

**Using
IBM® TotalStorage® Enterprise Storage Server® FlashCopy®
Function
with the
VMware ESX 2.5 Server**



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2 Executive Summary

Today, many businesses have become increasingly dependent on data storage and require a high level of availability to support 24 hours a day, seven days a week (24x7) operation. A lengthy outage could lead to significant financial losses, loss of credibility with customers, and possibly even a total failure of a business. Therefore, the ability to support high availability for the major applications is more often than not a necessity for business survival. A key component of a highly available system is the storage subsystem. It is essential that high availability of data is supported, and that downtime for data backup and software maintenance is minimized or more preferably eliminated.

In the current information age, the amount of data is increasing exponentially, and storing and managing this vast amount of data is critically important and challenging for customers. More and more businesses are transforming their operations into information-centric models and demanding uninterrupted availability of data. In addition to tremendous growth in the amount and the value of data, businesses are unwilling to tolerate outages for even routine maintenance and backups. As part of their data backup strategy, companies are increasingly replicating their data using point-in-time solutions such as FlashCopy® for ESS.

The IBM TotalStorage Enterprise Storage Server (ESS) is targeted at both mainframe and open system environments and is designed to provide improved reliability, ease of management and exceptional performance. Further, the ESS provides a rich set of Advanced Copy Services to providing point-in-time copies, synchronous copies, and remote mirroring.

VMware, an EMC company, was founded in 1998 to bring mainframe-class virtual machine technology to industry-standard computers. VMware delivered its first product, VMware® Workstation in 1999 and in 2001 introduced VMware GSX Server and VMware ESX Server. With the launch of VMware VirtualCenter in 2003, and the groundbreaking VMotion™ technology, the company established itself as the thought leader in the newly emerging virtual infrastructure marketplace. Virtual infrastructure introduces a new category of capabilities to the data center enabling business to reduce their IT costs through increased efficiency, flexibility and responsiveness. In 2004, the company extended the capabilities of virtual infrastructure to the enterprise desktop with the introduction of VMware ACE. VMware is based in the heart of Silicon Valley--Palo Alto, California.

IBM and VMware are working together to provide greater benefits to end-users by promoting greater interoperability in the solutions that each bring to the marketplace. This paper offers an overview of the use of the ESS's FlashCopy function to assist customers in meeting their data backup needs for applications running on the ESX Server.

3 Customer Requirements

As companies become more reliant on information systems and data, loss of data or loss of access to data could significantly disrupt the business. No longer is data part of the business - it is the business.

Gartner stated, "Two out of five enterprises that experience a disaster go out of business within five years. Business continuity plans and disaster recovery services ensure continuing viability." (Gartner, *Disaster Recovery Plans and Systems Are Essential*, by Roberta Witty, Donna Scott, 12 September 2001).

Customers are implementing procedures and technologies to proactively manage recovery and availability. Customers require high availability, minimal application downtime for maintenance, and the ability to perform data backups with minimal or no application outage in order to support the needs of their business. Traditionally, tape backups have been the standard for disaster recovery, but even with the latest high-end tape based solution, a restore procedure from tape could typically take anywhere from hours to days and inevitably result in hours of data loss.

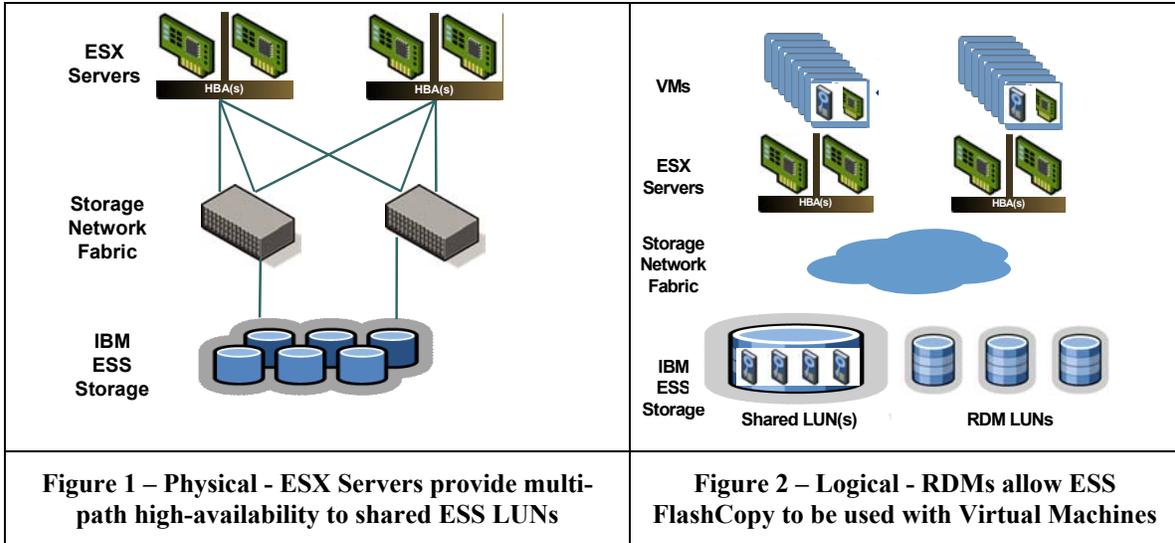
In order to choose the appropriate disaster recovery technologies, customers need to determine their most critical processes and their respective Recovery Point Objective (RPO) and Recovery Time Objective (RTO) requirements. RPO is the point in time to which applications data must be recovered to resume business transaction. RTO is the maximum elapsed time allowed before lack of business function severely impacts an organization.

Additionally, customers need to determine the Network Recovery Objective (NRO) as well. NRO indicates the time required to recover or fail over network operations. Comprehensive network failover planning is another dimension to data recovery in a disaster recovery scenario and will not be addressed in this whitepaper.

4 The VMware Environment

VMware provides a classical Virtual Machine abstraction to higher-level software, allowing multiple instances to run on a single piece of hardware. Each Virtual Machine has its own set of dedicated Virtual Devices that for I/O are abstractions of standard Ethernet and SCSI interfaces. The actual physical NICs and HBAs are not shown through to the Virtual Machines; no matter what card is in the physical box, a VM will always see either a Buslogic or LSI Logic SCSI adapter.

VMware ESX Server environments are made up of farms, a set of high-performance multi-processor x86-based systems such as the IBM x-Series x345, x365, and x445. I/O is attained through common SAN storage and connectivity to a common set of IP subnets.



In typical use a small set of moderate-sized LUNs (400GB – 1TB) are shared between all ESX Servers in a farm. Each LUN contains a single partition formatted as a VMware VMFS file system that in turn has a set of .dsk files, each representing a Virtual Machine’s virtual disk. A VMFS directory may have many files (up to ~128) each 1GB or larger, depending on the needs of the VMs. Though it’s possible to use the Copy Services FlashCopy facility with a VMFS LUN, it does not allow normal desired behavior since it is often difficult or impossible to ensure that all VMs using a given VMFS have flushed meta-data and quiesced I/O operations simultaneously.

ESX Server has the ability to map a raw SAN LUN directly into a Virtual Machine. In this configuration the virtual SCSI I/O operations are passed through the VMkernel to the underlying I/O system with minimal modification. Raw LUNs are formatted directly by the VM, so Linux LUNs would typically have ext3 partitions while Windows LUNs have NTFS. Starting with version 2.5, VMware ESX Server implements Raw Disk Maps (RDMS), a new facility that give the possibility of VMs using SCSI pass-through LUNs.

5 **ESS FlashCopy**

Point-in-time copy functions give you an instantaneous copy, or view, of what the original data looked like at the point in time at which the copy was made. The ESS FlashCopy function provides an instant or point-in-time copy of an ESS logical volume (LUN). The point-in-time copy created by the FlashCopy function is typically used where there is a need a copy of production data to be produced with minimal application downtime. The resulting copy can be used for such things as online backup, testing of new applications, or for copying a database for data mining purposes. The copy looks exactly like the original source volume and is an instantly available, binary copy. Immediately after the execution of the FlashCopy “Establish” operation there is independent read and write access to the source and target LUNs.

