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StorageWorks Rapid Restore for SQL Server 2000

A Cloning Solution Using SANworks EVM V2.0 for SQL Server 2000 Environments

Abstract

This solution leverages the hardware and software capabilities of Compaq *StorageWorks* and *SANworks* technologies within an integrated SAN environment. It allows customers to enhance the availability of their application environment and information processing resources through the use of clones. A clone is a physical copy of a disk volume and is also known within the industry as a Business Continuance Volume (BCV). Clones are available as a resource within your overall recovery strategy that you can use to perform an **extremely rapid restoration** of your application environment.

This controller-based software lets you perform simultaneous computing operations on the same copy of data without affecting system resources. You can streamline and accelerate operations such as backup, testing, and reporting. The underlying software product for this solution is **SANworks Enterprise Volume Manager v2.0**.

Through performance characterization tests, numerous insights were gained regarding the use of clones for rapid recovery of SQL Server data. By following the recommendations in this paper, SQL Server database administrators can successfully do the following:

- Create clones
- Automate the clone creation process
- Recover the SQL Server environment utilizing the clone
- Perform tape backups from the clone
- Automate the backup process

This guide also provides configurations, tools, technical best practices, cautions, considerations, and pointers to additional information and resources – all to support trouble-free deployment of this solution within your environment.

Help us improve our technical communication. Let us know what you think about the technical information in this document. Your feedback is valuable and will help us structure future communications. Please send your comments to: Microsoft.Storage.Solutions@hp.com

Notice

Rapid Restore Solution for SQL Server 2000
Solutions Guide prepared by Enterprise Storage Group

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1.0 Management Summary

The Rapid Restore for SQL Server 2000 storage solution allows you to restore your Microsoft SQL Server 2000 database quickly using the tools and strategies outlined within this guide.

By using this solution to augment your tape-based recovery plan, you can recover your entire application environment rapidly, decreasing the amount of application downtime.

Creating a database clone using *SANworks* Enterprise Volume Manager, provides you with an exact point in time copy of your production data – affording you the opportunity to perform operations to this copy that allow you to offload work from the production server. These operations include tape backup, which is discussed within this guide, as well as testing, data mining, and system maintenance.

The solution utilizes a Microsoft supported interface and is engineered within Microsoft support guidelines.

The Rapid Restore for SQL Server 2000 Solution demonstrates the following advantages:

- ***Database restores can occur nearly instantaneously*** – compared to potentially several hours from a tape-based restore
- The cloning process takes less than 25% of the time required for a full tape backup, thereby decreasing the waiting time for a reliable backup source
- The clone creation and splitting process occurs while the database remains online
- An offline tape backup from the clone volume represents ***no impact*** to the production SQL Server

"Microsoft SQL Server 2000 customers put their trust in the performance and reliability of the database. Compaq's StorageWorks solutions for SQL Server 2000 help provide even more robust storage solutions for our customers. *Rapid Restore for SQL Server 2000 by Compaq* and *Virtualized Storage Management for SQL Server 2000 by Compaq* are pre-tested and automated solutions that take advantage of Compaq's highly scalable and versatile storage management software. Together, *StorageWorks* and SQL Server 2000 offer enhanced application availability and organizational agility in fast-paced environments."

Stan Sorensen, Microsoft Corporation
Director, SQL Server Product Marketing

2.0 Solution Description

The Rapid Restore Solution for SQL Server 2000 is a validated and fully integrated configuration that provides a SAN-based backup and restore infrastructure for end-to-end data protection. This solution leverages the capabilities of *StorageWorks* RAID arrays configured with HSG80 controllers, *SANworks* Enterprise Volume Manager (EVM), and the *StorageWorks* Enterprise Backup Solution (EBS), as illustrated in Figure 1 below.

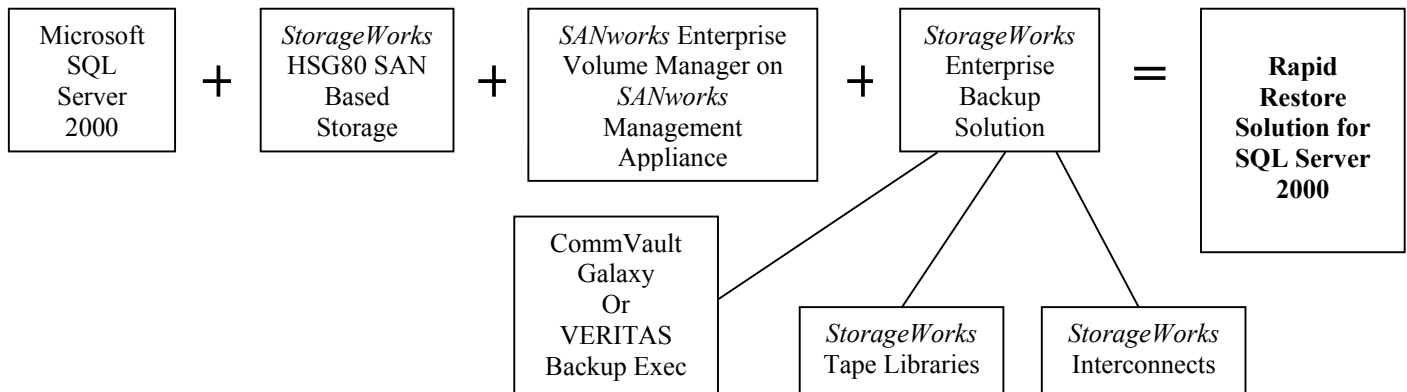


Figure 1 – Solution Building Blocks

SANworks EVM is browser-based storage management software that facilitates controller-based clone operations to make a block-to-block copy of a storage volume. With *SANworks* EVM, you can create, run, and manage automated storage replication jobs, as well as link them with external jobs. Although *SANworks* EVM uses snapshot (a virtual point-in-time copy of a data volume) and cloning (a physical point-in-time copy of a data volume) technologies, this solution is based only on the **cloning** capabilities of *SANworks* EVM and how to apply clones to protect SQL Server 2000 data.

StorageWorks EBS provides a consolidated backup infrastructure comprised of multiple servers connected over a high-speed Fibre Channel SAN to centrally attached SCSI tape libraries. EBS significantly shrinks backup windows with a flexible approach to data protection. *StorageWorks* EBS is an optional component of this solution.

Comprehensive lists of tested and qualified components for this solution are highlighted in subsequent sections.

