ESS Open Copy Services Considerations

IBM Storage Systems Group

13 December 2000

R. F. Kern
Disk Storage Architecture
IBM Storage Systems Division
9032 S. Rita Road
Tucson, Arizona, USA 85744
e-mail: BOBKERN@US.IBM.COM

Notices

Published : December 2000

Please send comments via e-mail to Bob Kern: Bobkern@us.ibm.com

ESS Storage Management Guidelines & Recommendations

Introduction

As disk storage prices continue to drop, 20-40% per year, the amount of information required to be online and available 24 hours a day, 7 days a week (24 X Forever) has greatly increased. Many corporations are seeing the storage in their Enterprises double each year.

As a result of the disk storage explosion, the next major issue has become the actual cost of managing storage. In the 1960's IT organizations talked about People management to physical storage ratios of 1 mb per person. The '70's extended this to 1 GB/Person, '80's 10's GB/person, the '90's TB's/person and today it is 10's of TBs/person. The cost of storage management vs the physical price per MB is typically in the range of 7:1 or as much as 10:1 in well run shops. People are much more expensive than the storage hardware in today's world. This paper will examine the new ESS Copy Services functions PPRC and FlashCopy for the Open environment and provide various guidelines/recommendations based on various customer's experience. Our objective is to assist other customer's to more effectively manage their ESS storage environment and exploit some of the new ESS web tools available.

ESS Copy Services

PPRC

Peer-to-Peer Remote Copy (PPRC) is a synchronous I/O mirroring technique between two "peer" ESS storage subsystems. The maximum distance between the 'primary' and 'secondary' ESS storage subsystems is 103km (via 9729,2029, or various channel extenders), however when coupled with FlashCopy this distance can be extended even further exploiting asynchronous techniques. Synchronous I/O means that when the primary application issues a write I/O, the command is issued to the primary storage subsystem, the primary storage subsystem communicates with the secondary storage subsystem and when the data is secured for that LUN in both the primary and secondary storage subsystems, successful I/O is given back to the application. ESS PPRC implementation has fewer protocol exchanges between the primary and secondary storage subsystems than other implementations in the industry. As the wire extends between the primary and secondary storage subsystems, the propagation distance delay becomes important.

The ESS Web Copy Services interface includes functions to perform the following PPRC tasks.

Establish Path - With ESS up to 8 PPRC paths may be established between the primary and secondary ESS Logical subsystems (LSS). With 16 LSS's within a single ESS and the ability for devices in a single primary LSS to be mirrored to up to 4 different secondary LSS's, complete flexibility in the enterprise configuration is possible. Further, many customer prefer a bi-directional PPRC implementation, splitting the I/O writes across the primary and secondary storage subsystems if the application(s) workload can be split appropriately.

Delete Path - Provides the granularity to break paths between a specific primary & secondary PPRC LSS pair.

Establish Pair - Provides the ability to establish PPRC device pairs with a number of options. A full copy of all primary data to the secondary, a NOCOPY option and a RESYNC option may be used.

Delete Pair - Provides the granularity to remove the PPRC relationship between a specific PPRC volume pair, returning both volumes to Simplex mode.

Suspend Pair - Provides the ability to suspend a PPRC pair, with change track bitmap recording. Real time PPRC Mirroring is suspended and the primary volume maintains a changed track bitmap.

Recover PPRC Secondary Volume - Recovers a secondary PPRC volume to simplex state. This command is issued only to the secondary volume (normally in a disaster, and the status of the primary volume is unknown and inaccessible.) The primary volume state is generally unchanged, unless the primary and secondary subsystems still have connectivity.

Freeze/Suspend All PPRC Pairs for SSID - Provides the ability to freeze all volumes participating in a PPRC remote copy between the specified storage subsystem pairs. The command interface is automated via the CLI to create a set of data consistent secondary site volumes on the first occurrence of a failure (disk or host sysplex detected) insuring a data base 'restart' in the event of a site switch.

FlashCopy

FlashCopy is a fast point in time copy technique designed to replicate all data on an entire LUN to another LUN within the same ESS Logical Storage Subsystem. From the ESS Copy Services Web Interface one can graphically select 'source' and 'target' LUNs to be used in the actual FlashCopy operation. A FlashCopy of a single or multiple LUNs can be extremely useful to the operations staff providing infrastructure flexibility to accomplish various storage management activities. FlashCopy Target volumes can be used for 'offline' backup, creating & refreshing a point in time Query Server Data Base, offloading End of Day reports from production servers, D/R & application testing, etc. FlashCopy can be invoked directly from your production volumes or from PPRC secondary volumes in a multi-site environment. Several customers have found that combining PPRC and FlashCopy helps them to optimize the use of various resources across multiple sites. Consider the following scenario:

One has two sites within 103KM for disaster/recover (D/R) purposes. All ESS LUNs associated with a specific server group are mirrored via Open PPRC to the remote location. This provides the ability for planned and unplanned site switches based on the operations requirements across your two sites. With FlashCopy, one can make a copy of the secondary site PPRC LUNs and then use the secondary site standby servers for local backup (sometimes called 'serverless backup' since the production server is not involved in the backup process), D/R or application testing, offloading production activities like end of day reports or managing a point in time query server. Since FlashCopy is fast and efficient, target volumes can be refreshed based on the needs of the business. Further, FlashCopy provides two convenient options relative to the 'copy'; No Background Copy or Full Copy. Generally if one is making a copy of the data for backup, one would use the no background copy option as the data will be read only once. The ESS provides access to the target volume immediately after the FlashCopy 'source' and 'target' relationship is established. Point in time data is maintained on the 'target' volume as the production application updates the 'source' volume. No physical copy of 'unchanged' data occurs. The backgroup full copy option is generally utilized when high access to the 'target' Lun is expected, as in a Data Base Query server, D/R or application test LUNs. Again, the ESS quickly establishes the 'source' 'target' relationship providing application access to the source and target volumes immediately. In the background, 'under the covers' the ESS quietly copies all data from the 'source' to the 'target' LUN. Secondary site servers are typically used as standby servers to accept the production load in the event of a problem at the primary site. Several customers use these stand by servers for test and development activities during part of the day. Exploiting the ESS PPRC and FlashCopy capabilities in the manner outlined above, the same servers can now perhaps be more fully utilized 24 X 7. Further, the test and development activities can utilize more 'current' copies of the production data as required.

ESS Open Copy Services (PPRC and FlashCopy) provide your operations staff the IT infrastructure flexibility required to maintain near continuous operations required in todays e-business environment. Detailed information on the ESS Copy Services functions can be found in the following publications:

- **IBM Enterprise Storage Server Introduction and Planning Guide, GC26-7294.**

This guide introduces the product and lists the features you can order. It also provides guidelines on planning for the installation and configuration of the ESS.

- **IBM Enterprise Storage Server Web Interface User's Guide, SC26-7346**

This book provides instructions for using the IBM StorWatch Enterprise Storage Server Web interfaces, ESS Specialist and ESS Web Copy Services.

- **IBM Enterprise Storage Server Host Systems Attachment Guide, SC26-7296.**

This book provides guidelines for attaching the ESS to your host system and for migrating from SCSI to fibre-channel attachment.

- **IBM Enterprise Storage Server Configuration Planner, SC26-7353.**

This book provides the worksheets for planning the logical configuration of the ESS.

- **IBM Enterprise Storage Server User's Guide, SC26-7295**

This guide provides instructions for setting up and operating the ESS and for analyzing problems**.**

The above documents can be found on the following ESS web site:
www.storage.ibm.com/hardsoft/products/ess/refinfo.htm

- **Implementing ESS Copy Services on UNIX and Windows NT/2000, SG24-5757**

This redbook tells you how to install, customize and configure Copy Services on IBM Enterprise Storage Servers on the UNIX or NT platforms. Copy Services functions include Peer-to-Peer Remote Copy and FlashCopy. This redbook gives a broad understanding of these functions, describes the pre-requisites and co-requisites, and then shows you how to implement each of the functions into your environment to ensure efficient usage and to maximise the benefits that these functions provide.This redbook also shows how to implement these solutions in an HACMP cluster.

