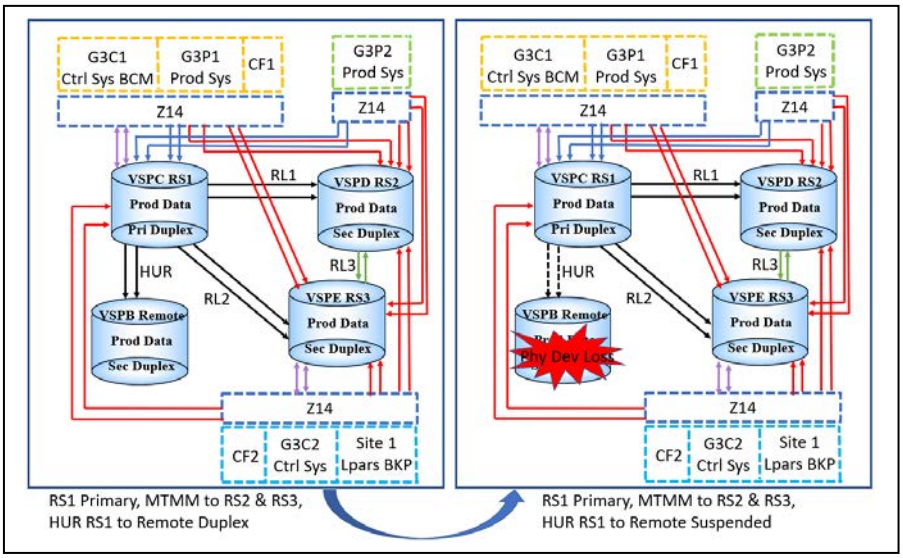
Returning back after resynching RS1 to RS2 disks (GDPS Start Secondary) using the same procedure used to '**RS2 disks maintenance'**. Stopping the workload was not required.

- RS3 disk failure.
- Simulation of RS3 failure by losing one parity group in the Pool. Stopping the application workload was not required.
- The PPRC replica from RS1 to RS3 disks is suspended. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2, and on the HUR replica from RS1 to Site Remote disks.



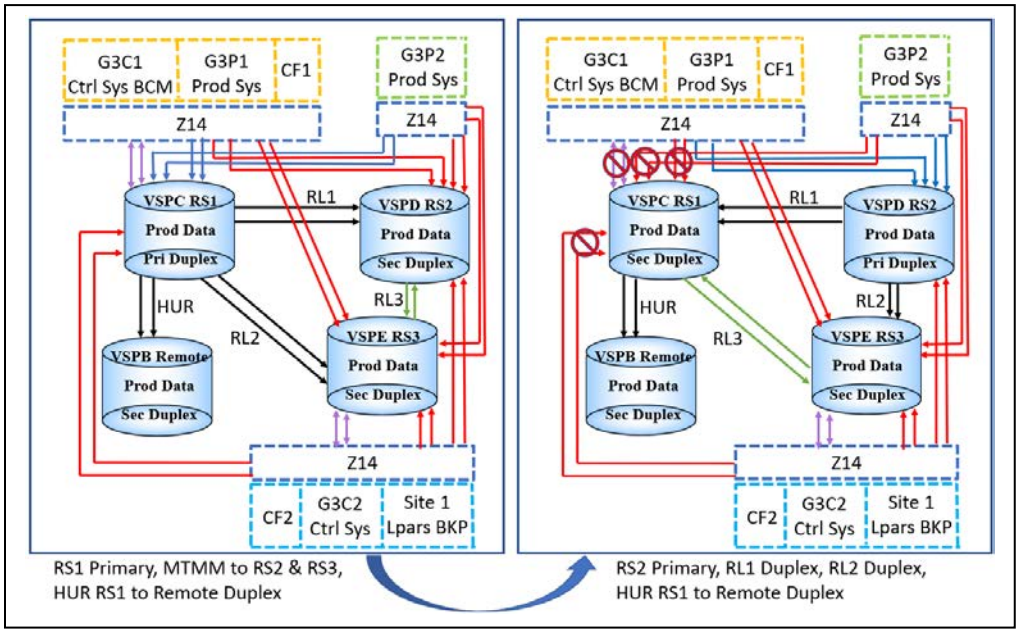
Returning back after resynching RS1 to RS3 disks (GDPS Start Secondary) using the same procedure used to '**RS3 disks maintenance'**. Stopping the workload was not required.