By default the FlashCopy function will copy the entire contents of a source LUN to a target LUN. At the completion of the background copy operation the ESS will dissolve the source-target relationship between the volumes. The complete background copy operation can optionally be suppressed at the time the FlashCopy Establish is executed and when this option is selected only changed data results in original data being copied from the source LUN to the target LUN. This results in a logical copy of the data with only the blocks that are about to be changed being recorded before the change occurs, commonly referred to as the “copy-on-write” technique. This may be useful if the copy is needed for only for a short time, such as making a backup to tape. Since a complete background copy is not being done, the source-target relationship of the source and target LUNs will remain and a FlashCopy Withdraw operation must be performed to terminate the source-target relationship.

5.1 Incremental FlashCopy Function

The Incremental FlashCopy function is a new feature of FlashCopy that is available with ESS Copy Services Version 2. This function is to be used in conjunction with the background copy option to track the changes on the source volume since the last FlashCopy relationship was invoked. When this option is selected, only the tracks that have been changed on the source are copied again to the target. The direction of the *refresh* can also be reversed, copying the changes made to the new source (originally the target volume) to the new target volume (originally the source volume).

5.2 Multiple Relationship FlashCopy Function

With ESS Copy Services Version 2, one FlashCopy source may have up to 12 FlashCopy targets. This gives you more flexibility as you can initiate the multiple relationships using the same source volume without needing to wait for other relationships to end.

5.3 FlashCopy Consistency Groups

New options are available with ESS Copy Services Version 2 to facilitate the creation of FlashCopy Consistency Groups. With the FlashCopy Consistency Groups, the ESS will hold off I/O activity to a volume until the **Consistency Created** task with the **FlashCopy Consistency Group** option is issued.

6 Making Point-In-Time Copies of Data

Point-in-time copies or (sometimes referred to as snapshots) are useful for creating copies of file systems and databases for backup and off-host processing as in database warehousing and decision support purposes. Point-in-time copies can be an important part of an overall disaster recovery strategy because they help protect against logical corruption and enable the ability to utilize the data at the secondary location.

6.1 Point in Time Copy using ESS FlashCopy

When the ESS FlashCopy Establish is executed, the command returns to the operating system as soon as the FlashCopy source/target pair has been established and the necessary control structures have been created. This process takes only a few seconds to complete. As soon as the pair has been established both the source and the target

volumes are available for independent read and write access. The copy on the target LUN looks exactly like the original source volume and is an instantly available, binary copy.

6.2 Invoking FlashCopy

To invoke FlashCopy on an ESS a copy services task must be defined using the Web User Interface (WUI) and that task can either be executed immediately or saved as a named copy services task to be executed later from the WUI or from a server command line using the ESS Command Line Interface (CLI). The procedure in chapter 3 of the ESS Web User Guide should be used to create FlashCopy tasks. Since the FlashCopy function operates only on a complete volume level, only LUNs attached to a VM in real device mapping mode should be copied using the FlashCopy function.

6.2.1 Mapping VM disks to ESS LUNs

When FlashCopy tasks are created, ESS LUNs are identified in the WUI panels by their serial number. The disk volume serial number for each ESS LUN attached to a VM in real device mapping mode is obtained using the *rsList2105s* command in the ESS CLI. Below is a sample of the output of the *rsList2105s* command.

```
c:\>rsList2105s
disk name          2105 serial number
-----
Disk1              20313698
Disk2              20413698
Disk3              20513698
Disk4              20613698
```

The above procedure of mapping each ESS LUN attached to a VM in real device mapping mode using the *rsList2105s* command in the ESS CLI requires maintaining a cross-reference list of each LUN for each VM. A better approach would be to use the *rsPrimeServer* command in the ESS CLI to load the VM host device names into the ESS Copy Services Server in order to view those names in the WUI when creating the FlashCopy tasks.

The following procedure shown in figures 3 through 6 demonstrate how the VM device names are loaded into the WUI using *rsPrimeServer*.

Figure 3 shows Disk Manager in a Windows 2000 guest named rich-w2k-os-1 with a Raw Disk Mapped drive as E: with the label “E_drive_W2K_1.”

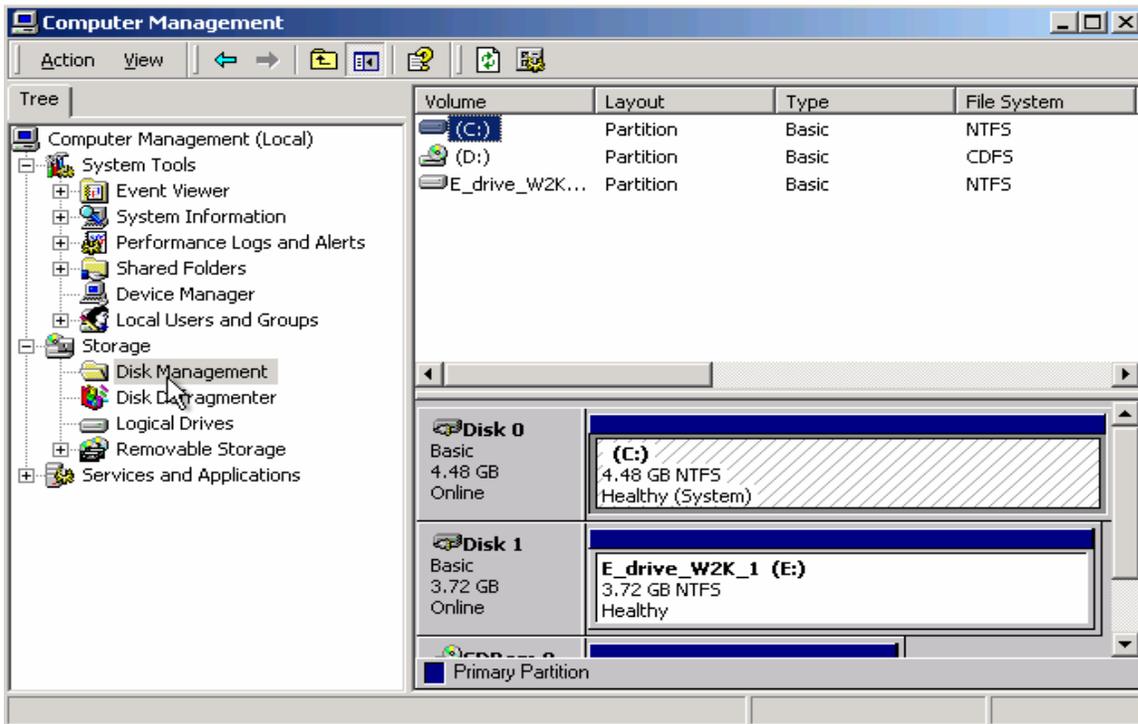


Figure 3 Disk Manager of rich-w2k-os-1

Figure 4 shows Disk Manager in a Windows 2000 guest named RICH-W2K-OS-2 with a Raw Disk Mapped Drive as E: with the label “E_Drive_W2K_2.”