The guide includes solution specific information intended to give administrators the tools needed to create database clones, perform clone-based recoveries and backups to tape, streamline the solution implementation, and make informed management decisions using pre-developed performance data. It includes:

- Step by step installation instructions, including creation and management of clones
- Validated scripts for the clone creation of a SQL Server 2000 database
- Best practice information, cautions, and areas of consideration
- Performance, sizing, and characterization information for a typical customer environment
- Discussion relating to the integration of this solution with standard backup processes relying on backup applications from CommVault and VERITAS Software
- A consolidated list of available tools, white papers, and other resources

2.1 Solution Components

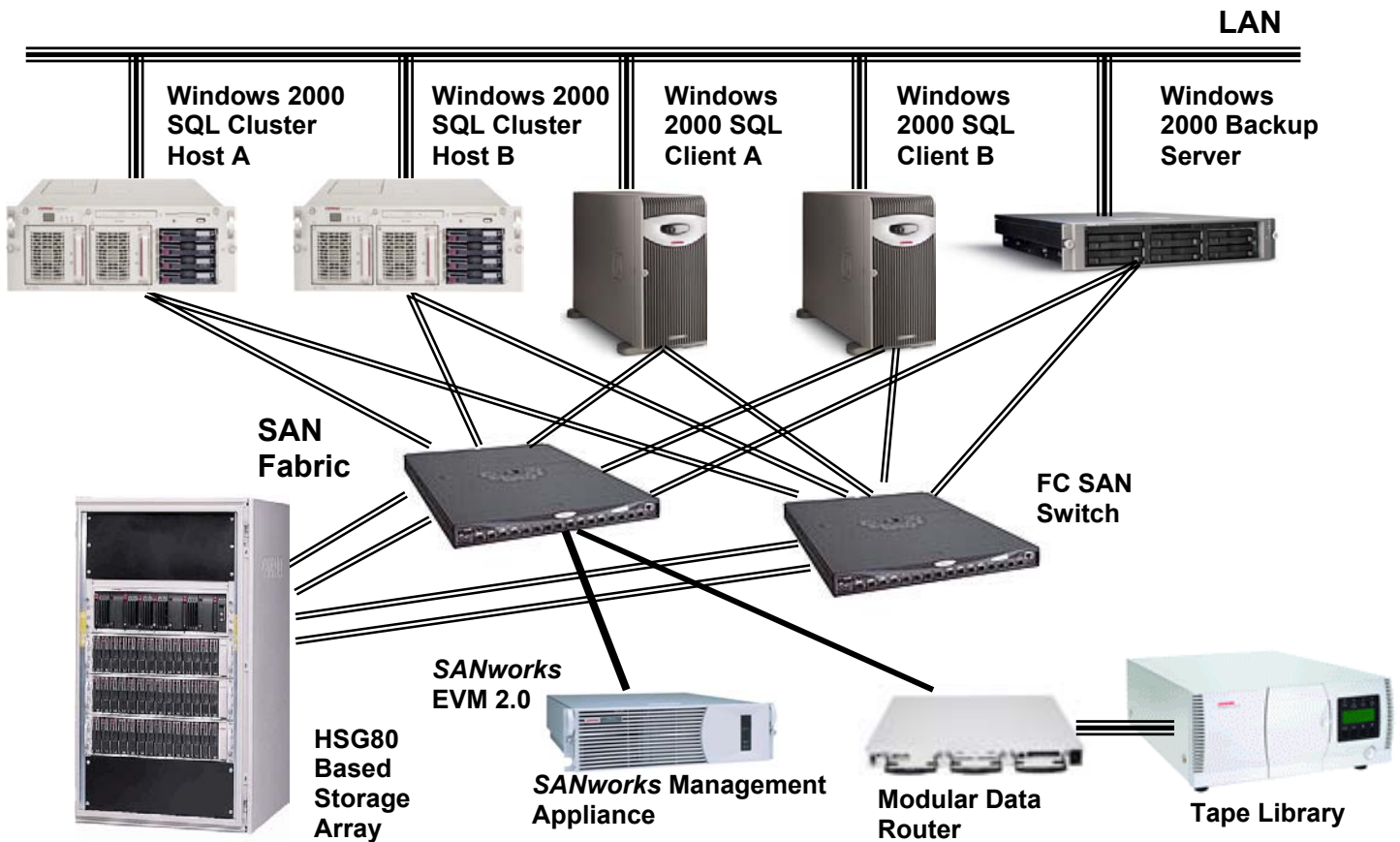


Figure 2 - Solution Configuration

The Rapid Restore for SQL Server 2000 Solution consists of four basic components:

1) Microsoft SQL Server 2000

You can configure the SQL Server 2000 application and database on any Windows 2000 server and use a MSCS configuration for improved application availability.

2) SAN-Based Disk Storage

The solution requires that the SQL Server database volumes be located on a StorageWorks HSG80-based disk array (or arrays). Clone creation is performed by the StorageWorks HSG80 Array Controller Software (ACS), which operates the storage subsystem.

3) *SANworks* Enterprise Volume Manager

You must have a *SANworks* EVM host agent on each database server to utilize controller-based database cloning. The *SANworks* Enterprise Volume Manager server application operates on the *SANworks* Management Appliance and is managed through a Web-based graphical interface.

The *SANworks* Management Appliance is used as the operating platform for *SANworks* EVM, which off-loads the processing from the user host systems. The appliance provides centralized Web-based storage configuration and monitoring to manage SAN-based hardware and applications.

4) Enterprise Backup Solution

You must use a SAN attached backup configuration when using this solution for clone-based offline tape backups. An approved third party backup application, with associated SQL Server agents and SAN agents, provides backup management. A separate backup host, with the associated backup application loaded, viewable to the storage sub-system, is required to act as the dedicated backup server. For granular backups and restores, a copy of the SQL Server 2000 application must be loaded on the backup server (granular restores are not discussed within this guide).

2.2 Features / Benefits

This solution provides the following benefits to administrators:

- Best practices to maximize SQL Server 2000 availability during database recovery scenarios
- Best practices to perform faster and more efficient backups without utilizing production server resources
- Simplified implementation and management, including script examples
- Data integrity and engineering within Microsoft guidelines
- Investment protection by leveraging existing Compaq hardware and software, supporting multiple configurations, and providing interoperability with future products
- Integration with third-party tape backup applications—specifically tested with VERITAS Backup Exec and CommVault Systems Galaxy

2.3 Key Supporting Products

This solution requires the following Compaq products (refer to Section 4.0, Supported Configurations, for complete configuration information).

SANworks Enterprise Volume Manager v2.0 – Provides the necessary management interface for controller-based cloning and clone volume management.

SANworks Management Appliance – Operating platform for the *SANworks* Enterprise Volume Manager application.

StorageWorks HSG80 Array Controller with *StorageWorks*TM array controller software (ACS) minimum version 8.5F (for clone capability only), or version 8.5S (for clone and snapshot capability) – Provides all necessary cloning functionality.

Optional - *StorageWorks* Enterprise Backup Solution with CommVault Galaxy v3.7.1 or VERITAS Backup Exec v8.6 – Provides SAN-based backup and restore operations for clone-based tape backups.

Optional – *SANworks* Automation Manager – Provides centralized policy-based automation and task scheduling. Creates and manages user-defined and supplied scripts.

2.4 Business Value

An administrator can rely on full and incremental database backups to tape as a method of database recovery. However, even online database backups using the Microsoft SQL Server interface compete with user reads and writes to the database. This can result in a lengthening in user database response times and longer backup windows. During database restoration, a tape-based backup or restore is limited by the tape transfer rate, resulting in lengthy restore times, especially for full database restores.

Trouble-Free Deployment

This solution provides all the necessary installation instructions, scripts, and operational best practices for a trouble-free deployment. The solution requires no additional products and/or services beyond those required to deploy *SANworks* Enterprise Volume Manager in a SAN-based infrastructure.

