

# Split Mirror Backup / Recovery Solution with the IBM<sup>®</sup> TotalStorage<sup>®</sup> Server DS6800

## CONTENTS

Abstract	4
1. Introduction	5
2. Customer Requirements	6
3. Introduction to the IBM TotalStorage DS6000 series	7
4. DS6000 Architecture	9
5. Copy Services	11
6. Installation Preparations and Lab Setup	13
7. SAP / Oracle Database Layout	14
8. Split Mirror Backup & Recovery Process	15
Phase Description of the SMBR Backup Process:	16
Appendix	23
9. Sample Scripts	23
10. Input Config Files	28
11. Hardware used	31
12. Software used	32
13. Logs	32
References	40

## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

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

AIX®, DB2 Universal Database®, Enterprise Storage Server (ESS)®, FlashCopy®, IBM TotalStorage Server DS6000®, Tivoli®

The following terms are trademarks of SAP AG in Germany, in the United States, other countries, or both:

SAP®, SAP Logo®, mySAP.com®, R/3®, ABAP®, SSQJ®, Advanced Technology Group®, OSS®, SAP R/3 Note®,

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

ORACLE®

The information provided in this document is distributed "AS IS" basis without any warranty either express or implied. IBM AND SAP DISCLAIM ALL EXPRESS AND IMPLIED WARRANTIES WITH RESPECT TO SUCH INFORMATION, INCLUDING ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. The use of this information or the implementation of any of these techniques is a customer responsibility and depends on the customer's ability to evaluate and integrate them into their operating environment. While the information contained in this paper has been reviewed by IBM and SAP for accuracy, there is no guarantee that the same or similar results will be obtained elsewhere. Customers attempting to adapt these techniques to their own environments do so at their own risk. The performance data contained herein was obtained in a controlled environment based on the use of specific data. Actual results that may be obtained in other operating environments may vary significantly. These values do not constitute a guarantee of performance.

References in this document to IBM and SAP products, programs, or services do not imply that IBM or SAP intend to make such products available in all countries in which each company operates. Neither IBM nor SAP warrants the others products. Each company's products are warranted in accordance with the agreements under which they are provided.

Version: 1.1  
June 24, 2005

Document Author:  
Sathees B Kodi/San Jose/IBM  
E-Mail: [satheesk@us.ibm.com](mailto:satheesk@us.ibm.com)  
Ph: 1-408-256-3065 (T/L: 276-3065)

Document Owner:  
Amit Mathur/San Francisco/IBM  
E-Mail: [amitmat@us.ibm.com](mailto:amitmat@us.ibm.com)  
Ph: 1-408-256-9932 (T/L: 276-9932)



## Abstract

This white paper explains the use of an IBM TotalStorage DS6800 storage server as an essential component of advanced infrastructure solutions, such as one implementing a High Availability Split Mirror Backup / Recovery solution (SMBR) for SAP® R/3® on the Oracle RDBMS and the AIX operating system environments.

It sets forth a methodology for a “zero” downtime backup of SAP databases used in the above SMBR environment. This solution is illustrated on an IBM TotalStorage DS6800 IBM’s recently announced midrange business class storage server and uses Advanced Copy functions to demonstrate a “no impact,” server-less backup of a live SAP R/3 system without loss of transactions in flight when backing up data.

“Near Instant” availability of a point-in-time copy of an SAP production database using Oracle’s HOT BACKUP feature and IBM’s consistency group technology provides the ability to deliver a global consistent copy of the database using the log information written during the online backup. The ability to provide consistent copies of the database provides flexibility to place an emergency system at users disposal while recovering the live database from a disaster. Beyond Backup / Recovery, a consistent copy of the database may be used for various purposes, such as creation of a reporting, production-fix, or a repository instance for a system running SAP® Business Information Warehouse (SAP BW).

## 1. Introduction

SAP's Advanced Technology Group (ATG) has developed scenarios using live databases that constantly copy or mirror data using storage subsystems, supporting continuous operation during the split (and resynchronization) of the mirror.

The solution demonstrates how IBM Metro Mirror [formerly known as Peer to Peer Remote Copy (PPRC) in Synchronous mode] can help SAP customers create a backup with little or no noticeable impact on production servers. This Split Mirror Backup solution can also use the IBM Consistency Group technology to suspend simultaneously writes to provide a global consistent copy as a backup. This paper describes in detail how the SAP R/3 Split Mirror solution can be implemented on a DS6800 using SAP R/3 Enterprise / Oracle 9i / AIX 5L platform. A solution similar to the one described in the following pages was implemented on an IBM ESS with SAP R/3 on Oracle / AIX and was first demonstrated in December 2000. This open systems solution for SAP with Oracle on AIX takes advantage of Oracle's Online or Hot Backup functionality.

The importance and the value of this Split Mirror Backup solution is that customer backups can be done in a few minutes instead of a few hours without this Split Mirror Backup solution. This Split Mirror Backup solution is automated through shell scripts and user needs to only provide the input values to the environment config file and data config file giving more flexibility to the customers. This Split Mirror Backup solution takes the advantage of Oracle hot backup methodology and copy services functions like FlashCopy<sup>®</sup> with freeze option using consistency group technology.

The Split Mirror Backup solution described in the white paper was implemented with a dual DS6800 configuration using the DS6800's advanced functions – the local copy function FlashCopy (FC) and the IBM Remote mirror and copy (Also known as Metro Mirror). The core SAP R/3 system was loaded using a tool developed by SAP – SSQJ to simulate online transactions.

## 2. Customer Requirements

The latest trend towards very large databases (VLDB), accompanied by the need for high availability in a global enterprise environment means that customers now demand production systems are available on a 24 x 7 basis. This also means that in case of a disaster, the system has to be available within minutes, or hardly longer than the time needed for the physical reload of the database from secondary or remote storage media. The high availability requirement also implies that backup and the creation of an emergency system may not cause any downtime of the live production system. Finally all procedures to achieve this must be automated.

### 3. Introduction to the IBM TotalStorage DS6000 series

IBM Total Storage DS6000 series is newly released and is designed to provide high availability, multiplatform and simplified management tools for business critical storage work loads. It is designed to support 24x7 operations.

The following list provides an overview of some of features associated with the DS6000 that allows the DS6000 to meet and exceed the customer DS6000 needs.

#### IBM TotalStorage® DS6000 series Highlights

The IBM TotalStorage® DS6000 series is a fibre channel based series of storage systems that supports a wide range of IBM and non-IBM server platforms and operating environments. This includes open, zSeries, and iSeries servers.

In a small 3U footprint, the new storage subsystem is designed to provide business continuity, disaster recovery and resiliency previously only available in expensive high end storage subsystems. The DS6000 series is compatible with previous Enterprise Storage Server (ESS) Models 800 and 750 copy functions, as well as with the new DS8000 series.

The DS6000 series introduces an entirely new era in price, performance and scalability. Now for the first time zSeries and iSeries customers have the option for a midrange priced storage subsystem with many of the features and functions of an higher end enterprise storage subsystem

#### PowerPC processor technology:

The DS6800 utilizes two 64-bit PowerPC 750GX 1 GHz processors for the storage server and the host adapters, respectively, and another PowerPC 750FX 500 MHz processor for the device adapter on each controller card. The DS6800 series controller's microcode shares many parts of the DS8000 series microcode and both are greatly enhanced extension of the ESS microcode.

#### Industry-standard fibre channel disk drives:

The DS6000 series products offers a selection of fibre channel disk drives. According to your performance needs you can select from three different disk drive types: fast 73 GB drives rotating at 15,000 RPM, good performing and cost efficient 146 GB drives operating at 10,000 RPM, and high capacity 300 GB drives running at 10,000 RPM. The minimum storage capability with eight 73 GB DDMs is 584 GB. The maximum storage capability with 16 300 GB DDMs for the DS6800 controller enclosure is 4.8 TB. If you want to connect more than 16 disks, you can use upto 7 DS6800 expansion enclosures that allow a maximum of 128 DDMs per storage system and provide a maximum storage capability of 38.4 TB.



### **Four-port fibre channel/FICON adapters:**

These new adapters are designed to not only enhance connectivity, but also increase configuration flexibility because the individual ports can be configured to support fibre channel or FICON.

### **New processor memory offerings:**

The DS6800 is equipped with 2 GB memory in each controller card, adding up to 4 GB. Some part of the memory is used for the operating system and another part in each controller card acts as nonvolatile storage (NVS), but 50% of the memory is used as cache. This design to use processor memory helps make cache accesses very fast.

### **New internal fabric:**

The DS6000 series features a new internal fabric which can help provide increased bandwidth and fault tolerant internal interconnection, which is also used in the IBM eServer pSeries systems. It is called RIO-2 (Remote I/O) and can operate at speeds up to 1 GHz and offers a 2 GB per second sustained bandwidth per link.

### **High availability:**

The DS6000 series is designed and implemented with component redundancy to help avoid many potential single points of failure.

### **Logical Unit Number (LUN) and volume management**

- Non-disruptive LUN and volume creation and deletion are now supported. When a LUN or volume is deleted, the capacity can be re-formatted and re-used.
- LUNs and volumes can be configured to span arrays. Therefore, the size of the volume/LUN is not constrained by the size of the array. LUNs up to 2 TB are supported. CKD volumes up to 65,520 cylinders are supported.