This redbook can be found on the redbooks web site at **www.redbooks.ibm.com**, under redpieces.

This white paper contains hints, tips and considerations obtained from the early support customers using the ESS Copy Services Open functions. It is assumed that the reader has a working understanding of the PPRC and FlashCopy functions.

Simplified Management of ESS Copy Services

The initial release of the ESS Web Copy Services is focused on providing rich management functions to simplify the management of the copy services environment. With the ESS WEB Copy Services interface acting as a single point of control, once set up a storage administrator can click and point at each ESS Pair server and view in real time the status of PPRC pairs or FlashCopy operations. Most customers will manage the storage associated with a specific server, server group, application or business units application in this manner from a single point of control. Typically one will find that specific storage administrators or operations personnel will focus on specific application groups. A desired design direction (not available in the first release) will be to extend the scope of a single copy services 'server' across multiple ESS clients in an enterprise. The ESS is uniquely designed under the Seascape architecture to be extended to a common Seascape Storage-Net type of management environment.

The open system's management environment typically varies from the S/390 environment as one typically finds a single application/server or clustered server group with assigned disk storage. The S/390 environment however typically finds multiple applications sharing storage across the same or multiple volumes attached to multiple ESSs. Initially, most customers will continue to manage the S/390 environment with the S/390 Host based PPRC tool set (TSO Commands, ICKDSF, Programming APIs, RCMF panels, GDPS™ etc.) As a result, ESS PPRC will be installed in most S/390 PPRC environments with minimal changes to the actual 'operational' environment and monitoring tools. This was a key design objective of ESS S/390 PPRC, making migration from IBM (and other vendor) PPRC

environments to ESS evolutionary. ESS PPRC can be managed side by side with existing PPRC implementations - especially in the GDPS™ or RCMF environments.

The open system's environment is a new environment for PPRC and the Web based management approach provided via the ESS Web Copy Services centralizes management to a single point of control. Open system's 'monitoring' servers or clustered servers can interact directly with the ESS Web Copy Services or via the Command Line Interface (CLI). This requires JAVA 1.1.8 to be installed on the server that executes the CLI interface. Via the CLI, host software can execute previously saved user defined ESS Web Copy Services tasks, customized to the specific customer environment to perform various PPRC or FlashCopy management functions. For example, PPRC Establish Path/Pair, Recover, Query or FlashCopy a volume.

The ESS Web Copy Services server should be disabled when doing ESS concurrent microcode load or making ESS configuration changes involving adding volumes or deleting ranks. Ongoing PPRC or FlashCopy relationships continue, but new relationships cannot be established until after the ESS Web Copy Services server is restarted.

ESS Web Copy Services

ESS Web Copy Services is a Java-Based client server application. The application consists of one Primary Copy Services (CS) server component, an optional Backup Copy Services (CS) server component, and one or more client components. The Backup CS Server refers to a server that can be started as a Primary CS Server in the event that the Primary CS Server fails.

The implementation of these application components in a collection of ESS clusters forms an ESS Web Copy Services server group. This implementation allows users to define, execute and view the status of Copy Services functions and tasks in, and between the server group clusters. For example, the ESS Web Copy Services application allows a user to:

- Initiate a FlashCopy task for two volumes in one ESS cluster
- Establish Peer-to-Peer (PPRC) relationships for volumes in two ESS clusters
- Execute predefined PPRC and FlashCopy tasks

Each ESS cluster within a server group runs the ESS Web Copy Services Client component. The user designates one of the ESS clusters in a server group to also run the Primary CS Server component, and optionally designates another ESS cluster to run the Backup CS Server component. If the server group consists of ESS clusters installed at different locations, then the Primary and Backup CS servers should be assigned to ESS clusters that are remote from each other.

The ESS clusters that are part of a Copy Services (CS) server group use the TCP/IP network to communicate. You can configure two ESS Copy Services servers to a group. Each ESS Copy Services server group manages four clusters and a maximum of 2048 volumes. IBM recommends using a domain name server (DNS) for name resolution. DNS resolves the names of the participating ESS Clusters and enables ESS Web Copy Services to operate correctly. This includes allowing the open system hosts to run the Command Line Interface (CLI) for Copy Services automation. When DNS is not available, the IBM SSR can configure each ESS to provide name resolution.

ESS Copy Services also includes a command-line interface (CLI). The CLI is a Java-Based applicaton package that you may optionally install on your open system host. The CLI application package provides a set of commands that allow a user to write customized scripts for a host system that will initiate predefined tasks in an ESS Copy Services server application. You use the set of CLI commands to indirectly control ESS PPRC and FlashCopy tasks within an ESS Copy Services server group.

The CLI capability permits host application and system coordination and invocation of the PPRC and FlashCopy commands. This is useful when integrated with applications like SAP/R3, such that a FlashCopy of an Oracle data base can be coordinated say via the TSM BACKINT interface. Execution of PPRC commands can be useful with Operating System functions like AIX HAGEO/HACMP cluster fail-over, fall back capabilities. CLI is currently available for AIX, HP-UX, Sun Solaris, Windows NT and Windows 2000.

Users access the ESS Web Copy Services interface from the ESS Specialist Introduction panel using an ESSNet console or a Web browser at a local workstation. Access to the ESS Web Copy Services from a browser window normally connects to the Primary CS server, which has the overall view and control of the server group Copy Services configuration. The Backup CS server provides similar view and control for handling the server group when the Primary CS server is unavailable. A user can access the Backup CS server if the Primary CS server is unavailable. A user must manually reset the Web Copy Services Function to connect to the Backup CS server when the Primary CS server is unavailable as in Disaster Recovery actions.

Requirements for Installing and using ESS Web Copy Services

To support the Copy Services feature through the IBM StorWatch ESS Web Copy Services or the Open Systems Command Line Interface (CLI), there are some configuration decisions that need to be made. The following two paragraphs provide an overview of the architecture of the ESS Web Copy Services interface and the configuration requirements. For details on the planning process, refer to the IBM Enterprise Storage Subsystem Introduction and Planning Guide. For specific details on how to use ESS Web Copy Services, refer to the IBM Enterprise Storage Subsystem Web Interface User's Guide.

ESS Web Copy Services is a Java based client server application. It provides an interface to define, execute and view the status of Copy Services tasks and activities. Copy Services Server Groups need to be configured. A Copy Services Server Group is a collection of ESS clusters that use Copy Services functions involving volumes located within those ESS clusters. For example if for ESS 1, PPRC is to be established to LUNs in ESS 2, then both ESS 1 and ESS 2 will have to be configured to be part of the same Copy Services Server Group. For each Copy Services Server Group, a single ESS cluster needs to be defined as the Primary Copy Services Server. Optionally, there could be a second ESS cluster designated as the Backup Copy Services Server. The Primary Copy Services Server will run in the designated ESS cluster, and will have the overall view of the configuration for all the clusters in a Copy Services Server Group. There are performance trade-offs in an ESS cluster, with regard to how many processing cycles are allocated for user interface functionality versus cycles allocated for processing application I/O. As a result, there are some practical limitations on how many ESS clusters a particular Copy Services Server can manage, without degrading the response time for I/O requests. Currently, IBM recommends that a maximum of 2 ESS machines (i.e. 4 clusters) and a maximum of 2048 LUNs be managed by an individual Copy Services server.