- Site Remote disks failure.
  Simulation of disk failure in Site Remote by losing one parity group in the Pool. Stopping the application workload was not required.
- The HUR replica from RS1 to Site Remote disks is not active. No impact on the application systems running on RS1 disks, on the PPRC replica SRS1 to RS2, and on the PPRC replica RS1 to RS3.
- The PPRC replica from RS1 to RS3 disks is suspended. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2, and on the HUR replica from RS1 to Site Remote disks.



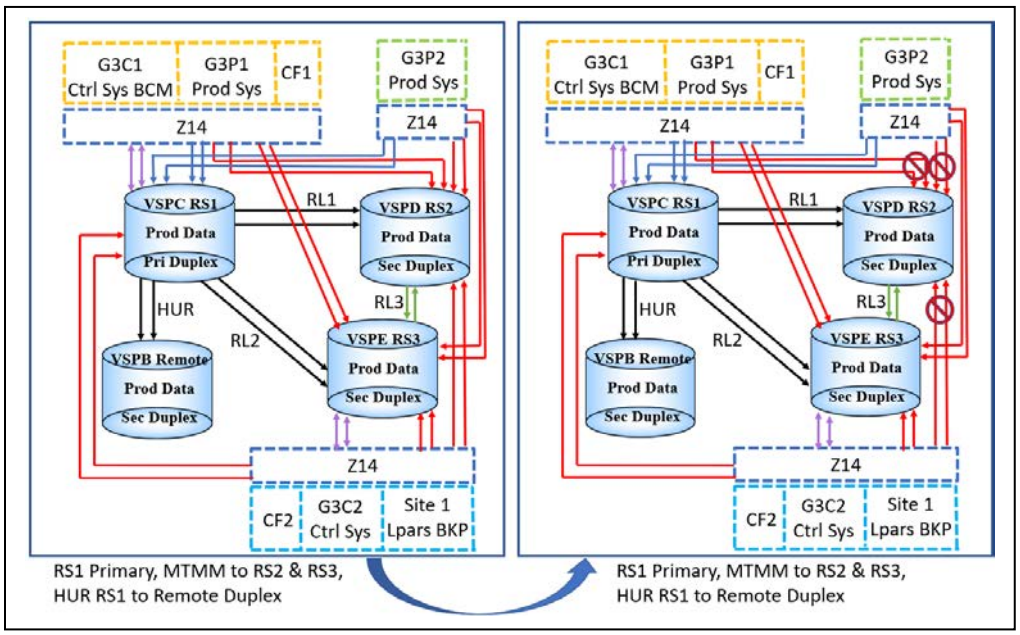
Returning to normal: when Site Remote disk is back available the HUR Copy Group from RS1 to Site Remote appears as SUSPENDED-CU, from BCM resynch HUR to Site Remote disks and wait to be back DUPLEX.

- FICON loss to RS1 disks.
  - Simulation of FICON loss to RS1 by unplugging cables. Stopping the application workload was not required.
  - Unplanned Hyperswap.
  - Suspend Purge HUR.
  - Start Secondary.