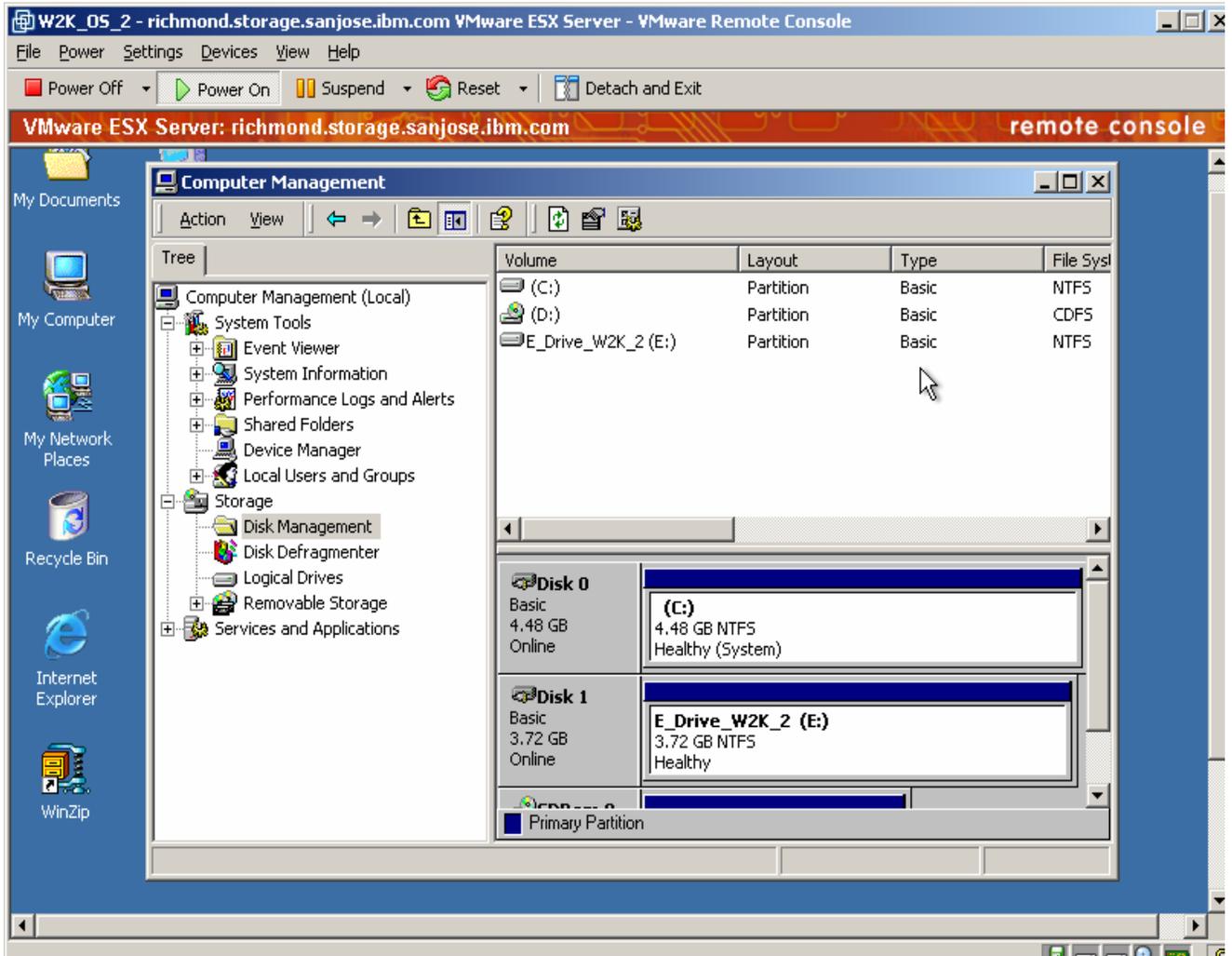
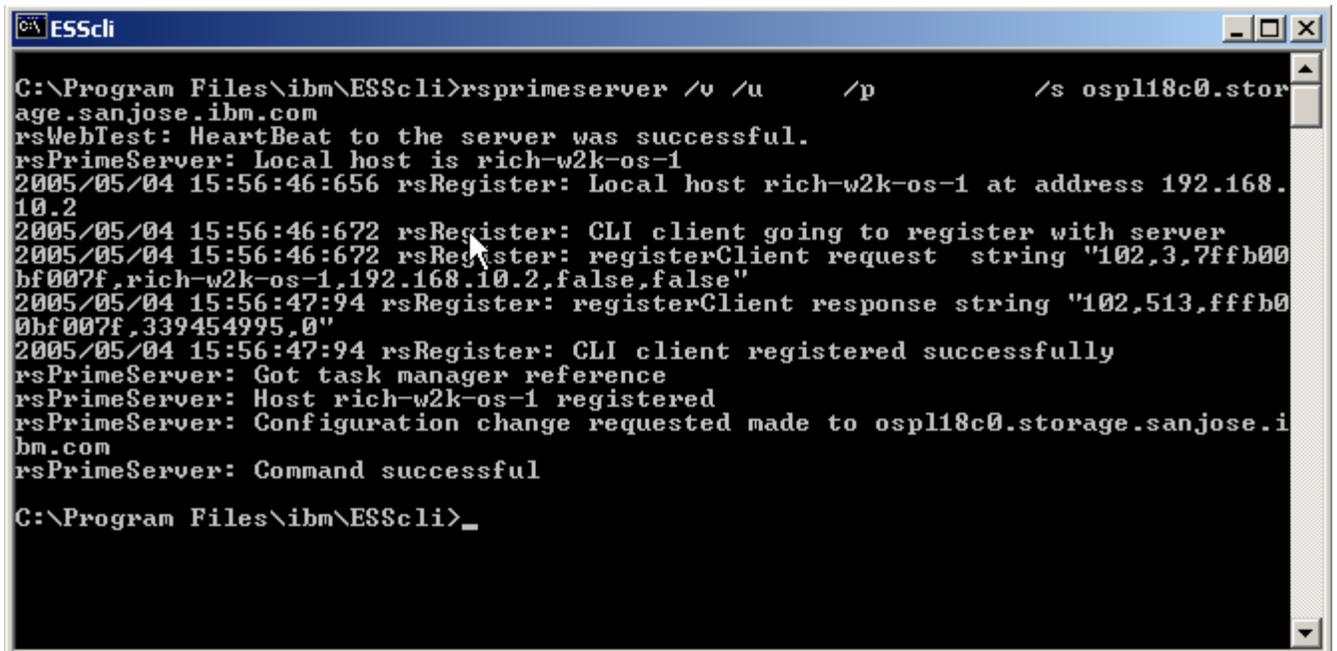


Figure 4 Disk Manager in RICH-W2K-OS-2

The next step is to execute *rsPrimeServer* in each of the VM guests. Figure 5 shows the successful output from *rsPrimeServer* command for rich-w2k-os-1 and Figure 6 shows successful output from *rsPrimeServer* command for RICH-W2K-OS-2.