When accessing the ESS Web Copy Services from a Netscape browser window, a connection is made to the ESS cluster designated as the Primary Copy Services server. IBM recommends having a Backup Copy Services configured such that in the event that the Primary CS server goes down, the ESS Web Copy Services can be accessed from the Backup CS server. For environments where a Copy Services Server Group spans more than one site, the Backup CS server and the Primary CS server should be configured on different sites to insure continued access in the case of a disaster.

ESS Open Copy Services Considerations

For the following discussion, assume that we have two ESS's, ESS1 and ESS2, configured as part of the same ESS WEB Copy Services group. All four clusters use the same Primary Copy Services server. This is the normal situation for a PPRC environment. A Backup CS server is also configured and the manual switch to the Backup CS server is described later. For Multi-Site PPRC environments some additional considerations need to be made as to the placement of the primary and backup Copy Services servers. There are two options:

1.**Primary Copy Services server is at your recovery site**
Choosing this configuration can gain provide some efficiency in terms of recovering from a disaster. When the Primary CS server is at the recovery site, the manual switch to the Backup CS server is not required. Recovery tasks should be created at this time. There are performance implications to placing the Primary CS server at the secondary site. All Web copy services communications are done via TCP/IP links and host server CLI communications at the primary site will be directed to the remote site 'primary' server. On the other hand, primary ESS volumes typically have high I/O rates (all reads and writes) where secondary volumes only receive the write I/O rate. Allocating secondary ESS cycles to ESS Web Copy Services might provide the least impact to the primary application I/O.

2. **Primary Copy Services server is at your production site**
This configuration might be the obvious configuration, but as mentioned in (1) above, one needs to weigh the impact of allocating cycles on the primary ESS for the Web Copy Services server vs the TCP/IP communication overhead and the recovery time objectives in the event of a disaster, factoring in the manual switch to the Backup Copy Services server.

The ESS clusters that are part of a Copy Services Server Group use the TCP/IP network to communicate. Each ESS cluster must have an IP address assigned to it. Enter this information on the Communication Resources (ESS Web Copy Services) work sheet . See "Chapter 4. Planning for communication" in the IBM Enterprise Storage Subsystem Introduction and Planning Guide for the procedures for filling in this worksheet. In order for this communication to work, name resolution has to be running in the customer's network. IBM strongly recommends using Domain Name Server (DNS) for name resolution. DNS resolves the names of the participating ESS clusters and enables the ESS Web Copy Services to operate correctly. If DNS is not configured in the customer's network, additional configuration steps need to be followed to enable the use of ESS Web Copy Services.

A decision relative to the use of ESS Web Copy Services for S/390 volumes also needs to be made. The default is that this capability is disabled for S/390 volumes. To enable, the information should be entered in the "Appendix B. Communication Resources (ESS Web Copy Services) work sheet" of the IBM Enterprise Storage Subsystem Introduction and Planning Guide" and the function then enabled as per the written procedures.

To summarize, before using either the ESS Web Copy Services or the Open Systems CLI, the following tasks need to be executed:

(1) Purchase the ESS FlashCopy and/or PPRC LIC features.

(2) If the ESS machine has already been installed, then the ESS needs to be upgraded to the 2105 LIC that supports Copy Services.

(3) Install and configure the ESS. ESS configuration includes:

Physical install of the ESS including connecting the ESS to the ESSNET network and configure the DNS.

Install/activate the Copy Services LIC features.

For PPRC, install ESS ESCON host adapters. If the ESCON feature code is specified with the initial order for an ESS, IBM will install the ESCON host adapters. After initial installation, an MES is required to install the adapters. ESS ESCON host adapters are required for PPRC because communication between the ESS in a Peer-to-Peer relationship is through the ESCON channels.

For each ESS in a Copy Services Server Group, decide if ESS Web Copy Services should be used for S/390 volumes.

For each ESS in a Copy Services Server Group, enter the information in the "Communication Resources (ESS Web Copy Services) worksheet" .Configure the ESS's for the use of ESS Web Copy Services.

For each ESS in a Copy Services Server Group, enter the IP addresses of the ESS clusters that have been identified as the primary and backup servers in the "Communication Resources (ESS Web Copy Services) worksheet". Configure a domain name server (DNS) for ESS Web Copy Services.

For each ESS in a Copy Services Server Group, enter the information in the "Communication Resources worksheet"

Logically configure the ESS, allocate storage and create logical unit numbers (LUNs).

(4) Attach the ESS to your host systems; this enables the functionality to identify, create and copy volumes. If the hosts are already installed, make sure that the correct levels of the 2105 install utility, Subsystem Device Driver (SDD) or equivalent, and Command Line Interface (CLI) are installed on all attached host systems. See the IBM Enterprise Storage Server Host Systems Attachment Guide for more information on CLI. Run operating system commands to configure the ESS volumes to your host systems. If using the CLI, run **rsTestConnection** to ensure that a connection can be established with the ESS Web Copy Services server.

(5) Run **rsPrimeServer.sh** on your host systems. This script notifies the ESS Web Copy Services server of the mapping of your host system's disks to ESS volume serial numbers. This function permits viewing volumes from a host point of view in the Volumes panel of the ESS Web Copy Services.

Creating Copy Services Tasks

Additional details to create various Copy Services tasks can be found in the IBM Enterprise Storage Server Web User's Interface Guide**.** Once the ESS has been configured for the use of WEB Copy Services, tasks can be created to exploit the FlashCopy and PPRC functions in a production environment. This assumes that if PPRC is being used for disaster/recovery purposes, normal D/R planning will also occur. For multi-site implementations with ESS PPRC, the placement of the ESS Web Primary Copy Services server needs to be decided and one needs to insure that tasks are available on both the primary & backup CS servers.

The following should be taken into account when creating copy services tasks:

1.Setup and run with all clusters having the Primary IP CS server's address for the active server. All tasks will be created from this configuration.

2. During task creation, all clusters must be registered with the active CS server and there should be no faults in the network. Tasks created and saved when the active CS server is the primary CS server, will

be automatically sent to the backup CS server. At the time a manual switch to the backup server occurs, the backup CS server comes up with full functionality. The tasks that were created at the primary CS server will be available for the backup CS server to use. New tasks can be created and saved. However, if the primary CS server becomes the active server again, then the tasks repository present in the primary CS server will be sent to the backup CS server and any tasks that were saved while the backup CS server was the active server will be lost.

3. Grouped tasks contain subtasks. When the Grouped task is executed or RUN, the subtasks run in parallel and no sequence can be assumed.

4. During task creation, all tasks that the customer anticipates needing should be created. Tasks should have meaningful names and should be compatible with Command Line Invocation. Multivolume selection mode is recommended for those operations that involve many volumes.

5. For PPRC operations:
   a. Determine if Consistency Grouping (CG) is required
      1. If CG is used, Create task(s) for ESTABLISH PATHS with CG selected, name, and save
      2. If CG is not used, Create task(s) for ESTABLISH PATHS without CG selected, name, and save
   b. Edit tasks from (a.1 or a.2) to convert to REMOVE PATHS, name and save
   c. Create task(s) for ESTABLISH PAIRS, name and save
   d. Edit tasks from (c) to convert to SUSPEND PAIR, name and save
   e. Edit tasks from (c) to convert to TERMINATE PAIR ON PRIMARY, name and save
   f. Edit tasks from (e) to convert to TERMINATE PAIR ON SECONDARY, name and save
   g. Determine if the Freeze/Consistency Groups Created operations will be used. and if so:
      1. Create tasks for FREEZE, name, and save
      2. Edit tasks from (g.1) to convert to CONSISTENCY GROUP CREATED, name and save

6. For FlashCopy operations:
   a. Create task(s) for FlashCopy Establish, select background copy or no background copy, name and save.
   b. Edit task(s) from (a) to convert to WITHDRAW, name and save

7. Following task creation and editing, like tasks can be grouped for execution.

ESS Web Copy Services Manual Restart Buttons

At a given point in time, for each ESS Web Copy Services Server Group, there is an active CS server. The active CS server can either be the primary CS server or the backup CS server. During normal mode of operation, the active server will be the primary CS server. For disaster recovery or manual switch of the ESS Web Copy Services servers, several functions are offered via a set of "buttons" in the ESS Specialist interface. This set of functions require ESS Specialist administration authority. To access the set of functions, establish a connection to the ESS Specialist to any of the clusters on the ESS machine to perform a given action. For the following discussion, assume that ESS1c1 (ESS 1, cluster 1) is configured as the primary CS server and ESS2c1 is configured as the backup CS server. Select the **?** at the upper right corner of the Information Panel. Further, ESS1 is physically located at the recovery site and ESS2 is physically located at the primary site.