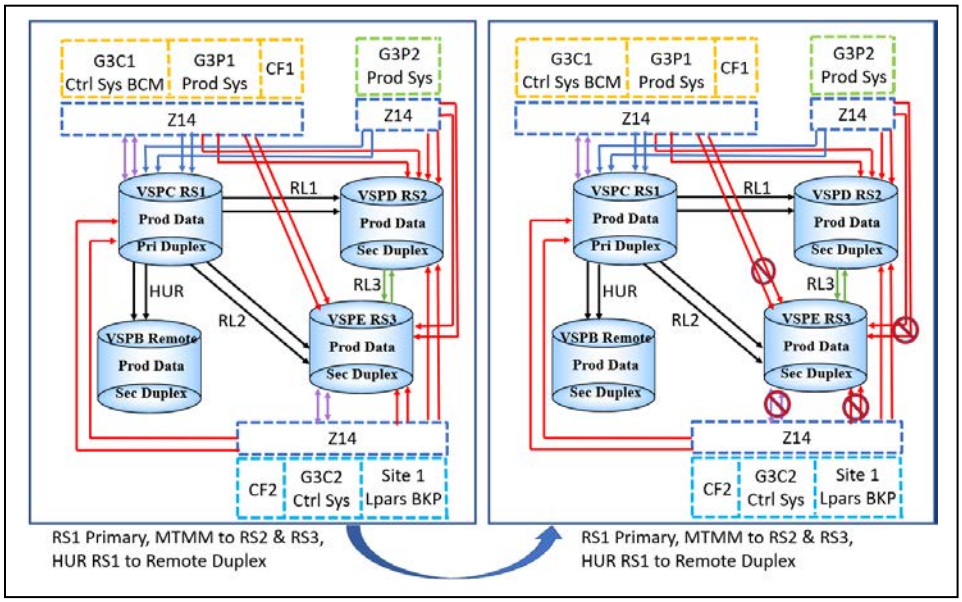
Returning back to RS1 after resynching RS2 to RS1 disks (GDPS Start Secondary) using the same procedure used to '**RS1 disks maintenance'**. Stopping the workload was not required. Pleas note that resync of PPRC RS2 to RS1 will cause suspend of HUR RS1 to Remote, one will need to resynch HUR after RL1 is Duplex.

- FICON loss to RS2 disks.
- Simulation of FICON loss to RS2 by unplugging cables. Stopping the application workload was not required.
- No impact on the application systems running on RS1 disks, neither on replications.



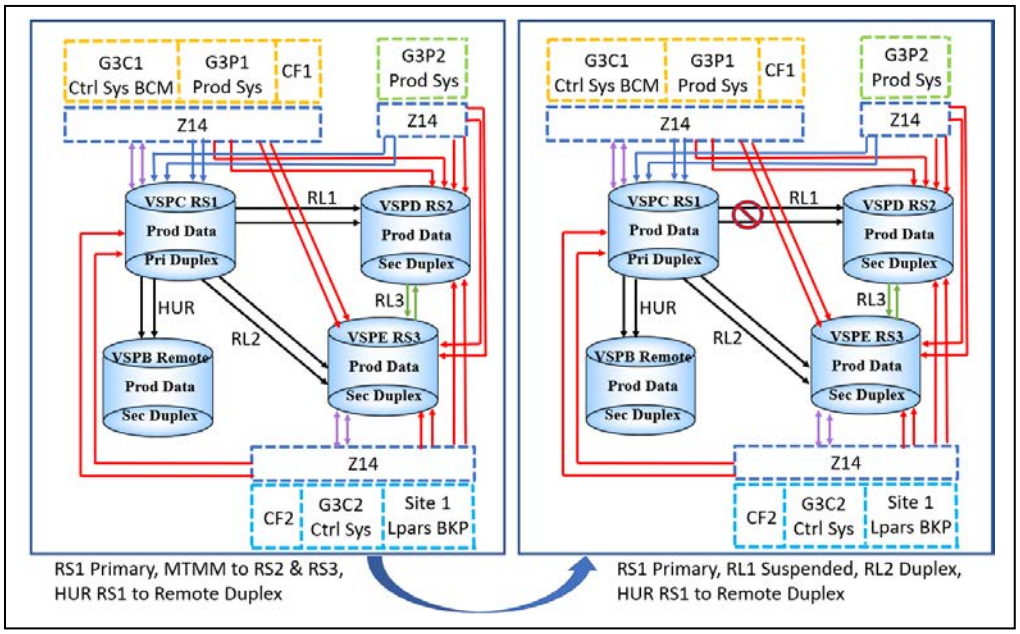
No need of returning back procedure from disks point of view. Stopping the workload was not required.

- FICON loss to RS3 disks.
- Simulation of FICON loss to RS3 by unplugging cables. Stopping the application workload was not required.
- No impact on the application systems running on RS1 disks, neither on replications.