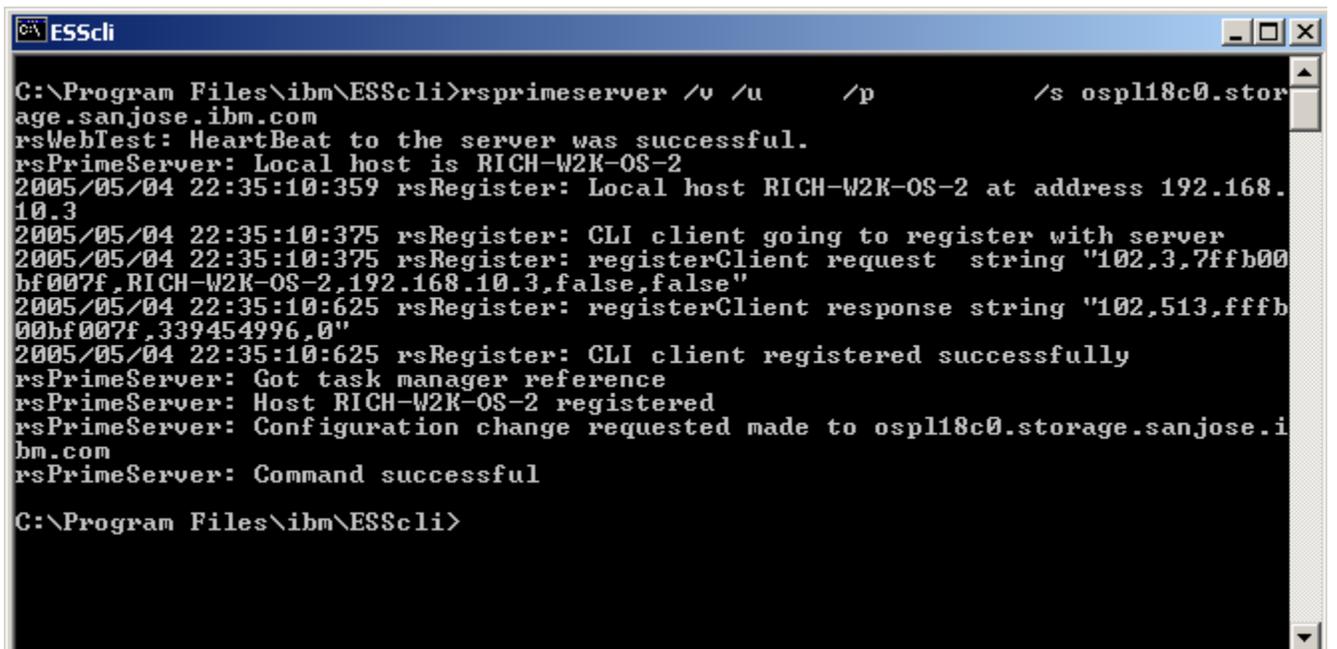
```

C:\Program Files\ibm\ESScli>rsprimeserver /v /u      /p      /s ospl18c0.storage.sanjose.ibm.com
rsWebTest: HeartBeat to the server was successful.
rsPrimeServer: Local host is rich-w2k-os-1
2005/05/04 15:56:46:656 rsRegister: Local host rich-w2k-os-1 at address 192.168.10.2
2005/05/04 15:56:46:672 rsRegister: CLI client going to register with server
2005/05/04 15:56:46:672 rsRegister: registerClient request string "102,3,7ffb00bf007f,rich-w2k-os-1,192.168.10.2,false,false"
2005/05/04 15:56:47:94 rsRegister: registerClient response string "102,513,fffb00bf007f,339454995,0"
2005/05/04 15:56:47:94 rsRegister: CLI client registered successfully
rsPrimeServer: Got task manager reference
rsPrimeServer: Host rich-w2k-os-1 registered
rsPrimeServer: Configuration change requested made to ospl18c0.storage.sanjose.ibm.com
rsPrimeServer: Command successful

C:\Program Files\ibm\ESScli>_

```

Figure 5 *rsPrimeServer* in rich-w2k-os-1



```

C:\Program Files\ibm\ESScli>rsprimeserver /v /u      /p      /s ospl18c0.storage.sanjose.ibm.com
rsWebTest: HeartBeat to the server was successful.
rsPrimeServer: Local host is RICH-W2K-OS-2
2005/05/04 22:35:10:359 rsRegister: Local host RICH-W2K-OS-2 at address 192.168.10.3
2005/05/04 22:35:10:375 rsRegister: CLI client going to register with server
2005/05/04 22:35:10:375 rsRegister: registerClient request string "102,3,7ffb00bf007f,RICH-W2K-OS-2,192.168.10.3,false,false"
2005/05/04 22:35:10:625 rsRegister: registerClient response string "102,513,fffb00bf007f,339454996,0"
2005/05/04 22:35:10:625 rsRegister: CLI client registered successfully
rsPrimeServer: Got task manager reference
rsPrimeServer: Host RICH-W2K-OS-2 registered
rsPrimeServer: Configuration change requested made to ospl18c0.storage.sanjose.ibm.com
rsPrimeServer: Command successful

C:\Program Files\ibm\ESScli>

```

Figure 6 *rsPrimeServer* in RICH-W2K-OS-2

6.2.2 Creating a FlashCopy Task

After the VM guests have sent the device identification information to the ESS using *rsPrimeServer*, the next thing to do is create the FlashCopy task using the WUI. Figure 7 shows the initial Copy Service panel and figures 8 through 10 demonstrate the creation of a FlashCopy task. Chapter 3 of the ESS Web User Guide contains more detail about creating a FlashCopy task as well as more information of the various options available.



Figure 7 ESS Copy Services

Under the Volumes tab on the ESS Copy Services WUI, select the appropriate host focus in the pull-down menu for the source and target. W2K guest 1 and guest 2 are listed as rich-w2k-os-1 and RICH-W2K-OS-2 respectively. When this is done the assigned disks for each guest as loaded into the ESS Copy Services Server by rsPrimeServer are shown.

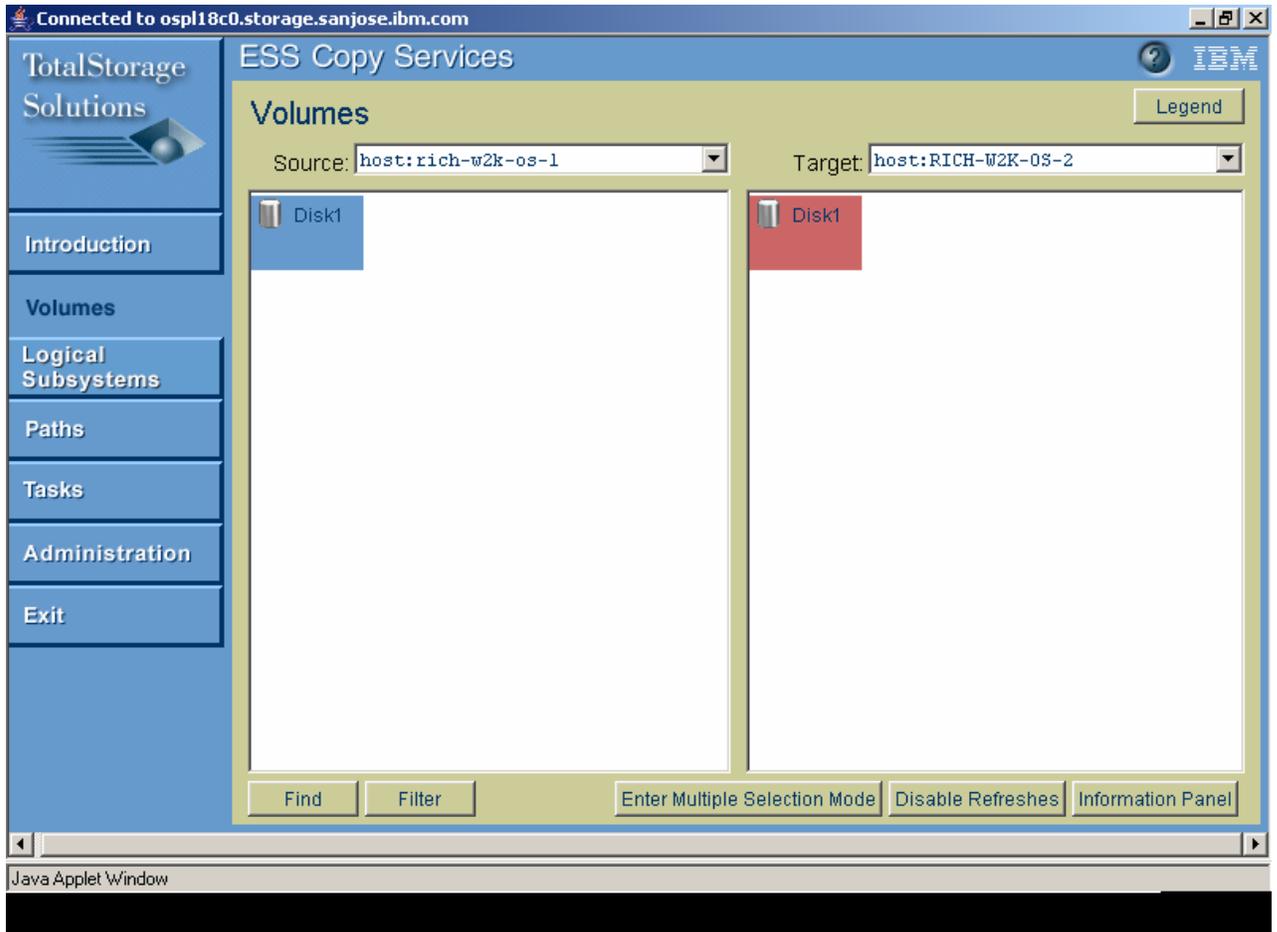


Figure 8 ESS Copy Services volume selection

After selecting Disk1 on host 1 (rich-w2k-os-1) as the source volume and Disk 1 on host 2 (RICH_W2K_OS_2) as the target volume, use the Task Wizard to create the Establish FlashCopy task as shown beginning in Figure 9.