Most importantly, Compaq gives you the choice of either customizing the scripts yourself or engaging the expertise of the Compaq Global Services Organization. Open systems tools are leveraged whenever possible and Compaq specific tools are provided only where specific functionality is required.

Improved Application Availability

Administrators who rely on tape restores for recovery can integrate a clone recovery strategy into their existing tape backup policy to improve full database restoration times and improve application availability.

2.5 Customer Profile

You can implement this solution in any organization where SQL Server 2000 is installed within a SAN environment using HSG80-based disk arrays, for customers who want improved application availability, backup functionality, recovery capability, performance, and flexibility.

The solution is specifically targeted towards enterprises requiring improved access to data and quick recovery. The solution is also particularly useful for backup administrators that have a limited backup window.

2.6 Solution Best Fits

This solution is best applied in situations that require:

- Quick restores or recovery from data corruption, lost or deleted data, or frequent user restore requests.
- An additional data protection scheme to provide 24-hour database protection, when the time to perform more frequent tape backups is unavailable, or when frequent tape backups compete with application availability.
- A solution that separates data backup management from application server management, allowing the database administrator the opportunity to present clone volumes to the backup administrator for scheduled or automated backups.

2.7 Cost / Value Analysis

Although an administrator can rely on full and incremental database backups to tape as a method of disaster recovery, online database backups using the Microsoft SQL Server interface competes with user reads and writes to the database. This results in longer user database response times and backup windows. During database restoration, a tape backup base restore is limited by the tape transfer rates, resulting in lengthy restore times, especially for full database restores.

The use of controller-based cloning allows for an increase in application availability during the backup process, by off-loading the backup to an offline server. During clone-based restores, a database copy is immediately available. Both processes improve the database user experience and application uptime. With an available clone copy of the data, the administrator can respond more quickly to certain failure events within target service levels. By using the automated scripts provided in this guide, the administrator can automate the cloning and clone-based backup process, making database management easier and less time consuming.

Table 1 – Cost / Value Summary

Controller-Based Cloning	Cost		Value	
	Initial Implementation	Continued Management	Initial Implementation	Continued Management
Clones as sources for database restoration	Requires <i>SANworks</i> Management Appliance, <i>SANworks</i> Enterprise Volume Manager licenses, and minimum SAN configuration with <i>StorageWorks</i> HSG80-based array. Requires additional allocations of disk capacity for clone volumes.	Requires experience with <i>SANworks</i> Enterprise Volume Manager and use of scripts to create clones. These scripts are provided in this guide.	Easy deployment using information provided in this guide.	Allows the database administrator an additional restore source using clones. Restoration from clones is almost immediate, greatly improving application availability.
Clones as sources for offline database backups	Same as above, with the additional requirement of a dedicated, fully configured, backup server.	Requires the development of backup application specific scripting, which is provided in this guide.	Easy deployment using information provided in this guide.	Greatly reduces the backup window and the impact of backup on the application performance. Provides the ability to automate the offline backup process for easy integration into existing backup policy management practices.

The solution requires minimal incremental costs over standard database storage / backup implementations. It requires the use of the SANworks Enterprise Volume Manager software, a SANworks Management Appliance, and a certain level of SAN-based infrastructure. In addition, cloning technology requires additional disk capacity for the clone. The clone technology solution also requires a dedicated backup server with the required backup application and agents.

2.8 Positioning with Other Compaq Products and Solutions

***StorageWorks* Enterprise Backup Solution**

The *StorageWorks* Enterprise Backup Solution (EBS) by Compaq leverages the high-speed Fibre Channel network, leading software applications, and automated tape libraries to provide high-speed data protection within shrinking back-up windows. Although EBS can be a component in the Rapid Restore for SQL Server 2000 solution, EBS can also be implemented separately as part of a standard backup and recovery policy. Both the CommVault Galaxy and VERITAS Backup Exec backup applications tested in this solution are fully supported within an EBS configuration. For more information, see the following Web site:

<http://www.compaq.com/products/storageworks/ebs/index.html>

***SANworks* Data Replication Manager**

For the highest level of data protection, Compaq offers the *SANworks* Data Replication Manager (DRM) solution. DRM lets you mirror data online and in real-time to remote locations using a local or an extended SAN. Using DRM, data replication is performed at the storage sub-system level and in the background of any host activity. For more information, see the following Web site:

<http://www.compaq.com/products/sanworks/drm/index.html>

Virtualized Storage Management for SQL Server 2000

For an implementation using a variety of storage platforms, you can review the Virtualized Storage Management for SQL Server 2000 solution. This solution, based on *SANworks* Virtual Replicator by Compaq, provides rapid recovery through Windows 2000 host-based snapshot technology. *SANworks* Virtual Replicator snapshots use minimal disk capacity and provide database restores in minutes. For more information, or to obtain the Solution Guide, see the following website:

<http://www.compaq.com/products/storageworks/solutions/vsm-sql2000/index.html>

3.0 Testing Information and Performance Results

A configuration was developed to test the performance of clone-based restores and clone-based backups within a SQL Server 2000 environment. Impacts to the SQL Server application during the creation of the clone, clone mounting, backup, and restoration, were measured and compared to standard tape backup and restore practices. Baseline performance information was also captured for comparison purposes.

3.1 Test Description

The following tests were performed:

1. Baseline configuration with *SANworks* Enterprise Volume Manager loaded but not running. Microsoft TPC-C load generation application was used to simulate SQL Server database user loads. Database and system performance indicators were monitored.
2. Creation of a clone for a 203 GB volume (SQL Server database size was 162 GB). Cloning time and performance impact on the application and system were measured.
3. Performed full online tape backups using VERITAS Backup Exec and CommVault Galaxy backup applications. Recorded backup time and impact to SQL Server application performance for both LAN and SAN based backups.
4. Performed clone-based backups using VERITAS Backup Exec and CommVault Galaxy backup applications. Recorded cloning time, mount time, and subsequent offline backup time along with impacts to SQL Server application performance.
5. Restored an entire SQL Server database from a clone volume of greater than 200 GB and recorded time to full restoration.
6. Restored entire database from tape using VERITAS Backup Exec and CommVault Galaxy backup applications. Recorded database restore times.

A performance comparison was made between online backups and clone-based backups using the same database and operational conditions. Clone-based restores were also compared to tape based restores for a similar database configuration.

3.2 Test Configuration

Components of the SAN-based configuration are listed in Table 2.

SQL Server Database Clients

A single database client was used to generate user load and database I/O. In this test, a minimum continuous load of 60 TPC-C User Connections and 40 Active Transactions was generated (refer to Table 3). This load compares to a 1000 user community in a real SQL Server environment.

SQL Server Application Servers

The SQL Server application servers were configured for high availability using a Microsoft Cluster Server (MSCS) configuration. The high availability environment involved two cluster nodes equipped with redundant Compaq fibre host bus adapters. Each server had 512 MB RAM and Dual Pentium III 1 GHZ processors.