Select the TASK HELP folder

1. Select the ? at the upper right corner of the Information Panel in the ESS Specialist window. This links to the Specialist help system.

2. Select the 'Task Help' tab.

3. Scroll to the bottom and select the last link, Recovering from an ‘Unable to Connect to the Copy Services Server' message.

4. Select the 'Reset ESS Web Copy Services' link. You will be prompted for an administration level username and password.

5. After entering the username/password, scroll to the bottom of the page where you will find two tables, The first table informs you of the TCP/IP addresses of the Primary and Backup CS Servers, and of the currently active Copy Services sever.

Reset to Primary, will restart Copy Services on the ESS machine that is connected via the Specialist. With this option the active ESS Web Copy Services server will be the one that was specified as the primary. Use this option on the ESS1 first and then ESS2. ESS1c1 will be the server, all other clusters will be clients.

Reset to Backup, will restart Copy Services on the ESS machine that is connected via the Specialist. With this option the active ESS Web Copy Services server will be the one that was specified as the backup. Use this option on the ESS2 first and then ESS1. ESS2c1 will be the active server, all other clusters will be clients.

Disable Copy Services will Stop Copy Services on the ESS machine that is connected via the Specialist.

Cancel Return to main task-help, without performing any action.

The **BACK** arrow is used to return to the previous menu after selecting either one.

Note: If **Reset to Primary** is used in ESS1 and **Reset to Backup** is used in ESS2 then two active servers exist, where each server sees two clients.

Testing PPRC Disaster Recovery

To test disaster recovery scenarios, the customer could use the ESS Specialist manual buttons to **Disable** ESS Web Copy Services at the primary or production site, ESS2 for our discussion. The customer can then invoke ESS Web Copy Services at the Recovery site, ESS1 for our discussion. This would emulate a disaster and those tasks designed for site switchover should be tested. An example would be to issue the TERMINATE PAIR ON SECONDARY tasks. To recover from disaster at the primary site when the Primary Copy Services server is configured at that site, the customer will use the ESS Specialist buttons at the recovery site to Reset to Backup. Please refer to the IBM Enterprise Storage Server Web User’s Interface Guide for additional details on how to recover from a disaster.

Network Configurations and Using Copy Services

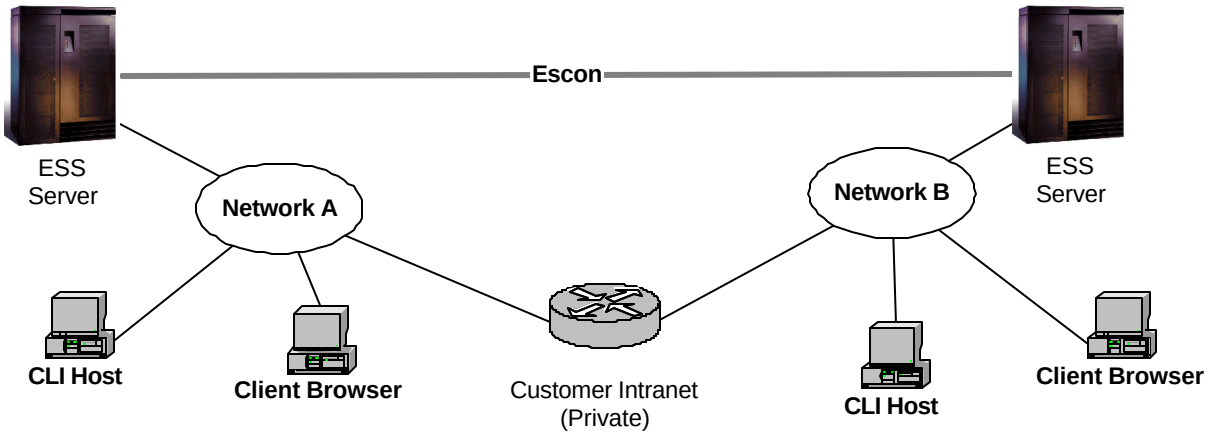
To use Copy Services in a network environment there are some questions you and your network administrator will have to answer. Each answer will depend on the configuration you are trying to

implement. For the purpose of narrowing the possible configurations, we have isolated the possible configurations to be within the following boundaries. As in any configuration, if you do not have the expertise available, IBM Global Services or your Service provider could assist your administrators in setting up the right configuration for your environment.

1. Each ESS Server is located within a private Network along with the CLI Host or Client Browsers as in Figure 1.
2. The Primary and Alternate ESS Servers are separated by a Non-Secured or Public Network with the CLI Host and Browser located at either end
3. The configuration of the sub-area network with Network Address Translation (NAT)/Firewalls in front of the ESS Server and placements of the CLI Host and Client Browsers.

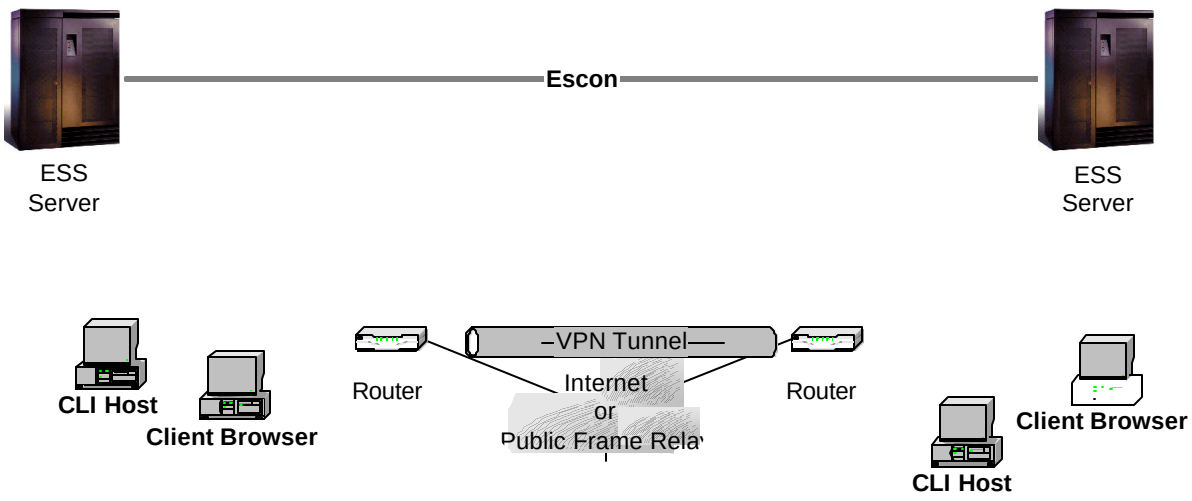
Figure 1

In Figure 1, the network connection attaching to the ESS Servers and CLI Hosts is connected within a customer intranet. This implies that each network is aware of each other and are routable to each other.