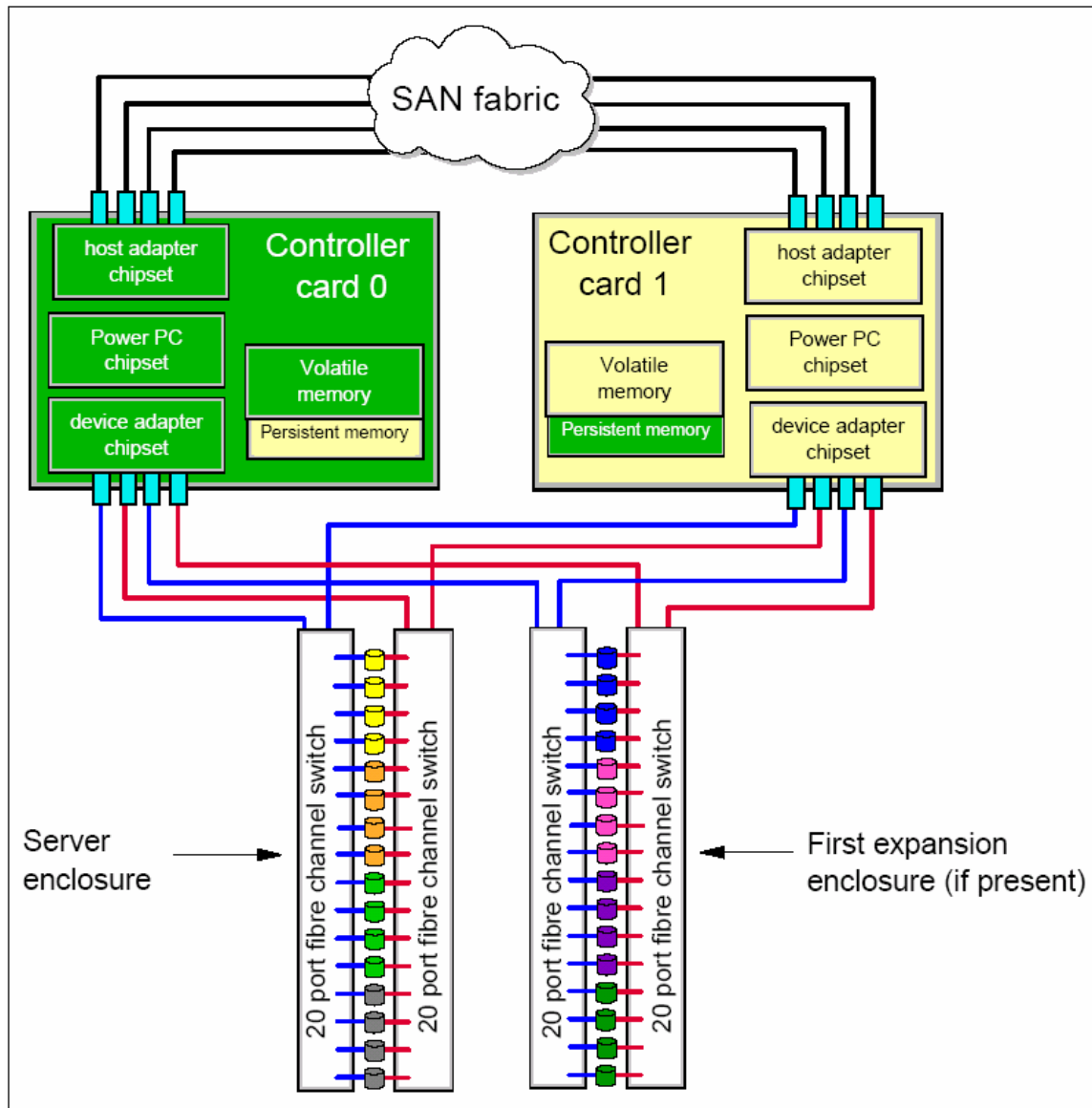
### **Addressing capabilities:**

More Logical Subsystems (LSS), logical devices, and logical paths can be defined versus the current DS6000.

- Up to 32 logical subsystems
- Up to 8192 logical volumes
- Up to 1040 volume groups
- Up to 2 TB LUNs
- Large z/OS volumes with up to 65520 Cylinders

## 4. DS6000 Architecture

The DS6800 consists of two controller cards. Each controller card contains an integrated four port host adapter to connect Fibre Channel and FICON hosts. For the disk subsystem, each controller card has an integrated four port FC-AL (Fibre Channel Arbitrated Loop) device adapter that connects the controller card to two separate Fibre Channel loops. Each switched loop attaches disk enclosures that each contains up to 16 disks. Each enclosure contains two 22 port Fibre Channel switches. Of these 22 ports, 16 are used to attach to the 16 disks in the enclosure and four are used to interconnect with other enclosures. The architecture is depicted in Figure 1.



*DS6000 architecture – Figure 1*

The remaining two are reserved for internal use. Each disk is attached to both switches. Whenever the device adapter connects to a disk, it uses a switched connection to transfer data. This means that all data travels via the shortest possible path. The attached hosts interact with microcode running on a PowerPC chipset to access data on logical volumes.

The microcode manages all read and write requests to the logical volumes on the disk arrays. For write I/O operations, the controllers use fast-write, whereby the data is written to volatile memory on one controller and persistent memory on the other controller. The DS6800 then reports to the host that the write is complete before it has actually been written to disk. This supports much faster write performance. Persistent memory is also called NVS or non-volatile storage.

When a host performs a read I/O, the controllers fetch the data from the disk arrays via the high performance switched disk architecture. The data is then cached in volatile memory in case it is required again. The controllers attempt to anticipate future reads by an algorithm known as SARC (sequential prefetching in adaptive replacement cache). Data is held in cache as long as possible using this smart algorithm. If a cache hit occurs where requested data is already in cache, then the host does not have to wait for it to be read from the disks.

If you can view Figure 1 in color, you can use the colors as indicators of how the DS6800 hardware is shared between the controllers (in black and white, the dark color is green and the light color is yellow). On the left side is the green controller. The green controller records its write data and caches its read data in its volatile memory area (in green). For fast-write data it has a persistent memory area on the right controller. It uses its device adapter chipset to access the disk arrays under its management. The yellow controller on the right operates in an identical fashion.

## 5. Copy Services

Copy Services run on the DS6800 storage unit and support open systems and zSeries environments. These functions are supported also on the previous generation of storage systems called the IBM TotalStorage Enterprise Storage Server (ESS).

Many design characteristics of the DS6800 and data copying and mirroring capabilities of Copy Functions contribute to the protection of data. The licensed Copy Functions are the following:

FlashCopy, which is a point-in-time copy function

Remote Mirror and Copy functions, previously known as Peer-to-Peer Remote Copy or PPRC, which include:

- IBM TotalStorage Metro Mirror, previously known as Synchronous PPRC
- IBM TotalStorage Global Copy, previously known as PPRC Extended Distance
- IBM TotalStorage Global Mirror, previously known as Asynchronous PPRC
- z/OS Global Mirror, previously known as Extended Remote Copy (XRC)
- z/OS Metro/Global Mirror

## Consistency Group Technology

IBM's Consistency Group technology supports the consistency between any set of source and target volumes defined in a Consistency group for local copy within a storage system or remote mirror and copy between storage systems. The split mirror backup solution uses the consistency technology at FlashCopy level as well as at remote mirror and Copy level. With Copy Functions, you can create *Consistency Groups* for FlashCopy and PPRC. Consistency Group is a function to keep *data consistency* in the backup copy. Data consistency means that the order of dependent writes is kept in the copy. For more details on the Consistency Group refer to the IBM Red Book "IBM TotalStorage Enterprise Storage Server Implementing ESS Copy Services in Open Environments."

## PPRC Consistency Groups

To maintain consistency of data across volumes at the recovery (target) site, volumes in a remote mirror and copy relationship can be collected into a *PPRC Consistency Group*. A PPRC consistency group is a set of volume pairs that



have the same primary and secondary LSS for which the PPRC Consistency Group option has been activated.

## Consistency Group FlashCopy

If a consistent point-in-time copy across many logical volumes is required, and the user does not wish to quiesce host I/O or database operations, then the user may use the Consistency Group FlashCopy function to create a consistent copy across multiple logical volumes in multiple storage units.

In order to create this consistent copy, the user would issue a set of Establish FlashCopy commands with a *freeze* option, which will hold off host I/O to the source volumes. In other words, the Consistency Group FlashCopy function provides the capability to temporarily queue (at the host I/O level, not the application level) subsequent write operations to the source volumes that are part of the Consistency Group. During the temporary queuing, the FlashCopy establish is completed. The temporary queuing continues until this condition is reset by the “*unfreezeflash*” command or the time-out value expires (the default is two minutes).

## 6. Installation Preparations and Lab Setup

This section is used describe the initial setup and activities associated with creation of the environment required for this project.

The production host (AIX LPAR) name is “host-a”. The Backup host name is “host-b”. The two hosts are connected to both DS6800 boxes in the demonstration as shown in Figure 2. These two hosts are connected to these storage servers through SAN switch using Fibre cables. The primary DS6800 server name is BAYONET. The secondary or backup DS6800 server name is PEBBLE. The Metro Mirror also known as PPRC synchronous mirroring, relationship is established between these two DS6800 storage servers and PPRC paths connected using fibre cables. In the lab setup only one PPRC path is used for this Split Mirror Backup solution.