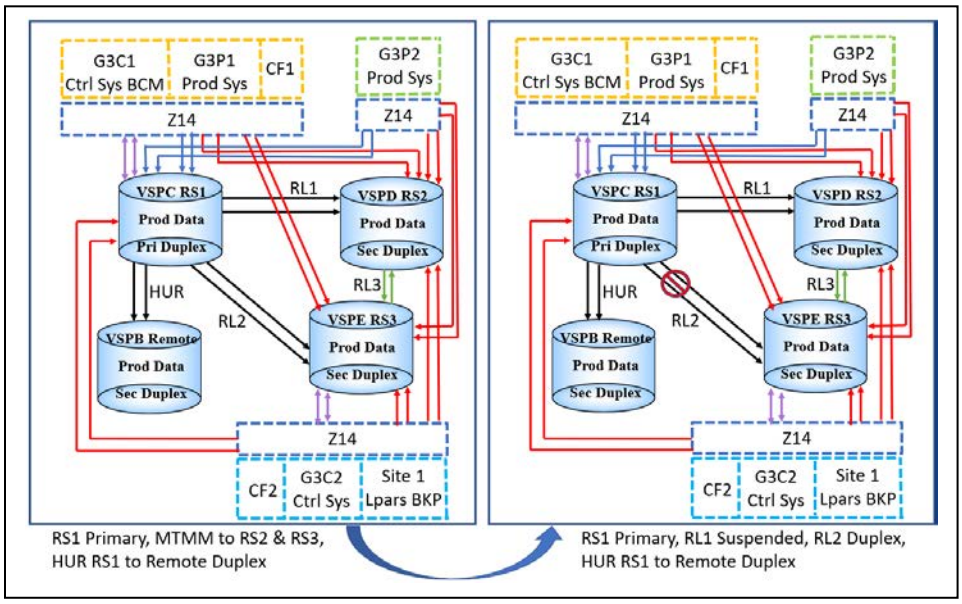
No need of returning back procedure from disks point of view. Stopping the workload was not required.

- RL1 (PPRC links RS1 to RS2) links failure.
- Simulation of RL1 links failure by unplugging cables. Stopping the application workload was not required.



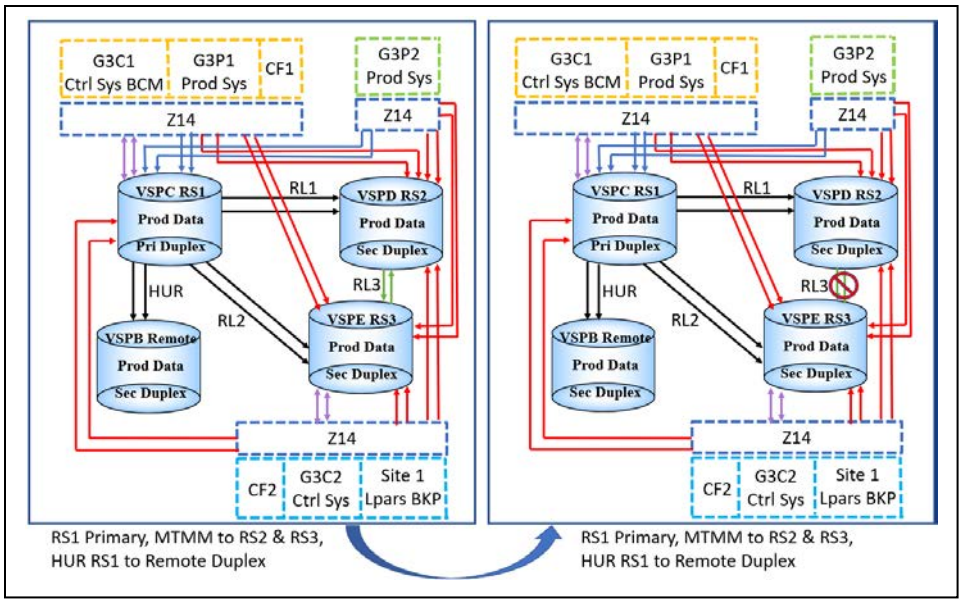
Returning back to RS1 after resynching RS1 to RS2 disks (GDPS Start Secondary) using the same procedure used to '**RS2 disks maintenance'**.. Stopping the workload was not required.

- RL2 (PPRC links RS1 to RS3) links failure.
- Simulation of RL2 links failure by unplugging cables. Stopping the application workload was not required.
- The PPRC replica from RS1 to RS3 disks is suspended. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2, and on the HUR replica from RS1 to Site Remote disks.