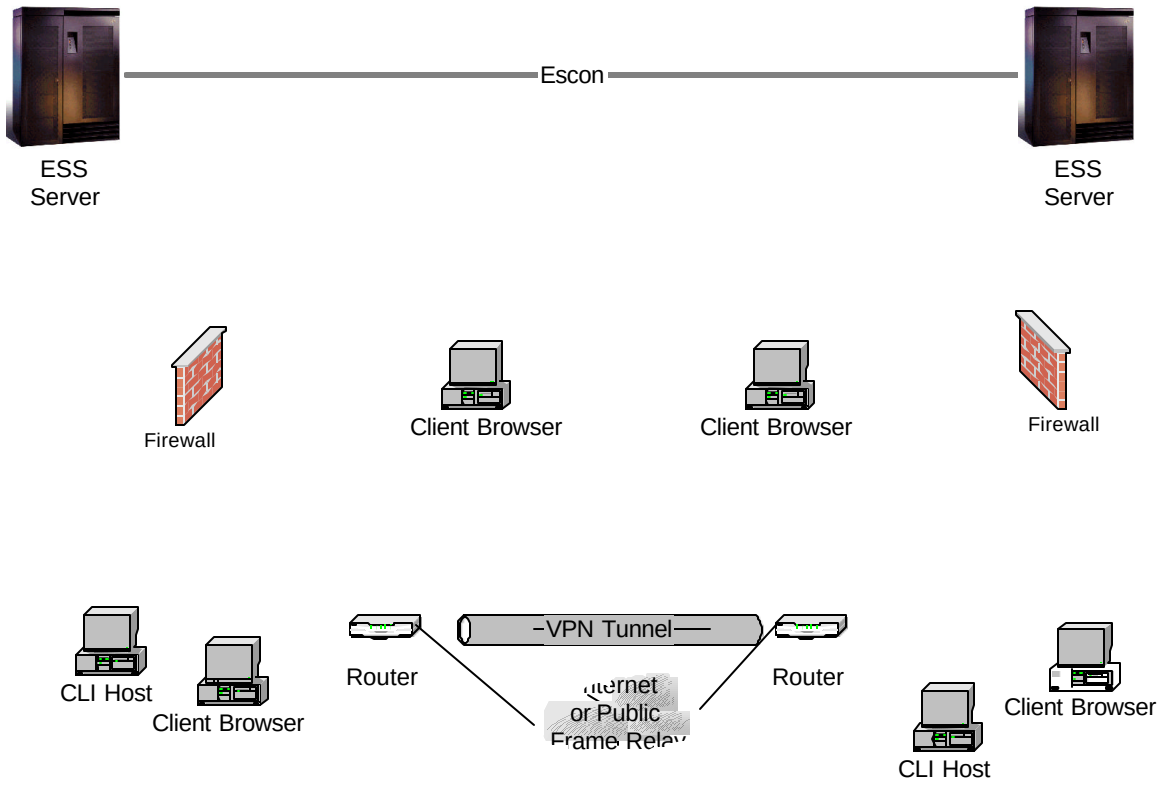
The firewalls protecting the intranet are not between network A and network B. This is important when attaching the ESS server to your network. The required IP addresses have been obtained and are properly configured on the ESS server and CLI Host. There are no other required configuration changes to be performed to have the ESS Specialist Console, CLI Host and Client Browsers talk to the ESS Servers. Note that the primary data transmissions and copies are done through the original connections.

Figure 2



In Figure 2, a connection is defined to simulate the attachment of two offices in locations remote to each other. The two networks are attached to the Internet and tunneling protocols have been implemented between the two sites to secure the configuration data and processing data being passed between the CLI Host, Client Browser, and ESS Servers. Again because the two networks are unique to each other the same communication channels are used to pass the management, configuration, and processing data as are used for communicating between the 2 remote sites. With the VPN Tunneling being established by the routers that are connecting the 2 sites, the data is being transmitted in a secured environment.

Figure 3



When connecting the CLI host to an ESS Server using various security type procedures such as NAT (Network Address Translation) and filtering routers, there are some procedures that should be followed to allow the passing of traffic from the CLI host to the ESS server. This may require verifying the configurations and port opens by your network security administrators. Below is the list of filters which have been tested with filtering router firewalls that will have to be opened by the network owner of the router/firewall. Use of other techniques such as application firewalls and statefull firewalls could also be used. Follow the filters with TCP any any established verifications/statefull filter.

TCP Port 80 - WWW
TCP Port 443 - HTTPS
TCP Port 23 - Telnet
UDP Port 53 - Domain (DNS)
TCP Port 1703 - Nameserver - SOCKS
TCP Port 1705 - appletserver - SOCKS
TCP Port 1707 - applet status server - SOCKS
TCP Port 1709 - client heartbeat - SOCKS
TCP Port 1711 - cobra code - SOCKS/IIOP
TCP Port gt 32000 - Heartbeat Opens between ESS Servers
Permit tcp any any established

ESS Open Copy Services Considerations

When using NAT (Network Address Translation) you must be careful where you put your CLI host. If it is located as CLI host A is shown in Figure 4, it will not be able to translate the web updates correctly. This is because the translation is done outside the data frames being transmitted to the ESS Servers. The solution to having the CLI host located outside your firewall with Private Addressing is to use VPN tunneling techniques. This can be done in two ways. The first is to simply install the client VPN software supporting IPSEC Standard for your firewall/NAT device (Figure 5A). The second is to install a device(s) which supports VPN Tunneling to connect CLI Host A to the ESS server (Figure 5B). This would place the CLI Host in the same network. If you moved CLI Host A to ESS Net A, you would simply apply the filters required for the 2 ESS servers to allow them to talk to each other. CLI Host A now would be on the NAT side of the router/firewall, which would then translate correctly and find the other ESS servers.

Figure 4

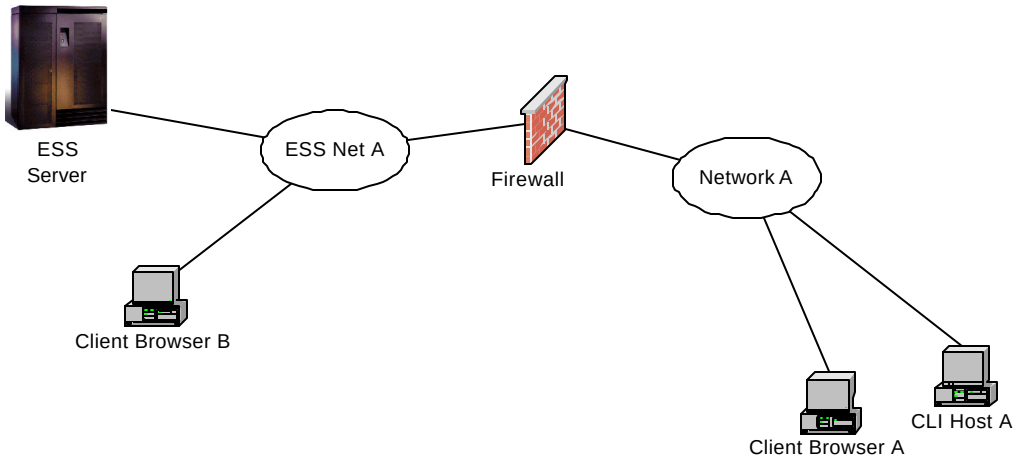
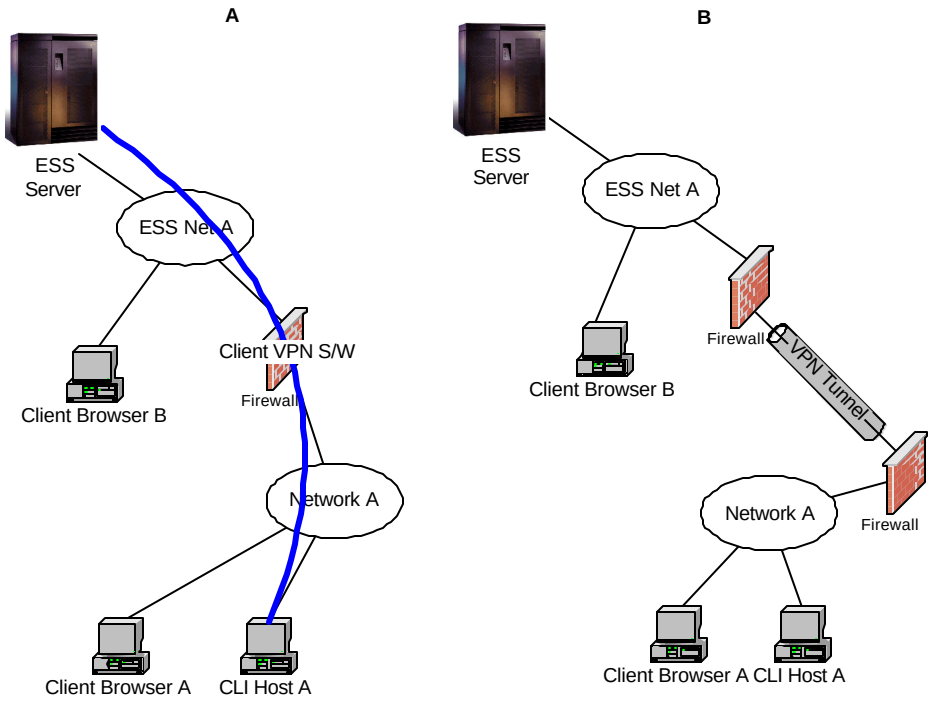