The host system operating software used in this solution is AIX 5L (5.2.0.0) and application software used is SAP R/3 Enterprise with Oracle 9i. The tool used to create load simulation on the SAP system is SSQJ 9.C that is designed by SAP. SSQJ is a generic test measurement tool that was developed with ABAP and function modules in core SAP R/3

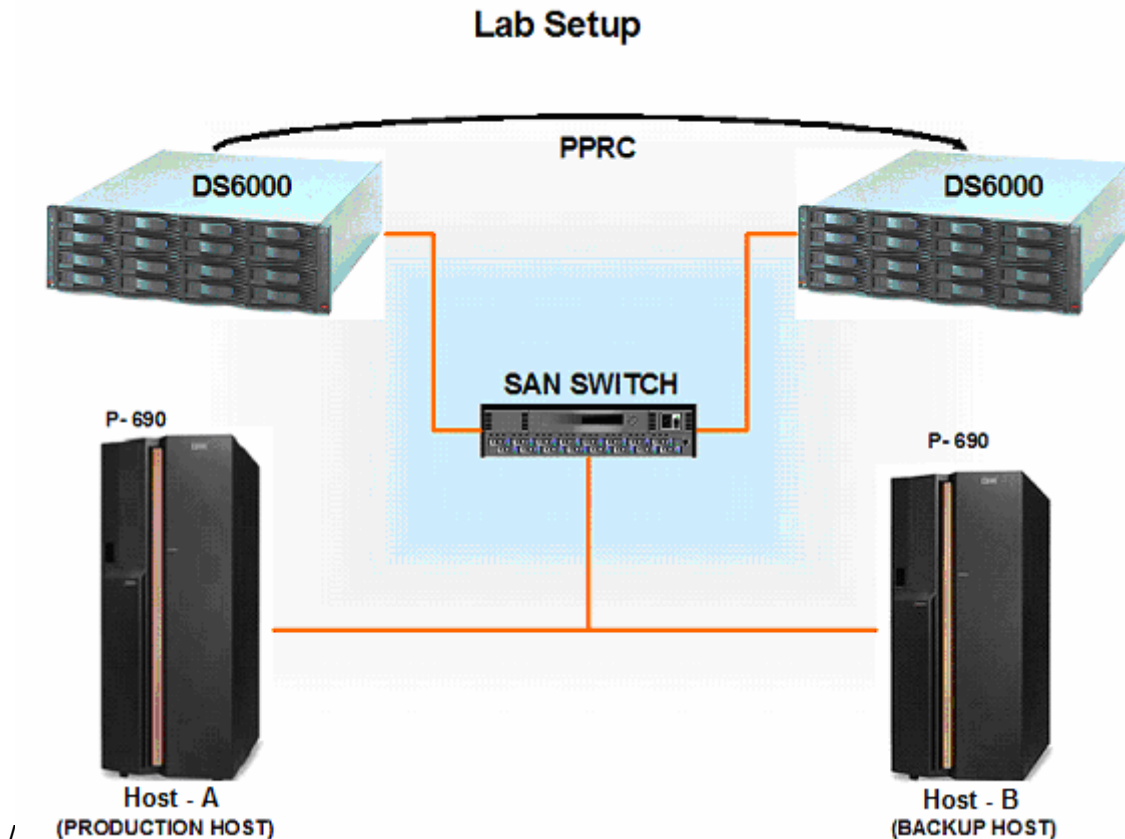


Figure 2

## 7. SAP / Oracle Database Layout

The SAP and Oracle file systems used in this Split Mirror Backup solution is depicted in the following table as shown below. The LUN sizes used are 1 GB, 2 GB, 6 GB, 10 GB, 20 GB and 40GB. The LUNs on a DS6800 can be created across the ranks from a single extent pool. This gives more potential flexibility and performance benefit to the customers. It is preferable to have the file system /oracle/S01/oraarch on a separate disk (LUN) in order to re-sync the archive log files in the hot backup process. The disk group S01sap07vg (File system /oracle/S01/sapdata5) is created to store SSQJ tablespaces. Figure 3 below provides the information on SAP and Oracle disk groups, File systems and LUN sizes and their functions.

Disk Group	File System Name	Function	LUN / Range	File System Size
<b>S01sap00vg</b>	/usr/sap/S01	work & global directory	0801-0803, 0832	5 GB
	/sapmnt/S01	SAP executables		2 GB
	/usr/sap/trans	Transport Directory		10 GB
<b>S01sap01vg</b>	/oracle/S01/origlogA	Online redo log files set I	0804-0809	512 MB
	/oracle/S01/mirrlogB	Online redo log files set II		512 MB
	/oracle/S01/mirrlogA	Mirror of origlogA files		512 MB
	/oracle/S01/origlogB	Mirror of origlogB files		512 MB
	/oracle/S01/sapreorg	Temporary data staging		2 GB
<b>S01sap02vg</b>	/oracle	Oracle base directory	0810-0814	256 MB
	/oracle/client	Oracle Client		512 MB
	/oracle/S01	Oracle Instance specific directory		3 GB
	/oracle/S01/920_64	Oracle Executables		4 GB
	/oracle/stage/920_64	Oracle Staging Area		2.5 GB
<b>S01sap03vg</b>	/oracle/S01/sapdata1	SAP R/3 data files	0815-0819	30 GB
<b>S01sap04vg</b>	/oracle/S01/sapdata2	SAP R/3 data files	0820-0822	30 GB
<b>S01sap05vg</b>	/oracle/S01/sapdata3	SAP R/3 data files	0825-0827	60 GB
<b>S01sap06vg</b>	/oracle/S01/sapdata4	SAP R/3 data files	0828-0829	80 GB
<b>S01sap07vg</b>	/oracle/S01/sapdata5	SAP R/3 data files	0830-0831	80 GB
<b>S01sap08vg</b>	/oracle/S01/oraarch	Archive log files	0823, 0824	40 GB

Figure 3

## 8. Split Mirror Backup & Recovery Process

Initially the production system is in normal READ/WRITE operation state. In the lab all volumes (Data & Log) are in sync, which are in a constant metro mirror relationship (synchronous PPRC) between source DB<sub>A</sub> and target DB<sub>B</sub> across the primary DS6000 and secondary DS60000 as shown below in Figure 4. This allows the secondary site to be up-to-date at any point of time. The following SMBR scenario is tested in the lab.

The entire process is automated through shell scripts. The scripts are very simplified, and customizations are limited to customers having to fill the environment config file and data config file. One main script can run the whole split mirror process and will complete the local safety FlashCopy target and remote FlashCopy target at secondary server.

### Split Mirror Backup and Recovery and Standby SAP R/3 System

The SMBR process steps are listed below:

The typical split mirror backup and recovery process is shown in Figure 4. In this Split Mirror Backup solution FlashCopy consistency groups with freeze option is used along with Oracle Hot Backup methodology to make global consistent copy.

#### Lab Setup

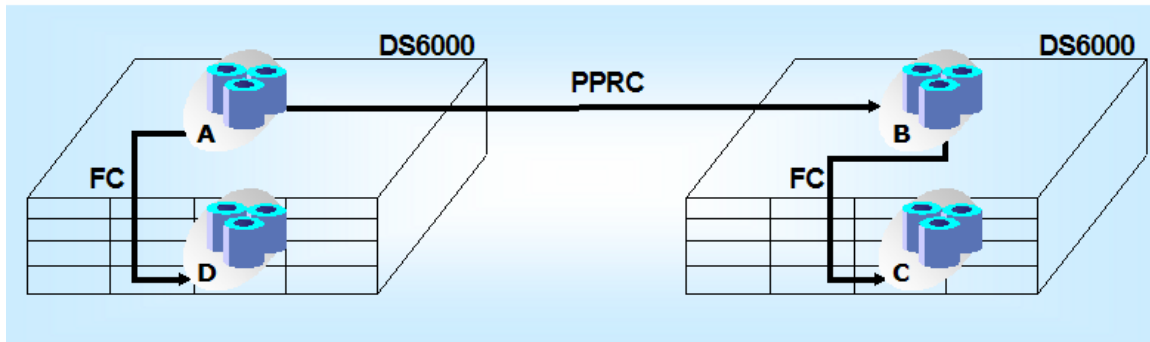


Figure 4

DB<sub>C</sub> volumes have been used to bring up an SAP instance after successful backup to tape. Using the SAP R/3 Homogeneous System Copy procedures for post copy BASIS administration tasks such as changing the RFC settings, locking user IDs, TMS setup and batch job cancellations etc., will confirm that the actual production related activities are deactivated in the test SAP instance on DB<sub>C</sub> volumes.

The first step in SMBR process would be to logoff all the users from the production-fix / reporting / standby instance i.e., DB<sub>C</sub> (on the backup (target) host) before stopping respective SAP and Oracle processes. The SAP / Oracle instance on the Safety FlashCopy target volumes DB<sub>D</sub> in the primary ESS is also stopped.

## Phase Description of the SMBR Backup Process:

The scripts are divided into various phases to make scripts user friendly for the customers.

### 1. Begin Phase:

1. Establish pprc path from DB<sub>A</sub> to DB<sub>B</sub> and ensure status as 'Full Duplex'.
2. Stop SAP, Database and Listener processes on Host connected to DB<sub>C</sub>.
3. Unmount the filesystems, Vary off the volume groups, Export volume groups and remove devices on target host connected to data volumes DB<sub>C</sub>.

### 2. FlashCopy Phase on Primary DS6000:

1. Withdraw Prior FlashCopy (FC) relation between DB<sub>A</sub> and DB<sub>D</sub>
2. Unmount the filesystems, Vary off the volume groups, Export volume groups and delete all previously existing disk groups on DB<sub>C</sub>.
3. Alter Tablespace Begin Backup on DB<sub>A</sub>; Suspend the Database.
4. FlashCopy Data volumes DB<sub>A</sub> to DB<sub>D</sub> (Safety Copy).
5. Unfreeze the FlashCopy source volumes DB<sub>A</sub> to DB<sub>D</sub>.
6. Alter database Resume; on DB<sub>A</sub> Database.
7. Alter Tablespace End Backup; on DB<sub>A</sub> Database.
8. Alter system archive log current; on DB<sub>A</sub> Database.
9. Alter database backup controlfile 'where archive log are located'; on DB<sub>A</sub> Database.
10. Alter system archive log current; on DB<sub>A</sub> Database.
11. Resync the archive volumes.