SANworks Management Appliance

The *SANworks* Management Appliance was used as the operating platform for the *SANworks* EVM application. Note that the Appliance operates out of band, meaning that the SQL Server data does not pass through the appliance. For more information on the *SANworks* Management Appliance see: <http://www.compaq.com/products/sanworks/managementappliance/description.html#qs>

Disk Array

- StorageWorks* HSG80 Array with Dual Controllers
- (2) 1 Gigabit *StorageWorks* fabric switches
- (6) 4314R disk shelf (single bus)
- (36) 72 GB, 10,000 rpm, Ultra3 disk drives

Database Configuration

SQL Server 2000 database size of 160 GB spread over 6 disks of RAID 1+0.

Two volumes were used, one for the database (200 GB) and one for the logs (60 GB).

Logical drives were created using the Compaq Array Controller Utility, creating separate arrays for data files and log files.

Best Practice: When configuring the database, use different arrays for data volumes and log volumes to ensure that the two volumes do not share physical disk resources. Using this strategy, your log files will always be located on different volumes than your database files. This configuration method will ensure that random disk writes (data files) and sequential disk writes (log files) do not compete for the same disk resources, thereby maximizing performance.

Tape Backup

A dedicated tape backup server was connected to the SAN for SAN-based backups. The SQL Server 2000 application was loaded on the backup server. By loading the SQL Server application on the backup server, which is already attached to the SAN, the backup server can operate as the primary SQL Server application server, if necessary. A *StorageWorks* SSL2020 AIT tape library (2 AIT 50-GB drives for native transfer rates up to 43 GB/hr) was used as the tape backup device. A *StorageWorks* Modular Data Router provided fibre connectivity to the tape library.

VERITAS Backup Exec Configuration

Version 8.6 of VERITAS Backup Exec for Windows NT and Windows 2000 was loaded on the dedicated backup server. To perform online SQL Server backups and backups from a clone volume mounted locally to the dedicated backup server, the VERITAS SQL Server 2000 agent and SAN Shared Storage Option agent were loaded on the dedicated backup server. A local copy of VERITAS Backup Exec and Shared Storage Option was loaded on each SQL application server on the SAN to allow for SAN-based (LAN-free) backup.

The backup performances of both SAN-based and LAN-based backup scenarios were tested. By backing up directly from the online SQL Server cluster and the locally mounted clone, the performance of both online backup and clone-based offline backup models were also compared. For more information, refer to Section 3.3 – Table 4.

CommVault Galaxy Configuration

The CommVault Galaxy 3.7.1 Proxy Host iDataAgent software was loaded on the SQL Server application server to allow backup data transfer across the SAN without affecting the production server. A separate Galaxy CommServer was used, with the CommVault Galaxy CommServer software loaded, for backup management. You can also use the backup server as the backup management server. The CommVault Galaxy MediaAgent was installed on a CommCell client (not necessarily the same machine as the CommServer). CommVault Galaxy File system iDataAgent software was loaded on the dedicated backup server.

The Microsoft SQL Server 2000 application and CommVault Galaxy SQL 2000 iDataAgent software are required on the backup server should you require granular restores.

Table 2 - Test Configuration

SQL Server Database Host	
Compaq ProLiant DL380	193706-001
Two Pentium III 1GHz Processors 512K level 2 cache (256 per processor)	187602-B21
Two 256MB Memory SIMMs of SDRAM	128278-B21
Two 9GB Ultra 3, 7.2K rpm Drives per client	123065-B22
Compaq NC6134 Gigabit NIC 64 PCI, 1000 SX	174818-B31
NC3134 Dual 10/100 NIC	138603-B21
(2) Compaq StorageWorks 64-Bit/33-MHz PCI-to-Fibre Channel Host Bus Adapter - Fibre HBA for Windows NT/2000	176479-B21
Compaq 16 port Fibre Switch	158223-B21
SQL Server Application Host / Software	
<i>SANworks</i> Enterprise Volume Manager 2.0b client	Included in <i>SANworks</i> EVM server kit
Additional <i>SANworks</i> EVM Server License – Includes EVM Server software license	263671-B21
Compaq DButil v1.0 SQL utility	http://www.compaq.com/products/storageworks/solutions/request/rrsql2kit.html
Windows 2000 Advanced Server with Service Pack 2	Microsoft
SQL 2000 Enterprise Server with Service Pack 2	Microsoft

Clients	
<i>Client Hardware Configuration similar to application server</i>	see above
Microsoft TPC-C Benchmark Kit for SQL Server	third party
Client / Software	
<i>SANworks Enterprise Volume Manager 2.0b client</i>	Included in <i>SANworks EVM server kit</i>
Enterprise Storage	
<i>StorageWorks Enterprise Modular Array (EMA) 12000</i>	175993-B21
(2) <i>StorageWorks HSG80 controllers, 512 MB cache (256 mirrored on each controller)</i>	Included in above array
<i>SANworks Secure Path 3.1A update</i>	165989-B21
<i>StorageWorks ACS 8.6 F/S Firmware</i>	222364-B21
<i>StorageWorks Windows 2000 v8.6 platform kit</i>	222322-B21
(36) <i>StorageWorks 72 GB Hot Pluggable Ultra3 SCSI 10K Universal Disk Drives (1")</i>	232432-B22
SAN Management	
<i>SANworks Management Appliance</i>	189715-001
<i>SANworks Enterprise Volume Manager (EVM) Starter Kit – Includes SANworks EVM Server software CD and license, SANworks EVM host agent CD with 5 SANworks EVM host agent licenses, and one Documentation Kit</i>	263670-B21
Backup Configuration	
Backup Server - Dual Pentium III, 1 GHz, 512 MB RAM	
<i>StorageWorks Windows 2000 v8.6 platform kit</i>	222322-B21
<i>SANworks Enterprise Volume Manager 2.0b client</i>	Included in <i>SANworks EVM server kit</i>
CommVault Galaxy v3.7.1 with associated agents (optional)	third party
VERITAS Backup Exec v8.6 Advanced Server Edition for Windows NT and Windows 2000 with associated agents (optional)	third party
<i>StorageWorks Modular Data Router</i>	163083-B21
<i>StorageWorks SSL2020TL (AIT) Tape Library, 2 drive</i>	175196-B22

3.3 Performance Results

Baseline

Baseline performance was recorded for the test configuration with *SANworks* EVM loaded but not operational. SQL Server user I/O was generated using the TPC-C load generator tool during baseline testing.

Results: Results are presented in Table 3.

Clone Creation Using *SANworks* Enterprise Volume Manager

SANworks EVM was used to create a clone volume of the SQL Server database. Disks were added to the existing mirror set to create a redundant third member set. The disks were then normalized and broken off from the mirror to create an independent LUN, containing a point-in-time database copy.

Results: The performance counters in Table 3 show the impact of the cloning process on the SQL Server application. During the normalization process, all transactions occurred normally. During the clone split, database reads were unaffected and database writes were temporarily queued until the split process is complete (approximately three minutes).

Conclusion: The *SANworks* EVM clone creation and splitting process occurs while the database remains online and with minimal impact.