Figure 5 A and B



ESS - Standard ESS Configurations Guidelines

As the amount of storage to be managed in an account grows, the need for standards grows higher and higher. One customer's experience in this arena might be worth recounting. The customer today has some 250+TB (127TB S/390, 125tb Fixed Block) of disk installed across 4 sites. All storage on all platforms is centrally managed by a small storage management team located at one of the sites. The customer has grown over the last 20 years by a variety of means. (normal growth, mergers and acquisitions, etc.) The net result has been tremendous growth in storage (today S/390 grows at 35%/year, Fixed Block "open" storage at 55%/year). There has been little growth in the storage management team. This customer made some interesting observations related to the management of 250+tb of storage with a small staff.

1) The customer determines a Standard Configuration and tests it in their test environment for S/390, Fixed Block, and mixed environments. The standard configuration is selected based on their past experience and input from IBM on the recommended 'optimal storage' and number and type of host attachments. Then, say a 3.6TB box becomes the standard for open systems. The customer account team orders that size ESS and qualifies the box's performance with a representative workload in their test environment. With standard configurations, this customer found that it became much easier to interchange like storage subsystems thus reducing complicated planning exercises. Further, standard configurations simplify not just the production environment planning but D/R site recovery planning.

2) Standard LUN sizes. For example, 16GB LUNs seemed to work well in their environment across all server types. As a result they carve a 3.6 TB ESS into 16GB LUNS, test and qualify this configuration which they determine gives some specific level of performance. As a result, any server can in theory be attached to any ESS and additional growth can be managed on a generic configuration/install basis. Further, storage subsystems at the backup disaster/recovery site know and understand the standard configuration. The customer knows how long it takes to dump and restore an ESS, the number of required Physical tapes and tape drives etc.

Further, as the corporation thinks about exploitation of advanced features like FlashCopy, the 16GB LUNs can be defined over some fixed number of logical storage subsystems, reserving address ranges for FlashCopy target LUNs.

3) For Business Unit applications that require advanced features like ESS Open PPRC, the target secondary storage subsystems match the primary 1:1, yielding the same performance and management in the event of a planned or unplanned site switch. Further, as growth occurs in this environment the standard ESS Configuration is easily replicated.

4) Naming considerations - if possible place some sort of identifier in the logical & physical name for a device, as well as the SSID for the subsystem so that the operations staff can quickly identify which physical site the particular device/subsystem is located. PPRC secondaries and FlashCopy targets can also adopt a unique naming convention to simplify operations.

5) Recognize that there will be some waste of storage by moving to standard configurations, but also realize that in today's world it will cost your corporation more money in storage management costs to manage exceptions than any additional hardware costs. Yes, there will be exceptions/special cases but manage them as exceptions, not as the norm, with a focus on the total cost of storage.

6) PPRC Configurations are best managed in a 1:1 configuration. Mirror all volumes from a single primary site ESS LSS to a single secondary site ESS LSS. This type of configuration fits well with naming conventions and the standard configuration/LUN sizes outlined above. Simplification of configurations helps to reduce the storage management costs associated with managing multiple site

configurations. Note that the ESS does provide for alternative configurations. A single ESS LSS can actually have volumes mirrored to up to 4 different secondary LSS's. But, when one attempts to manage up to 8 physical paths and operationally define and manage the establish paths/pairs topology one quickly learns what many of the S/390 PPRC customers have discovered over the last 5+ years. That is not to say that there are no customers who manage complex environments, but 1:1 configurations are the most common.

Another common configuration is bi-directional. In this case, with separate applications running on servers in opposite sites one will mirror via PPRC application A's volumes from site 1 to site 2 and application B's volumes from site 2 to site 1. The critical design point is that all Primary PPRC volumes that an application requires be in one site and all secondary volumes be in the opposite site. If one ends up with primary volumes for a single application across both sites, one loses cross volume data integrity and data consistency which will make recovery longer and more complicated. Data loss also becomes an issue if this were to occur as well.

7) ESS Combination of Functions - note that **a PAV** can be a XRC source, XRC target, PPRC source, FC source or target, CC source. The following table is used to show combinations of various extended functions. The top of the table shows the initial state of the volume, then look up the column to see if the volume may become the state as indicated.

If a device is => ---------- To become	FlashCopy Source	FlashCopy Target	XRC Source	XRC Target	PPRC Primary	PPRC Secondary	Concurrent Copy
XRC Source	YES	YES	No	YES	YES	No	YES
XRC Target	YES	YES	YES	No	YES	No	YES
PPRC Primary	YES	YES	YES	YES	No	No	YES
PPRC Secondary	YES	YES	No	No	No	No	No
ConcurrentCopy	YES	YES	YES	YES	YES	No	YES
FlashCopy Source	No	No	YES	YES	YES	YES	YES
FlashCopy Target	No	No	No	No	No	No	No

ESS Open PPRC D/R Considerations

Introduction

With the rise of the Internet and the growth of on-line applications to support e-business and B2B, enterprises are increasingly looking for ways *to improve availability*, avoid outages and minimize the adverse effects on business critical applications when they do occur.

If an unplanned outage does occur, most IT installations would say that the ideal scenario is:

- recovery occurs instantaneously with no data loss,
- there is no performance impact to the current production environment, and

- the resources necessary to perform the recovery actions are available at a minimal cost.

Technology keeps moving recovery scenarios toward this ideal, however, even with the various hardware and software capabilities available today, there are still "Business Impact & Cost" tradeoffs that must be made.

Response Time and Recovery Point Objectives

When planning for recovery from outages, the typical tradeoffs which must be made are Recovery Time Objectives (ROT), Recovery Point Objectives (RPO) and of course Cost. To meet ROT requirements customers must weigh the following:

- Cost of some data loss which yields the ability to perform a data base restart (typically seconds to minutes in duration)

vs.

- Cost of no data loss which either will impact production on all operational errors in addition to disaster recovery failure situations or yield a data base recovery (typically hours to days in duration) in the event of a site switch.