### 3. REMOTE MIRROR AND COPY Phase between Primary DS6000 and Secondary DS6000:

1. Withdraw Prior FlashCopy (FC) relation between DB<sub>B</sub> and DB<sub>C</sub>.
2. Alter Tablespace Begin Backup on DB<sub>A</sub>; Suspend the Database.
3. Freeze PPRC relations between DB<sub>A</sub> and DB<sub>D</sub>. (**OPTIONAL**) This step is not required for high availability point of view.
4. Unfreeze PPRC source volumes DB<sub>A</sub>. (**OPTIONAL**)
5. End backup steps for DB<sub>A</sub> Database, Repeat step 6 through 10 of phase 2.

In phase 3, pprcfreeze and pprcunfreeze commands are not mandatory. These commands will make sure no data is passing through DB<sub>A</sub> to DB<sub>B</sub>

during the freeze. Again it is only option. For the customers who are looking for high availability, they can ignore pprc freeze option.

**4. FlashCopy Phase on Secondary DS6000:**

1. FlashCopy Data volumes DB<sub>B</sub> to DB<sub>C</sub>.
2. Unfreeze FlashCopy volumes on DB<sub>A</sub>.

**5. PPRC Phase between Primary DS6000 and Secondary DS6000:**

1. Re-establish PPRC path between DB<sub>A</sub> and DB<sub>B</sub>. (OPTIONAL)
2. Resume PPRC relation between DB<sub>A</sub> and DB<sub>B</sub>. (OPTIONAL)
3. Make sure PPRC status between DB<sub>A</sub> and DB<sub>B</sub> is 'Full Duplex'.

**6. FlashCopy Phase on Secondary DS6000:**

1. Perform an incremental FlashCopy for Archive Volumes between DB<sub>B</sub> and DB<sub>C</sub>.

**7. Second Instance Phase (target host):**

1. Run the following AIX commands config manager, convert all hdisks to vpaths using "cfallvpath" command, import the volume groups, vary on volume groups and mount filesystems scripts on the target host.
2. Create users and groups oracle and sap, dba and sapsys on target host if needed.
3. Make change to profile, user env, and permissions on target host for sap<SID>adm and ora<SID>.
4. Make changes to /etc/services for SAP-related entries. And other changes required by the SAP installation on AIX (refer SAP and AIX documentation).
5. Start oracle listener on target host.
6. Recover oracle database on target host
7. Startup mount; set autorecovery on; recover database using backup controlfile until cancel; alter database open resetlogs; on target host database.
8. Delete all print jobs and their lists on Target on target host database.
9. Update RFC on target host SAP
10. Start SAP on target host.
11. Logon to SAP on target host and run following SAP transaction "sick", to verify if the system shows-up any errors.

**8. New Backup Cycle Initialization Phase:**

In order to be prepared for a new backup cycle, the systems (DB<sub>B</sub>, DB<sub>C</sub> and DB<sub>D</sub>) must be set back to the start situation

In this SMBR solution, the following tasks were created using DS6000 DSCLI command sets:

Please review the dscli documentation for following dscli commands, lsprrc, mkpprc, mkpprcpath, mkflash, resyncflash, rmflash, unfreezeflash, freezepprc, unfreezepprc etc. The following SMBR steps will give the clear explanation on how to use these DSCLI commands.

## SMBR Implementation Steps in Detail

Each SMBR step is described as follows:

### Synchronize DB<sub>A</sub> to DB<sub>B</sub>

#### 1. Begin Phase:

Ensure that the pprc Paths exist (and LUN's are in Full Duplex on both DB<sub>A</sub> and target DB<sub>B</sub>) between PPRC source (DB<sub>A</sub>) and target (DB<sub>B</sub>) volumes; 'establish' if they do not already exist:

IF PPRC EXIST:

The lsprrc command displays the status information for each remote mirror and copy volume relationship in the list.

```
Dscli> lsprrc -dev IBM.1750-13AAG7A -remotedev IBM.1750-13AAD0A -l  
0801-0809:1001-1009 0810-0815:1010-1015 0816:1036 0817-0819:1017-  
1019 0820:1020 0821-0822:1021-1022 0823-0824:1023-1024 0825-  
0829:1025-1029 0830-0832:1030-1032
```

IF PPRC PATH DOES NOT EXIST:

mkpprcpath: command establishes or replaces a remote mirror and copy (formerly PPRC) path between source and target logical subsystems (LSSs) over a fibre channel connection.

```
Dscli> mkpprcpath -dev IBM.1750-13AAG7A -remotedev IBM.1750-  
13AAD0A -consistgrp -srclss 08 -tgtlss 10 -remotewwnn  
500507630CFE03D2 I0002:I0002  
CMUC00149I mkpprcpath: Remote Mirror and Copy path 10:14  
successfully established.
```

lsprrcpath: list of existing remote mirror and copy (formerly PPRC) path definitions.

```
Dscli> lsprrcpath -dev IBM.1750-13AAG7A 08  
Date/Time: June 15, 2005 1:23:07 PM CDT IBM DSCLI Version: 5.0.3.139  
DS: IBM.1750-13AAG7A  
Src Tgt State SS Port Attached Port
```



```
=====
08 10 Success FF10 I0002 I0002
```

*mkpprc*: command establishes a remote mirror and copy (formerly PPRC) relationship for a volume pair.

```
Dscli> mkpprc -dev IBM.1750-13AAG7A -remotedev IBM.1750-13AAD0A
-type mmir 0801-0809:1001-1009 0810-0815:1010-1015 0816:1036 0817-
0819:1017-1019 0820:1020 0821-0822:1021-1022 0823-0824:1023-1024
0825-0829:1025-1029 0830-0832:1030-1032
```

## 2. FlashCopy Phase on Primary DS6000

Create a Safety FlashCopy of the Production Instance at PRIMARY-DS6000.

*Rmflash*: command removes a relationship between FlashCopy volume pairs.

```
Dscli> rmflash -dev IBM.1750-13AAG7A -quiet 1051:112B 100C-
1012:1124-112A 101B-1022:1114-111B 1045-104A:1142-1147 102B-
102E:1132-1135 1037-1038:113A-113B 1088-1089:1190-1191 102F:1136
1030:1137
```

Source database:

```
SQL> alter Tablespace <PSAP...> Begin Backup;
SQL> alter system suspend;
```

*Mkflash*: command initiates a point-in-time copy from source volumes to target volumes.

```
Dscli> mkflash -dev IBM.1750-13AAG7A -freeze -record -persist
1051:112B 100C-1012:1124-112A 101B-1022:1114-111B 1045-
104A:1142-1147 102B-102E:1132-1135 1037-1038:113A-113B 1088-
1089:1190-1191 102F:1136 1030:1137
```

*unfreezeflash*: command resets a FlashCopy consistency group that was previously established with the *-freeze* flag when the *mkflash* or *inflash* commands were issued

```
Dscli> unfreezeflash -dev IBM.1750-13AAG7A 10
```

source database:

```
SQL> alter database Resume;
SQL> alter Tablespace <PSAP...> End Backup;
SQL> alter system archive log current;
```

```
SQL> alter database backup controlfile to  
'/oracle/S01/oraarch/cntrlS01.dbf' REUSE;  
SQL> alter system archive log current;
```

*Resyncflash*: command (formerly called *incflash* for an incremental FlashCopy process) increments an existing FlashCopy pair that has been established with the *-record* and *-persist* flags.

```
Dscli> resyncflash -dev IBM.1750-13AAG7A 1088:1189 – Archive luns  
only
```

### 3. PPRC Phase between Primary DS6000 & Secondary DS6000:

Create PPRC Between DB<sub>A</sub> & DB<sub>B</sub>, PRIMARY DS6000 and SECONDARY DS6000.

Remove a FlashCopy between DB<sub>B</sub> and DB<sub>C</sub> PRIMARY-DS6000.  
*Rmflash*: command removes a relationship between FlashCopy volume pairs.

```
Dscli> rmflash -dev ${CLI_TARGET_SQ_DEV} -quiet  
${FCS_B_TO_C_VOLS}
```

Source database:

```
SQL> alter Tablespace <PSAP...> Begin Backup;  
SQL> alter system suspend;
```

*Freezepprc*: command creates a new remote mirror and copy consistency group. It places the source logical subsystem (LSS) in the long busy state so that no I/Os can be directed to it.

```
Dscli> freezepprc -dev ${CLI_SOURCE_SQ_DEV} -remotedev  
${CLI_TARGET_SQ_DEV} \  
${A_LSSID}:${B_LSSID}
```

*unfreezepprc*: command thaws an existing remote mirror and copy (formerly PPRC) consistency group. The command resets the queue full condition for the primary volume. All queued writes to the source volume are written.

```
Dscli> unfreezepprc -dev ${CLI_SOURCE_SQ_DEV} -remotedev  
${CLI_TARGET_SQ_DEV} \  
${A_LSSID}:${B_LSSID}
```

The above two DSCLI commands *freezepprc* and *unfreezepprc* are not required for high availability point of view. These two commands are not

mandatory for split mirror process. This will command will make sure no data is transferred to secondary DS6000 server.

source database:

```
SQL> alter database Resume;  
SQL> alter Tablespace <PSAP...> End Backup;  
SQL> alter system archive log current;  
SQL> alter database backup controlfile to  
'/oracle/S01/oraarch/cntrlS01.dbf' REUSE;  
SQL> alter system archive log current;
```

#### 4. FlashCopy Phase on Secondary DS6000:

Create a FlashCopy of the between DB<sub>B</sub> and DB<sub>C</sub> at secondary DS6000:  
*Mkflash*: command initiates a point-in-time copy from source volumes to target volumes.

```
Dscli> mkflash -dev ${CLI_TARGET_SQ_DEV} -freeze -record -persist  
${FCS_B_TO_C_VOLS}
```

*unfreezeflash*: command resets a FlashCopy consistency group that was previously established with the *-freeze* flag when the *mkflash* or *resyncflash* commands were issued.

```
Dscli> unfreezeflash -dev ${CLI_TARGET_SQ_DEV} ${B_LSSID}
```