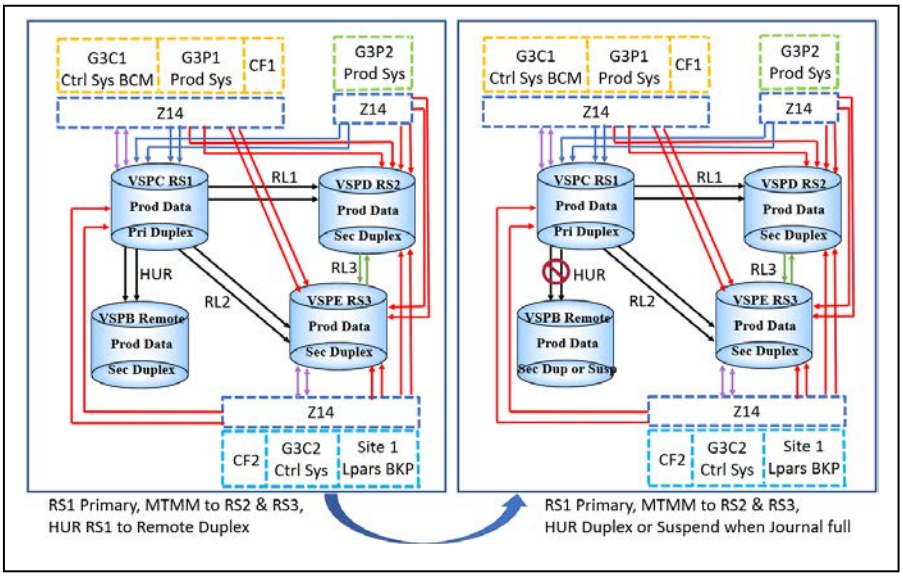
Returning back after resynching RS1 to RS3 disks (GDPS Start Secondary) using the same procedure used to '**RS3 disks maintenance'**. Stopping the workload was not required.

- RL3 (PPRC links RS2 <-> RS3) links failure.
- Simulation of RL3 links failure by unplugging cables. Stopping the application workload was not required.
- The no impact on PPRC replica. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2 & Site 1 RS1 to RS3, and on the HUR replica from RS1 to Site Remote disks.



Returning back does not require special procedure. Stopping the workload was not required.

- HUR links failure.
  Simulation of HUR links failure by unplugging HUR links. Stopping the application workload was not required.
- The HUR replica from RS1 to Site Remote disks stays Duplex until Journal becomes full, if that is the case then goes to track mode. No impact on the application systems running on RS1 disks, on the PPRC replica RS1 to RS2, and on the PPRC replica RS1 to RS3.



Returning to normal: when Site Remote disk is back available the HUR Copy Group from RS1 to Site Remote either stays Duplex as Journal on RS1 did not fill (nothing to do) or appears as SUSPENDED. If suspended, from BCM resynch HUR RS1 to Site Remote disks and wait to be back DUPLEX.

GDPS Metro DL with HUR controlled by BCM test results

All the scenarios described have been successfully run, all the data resynchronizations were incremental. All the tests were performed with a single consistency group. In addition, the planned hyperswap scenarios were also performed with multiple consistency groups (EXCTG).

Additional Information

GDPS home page:
https://www.**ibm.com**/it-infrastructure/z/technologies/gdps

System z Business Resiliency Web site:
https://www.**ibm.com**/it-infrastructure/z/capabilities/resiliency

For the Interagency White Paper on Sound Practices to strengthen the resilience of the US. Financial System, refer to:
www.sec.gov/news/studies/34-47638.htm

For Summary of "Lessons Learned" from Events of September 11 and Implications for Business Continuity prepared by the Securities and Exchange Commission, refer to:
http://www.sec.gov/divisions/marketreg/lessonslearned.htm

GDPS Family - An Introduction to Concepts and Capabilities, SG24-6374 at:
www.redbooks.**ibm.com**/abstracts/sg246374.html

For additional information on GDPS®, contact your IBM representative or e-mail to:
gdps@us.**ibm.com**

Hitachi Vantara Home Page:
www.**hitachivantara.com**

Hitachi Virtual Platform home page:
www.**hitachivantara.com**/en-us/products/storage.html

VSP 5000 series' web site
www.**hitachivantara.com**/en-us/products/storage/flash-storage/enterprise/vsp-5000-series.html

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