Best Practice: The SQL Server application server must be sized appropriately to support the queuing of user transactions during the suspend process. As with any transaction queuing process, an incorrectly sized or overloaded server will overrun its buffer during the suspend operation. It is recommended that you perform the cloning operation during periods of low user transaction rates to minimize the potential of queuing buffer overflows.

Online Tape Backup

For comparison, a SQL Server native online backup was performed using the necessary SQL Server agents for the associated backup applications (VERITAS Backup Exec, CommVault Galaxy) while under simulated user load.

Results: The time to perform a full online tape backup of the 160 GB database was four times longer than the time needed to create the clone. The performance counters in Table 3 show the impact on the SQL Server application.

Conclusion: Although online tape backups have a minimal effect on database performance, they are an inefficient method for frequent backups, due to the time required for completion and the potential contention with user activity during this period. Clone-based backups also have a minimum impact on the application performance but require less time for completion.

Clone-Based Backups

The clone volume was mounted on the remote backup server. VERITAS Backup Exec and CommVault Galaxy backup applications were used to perform offline backups to tape from the

backup server. Although user load continued on the application server, it did not affect the offline backup process, as the backup operation occurs on a server that is remote from any user activity.

Results: Offline tape backup from a clone mounted to the backup server was completed in less time than the online backup process and did not affect application or production server performance.

Conclusion: Offline tape backup is a more efficient process for creating a tape backup than conventional SAN or LAN-based online tape backups.

Table 3 – System and Application Performance Results

Performance Parameters Recorded from Performance Monitor				
		<i>SANworks</i> EVM	Tape Backup	
Metrics	Baseline	Clone	Clone-Based Backup	Online Backup
Processor Utilization				
CPU - % Processor Time	50.439	45.423	45.540	43.843
Process - % CPU Time	196.332	196.574	196.164	195.090
System – Processor Queue Length	2.962	3.115	3.134	2.725
Memory Utilization				
Memory - Pages/sec	61.714	117.251	94.030	135.574
Memory – Available MBytes	4.095	4.23	4.115	4.06
Paging File - % Usage	20.281	22.473	25.073	21.09
Logical Drive Utilization				
Physical Disk – Disk Transfers/sec	878.166	733.537	911.364	921.937
Physical Disk – Average Disk Queue Length	14.655	37.766	18.845	35.48
Physical Disk – Average Disk_sec/ Transfer	0.017	.054	0.021	.039
SQL Counters				
User Connections	63	63	63	64

SQL Server Processor % (2 CPUs)	101.758	85.117	86.665	N/A
Database – Active Transactions	46.44	43.672	42.928	43.190
Database – Log Flush Waits/sec	11.941	18.003	23.721	22.10
SQL Cache Memory (KB)	104	104	104	104
Buffer Manager - Buffer Cache Hit Ratio	88.079	88.940	88.985	87.784
Buffer Manager – Page Reads/sec	584.890	467.947	602.543	576.618
Buffer Manager – Page Writes/sec	254.82	192.501	246.661	240.799

Backup Performance Comparison

Table 4 compares the performance of a SQL Server online database backup with a clone-based backup. The time to perform a SQL Server native online backup was more than twice the time to perform the entire clone backup process, which includes the cloning time and the time to backup the clone from the backup server.

The SQL Server online backup process competes with access to the database and can affect database performance during the backup period. With offline backups, this contention only occurs during the cloning period. Most importantly, database restores can be performed from clones as well as tape backups, which dramatically shortens the restore time to only the time required to create the clone.

Backup and Restore Performance Comparison

Table 4 compares the times for full database backup and restoration from tape and clone.

A clone volume can be used as a source for database restoration. Since the time to create a clone volume is dramatically less than that for a full backup image to tape (3 hours for clone creation vs. 12 to 31 hours for tape), your wait time for data protection is significantly reduced. In addition, in the event of a backup job failure, the clone is still available as a disaster recovery volume.

Since a clone-based tape backup is not affected by the user load on the production server, it can occur in less time than an online backup. The offline backup for our test took almost two hours less time than even the fastest online backup method.

Tape restore times are dependent on the size of the database file and the tape transfer rate. Clone volumes are almost instantly available for restore and restore times depend only on the restore method used (see Section 5.0, Operation) and the administrator's experience.

Table 4 – Backup and Restore Performance Results

Configuration	
LUN Size (GB)	203 ¹
Database Size -w/logs (GB)	162
Clone Creation	
<i>SANworks</i> EVM Clone ²	2:59
Backup Performance Results – Process Time (hours:minutes)	
SQL Online Backup (LAN)	31:06
SQL Online Backup (SAN)	13:29
Clone-Based Offline Backup	11:37
Restore Performance Results – Process Time (hours:minutes)	
Restore from Clone ³	Almost immediate
Restore from Tape	5:05

¹ Although the clone duplicated the 162 GB of data, the entire 203 GB volume was cloned. The average MB/min displays both *SANworks* EVM performance and application performance.

² The SQL Server database remains online during the entire cloning process. See Section 5.0, Operational Guidelines.

³ Results depend on administrator experience. Clone is available immediately for restoration purposes.

4.0 Supported Configurations

Note: In order to continually provide improved features and functions, the hardware and software products used in this solution are subject to change. Although it is our objective that all newly released products be compatible with previously released solutions, Compaq makes no warranty of compatibility of any kind. As always, it remains the responsibility of the user to refer to the specific component documentation when applying component versions that do not match those stated in this section.

4.1 Configuration Information

Minimum Requirements

The Rapid Restore for SQL Server 2000 configuration must include:

- One Windows 2000 Service Pack 2 (Server, Advanced Server, and Datacenter) host operating on a SQL Server 2000 database with Service Pack 2 (required for proper DButil functionality)
- Additional Windows 2000 host with appropriate backup application (for use as backup server)
- *SANworks* Management Appliance
- *SANworks* Enterprise Volume Manager v2.0b application and host agents
- *SANworks* EVM scripting for cloning, mounting, and backup
- DButil v1.0 application
- *StorageWorks* HSG80 controller-based disk array in a fiber channel switch configuration. Also required a storage volume equal to three times the database volume (assume RAID 1+0 with single clone volume), which can be viewed by the application server. You must have one of the following:
 - RAID Array 8000 (RA8000)
 - Enterprise Storage Array 12000 (ESA12000)
 - Modular Array 8000 (MA 8000)
 - Enterprise Modular Array 12000 (EMA 12000)
 - Enterprise Modular Array 16000 (EMA 16000)
- *StorageWorks* Array Controller Software (ACS) version 8.5F (clone capability only), or version 8.5S (clone and snapshot capability) or higher
- *StorageWorks* Enterprise Backup Solution or other SAN-based backup configuration
 - SAN attached tape library
 - Backup software application
 - CommVault Galaxy v3.7.1 and appropriate agents and options
Information on supported CommVault configurations can be found at:
<http://www.commvault.com/compaq/ebs.asp>
 - VERITAS Backup Exec v8.6 and appropriate agents and options
Information on supported VERITAS configurations can be found at:
http://support.veritas.com/dsl/dslselect_ddProduct_BEWNT_matrix_type_Platform_order_Product.htm
 - Dedicated SAN attached backup server
- Scheduler (optional)

- *SANworks* Automation Manager (requires Open SAN Manager version 1.0c which operates on the *SANworks* Management Appliance)
- Microsoft Task Manager

4.2 Sizing

Since this solution relies on cloning, which is a complete copy of the database volume, you need free disk capacity available on the array that equals or exceeds the disk capacity of the source unit that you want to clone. Additional free capacity is required for additional cloning. To create a single clone of a RAID 1+0 volume, you must have disk capacity equal to three times the database volume (1x for the database, 2x for the RAID mirror set, 3x for the database, mirror set and clone). *SANworks* EVM automatically locates free disks during the clone creation process.