#### 5. PPRC Phase between Primary DS6000 & Secondary DS6000:

Create PPRC PATH Between DB<sub>A</sub> & DB<sub>B</sub>, primary DS6000 and secondary DS6000

*mkpprcpath*: command establishes or replaces a remote mirror and copy (formerly PPRC) path between source and target logical subsystems (LSSs) over a fibre channel connection.

```
Dscli> mkpprcpath -dev ${CLI_SOURCE_SQ_DEV} -remotedev  
${CLI_TARGET_SQ_DEV} \  
-consistgrp -srcLSS ${A_LSSID} -tgtLSS ${B_LSSID} -remotewwnn  
${REMOTEWWNN} \  
${SOURCE_PORT_ID}:${TARGET_PORT_ID}
```

*resumepprc*: command resumes a remote mirror and copy (formerly PPRC) relationship for a volume pair.

```
Dscli> resumepprc -dev ${CLI_SOURCE_SQ_DEV} -remotedev  
${CLI_TARGET_SQ_DEV} \  
-type mmir ${PPRC_A_TO_B_VOLS}
```

Check if archive luns Between DB<sub>A</sub> & DB<sub>B</sub> are in Full Duplex State:

*Lspprc*: command displays a list of remote mirror and copy (formerly PPRC) volume relationships for a storage image, and status information for each remote mirror and copy volume relationship in the list.

```
Dscli> lspprc -dev ${CLI_SOURCE_SQ_DEV} -remotedev  
${CLI_TARGET_SQ_DEV} \  
${PPRC_A_TO_B_VOLS_ARCH}
```

The above (Step 5) commands are not required if pprcfreeze option is not used in Split Mirror Backup process.

## 6. FlashCopy Phase on Secondary DS6000:

*resyncflash*: command (formerly called *inflash* for an incremental FlashCopy process) increments an existing FlashCopy pair that has been established with the *-record* and *-persist* flags.

Resync archive luns Between DB<sub>A</sub> & DB<sub>C</sub>:

```
Dscli> resyncflash -dev ${CLI_TARGET_SQ_DEV} -record -persist \  
${FCS_B_TO_C_VOLS_ARCH}
```

## Appendix

### 9. Sample Scripts

Script for importing, varyoff volumes and mounting file systems.

---

```
#!/usr/bin/ksh
#importvlg, varyonvg and mount filesystem.

TARGET_HOST="host-b"
REMOTE_SHELL_CMD=/usr/bin/ssh
TGT_ORACLE_SID=S01
SQL_DIR=/scripts/pprc/SQL
TGT_FC_ADAPTER=fcs1
TGT_FC_ADAPTER_FSCSI=fscsi1

RC=0
x=1
#####
#The cfgmgr command configures devices and optionally installs device software
#into the system. The devices to be configured are controlled by the
#Configuration Rules object class, which is part of the Device Configuration
#database. Each configuration rule specifies three items:
#####
${REMOTE_SHELL_CMD} ${TARGET_HOST} "cfgmgr -l ${TGT_FC_ADAPTER}"

#####
#Get vpath's, SDD command cfallpath
#####
${REMOTE_SHELL_CMD} ${TARGET_HOST} "cfallvpath"

#####
#Check if the target mount point list were created
#####
if [[ -f ${SQL_DIR}/tgt_mountpoints_${TARGET_HOST}.lst ]]
then
    rm ${SQL_DIR}/tgt_mountpoints_${TARGET_HOST}.lst
fi
echo "\n"

#####
#Iterate through all the physical volumes, Import volume groups, create volume groups
#####
for fvpath in ` ${REMOTE_SHELL_CMD} ${TARGET_HOST} "lspv | grep None |tr -s ' '|cut -d ' ' -
f1|grep vpath"
do
    ##make sure the status of vpath is not 'concurrent or active'
    ${REMOTE_SHELL_CMD} ${TARGET_HOST} "lspv | grep None |tr -s ' '|cut -d ' ' -f1|grep
\"${fvpath}\">/dev/null
```

## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
RC=$?
if [[ ${RC} = 0 ]]
then
    ###-----Import Volume Groups - Step-----##
    ${REMOTE_SHELL_CMD} ${TARGET_HOST} "importvg -y
    ${TGT_ORACLE_SID}sap0${x}vg ${fvpath}">/dev/null 2>&1
    RC=$?
    if [[ ${RC} = 0 ]]
    then
        ###-----Varyon - Step-----##
        ${REMOTE_SHELL_CMD} ${TARGET_HOST} "varyonvg
        ${TGT_ORACLE_SID}sap0${x}vg">/dev/null 2>&1
        let x=x+1
    else
        echo "Importvg ${fvpath} - Failed on host ${TARGET_HOST}"
    fi
fi
${REMOTE_SHELL_CMD} ${TARGET_HOST} "lspv -l ${fvpath}|tr -s ' '|cut -d ' ' -f 5|grep ^[/]"
>> ${SQL_DIR}/tgt_mountpoints_${TARGET_HOST}.lst
done

###----- Mount - Step -----##
for mount_pt in `cat ${SQL_DIR}/tgt_mountpoints_${TARGET_HOST}.lst|sort`
do
    ${REMOTE_SHELL_CMD} ${TARGET_HOST} "mkdir -p ${mount_pt}" > /dev/null
    ${REMOTE_SHELL_CMD} ${TARGET_HOST} "mount ${mount_pt}" > /dev/null
done
```

The main Split Mirror Backup / Recovery script is shown below. In the lab, Secured Shell (SSH) is configured for communication between source and target hosts. Customers need to setup the secured shell on the hosts to use the following Split Mirror Backup scripts in their environment.

### smbr\_main.sh Script

```
#!/usr/bin/ksh

RC=0
SCRIPT_DIR=`pwd`
echo ${SCRIPT_DIR}

echo
"#####"
echo ""date | tr -s ' ' | cut -f4 -d ' ' " Step - 1: SOURCE ENV VARIABLE FOR SHELL."
echo
"#####\n"
. ${SCRIPT_DIR}/env_source.sh
RC=$?
if [[ ${RC} -ne 0 ]]
then
    echo "Error during ${SCRIPT_DIR}/env_source.sh execution."
    exit 2
fi
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
echo
#####
echo ""date | tr -s ' ' | cut -f4 -d ' "' Step - 2: Check for Current user: root, dscli, ssh"
echo
#####\n"
time . ${EXE_DIR}/test_env_variable.sh 2>&1 | tee ${LOG_DIR}/test_env_variable.log
egrep 'ERROR|Error|error' ${LOG_DIR}/test_env_variable.log >/dev/null
RC=$?
if [[ ${RC} = 0 ]]
then
    echo "Step-2: Check for Current user: root, dscli, ssh - Failed"
    exit 2
fi

echo
#####
echo ""date | tr -s ' ' | cut -f4 -d ' "' Step - 3: Make sure pprc status 'Full Duplex' between A and B."
echo
#####\n"
time . ${EXE_DIR}/lspprc_A_to_B_scripts.sh 2>&1 | tee ${LOG_DIR}/lspprc_A_to_B_scripts.log
egrep 'ERROR|Error|error' ${LOG_DIR}/lspprc_A_to_B_scripts.log >/dev/null
RC=$?
if [[ ${RC} = 0 ]]
then
    echo "Step-3 pprc status is not 'Full Duplex' between A and B: Error."
    exit 2
fi

echo
#####
echo ""date | tr -s ' ' | cut -f4 -d ' "' Step - 4: Check for database status: OPEN."
echo
#####\n"
chmod -R 777 ${SQL_DIR}
rm ${SQL_DIR}/source_db_status.lst >/dev/null
su - ${SRC_DB_OWNER_ID} -c 'sqlplus -s "/as sysdba"'<<ENF>/dev/null
    set heading off
    set feedback off
        alter system resume;
    pool ${SQL_DIR}/source_db_status.lst
    select status from v$instance;
    pool off
ENF
grep "OPEN" ${SQL_DIR}/source_db_status.lst >/dev/null
RC=$?
if [[ ${RC} != 0 ]]
then
    echo "Step-4 Source database must have OPEN status, Error."
    exit 2
fi

echo
#####
echo ""date | tr -s ' ' | cut -f4 -d ' "' Step - 5: STOP DATABASE and SAP on TARGET."
echo
#####\n"
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
time . ${EXE_DIR}/tgt_stop_sap.sh 2>&1 | tee ${LOG_DIR}/tgt_stop_sap.log
egrep 'ERROR|Error|error' ${LOG_DIR}/tgt_stop_sap.log >/dev/null
RC=$?
if [[ ${RC} = 0 ]]
then
    echo "Step-5: check the required env variables, and review logfile:
${LOG_DIR}/tgt_stop_sap.log."
    exit 2
fi

echo
"#####"
echo ""date | tr -s ' ' | cut -f4 -d ' '" Step - 6: FCS_A_to_D flash copy."
echo
"#####\n"
time . ${EXE_DIR}/FCS_A_to_D_script.sh 2>&1 | tee ${LOG_DIR}/FCS_A_to_D_script.log
egrep 'ERROR|Error|error' ${LOG_DIR}/FCS_A_to_D_script.log >/dev/null
RC=$?
if [[ ${RC} = 0 ]]
then
    echo "Step-6: error Executing FCS_A_to_D_script.sh, RC=${RC}"
    exit 2
fi

echo
"#####"
echo ""date | tr -s ' ' | cut -f4 -d ' '" Step - 7: FCS_A_to_B PPRC."
echo
"#####\n"
time . ${EXE_DIR}/PPRC_A_to_B_script.sh 2>&1 | tee ${LOG_DIR}/PPRC_A_to_B_script.log
egrep 'ERROR|Error|error' ${LOG_DIR}/PPRC_A_to_B_script.log>/dev/null
RC=$?
if [[ ${RC} = 0 ]]
then
    echo "Step-7: error Executing PPRC_A_to_B_script.sh, RC=${RC}."
    exit 2
fi

echo
"#####"
echo ""date | tr -s ' ' | cut -f4 -d ' '" Step - 8: FCS_B_to_C flash copy."
echo
"#####\n"
time . ${EXE_DIR}/FCS_B_to_C_script.sh 2>&1 | tee ${LOG_DIR}/FCS_B_to_C_script.log
egrep 'ERROR|Error|error' ${LOG_DIR}/FCS_B_to_C_script.log>/dev/null
RC=$?
if [[ ${RC} = 0 ]]
then
    echo "Step-8: error Executing FCS_B_to_C_script.sh, RC=${RC}."
    exit 2
fi

echo
"#####"
echo ""date | tr -s ' ' | cut -f4 -d ' '" Step - 9: START DATABASE and SAP on TARGET."
echo
"#####\n"
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
time . ${EXE_DIR}/tgt_start_sap.sh 2>&1 | tee ${LOG_DIR}/tgt_start_sap.log
RC=$?
if [[ ${RC} != 0 ]]
then
    echo "Step-9: Error Executing ${EXE_DIR}/tgt_start_sap.sh."
    exit 2
fi

echo
"#####"
echo "`date | tr -s ' ' | cut -f4 -d '`" SMBR Steps completed."
echo
"#####\n"
```

Customer needs to provide the data to the Input Config File which is shown below in blue color.

## 10. Input Config Files

### env\_source.sh file