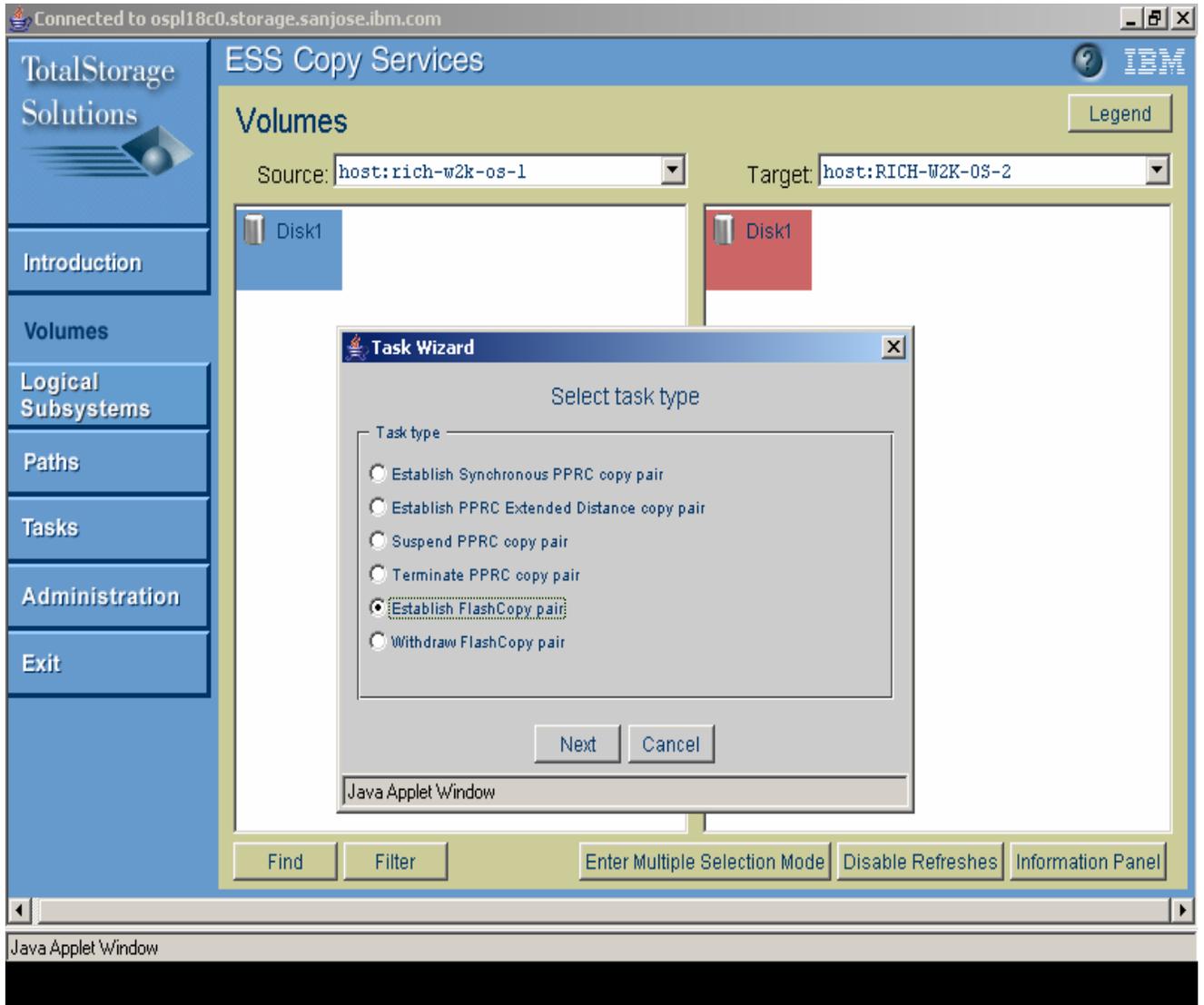


Figure 9 ESS Copy Services Establish FlashCopy

The FlashCopy task just created could be executed from the WUI, but in this example we will save the task using the name VMWare_W2K_FC as shown in Figure 10 so it can be executed at a later point in time from a script executed in a VM.