The Impact of e-business on System Availability Requirements

The rapid rise of e-business and the Internet has given various business units the requirement to be available "24 x Forever". This, in turn, has caused a number of businesses to move towards a GDPS™ Application and data availability type environment for S/390. The long term direction for the IBM GDPS™ Service offering is to embrace and manage various 'clustered' Open system resources (Server, Data & Network) in much the same way as S/390 multi-site resources are managed today under GDPS™. From a storage perspective the first step towards this end goal is the delivery of ESS Open PPRC. The PPRC design and architecture for S/390 has been extended and adapted to the Open system's environment. Rather than changing storage management software and hundreds of operating systems & levels, ESS Open PPRC extends the ESS Specialist with a Copy Services component providing all the necessary management tools and interfaces to manage the Open Systems ESS PPRC and FlashCopy environments. This Web based management tool has been complimented with a Command Line Interface (CLI) that permits various open system's operating systems 'automation' packages and applications (ex. SAP via the TSM BACKINT Interface) to manage the PPRC and FlashCopy to provide solutions like mirroring for D/R and "offline or serverless" backup via a split mirroring approach.

In response to growing e-business requirements, in may cases new applications are developed. As part of the move to e-business, enterprises should evaluate the availability requirements on various applications and weigh the various options available to them through today's technology.

Transactions which are received by a Web site which cause a response back to the user indicating that the desired action has been taken become a true business commitment that carries financial commitments and consequently these transactions must be logged. An example could be ordering a piece of merchandise over the Internet.

- The user clicks "OK" in response to a question to confirm the order.
- The Web site receives the user's confirmation and responds with a message that the transaction, i.e. the customer's order, will be processed.

- The response back to the customer implies a financial commitment on the part of the installation to fulfill the transaction.

In the above example, typically a customer will perform a number of Query transactions, investigating various pieces of information, before making any sort of financial commitment. Consequently only a subset of all transactions ultimately need to be logged.

Another approach could be to utilize a front end transaction processor to perform the required transaction logging before the transaction is transmitted to the host back-end server for processing. Some customers take the order and then return confirmation of the transaction after some preset delay time, insuring that the data related to the transaction is secured in the business.

Sometimes the transaction confirmation occurs via e-mail or a notice is posted to the customer's account after the "real transaction" has occurred. For example, when one places an order with a stock broker, it gets executed on the trading floor and sometime later confirmation is sent back to the client that the trade actually took place along with the actual buy or sell amounts.

In addition to mirroring critical transaction information at a remote site, businesses often also have paper trails or audit records that can be analyzed by hand to recreate and repair lost transactions. Typically, these transactions are prioritized by the monetary amount of the transactions. As one bank said: "We know very well, all transactions over $1M in our bank - transactions over this amount are tracked, checked and audited several times in the business cycle before the actual transaction is completed and confirmation is given back to the customer."

Through various techniques outlined above, enterprises can also 'limit' the knowledge of a disaster or a planned site switch event to only systems/applications that have access to the business's back end systems. Transactions may be accepted and logged in end user 'front end' systems, but the actual transaction update is queued until the back-end business system is available. With GDPS™ the back-end system outage can be greatly minimized, even in the event of a complete disaster. With ESS Open PPRC and FlashCopy the various stand alone open systems as well as the Open system servers that support the 'business' environment (front end systems, B2B servers, etc.) working with the S/390 legacy data can be given a high level of D/R protection using the same mirroring and data replication techniques that have been proven in the S/390 environment for years.

Comparison of Disaster Recovery Techniques

The table below illustrates some disaster recovery techniques that various customers use today.

Physical Transport, Electronic Vaulting and Application Mirroring

Most customers still use the traditional method[1] of creating tapes nightly and then transporting them to a remote site overnight. Electronic Tape Vaulting replaced physically transporting tapes, with the tradeoff of the added expense for telecommunication lines.

Various data base or application-based mirroring techniques[2] also have provided more current data, but these techniques are limited to data contained in the particular data base for which they were designed.

The IBM VTS (Peer to Peer) PTP capability (recently available) now provides a hardware based tape copy across two sites based on the same Disk storage subsystem PPRC architecture techniques modified as required for tape processing.

---

[1] Known unofficially within the industry as: Pickup Truck Access Method (PTAM).

[2] Examples are: IMS RSR and Replidata.

Storage Subsystem Mirroring

Disk mirroring is popular today because it is based on the storage subsystem and hence is independent of the host applications, data bases and file systems which utilize the subsystem. Storage subsystem mirroring is accomplished by using PPRC, SRDF etc.

Host-based Software

The Open systems environment has provided Host based software mirroring via the operating system file system for some time. This “dual write” capability is coordinated by the host operating system file system and can be used for all data that resides in that file system. Many customers prefer to outboard this function and its management to the disk storage subsystem, thus reducing the complexity of managing the mirroring function uniquely on each platform. An outboard approach permits the storage team and the D/R team to manage the mirroring. Standardization also simplifies automated operations.

GDPS™

GDPS™ is the only solution available in the marketplace today that provides full recovery of all the components in the IT Infrastructure which are required to recover an application or a set of application(s) in the event of a disaster. Examples of these components are:

- data
- processors
- CF structures
- network
- data base restart, and
- application restart.

Prior to GDPS™, customers invoked manual procedures with some automation in support of those procedures, but recovery was very labor intensive. As a consequence of being so labor intensive, the recovery placed less emphasis on the recovery time or recovery point and just concentrated on getting critical business applications running again.

Today's e-business world has placed renewed emphasis on recovery time objectives and recovery point objectives. Each of these factors is an application(s) metric, therefore even with disk mirroring, recovery of disk data is fast, but the recovery of the ‘rest of the environment' is non-trivial. Hence the high demand and customer interest in the GDPS™ Enterprise solution. As the GDPS™ offering moves to embrace the open environment recovery times of the enterprise will continue to reduce. The following chart taken from S/390 customer experience show RPO and ROT time frames for the various D/R methods outlined above. One would expect that in large open server environments, similar times would exist, especially as automated operations for open servers continue to evolve.

ESS Open Copy Services Considerations

	function / DR option	PTAM	Elect. vault	Data repl	Disk mirror	GDPS
	appl / system start-up					X
	appl / system shutdown					X
	user defined actions					X
	application failure					X
	OS/390 image failure					X
	processor failure					X
	CF failure					X
	disk subsystem failure					X
D/R	site failure	X	X	X	X	X
	application independent				X	X
	recovery point objective (RPO)	24-48h	12h	<5m	0/<1m	0
	recovery time objective (RTO)	24-48h	24-48h	24-48h	2-4h	<1h

GDPS provides continuous availability AND near-transparent DR

A Disaster Scenario

A disaster has occurred, your corporation had implemented ESS Open PPRC and successfully recovered all disk data at the remote site. Lost Transactions are being identified and analyzed. Employee's, having helped their families through the disaster, are returning to work satisfied that the corporation survived. Is that all there is ?

The first thought might be to backup all corporate data just recovered. Coupled with ESS Open PPRC is ESS FlashCopy, which one could invoke after having recovered all PPRC secondary disks. This FlashCopy (with the no background copy option) would provide a quick, point in time backup of all corporate data that could then be backed up to tape while the production environment continues. To do this one would need to have target LUNs/devices defined for each secondary PPRC LUN/device on the secondary ESS LSS. One could use the same FlashCopy target devices used by the operational team to FlashCopy all secondary site disks before a PPRC resync operation, or the FlashCopy disks used by operations for daily offloading of normal backup operations from the production server. The key is to recognize the new possibilities that technology offers to minimize business risk.

Secondly, with the corporation's critical production is back up and running, but without additional planning and action your business may now exposed to a subsequent disaster at the recovery site. Perhaps an ESS Open PPRC infrastructure design should also be also defined to a third party recovery site, only to be invoked in the event of a disaster. Further, on a planned site switch, this same infrastructure should be utilized to minimize risk to the business. Perhaps additional disaster recovery insurance covers the business for financial loss. As one begins to investigate planned and unplanned site switches and managing business risks it is clear that there is no substitute for planning, planning and more planning up front.