```
#!/usr/bin/ksh
#####
#
# Environmental variables for SMBR scripts
#####

SCRIPT_DIR=/manju/scripts/pprc      #Please don't user `pwd` - other
scripts will not work - thanks
IGNORE_PPRC_FREEZE=Y #Valid input Y and N, Y=Yes N=NO

REMOTE_SHELL_CMD=/usr/bin/ssh
TARGET_HOST="host-b"
SOURCE_HOST="host-a"
ORACLE_SID=S01                      ## Always Source oracle SID
TGT_ORACLE_SID=${ORACLE_SID}        ## For pprc with no SID Change
ORACLE_HOME=/oracle/${ORACLE_SID}/920_64
SOURCE_SAP_SCHEMA=SAPS01

SAP_SYSID=S01
TGT_SAP_SYSID=${SAP_SYSID}
SRC_DB_OWNER_ID=ora`echo ${ORACLE_SID} | tr 'A-Z' 'a-z'`
TGT_DB_OWNER_ID=ora`echo ${TGT_ORACLE_SID} | tr 'A-Z' 'a-z'`
SRC_SAP_OWNER_ID=`echo ${SAP_SYSID} | tr 'A-Z' 'a-z'`adm
TGT_SAP_OWNER_ID=`echo ${TGT_SAP_SYSID} | tr 'A-Z' 'a-z'`adm

TGT_ORA_USR_HOME=/oracle/${TGT_ORACLE_SID}
TGT_SAP_USR_HOME=/home/`echo ${TGT_SAP_SYSID} | tr 'A-Z' 'a-z'`adm
SRC_ORA_USR_HOME=/oracle/${ORACLE_SID}
SRC_SAP_USR_HOME=/home/${SRC_SAP_OWNER_ID}
TGT_SAP_PROFILE_DIR=/sapmnt/${TGT_SAP_SYSID}/profile
SRC_SAP_PROFILE_DIR=/sapmnt/${SAP_SYSID}/profile

TGT_FC_ADAPTER=fcs1
TGT_FC_ADAPTER_FSCSI=fscsil

#####
##CLI_SOURCE_SQ_IP=oslsq04 #SQ04 STORAGE
##CLI_TARGET_SQ_IP=oslsq05 #SQ05 STORAGE
# Storage console configuration information
#####

CLI_SOURCE_SQ_IP=9.43.225.101 #SQ04 STORAGE
CLI_TARGET_SQ_IP=9.43.225.113 #SQ05 STORAGE

CLI_SOURCE_SQ_DEV=IBM.2107-7505831 #SQ04
CLI_TARGET_SQ_DEV=IBM.2107-7510621 #SQ05

CLI_SRC_USER_ID=admin
CLI_SRC_PASSWD=admin
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
CLI_TGT_USER_ID=admin  
CLI_TGT_PASSWD=sanj0se
```

```
SOURCE_PORT_ID=I0201  
TARGET_PORT_ID=I0201
```

```
#SOURCE_PORT_ID=I0330  
#TARGET_PORT_ID=I0202  
REMOTEWNN=5005076303FFC0E4
```

```
#####  
# Check to for Source hmc available
```

```
#####  
DSCLI_SRC_CMD="dscli -hmc1 ${CLI_SOURCE_SQ_IP} -hmc2 {CLI_SOURCE_SQ_IP}  
-user ${CLI_SRC_USER_ID} -passwd ${CLI_SRC_PASSWD}"
```

```
#####  
# Check to for Target hmc available
```

```
#####  
DSCLI_TGT_CMD="dscli -hmc1 ${CLI_TARGET_SQ_IP} -hmc2  
${CLI_TARGET_SQ_IP} -user ${CLI_TGT_USER_ID} -passwd  
${CLI_TGT_PASSWD}"
```

```
LIBPATH=$ORACLE_HOME/lib:/sapmnt/${SAP_SYSID}/exe
```

```
#####  
# Check to for validity of DSCLI
```

```
#####  
DSCLI=/opt/ibm/dscli  
if [[ ! -f $DSCLI/dscli ]]  
then  
    echo "$DSCLI directory is invalid"  
    exit 3  
fi
```

```
PATH=$ORACLE_HOME/bin:$DSCLI:$PATH
```

```
EXE_DIR=${SCRIPT_DIR}/exe
```

```
#####  
# Check to for log directory availability
```

```
#####  
LOG_DIR=${SCRIPT_DIR}/log  
if [[ ! -d $LOG_DIR ]]  
then  
    mkdir -p $LOG_DIR  
    chmod -R 775 $LOG_DIR  
fi
```

```
#####  
# Check to for LUN's table location directory
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
LUN_PAIR=${SCRIPT_DIR}/lun_pair
if [[ ! -d ${LUN_PAIR}/lun_pair ]]
then
    mkdir -p ${LUN_PAIR}
    chmod -R 775 ${LUN_PAIR}
fi

#####
# Check to for Table availability
#####
PPRC_VOLLS=${LUN_PAIR}/pprc_vols.dat
if [[ ! -f ${PPRC_VOLLS} ]]
then
    echo "${PPRC_VOLLS} file does not exist"
    exit 5
fi

#####
# Check to for Dynamic SQL directory availability
#####
SQL_DIR="${SCRIPT_DIR}/SQL"
if [[ ! -d ${SQL_DIR} ]]
then
    mkdir -p ${SQL_DIR}
    chmod -R 777 ${SQL_DIR}
fi

#####
# Check to for Backup control file location directory and file availability
#####
if [[ ! -d ${BACKUP_CONTROLFILE_NAME} ]]
then

BACKUP_CONTROLFILE_NAME="/oracle/${ORACLE_SID}/oraarch/cntrl${ORACLE_SI
D}.dbf"
    if [[ -f ${BACKUP_CONTROLFILE_NAME} ]]
    then
        rm ${BACKUP_CONTROLFILE_NAME}
    fi
fi

#####
# Source for A, B, C, and D vols in to variable's to be used with DSCLI commands
#####

. ${EXE_DIR}/pprc_vols_pair_data.sh
RC=$?
if [[ ${RC} -ne 0 ]]
then
    echo "Error running ${EXE_DIR}/pprc_vols_pair_data.sh"
    exit33
fi

#####
```



# LUN's table to be used with DSCLI command  
 #####

/lun\_pair/pprc\_vols.dat

```
## Example of 1 to 1 luns:
##### lunA:lunB:lunC:lunD
## Example of grouped luns
##### lunA1-lunA4:lunB1-lunB4:lunC2-lunC5:lunD1-
lunD4
## Example of grouped ARCHIVE luns
##### lunA6-lunA7:lunB6-lunB7:lunC8-lunC9:lunD6-
lunD7:ARCH
0801-0809:1001-1009:0901-0909:0701-0709
0810-0815:1010-1015:0910-0915:0710-0715
0816:1036:0916:0716
0817-0819:1017-1019:0917-0919:0717-0719
0820:1020:0920:0720
0821-0822:1021-1022:0921-0922:0721-0722
0823-0824:1023-1024:0923-0924:0723-0724:ARCH
0825-0829:1025-1029:0925-0929:0725-0729
0830-0832:1030-1032:0930-0932:0730-0732
```

## 11. Hardware used

The following hardware is used for Split Mirror Backup / Recovery solution in the lab.

<b>Server System</b>	<b>IBM pSeries 690</b>		
	24 CPUs, 32 GB Memory		
Host	Used as	CPU's	Memory
"host-a"	Production System	6	6 GB
"host-b"	Backup System	4	5 GB
<b>Storage System</b>	<b>IBM DS6000 1 (IBM.1750-13AAG7A)</b>		
Disk	Characteristics	Size	Number
Physical Drive	RAID 5	2 GB	2 x 8
Physical Drive	RAID 5	5 GB	2 x 8



Physical Drive	RAID 5	10 GB	2 x 12
Physical Drive	RAID 5	20 GB	2 x 4
Physical Drive	RAID 5	40 GB	2 x 4
<b>Storage System</b>	<b>IBM DS6000 2 (IBM.1750-13AAD0A)</b>		
Disk	Characteristics	Size	Number
Physical Drive	RAID 5	2 GB	2 x 8
Physical Drive	RAID 5	5 GB	2 x 8
Physical Drive	RAID 5	10 GB	2 x 12
Physical Drive	RAID 5	20 GB	2 x 4
Physical Drive	RAID 5	40 GB	2 x 4
<b>Connection</b>	<b>Switched Fibre Fabric (1 Brocade 16 Port Switch)</b>		
Switch to	Characteristics	Number	
Server-Node	Emulex LP9802	1	

## 12. Software used

The following software is used for the Split Mirror Backup / Recovery solution in the lab.

Type	Software	Version
Storage	IBM DS8000 Microcode	R9a.5b050517b
	IBM DSCLI	5.0.3.139
Operating System	AIX 5L	5.2
Database System	Oracle 9i	9.2.0.6
SAP	S01 – Production Central and DB Instance	4.7
	B01 – Backup Central and DB Instance	4.7
Miscellaneous	OpenSSH	3.8.1p1
	OpenSSL	0.9.7d

## 13. Logs

The Split Mirror Backup & Recovery process log output is directed to the following three log files. FlashCopy phase log, PPRC phase log and FlashCopy phase at Target DS6000.

FCS\_A\_to\_D\_script.log  
 PPRC\_A\_to\_B\_script.log  
 FCS\_B\_to\_C\_script.log

Basically the log output is divided into three files to make it easier for customer to identify the errors.

### **/log/FCS\_A\_to\_D\_script.log**

---