You can review related sizing information from the following Web site:

Active Answers Sizer Tools for Microsoft SQL Server

<http://activeanswers.compaq.com/ActiveAnswers/Render/1,1027,519-6-100-225-1,00.htm>

4.3 Partner Content

This solution was tested with the following Compaq backup software partner applications. Operational guidelines are provided in Section 5.1, Operation of Solution, for both partner applications.

CommVault Galaxy for Windows 2000

http://www.commvault.com/products_sub.asp?id=60

For additional information about backing up and restoring Windows 2000 environments using CommVault Galaxy:

<http://www.microsoft.com/technet/treeview/default.asp?url=/technet/ittasks/maintain/backuprest/Default.asp>

VERITAS Backup Exec for Windows NT and Windows 2000

<http://www.veritas.com/products/category/ProductDetail.jhtml?productId=bent2000>

For additional information on VERITAS Backup Exec hardware compatibility:

http://support.veritas.com/dsl/dslselect_ddProduct_BEWNT_matrix_type_Device.htm

4.4 Compatibility

This solution requires the use of *SANworks* Enterprise Volume Manager v2.0b, which operates on the *SANworks* Management Appliance. It requires a storage array network configuration using a *StorageWorks* HSG80 controller-based RAID array, viewable to the application server.

Specific compatibility information is described in the *SANworks* Enterprise Volume Manager Quick Specs (Specifications):

<http://www.compaq.com/products/sanworks/evm/index.html>

SAN-based backup configuration information may be obtained from the *StorageWorks* Enterprise Backup Solution Compatibility Table:

<http://www.compaq.com/products/storageworks/ebs/EBScompatmatrix.html>

4.5 Setup and Installation

Caution: Many of the commands and procedures described require database administrator privileges and could disrupt database operation if used incorrectly. If not familiar with these commands and functions, consult your application and hardware documentation before proceeding. As with any change to your database configuration or backup plan, be sure to test these changes thoroughly before implementing them in a production environment.

You must install and configure these four components before you can use the clone technology described in this solution.

- *StorageWorks* HSG80 Compaq Storage Array for Windows 2000
- *SANworks* Management Appliance with *SANworks* EVM 2.0
- Microsoft SQL Server 2000 on Windows 2000 (MSCS optional)
- SAN Attached Tape Backup Server

Be sure to follow these steps in sequential order:

1. Configure *StorageWorks* HSG80 Storage Array for Windows 2000

Microsoft recommends using separate LUNs for log files and data files in a high availability environment. You should also configure log files and data files as RAID 1+0 for maximum availability and performance.

For additional information on setting up storage arrays, refer to the following Web site:

<http://www.compaq.com/products/storageworks/ma8kema12k/documentation.html>

2. Install *SANworks* EVM 2.0 Server on the *SANworks* Management Appliance

Refer to the *SANworks* EVM 2.0 Installation Guide for Windows 2000.

<http://www.compaq.com/products/sanworks/evm/documentation.html>

SANworks EVM Installation Instructions for Clustered Configurations

SANworks EVM 2.0c is cluster aware. You can install a *SANworks* EVM client on each node of a cluster, but you are limited when trying to execute cluster operations. This guide provides instructions for executing Microsoft cluster aware command line scripting for *SANworks* EVM-based cloning.

3. Configure Microsoft SQL Server 2000 within a Windows 2000 Cluster

Ensure that all cluster nodes have Windows 2000 Advanced Server and Service Pack 2 installed.

Perform the following steps in sequence to properly setup a Microsoft cluster node with the correct software for this solution.

a) **Install fibre channel host bus adapters and adapter software**

<http://www.compaq.com/products/servers/proliantstorage/adapters/docs/index.html>

b) **Install the *StorageWorks* Fibre Channel SAN switch software**

<http://www.compaq.com/products/storageworks/fcsanswitch216/documentation.html>

c) **Install *SANworks* Secure Path v3.1A for Windows and Service Pack 2**

Secure Path v3.1 for Windows

<http://www.compaq.com/products/sanworks/secure-path/sp31w2k.html>

SANworks Secure Path v3.1A Service Pack Update for Windows

<http://www.compaq.com/products/sanworks/softwaredrivers/securepath/index.html>

d) **Install large LUN support**

<http://www.compaq.com/products/storageworks/softwaredrivers/ra8000fc/largelunutility.html>

e) **Install *SANworks* EVM client on all nodes that have Compaq SAN storage attached. Be sure the *SANworks* EVM server is installed before you install the client. If you are installing the client on a cluster, you must select the cluster option when prompted during the install.**

<http://www.compaq.com/products/sanworks/evm/documentation.html#install>

f) **Create disks/LUNs for SQL Server cluster**

Present all LUNs to each SQL Server cluster node with the same drive letter assignment. Depending on each end user application or SAN configuration, the number and size of your LUNs will vary.

Create three LUNs as follows:

- One small LUN to use as the Quorum disk. (Do not place application program file data on this LUN.)
- A log LUN
- A database LUN

g) **Install and Configure Windows 2000 Cluster Component on Each Server Node**

Use one of the smaller LUNs for the quorum disk. Refer to Microsoft Windows 2000 Advanced Server Installation Documentation for Best Practices on installing MSCS (Microsoft Cluster Server).

h) **Install SQL Server 2000 on your Cluster**

Before you install SQL Server 2000 on a Microsoft Cluster, verify that you have created a MSDTC resource. If MSDTC is present, continue with the configuration. If it is not present, run the Comclust.exe on each cluster node. To configure MSDTC, enter Comclust.exe at the DOS command prompt.

You must configure MSDTC for each node in the cluster.