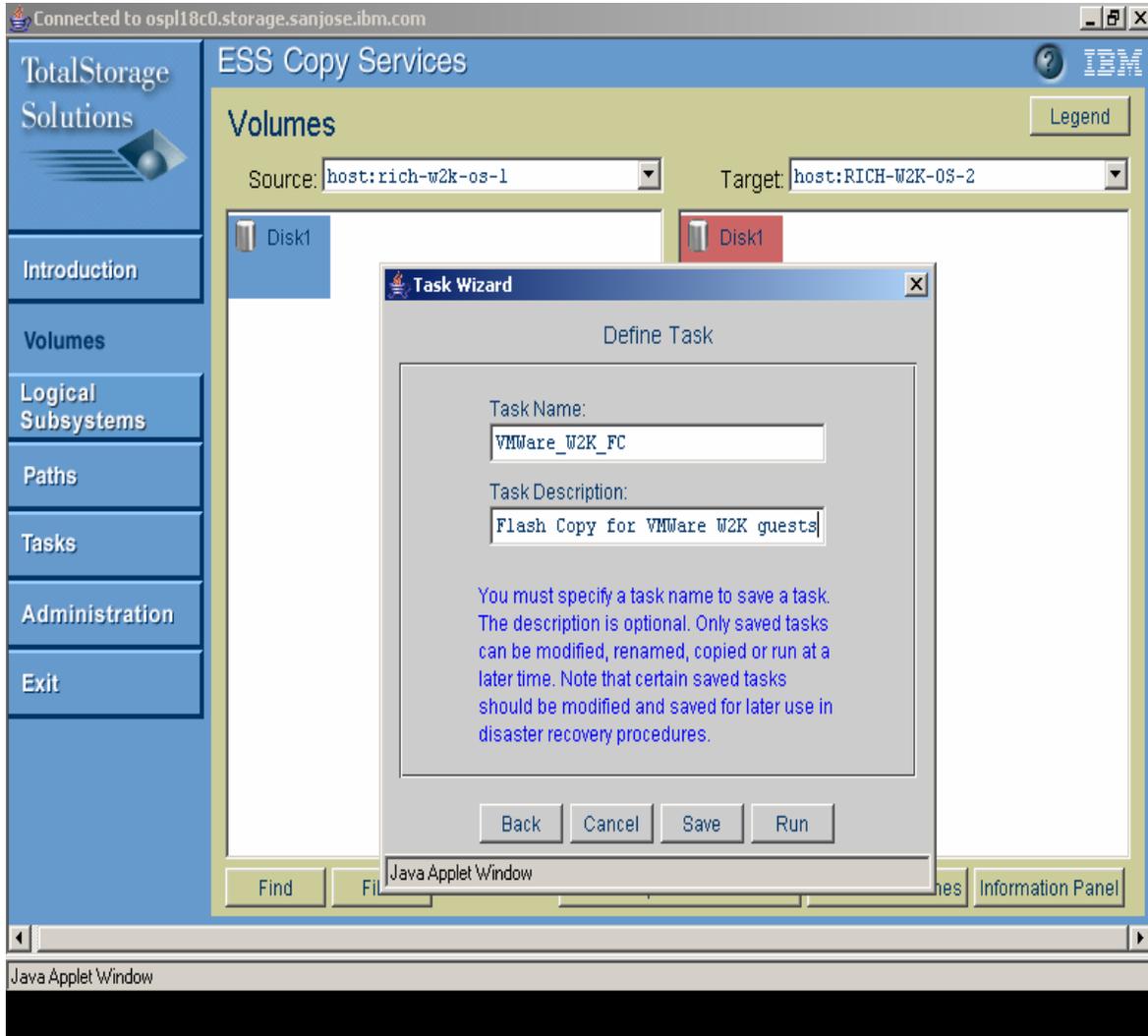
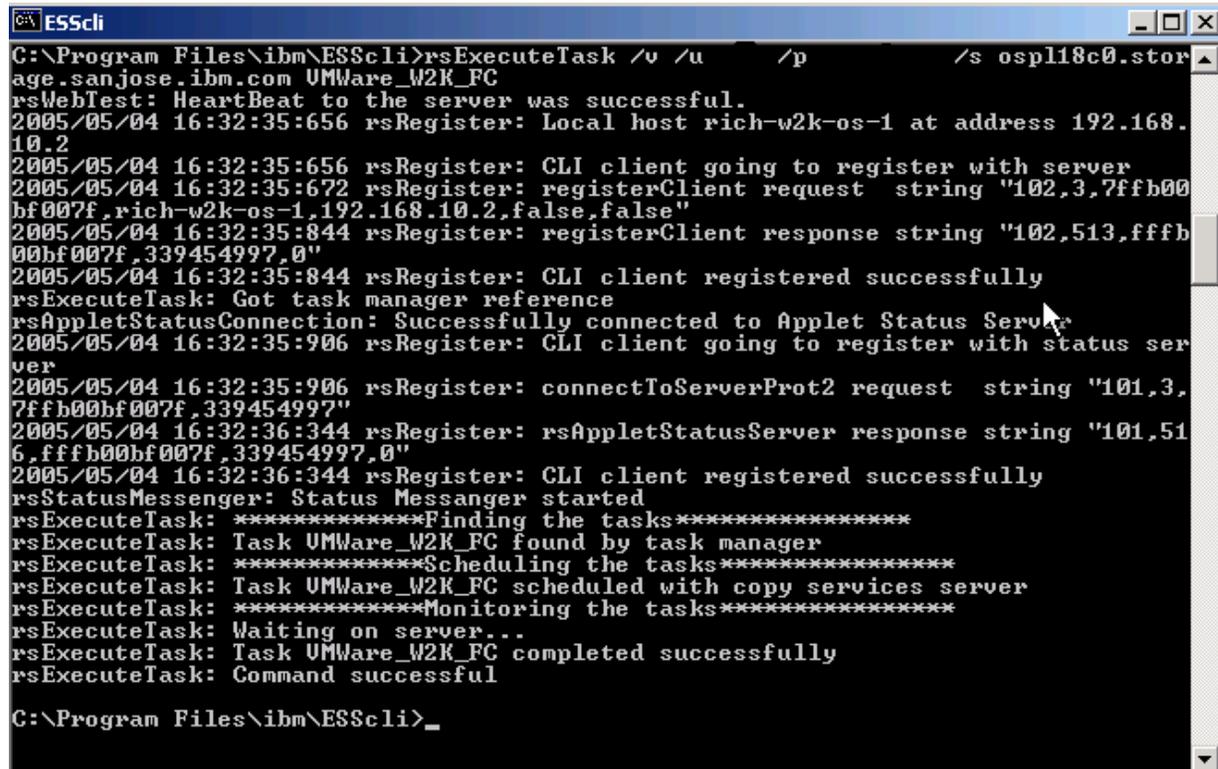


Figure 10 ESS Copy Services save named task

6.2.3 Executing Predefined Copy Services Tasks

Predefined copy services tasks are executed from the VM command line using the `rsExecuteTask` command in the ESS CLI specifying the name of the saved copy services task. Figure 11 shows the execution of the saved FlashCopy task using the ESS CLI from `rich-w2k-os-1`.



```

C:\Program Files\ibm\ESScli>rsExecuteTask /v /u /p /s ospl18c0.stor
age.sanjose.ibm.com UMWare_W2K_FC
rsWebTest: HeartBeat to the server was successful.
2005/05/04 16:32:35:656 rsRegister: Local host rich-w2k-os-1 at address 192.168.
10.2
2005/05/04 16:32:35:656 rsRegister: CLI client going to register with server
2005/05/04 16:32:35:672 rsRegister: registerClient request string "102,3,7ffb00
bf007f,rich-w2k-os-1,192.168.10.2,false,false"
2005/05/04 16:32:35:844 rsRegister: registerClient response string "102,513,fffh
00bf007f,339454997,0"
2005/05/04 16:32:35:844 rsRegister: CLI client registered successfully
rsExecuteTask: Got task manager reference
rsAppletStatusConnection: Successfully connected to Applet Status Serv
2005/05/04 16:32:35:906 rsRegister: CLI client going to register with status ser
ver
2005/05/04 16:32:35:906 rsRegister: connectToServerProt2 request string "101,3,
7ffb00bf007f,339454997"
2005/05/04 16:32:36:344 rsRegister: rsAppletStatusServer response string "101,51
6,fffh00bf007f,339454997,0"
2005/05/04 16:32:36:344 rsRegister: CLI client registered successfully
rsStatusMessenger: Status Messenger started
rsExecuteTask: *****Finding the tasks*****
rsExecuteTask: Task UMWare_W2K_FC found by task manager
rsExecuteTask: *****Scheduling the tasks*****
rsExecuteTask: Task UMWare_W2K_FC scheduled with copy services server
rsExecuteTask: *****Monitoring the tasks*****
rsExecuteTask: Waiting on server...
rsExecuteTask: Task UMWare_W2K_FC completed successfully
rsExecuteTask: Command successful

C:\Program Files\ibm\ESScli>_

```

Figure 11 `rsExecuteTask` for the saved FlashCopy task

A comparison of a Windows Explorer view of the source disk in Figure 12 with a Windows Explorer view of the target disk in Figure 13 shows the original contents of the source disk was duplicated on the target disk.