```

09:58:44 ##### REMOVE FLASH FCS_A_TO_D_VOLS DCSLI.
Date/Time: June 15, 2005 9:58:47 AM CDT IBM DSCLI Version: 5.0.3.139 DS:
IBM.1750-13AAG7A
CMUC00140I rmflash: FlashCopy pair 0801:0701 successfully removed.
    
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
CMUC00140I rmflash: FlashCopy pair 0802:0702 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0803:0703 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0804:0704 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0805:0705 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0806:0706 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0807:0707 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0808:0708 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0809:0709 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0810:0710 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0811:0711 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0812:0712 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0813:0713 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0814:0714 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0815:0715 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0816:0716 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0817:0717 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0818:0718 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0819:0719 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0820:0720 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0821:0721 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0822:0722 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0823:0723 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0824:0724 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0825:0725 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0826:0726 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0827:0727 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0828:0728 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0829:0729 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0830:0730 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0831:0731 successfully removed.
CMUC00140I rmflash: FlashCopy pair 0832:0732 successfully removed.
```

```
real 0m15.14s
```

```
user 0m5.37s
```

```
sys 0m0.26s
```

```
09:58:59 ##### BEGIN BACKUP DATABASE A.
09:58:59 ##### TABLESPACE - BEGIN BACKUP - IN BACK GROUND Started.
09:59:00 ##### SYSTEM - Tablespace is in backup mode - START.
09:59:00 ##### PSAPSSQJI - Tablespace is in backup mode -
START.
09:59:00 ##### PSAPSSQJD - Tablespace is in backup mode -
START.
09:59:00 ##### PSAPS01USR - Tablespace is in backup mode -
START.
09:59:00 ##### PSAPS01620 - Tablespace is in backup mode -
START.
09:59:00 ##### PSAPS01 - Tablespace is in backup mode -
START.
09:59:00 ##### PSAPROLL - Tablespace is in backup mode -
START.
09:59:00 ##### PSAPSSQJI - Tablespace is in backup mode
completed - END.
09:59:01 ##### PSAPROLL - Tablespace is in backup mode
completed - END.
09:59:01 ##### SYSTEM - Tablespace is in backup mode
completed - END.
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
09:59:01 ##### PSAPS01USR - Tablespace is in backup mode
completed - END.
09:59:01 ##### PSAPSSQJD - Tablespace is in backup mode
completed - END.
09:59:01 ##### PSAPS01620 - Tablespace is in backup mode
completed - END.
09:59:01 ##### PSAPS01 - Tablespace is in backup mode
completed - END.
09:59:02 ##### Source database is in SUSPENDED state.
09:59:02 ##### TABLESPACE - BEGIN BACKUP - IN BACK GROUND Completed.

real  0m2.38s
user  0m0.41s
sys   0m1.54s
09:59:02 ##### MAKE FLASH FCS_A_TO_D_VOLS.
Date/Time: June 15, 2005 9:59:04 AM CDT IBM DSCLI Version: 5.0.3.139 DS:
IBM.1750-13AAG7A
CMUC00137I mkflash: FlashCopy pair 0801:0701 successfully created.
CMUC00137I mkflash: FlashCopy pair 0802:0702 successfully created.
CMUC00137I mkflash: FlashCopy pair 0803:0703 successfully created.
CMUC00137I mkflash: FlashCopy pair 0804:0704 successfully created.
CMUC00137I mkflash: FlashCopy pair 0805:0705 successfully created.
CMUC00137I mkflash: FlashCopy pair 0806:0706 successfully created.
CMUC00137I mkflash: FlashCopy pair 0807:0707 successfully created.
CMUC00137I mkflash: FlashCopy pair 0808:0708 successfully created.
CMUC00137I mkflash: FlashCopy pair 0809:0709 successfully created.
CMUC00137I mkflash: FlashCopy pair 0810:0710 successfully created.
CMUC00137I mkflash: FlashCopy pair 0811:0711 successfully created.
CMUC00137I mkflash: FlashCopy pair 0812:0712 successfully created.
CMUC00137I mkflash: FlashCopy pair 0813:0713 successfully created.
CMUC00137I mkflash: FlashCopy pair 0814:0714 successfully created.
CMUC00137I mkflash: FlashCopy pair 0815:0715 successfully created.
CMUC00137I mkflash: FlashCopy pair 0816:0716 successfully created.
CMUC00137I mkflash: FlashCopy pair 0817:0717 successfully created.
CMUC00137I mkflash: FlashCopy pair 0818:0718 successfully created.
CMUC00137I mkflash: FlashCopy pair 0819:0719 successfully created.
CMUC00137I mkflash: FlashCopy pair 0820:0720 successfully created.
CMUC00137I mkflash: FlashCopy pair 0821:0721 successfully created.
CMUC00137I mkflash: FlashCopy pair 0822:0722 successfully created.
CMUC00137I mkflash: FlashCopy pair 0823:0723 successfully created.
CMUC00137I mkflash: FlashCopy pair 0824:0724 successfully created.
CMUC00137I mkflash: FlashCopy pair 0825:0725 successfully created.
CMUC00137I mkflash: FlashCopy pair 0826:0726 successfully created.
CMUC00137I mkflash: FlashCopy pair 0827:0727 successfully created.
CMUC00137I mkflash: FlashCopy pair 0828:0728 successfully created.
CMUC00137I mkflash: FlashCopy pair 0829:0729 successfully created.
CMUC00137I mkflash: FlashCopy pair 0830:0730 successfully created.
CMUC00137I mkflash: FlashCopy pair 0831:0731 successfully created.
CMUC00137I mkflash: FlashCopy pair 0832:0732 successfully created.

real  0m16.66s
user  0m5.36s
sys   0m0.22s
09:59:18 ##### UNFREEZE FLASH A_to_D.
Date/Time: June 15, 2005 9:59:21 AM CDT IBM DSCLI Version: 5.0.3.139 DS:
IBM.1750-13AAG7A
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

CMUC00172I unfreezeflash: FlashCopy consistency group for logical subsystem 08: successfully reset.

```
real 0m12.42s
user 0m4.63s
sys 0m0.17s
09:59:31 ##### END BACKUP DATABASE A.
09:59:31 ##### Source database - resumed step Completed.
09:59:31 ##### DATABASE - Alter system resume - Completed.
09:59:31 ##### TABLESPACE - END BACKUP - IN BACK GROUND - START.
09:59:31 ##### SYSTEM - Tablespace not in backup mode -
START.
09:59:32 ##### PSAPSSQJI - Tablespace not in backup mode -
START.
09:59:32 ##### PSAPSSQJD - Tablespace not in backup mode -
START.
09:59:32 ##### PSAPS01USR - Tablespace not in backup mode -
START.
09:59:32 ##### PSAPS01620 - Tablespace not in backup mode -
START.
09:59:32 ##### PSAPS01 - Tablespace not in backup mode -
START.
09:59:32 ##### PSAPROLL - Tablespace not in backup mode -
START.
09:59:32 ##### SYSTEM - Tablespace not in backup mode -
completed - END.
09:59:32 ##### PSAPSSQJD - Tablespace not in backup mode -
completed - END.
09:59:32 ##### PSAPSSQJI - Tablespace not in backup mode -
completed - END.
09:59:33 ##### PSAPS01620 - Tablespace not in backup mode -
completed - END.
09:59:33 ##### PSAPROLL - Tablespace not in backup mode -
completed - END.
09:59:33 ##### PSAPS01 - Tablespace not in backup mode -
completed - END.
09:59:33 ##### PSAPS01USR - Tablespace not in backup mode -
completed - END.
09:59:34 ##### Source: Backup Controlfile to
'/oracle/S01/oraarch/cntrlS01.dbf' - Completed.
09:59:34 ##### System altered: Archive log current - Completed.
09:59:34 ##### TABLESPACE - END BACKUP - IN BACK GROUND Completed -
END.
```

```
real 0m2.86s
user 0m0.53s
sys 0m1.84s
09:59:34 ##### MAKE FLASH FCS_A_TO_D_VOLS_ARCH.
Date/Time: June 15, 2005 9:59:36 AM CDT IBM DSCLI Version: 5.0.3.139 DS:
IBM.1750-13AAG7A
CMUC00168I resyncflash: FlashCopy volume pair 0823:0723 successfully
resynchronized.
CMUC00168I resyncflash: FlashCopy volume pair 0824:0724 successfully
resynchronized.
```

```
real 0m18.07s
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
user 0m4.64s
sys 0m0.32s
09:59:52 ##### FCS_A_to_D COMPLETED.
```