4. Install and Configure Backup Server:

You must load the backup server with Windows 2000 Server and Service Pack 2 and the server must be attached to the SAN and LAN.

a) **Install fibre channel host bus adapters and adapter software**

<http://www.compaq.com/products/servers/proliantstorage/adapters/docs/index.html>

- b) **Install the *StorageWorks* Fibre Channel SAN Switch software**
<http://www.compaq.com/products/storageworks/fcsanswitch216/documentation.html>
- c) **Install *SANworks* Secure Path v3.1A for Windows and Service Pack 2**
Secure Path v3.1 for Windows
<http://www.compaq.com/products/sanworks/secure-path/sp31w2k.html>

SANworks Secure Path v3.1A service pack update for Windows
<http://www.compaq.com/products/sanworks/softwaredrivers/securepath/index.html>
- d) **Install Large LUN Support**
<http://www.compaq.com/products/storageworks/softwaredrivers/ra8000fc/largelunutility.html>
- e) **Install *SANworks* EVM Client/Agent.**
<http://www.compaq.com/products/sanworks/evm/documentation.html#install>
- f) **Install SQL Server 2000 Service Pack 2**
- g) **Install and setup EBS tape backup application with SAN, Windows 2000, and SQL agents**
<http://www.compaq.com/products/storageworks/ebs/documentation.html>

4.6 Service

The following optional services are available for the design, installation, configuration, and start-up of this solution:

***SANworks* Enterprise Volume Manager Deployment Service**

Part Number: QS-SN7A9-HK

Service Description

The *SANworks* Enterprise Volume Manager Deployment Service provides basic integration support to customers, who want to implement *SANworks* EVM to improve application availability, backup functionality, recovery capability, performance, and flexibility. By utilizing the services of knowledgeable, experienced Compaq Professional Services consultants, you receive many advantages, including timely, cost-effective solution deployment, risk reduction, and knowledge transfer.

This service yields the following primary deliverables:

- A working, architecturally-sound *SANworks* EVM solution integrated into an existing Compaq high-availability Storage Area Network
- Documentation that outlines the design, implementation process, and configuration of the *SANworks* EVM environment.
- Transfer of operational knowledge to customer IT staff

***StorageWorks* Enterprise Backup Solution Deployment Service**

Part Number: QS-SN6A9-HK

Service Description

The *StorageWorks* Enterprise Backup Solution Deployment Service provides basic integration support to customers who want to implement SAN-based backups based on the *StorageWorks* Enterprise Backup Solution (EBS). By utilizing the services of knowledgeable, experienced Compaq Professional Services, you receive many advantages, including timely, cost-effective solution deployment, risk reduction, and knowledge transfer.

This service provides the following deliverables:

- Installation of storage products and testing of your *StorageWorks* subsystem, including Fibre Channel hubs or fabric switches and host bus fibre channel adapters for each server
- System testing and diagnostics to ensure that the current device software and firmware are loaded and conform to base-level specifications
- Installation and configuration of supported backup software
- Development and testing of backup/restore procedures
- Orientation including demonstration of hardware and software functionality

5.0 Operational Guidelines

5.1 Operation of Solution

Everything you need to implement this solution is provided in this section. This section provides detailed procedures to perform the following activities.

Cloning a SQL Server Database

- Using a Clone as a Backup Source
- Choosing SQL Server Files for Cloning
- Clone Creation
- Using Rolling Clones
- Using the Compaq DButil Utility
- Creating Scripts
- Pre and Post Scripts
- Cloning Using `-pre` and `-post` Commands

Performing Clone-Based Backups

- Attach Scripts and Detach Scripts
- Attaching a Clone to a Backup Server
- Scheduling a Clone-Based Backup Using *SANworks* Automation Manager
- Scheduling a Clone-Based Backup Using a Third Party Backup Application
- Automated Clone-Based Backup Using CommVault Galaxy
- Automated Clone-Based Backup Using VERITAS Backup Exec
- Backup Strategies

Clone-Based Restore and Recovery

- Rapid Database Restoration
- Restore Database from Clone
- Restore Incremental Transaction Logs

Operating *SANworks* EVM within a SQL Server Cluster

In a clustered SQL Server environment, you must have selected the cluster option during the installation of the EVM client software on the cluster node. This will automatically create a virtual host on the *SANworks* Management Appliance so that you can execute the SQL pause and resume commands from *SANworks* EVM to the active cluster node. After installation, you will notice on the EVM server a new host icon with the cluster group name. Since EVM chooses the main cluster group, you must have your SQL resources within the same cluster group. You can verify that all cluster nodes are running properly by viewing the status of the Cluster SQL Server Service from the Cluster Administration GUI.

To maintain a consistent state of the SQL Server database during clone creation, Compaq has developed the DButil utility. This utility utilizes `-pre` and `-post` commands for SQL Server management during the cloning process (see Section 5.2, Cloning a SQL Server Database). For the `-pre` and `-post` commands to run properly within a cluster, you need to perform the `-pre` and `-post` scripts on the cluster node that owns the database at that time.

Please refer to the EVM installation document for more detail on installing EVM client on a cluster.

<http://www.compaq.com/products/sanworks/evm/documentation.html>

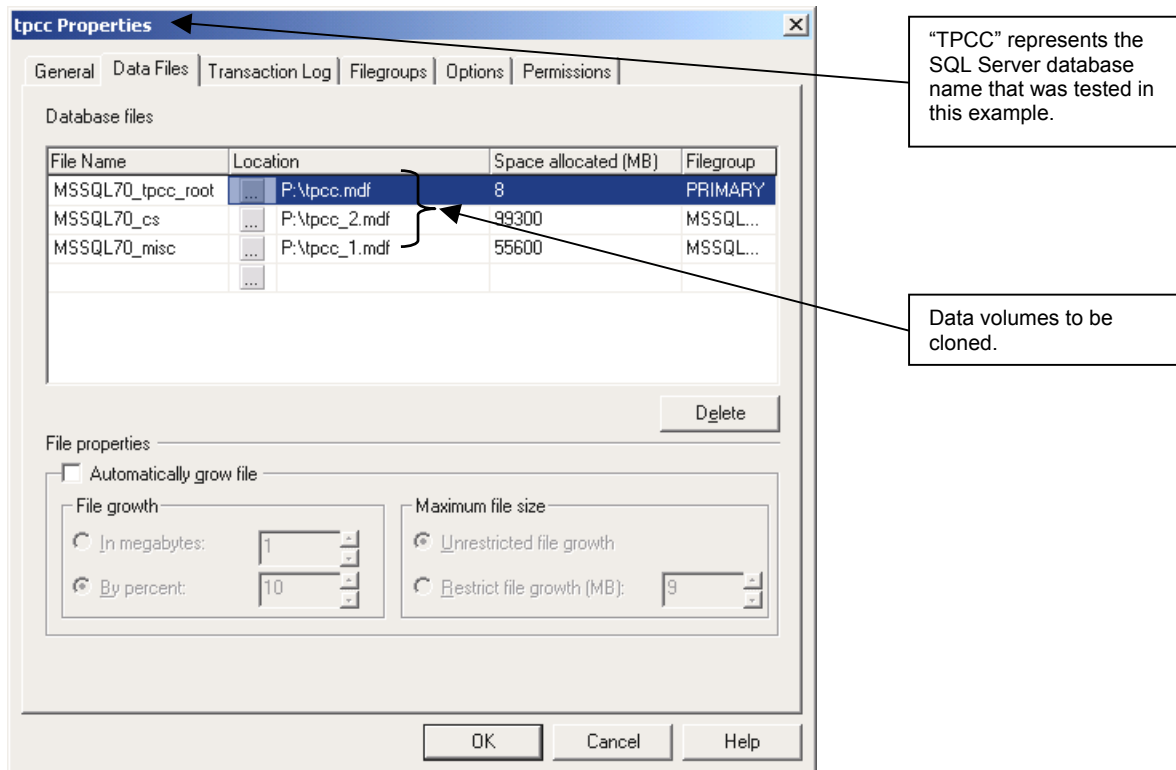
Caution: Only use cluster virtual hosts to execute –pre and –post commands on a cluster through a *SANworks* EVM job. Do not use *SANworks* EVM to mount a clone volume to the cluster virtual host.