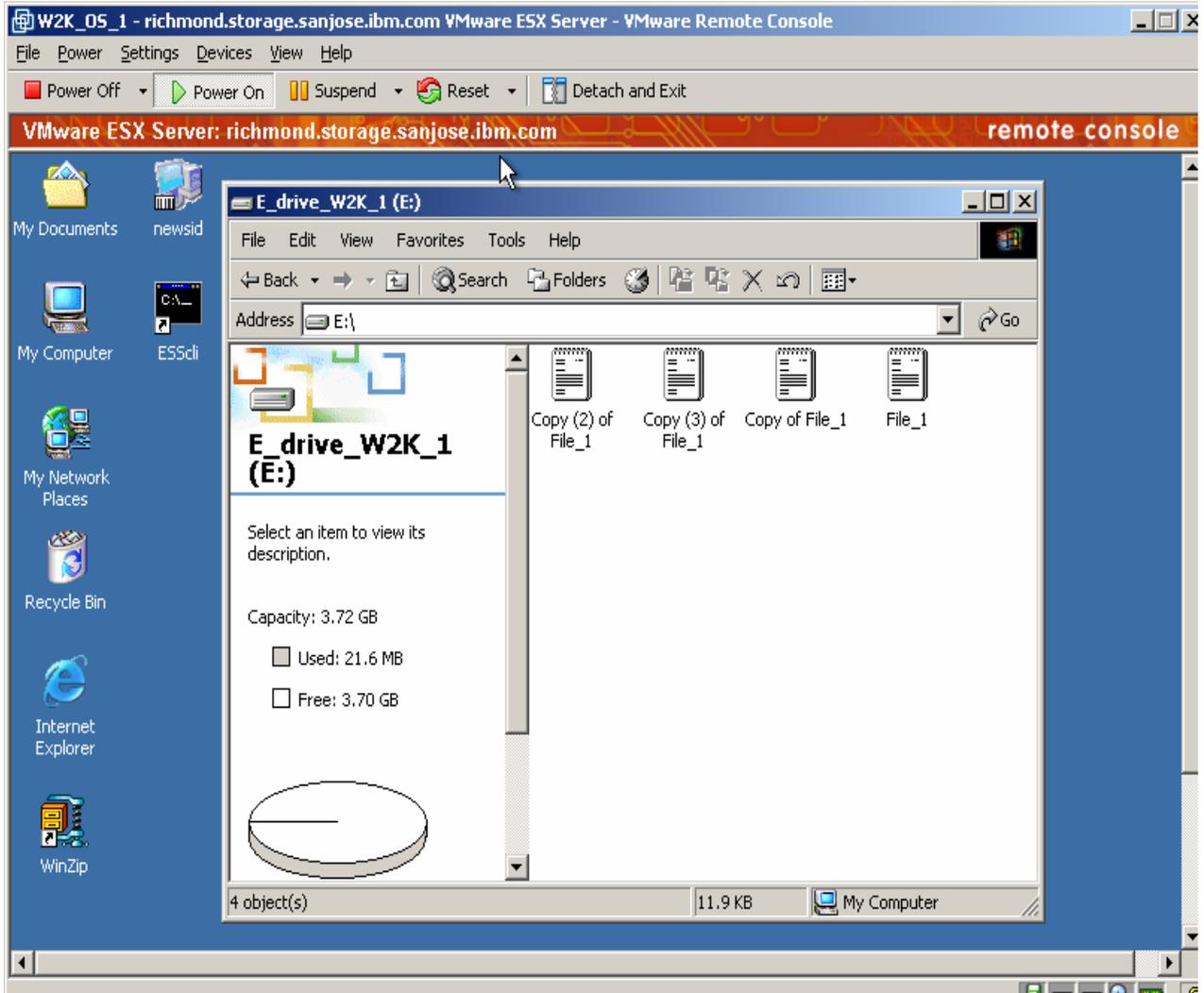


Figure 12 Source disk on rich-w2k-os-1

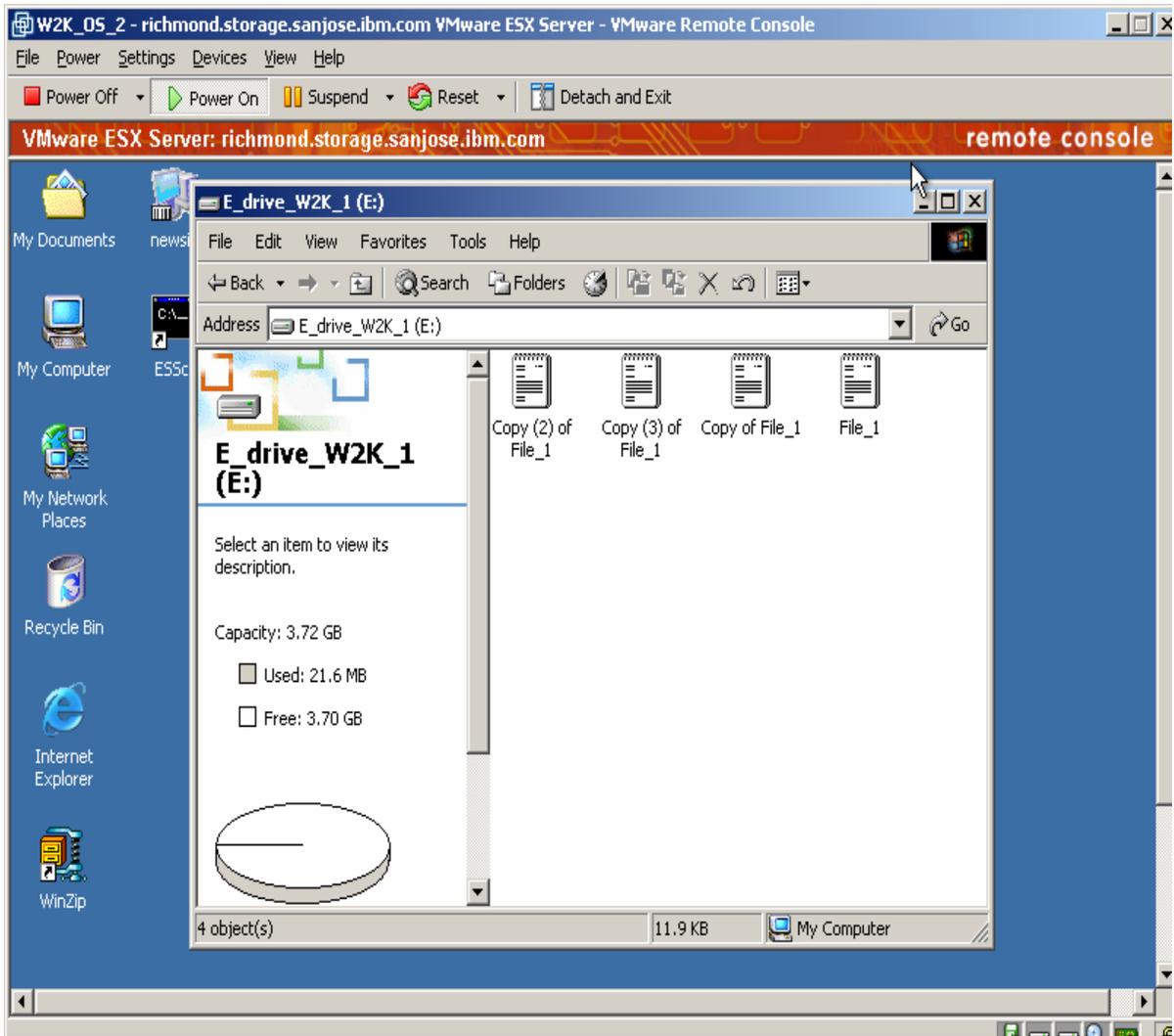


Figure 13 Target disk on RICH-W2K-OS-2 after FlashCopy

Opening one of the files on the RICH-W2K-OS-2 disk shows the original content from the source volume on rich-w2k-os-1 as seen in Figure 14.