Cost Justifications and Tradeoffs

Better Utilization of Resources

It is interesting that most customer interest in briefings related to ESS Open PPRC start with a focus on disaster recovery related issues. But typically, as one moves to cost-justify an implementation, disaster recovery ends up being just one facet of what the total solution provides. One major benefit is the simplification of daily management functions of cross site resources for the enterprise. Another is a

reduction in the dependency on skilled operations support staff which is especially important at the time of an actual planned or unplanned site switch. All of these factors can translate to real dollar savings as well as on overall reduction in IT infrastructure. Several S/390 customers justified PPRC to their business by looking at the operational value of both planned and unplanned site switches to their coporation's total IT availability plan. IT-Austria, for example, has had S/390 GDPS in production since 5/98. Although up to this point, they have never required the unplanned site switch support except for testing, the capability for planned site switches provides them with valuable flexibility in managing their IT infrastructure. Knowing that they can do a complete site switch in 54 minutes (which has been done many times), allows IT-Austria to further minimize risk, when planned actions have a potential negative effect on their computing environment. Why risk a disruption of their production systems due to major equipment or environmental upgrades (power, cooling, etc.) ? Human error by service and operations personnel while changing or upgrading equipment can simply be eliminated by switching production to the backup site, before any upgrade work is started.

For customers interested in a total Enterprise GDPS™ solution, the first steps would be to implement GDPS™ for their S/390 environment and ESS Open PPRC for all non-S/390 platforms (excluding AS/400 where Mimics is the recommended D/R solution). This will strategically position customers to implement a complete Enterprise wide GDPS™ solution. The number one customer requirement against GDPS™ today is to extend it to embrace the various open systems clustered environments.

What Data To Mirror?

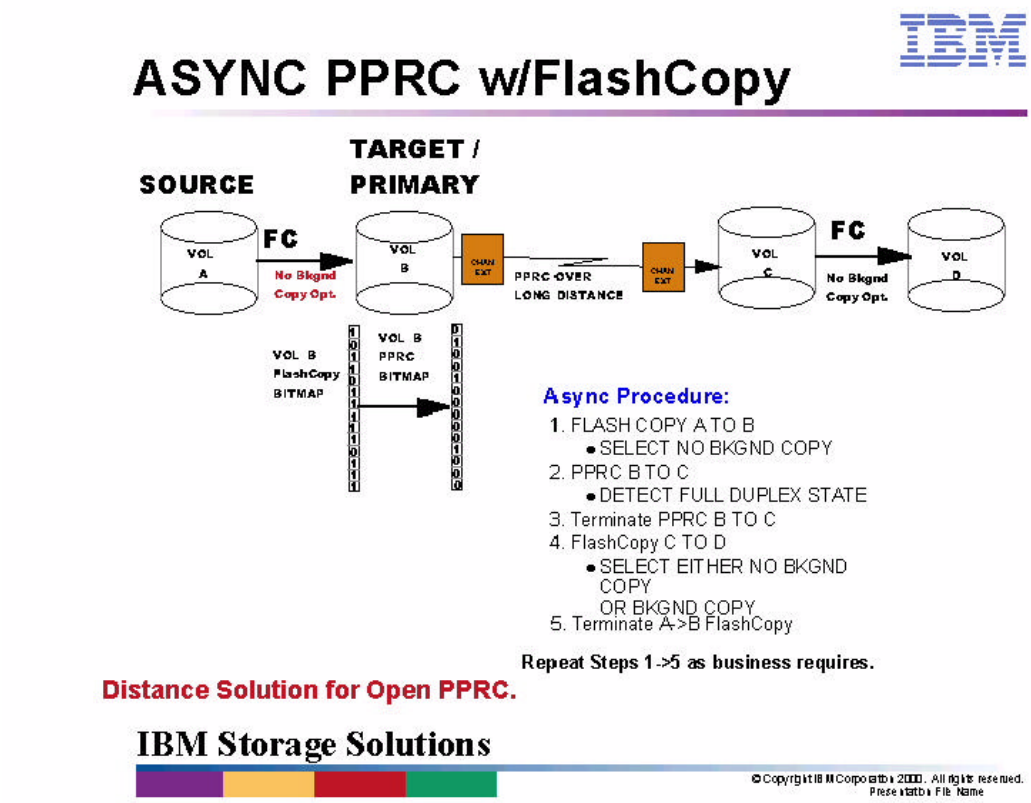
Selecting the criteria for determining what data needs to be mirrored can be very difficult, especially since these criteria can change as business systems and their critical data evolve over time. Some customers attempt to separate critical and non-critical data and find that this technique is only possible via extremely rigid allocation controls. In most cases, especially for larger installations, it is a sure way to achieve 'unrecoverability' in the case of a disaster, since something always seems to fall through the cracks. On S/390, SMS Storage groups can aid in separating critical from non-critical data, but again, this process can be very labor intensive and prone to errors over time.

On Open Systems, all data within a specific file system can be secured via PPRC, but it is difficult to determine whether or not this represents all files needed to recover the entire operational environment in the event of a disaster or planned site switch. An additional concern is the change of the environment over time. Many customers have analyzed the cost of the support staff necessary to manage such a separation of critical and non-critical data, and have concluded that it is more cost effective to simply mirror all disk resident data. With the advent of VTS PTP, these same sort of decisions are now also being made for tape data.

One other issue to note is that today, most customers seek vendor independent solutions. Proprietary disk mirroring solutions mean that all disk subsystems involved in mirroring, including any additional storage required for future growth, must be from that same vendor. Furthermore, if one considers an unplanned site switch due to a disaster, and factors in the additional disaster recovery procedures to secure the data at the backup site to, perhaps, a third party recovery house, it should be readily apparent that any requirement for vendor-specific storage subsystems could add significant cost to a contract with such a recovery house. Selecting an industry standard architecture helps to maintain focus on competitive prices when adding additional storage as data grows, but also when in the position of having to rent additional storage capacity in the case of a disaster.

Asynchronous ESS Open PPRC with FlashCopy

With the ESS, IBM can offer a similar combination of ESS FlashCopy and PPRC, generally recommended to only be used with the data base log volumes and achieve similar results to the Multi-Hop approach provided by other vendors.



An approach for say a 1TB Data Base running on an open system would be to clone a copy of the data base to a remote location. Then, as your business requirements dictate, FlashCopy the Data Base logs for that data base on the production system. Once the FlashCopy (w/NOCOPY) completes, one can do a PPRC session to the remote location over channel extensions. The PPRC initialization process runs asynchronously. When the PPRC pair is in full duplex, a FlashCopy of the secondary site PPRC 'secondary volume' can be made. From this secondary site FlashCopy volume one can log apply the DB log to the secondary site DB. The process can be repeated as it makes sense for the business or immediately after the secondary site FC (w/NOCOPY option) completes.

This solution provides for the minimal use of Telco lines, just doing a copy of the write updates to the log and can reduce typical pickup truck access method (PTAM) D/R which currently provides RPO of 24 hours and RTO to as much as 48 hours to a RPO of say 1-2 hours and a RTO of 4-6 hours, for a small additional cost.

.

ESS Copy Services Summary

ESS Copy Services provides flexible solutions for single and multi-site customers. Data replication techniques previously provided on the OS/390 platform are now available for Open system platforms. The Enterprise customer can utilize the same solution across his server platforms and reduce his total storage management costs by leveraging this new technology. The ESS Copy Services Web interface simplifies the

tasks associated with managing storage across multiple Open System platforms by centralizing its storage management tasks to a single interface invoked from the user's favorite browser interface. Flexibility, reduced costs and simplified storage management through the ESS Copy Services solution yields the perfect storage subsystem solution on which one can consolidate all storage in the Enterprise.