---

### /log/PPRC\_A\_to\_B\_script.log

---

```
09:59:52 ##### REMOVE FLASH - FCS_B_to_C.
Date/Time: June 15, 2005 9:59:55 AM CDT IBM DSCLI Version: 5.0.3.139 DS:
IBM.1750-13AAD0A
```

```
CMUC00140I rmflash: FlashCopy pair 1001:0901 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1002:0902 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1003:0903 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1004:0904 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1005:0905 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1006:0906 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1007:0907 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1008:0908 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1009:0909 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1010:0910 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1011:0911 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1012:0912 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1013:0913 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1014:0914 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1015:0915 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1036:0916 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1017:0917 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1018:0918 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1019:0919 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1020:0920 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1021:0921 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1022:0922 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1023:0923 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1024:0924 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1025:0925 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1026:0926 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1027:0927 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1028:0928 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1029:0929 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1030:0930 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1031:0931 successfully removed.
CMUC00140I rmflash: FlashCopy pair 1032:0932 successfully removed.
```

```
real 0m15.52s
user 0m5.42s
sys 0m0.18s
```

```
10:00:08 ##### BEGIN BACKUP - DATABASE A.
10:00:08 ##### TABLESPACE - BEGIN BACKUP - IN BACK GROUND Started.
10:00:08 ##### SYSTEM - Tablespace is in backup mode - START.
10:00:08 ##### PSAPSSQJI - Tablespace is in backup mode -
START.
10:00:08 ##### PSAPSSQJD - Tablespace is in backup mode -
START.
10:00:08 ##### PSAPS01USR - Tablespace is in backup mode -
START.
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
10:00:08 ##### PSAPS01620 - Tablespace is in backup mode -  
START.  
10:00:08 ##### PSAPROLL - Tablespace is in backup mode -  
START.  
10:00:08 ##### PSAPS01 - Tablespace is in backup mode -  
START.  
10:00:09 ##### PSAPSSQJI - Tablespace is in backup mode  
completed - END.  
10:00:09 ##### SYSTEM - Tablespace is in backup mode  
completed - END.  
10:00:09 ##### PSAPROLL - Tablespace is in backup mode  
completed - END.  
10:00:09 ##### PSAPSSQJD - Tablespace is in backup mode  
completed - END.  
10:00:09 ##### PSAPS01USR - Tablespace is in backup mode  
completed - END.  
10:00:10 ##### PSAPS01620 - Tablespace is in backup mode  
completed - END.  
10:00:10 ##### PSAPS01 - Tablespace is in backup mode  
completed - END.  
10:00:10 ##### Source database is in SUSPENDED state.  
10:00:10 ##### TABLESPACE - BEGIN BACKUP - IN BACK GROUND Completed.
```

```
real 0m2.44s  
user 0m0.27s  
sys 0m1.80s
```

```
10:00:10 ##### MAKE FLASH - FCS_B_TO_C_VOLLS.  
Date/Time: June 15, 2005 10:00:13 AM CDT IBM DSCLI Version: 5.0.3.139  
DS: IBM.1750-13AAD0A
```

```
CMUC00137I mkflash: FlashCopy pair 1001:0901 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1002:0902 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1003:0903 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1004:0904 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1005:0905 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1006:0906 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1007:0907 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1008:0908 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1009:0909 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1010:0910 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1011:0911 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1012:0912 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1013:0913 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1014:0914 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1015:0915 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1036:0916 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1017:0917 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1018:0918 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1019:0919 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1020:0920 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1021:0921 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1022:0922 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1023:0923 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1024:0924 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1025:0925 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1026:0926 successfully created.  
CMUC00137I mkflash: FlashCopy pair 1027:0927 successfully created.
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
CMUC00137I mkflash: FlashCopy pair 1028:0928 successfully created.
CMUC00137I mkflash: FlashCopy pair 1029:0929 successfully created.
CMUC00137I mkflash: FlashCopy pair 1030:0930 successfully created.
CMUC00137I mkflash: FlashCopy pair 1031:0931 successfully created.
CMUC00137I mkflash: FlashCopy pair 1032:0932 successfully created.

real  0m15.59s
user  0m5.28s
sys   0m0.27s
      10:00:26 ##### UNFREEZE FLASH - FCS_B_TO_C_VOLS.
Date/Time: June 15, 2005 10:00:28 AM CDT IBM DSCLI Version: 5.0.3.139
DS: IBM.1750-13AAD0A
CMUC00172I unfreezeflash: FlashCopy consistency group for logical
subsystem 10: successfully reset.

real  0m12.49s
user  0m4.51s
sys   0m0.21s
      10:00:38 ##### END BACKUP - DATABASE A.
      10:00:38 ##### Source database - resumed step Completed.
      10:00:39 ##### DATABASE - Alter system resume - Completed.
      10:00:39 ##### TABLESPACE - END BACKUP - IN BACK GROUND - START.
      10:00:39 ##### SYSTEM - Tablespace not in backup mode -
START.
      10:00:39 ##### PSAPSSQJI - Tablespace not in backup mode -
START.
      10:00:39 ##### PSAPSSQJD - Tablespace not in backup mode -
START.
      10:00:39 ##### PSAPS01USR - Tablespace not in backup mode -
START.
      10:00:39 ##### PSAPS01620 - Tablespace not in backup mode -
START.
      10:00:39 ##### PSAPS01 - Tablespace not in backup mode -
START.
      10:00:39 ##### PSAPROLL - Tablespace not in backup mode -
START.
      10:00:39 ##### PSAPSSQJI - Tablespace not in backup mode -
completed - END.
      10:00:39 ##### SYSTEM - Tablespace not in backup mode -
completed - END.
      10:00:39 ##### PSAPSSQJD - Tablespace not in backup mode -
completed - END.
      10:00:40 ##### PSAPS01 - Tablespace not in backup mode -
completed - END.
      10:00:40 ##### PSAPROLL - Tablespace not in backup mode -
completed - END.
      10:00:40 ##### PSAPS01620 - Tablespace not in backup mode -
completed - END.
      10:00:40 ##### PSAPS01USR - Tablespace not in backup mode -
completed - END.
      10:00:40 ##### Source: Backup Controlfile to
'/oracle/S01/oraarch/cntrlS01.dbf' - Completed.
      10:00:40 ##### System altered: Archive log current - Completed.
      10:00:40 ##### TABLESPACE - END BACKUP - IN BACK GROUND Completed -
END.
```



## Split Mirror Backup / Recovery Solution with the IBM TotalStorage DS6800

```
real 0m2.40s
user 0m0.37s
sys 0m1.88s
10:00:40 ##### PPRC_A_to_B COMPLETED.
```

---

### /log/FCS\_B\_to\_C\_script.log

---

```
10:00:41 ##### LIST PPRC - PPRC_A_TO_B_VOLS_ARCH - check Full
Duplex.
10:00:56 ##### RESYNCFLASH - FCS_B_TO_C_VOLS_ARCH.
Date/Time: June 15, 2005 10:00:59 AM CDT IBM DSCLI Version: 5.0.3.139
DS: IBM.1750-13AAD0A
CMUC00168I resyncflash: FlashCopy volume pair 1023:0923 successfully
resynchronized.
CMUC00168I resyncflash: FlashCopy volume pair 1024:0924 successfully
resynchronized.

real 0m14.68s
user 0m4.70s
sys 0m0.21s
#####
#####
10:01:11 DSCLI - PPRC STEPS - COMPLETED ON SOURCE
#####
#####
```



## References

- 1) IBM TotalStorage DS6000 Series: Concepts and Architecture - IBM Document Number: SG24-6471-00 <http://www.redbooks.ibm.com/>
- 2) IBM Enterprise Storage Server - IBM Document Number: SG24-5465-00 <http://www.redbooks.ibm.com/>
- 3) ESS Layout Considerations for a Heterogeneous System Landscape - Dr. Jens Claussen, SAP Advanced Technology Group, December 2000 [Presentation]
- 4) SAP R/3 Storage Management - Split Mirror Backup Recovery on IBM's Enterprise Storage Server (ESS) - Siegfried Schmidt, SAP AG, Advanced Technology Group, February 2000, <http://service.sap.com/split-mirror> or <http://www.storage.ibm.com/hardsoft/diskdrls/technology.htm>
- 5) Fundamentals of Database Layout SAP AG, Version 2.0 August 2000 <http://service.sap.com/atg> -> DB & Storage Layouts
- 6) Oracle 8i Backup & Recovery Handbook - Rama Velpuri and Anand Adkoli, Oracle Press, Osborne McGraw Hill, 2001
- 7) SSQJ Documentation Version 9.B – SAP Advanced Technology Group. <http://service.sap.com/atg>
- 8) Storage Management for SAP and DB2 UDB: Split Mirror Backup / Recovery With IBM's Enterprise Storage Server (ESS) - Sanjoy Das, Siegfried Schmidt, Jens Claussen, BalaSanni Godavari, August 2001, <http://service.sap.com/split-mirror> or <http://www.storage.ibm.com/hardsoft/diskdrls/technology.htm>
- 9) Storage Management for SAP and Oracle: Split Mirror Backup / Recovery With IBM's Enterprise Storage Server (ESS) - Sanjoy Das, Siegfried Schmidt, Peter Pitterling, BalaSanni Godavari, October 2001 <http://service.sap.com/split-mirror> or [www.storage.ibm.com/hardsoft/products/sap/splitmirror-oracle.pdf](http://www.storage.ibm.com/hardsoft/products/sap/splitmirror-oracle.pdf)
- 10) Storage Management for SAP and Oracle8i on SUN SOLARIS: Split Mirror Backup / Recovery With IBM's Enterprise Storage Server (ESS) - Sanjoy Das, Siegfried Schmidt, Sathees Kodi, Bala Sanni Godavari, June, 2002, <http://service.sap.com/split-mirror>
- 11) Consistency Technology for mySAP Business Suite – Creating Consistent Images of a Distributed System Landscape With IBM's Enterprise Storage Server (ESS)