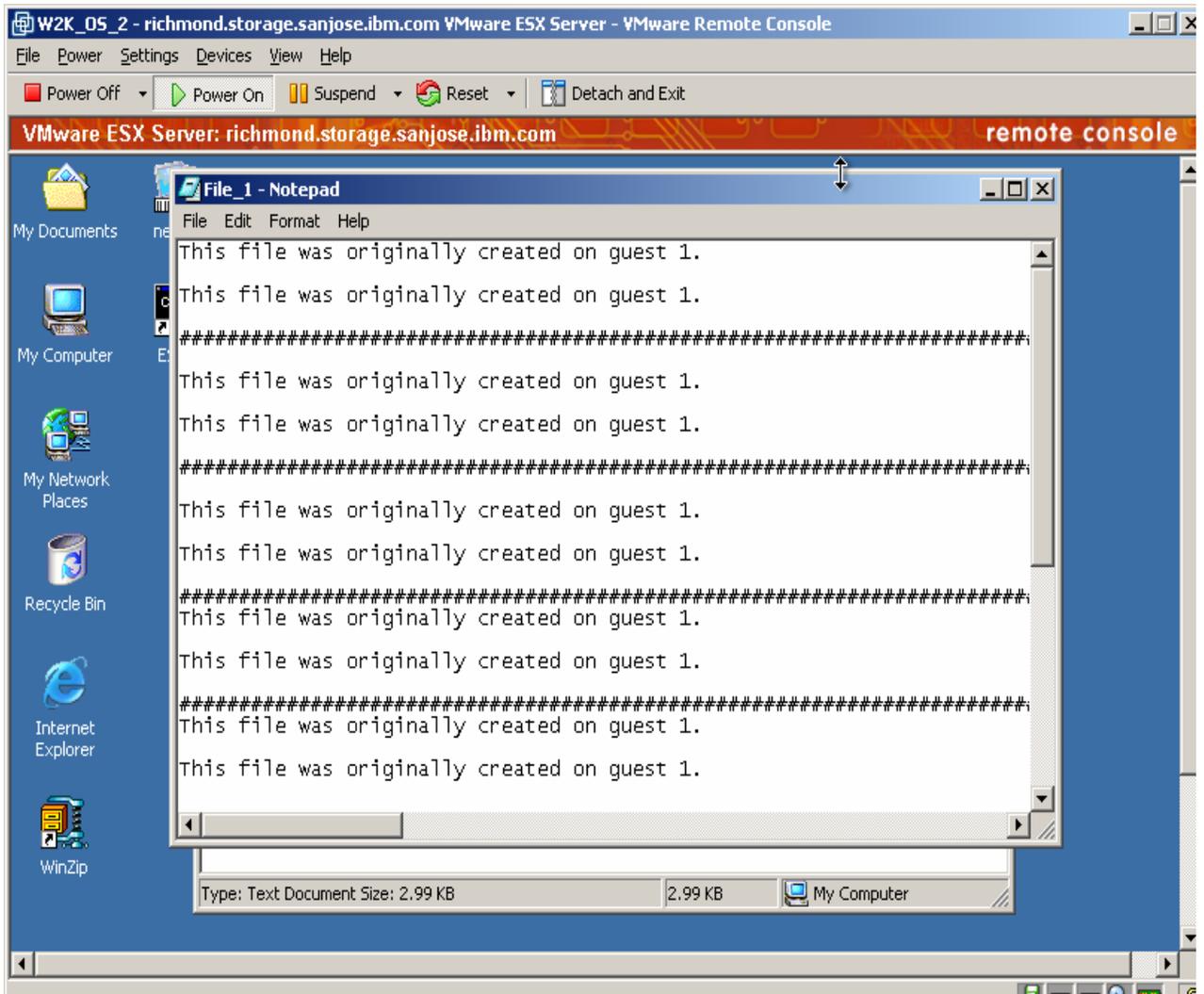


Figure 14 Sample file content

7 IBM ESS and VMware ESX Server Interoperability

ESS and VMware products have been tested for interoperability in the IBM San Jose Open Systems Lab in typical customer scenarios. The solution scenarios below were tested using the generic steps listed in the preceding sections of this whitepaper.

The hardware setup for the solution validation included:

- 1) An X-Series 440
- 2) Multiple ESS Logical Sub-Systems

The software setup included:

- 1) VMWare ESX Server 2.5
- 2) Microsoft Windows 2000 Advanced Server
- 3) Microsoft Windows 2003 Enterprise Edition
- 4) Red Hat Advanced Server 2.1
- 5) Red Hat Enterprise Linux 3.0
- 6) SuSE Linux Enterprise Server 8
- 7) SuSE Linux Enterprise Server 9

7.1 Setup Details

The system was setup with Multiple Logical Sub-Systems from an ESS connected to one server running VMware ESX Server 2.5. Volumes (ESS LUNs) were configured to the ESX server and attached to guest virtual machines using Real Device Mapping mode, which became available in ESX Server 2.5.

Each guest was assigned at least two volumes (ESS LUNs) for writing and reading data. The data drives were formatted and setup using the guest's native application (fdisk for Linux guests, and Windows Disk Management for Windows guests).

7.2 Point in Time Copy Scenarios using ESS FlashCopy

Solution Scenario 1: Validate the ESS FlashCopy for a File System.

Solution Application: To confirm that the snapshot is consistent and can be used for backup and off-host processing.

For the Linux guests, the file system on the data drive is created using mke2fs command and for the Windows guests, using the partition format tool. After copying over the drive, the file system remained in tack. This was shown by the second guest being able to open the drive without any additional formatting or file system change.

Making a FlashCopy copy of disks to another virtual machine for data management is a growing area of use cases for backup and recovery. When making a FlashCopy copy of a disk on the array there must be coordination between the Virtual Machine and the array activities.

When issuing FlashCopy commands it is suggested that the source virtual machine is either down or the application data residing on the disk is quiesced (I/O is frozen) during the actual FlashCopy Establish task execution. This suggested method would insure that the snapshot of the disk has consistent data and can be used for data management functions.

This case provides uses where the production (or source) machine has minimal impact during the FlashCopy activities. The production data then can be managed from a target machine to perform the data management functions.

Solution Scenario 2: Validate the ESS FlashCopy for a SQL database.

Solution Application: To confirm that the snapshot is consistent and can be used for backup and off-host processing.

This scenario involves accessing the copied drive's data on the second guest after the ESS FlashCopy process. After the FlashCopy function completed, a reboot was necessary of the second guest, once the guest came back online, the copied data files were present and the actual data was the same as the original on guest one.

Similar to the data management case, the FlashCopy function can be used to create copies of a Microsoft SQL database running in a virtualized environment. SQL uses technologies such as Virtual Device Interface (VDI) to freeze and thaw I/O. Using SQL VDI commands in conjunction with the FlashCopy array commands provides a consistent copy of the database(s).

Mounting the SQL database once the FlashCopy commands have been executed is similar to the first case. Devices can be mounted to an ESX Server where a data management virtual machine may reside.

All of the above scenarios were validated in lab settings and the results were successful.

8 Summary

The ESS and VMware configurations described in the paper are a sample of the scenarios that have been tested. There is additional work underway to integrate IBM ESS functions with VMware software even more deeply, with the goal of further reduced backup times and additional availability.

Disaster recovery planning and implementation can be very complex. In these situations, consider using professional services, such as IBM Global Services.

9 **References:**

- 1) IBM TotalStorage Enterprise Storage Server: Implementing ESS Copy Services in Open Environments -- IBM Redbook, Document Number SG24-5757-04, July 2004 <http://www.redbooks.ibm.com>
- 2) IBM TotalStorage Enterprise Storage Server: Implementing ESS Copy Services with IBM eServer zSeries -- IBM Redbook, Document Number SG24-5680-04, July 2004 <http://www.redbooks.ibm.com>
- 3) IBM TotalStorage Enterprise Storage Server: PPRC Extended Distance – IBM Redbook, Document Number SG24-6568-00, June 2002 <http://www.redbooks.ibm.com>
- 4) IBM Enterprise Storage Server - IBM Document Number: SG24-6424-01, November 2002 <http://www.redbooks.ibm.com>
- 5) IBM TotalStorage Enterprise Storage Server: Implementing the Enterprise Storage Server in your Environment -- IBM Redbook, Document Number SG24-5420-00, March 2002 <http://www.redbooks.ibm.com>
- 6) IBM TotalStorage Enterprise Storage Server Performance Monitoring and Tuning Guide - - IBM Redbook, Document Number SG24-6422-00, July 2003 <http://www.redbooks.ibm.com>

10 **Related Websites**

- 1) IBM Website
<http://www.ibm.com>
- 2) IBM Storage Website
<http://www.storage.ibm.com>
- 3) IBM TotalStorage Proven Website.
<http://www.storage.ibm.com/proven/index.html>
- 4) IBM Redbooks Website
<http://www.redbooks.ibm.com/>
- 5) IBM Sales Website
<http://www.storage.ibm.com/readytobuy.html>
- 6) IBM Enterprise Storage Server Product Page
<http://www-1.ibm.com/servers/storage/disk/enterprise/index.html>

- 7) IBM Enterprise Storage Server Product Specifications
<http://www-1.ibm.com/servers/storage/disk/enterprise/index.html>
- 8) VMware Website
<http://www.vmware.com>

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