5.2 Cloning a SQL Server Database

Choosing SQL Server Volumes for Cloning

You need to locate which SQL Server volumes contain the data you want to clone.

1. Right-click the icon of any database listed in SQL Server Enterprise Manager. Select properties. The “Data Files” and “Transactional Log” headers will display. Use this view to identify the drives and drive letters you want to clone.
2. Proceed to Disk Manager under the Computer Manager GUI in Windows 2000. Within properties of the drive, you can determine which unit is assigned to that drive letter. Use Disk Manager to determine which Compaq disk unit correlates to which drive letter. Decide which drive units you want to clone.
3. Once you know the disk unit numbers, you can setup the *SANworks* EVM clone job.
4. Make sure that the scripts you want to execute are created and verify that they are in place. The DButil utility should exist on one of the units that is to be cloned.
5. Create the *SANworks* EVM job.



Screen Shot 1 – Database Properties in Enterprise Manager

Best Practice: Microsoft recommends that the log files and data files be kept on separate volumes (refer to Chapter 6 – Capacity and Storage Management, in the [Microsoft SQL Server 2000 Operation Guide](#)). The data files and log files must be cloned simultaneously in order to maintain synchronization (shown in Screen Shot 3).

You will need to know your Compaq Storage Array Disk Unit Number (LUN number) in order to setup the clone. If you do not already know the LUN number, it can be found by viewing the properties of the disk in the Disk Manager screen.

Once you know which disks need to be cloned, you will need to verify that all of your scripts are in place. The scripts that you would like *SANworks* EVM to execute should be created first, before the *SANworks* EVM job is created.

Clone Creation

In order to preserve database integrity while the clone is split from the database volume, it is necessary to first put the SQL Server database into a consistent state and queue disk writes until the process is complete. This temporary state lasts for only a few minutes, until the clone split process has successfully been completed. Since reads and writes continue, the clone split process is transparent to the user.

Caution: Before continuing with this section it is important to review and understand the process for creating clone jobs using *SANworks* Enterprise Volume Manager 2.0. All of the following procedures assume a basic working knowledge of *SANworks* Enterprise Volume Manager operation. You should also verify that the latest versions of drivers and software are installed.

When cloning an online SQL Server database, you need to execute pre and post scripts within *SANworks* EVM to successfully perform the cloning process. The pre script executes the DButil backup command and puts the database in a consistent state by queuing disk writes. When the clone splitting process is complete, *SANworks* EVM calls the –post command in order to resume disk activity.

Using Rolling Clones

Note: Transaction Log Backups should be scheduled independently as needed between cloning intervals. This strategy and procedure will be discussed thoroughly later within this document.

Using two sets of rolling clones that cycle every 48 hours, a full clone each day, is a recommended clone-based backup strategy. Your specific environment will determine the required clone and backup frequency. The disks recycle automatically and provide rapid restoration of data up to 48 hours. When you use two clone sets, you need to recycle the clones (undo and re-execute the clone job) every two days. You can run an “undo” job to release clone disks. In *SANworks* EVM, every clone job automatically creates an undo job. The *SANworks* Automation Manager recognizes the need to run an undo job, if the original job has not been undone. You must undo clones after a period of time to prevent running out of disk capacity fairly quickly.

You can run a *SANworks* EVM undo job manually or schedule it. Do one of the following:

- To run a manual undo job, right-click on a completed job in the *SANworks* EVM Job Status screen and select UNDO.
- To schedule an undo job, use Automation Manager or Task Scheduler. Use the `evmcl.exe` command to create a batch script, which launches a *SANworks* EVM job. You can determine the correct job syntax name by viewing the `c:\program files\Compaq\Sanworks\Enterprise Volume Manager\bin\jobs\` directory on the *SANworks* EVM server.

You can use the `evmcl.exe` command, which comes with *SANworks* EVM, to execute *SANworks* EVM jobs from the command line of any node on the network. With Task Scheduler, you can schedule all required operations, including the daily cycling or “rolling” of clones.

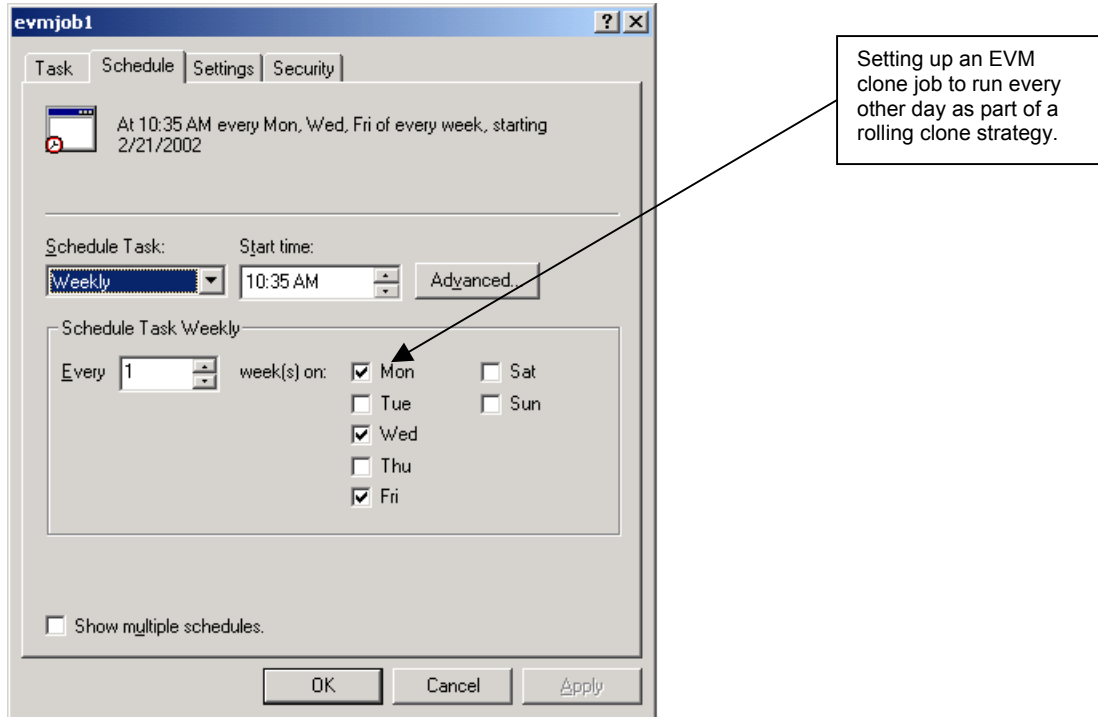
`C:\evmcl.exe <san_appliance_ip_address> execute <Job name>`

`C:\evmcl.exe <san_appliance_ip_address> undo <Undo Job name>`

You should maintain a minimum of two sets of clones. Using this strategy, one clone is available for restore at all times. Suppose you have two clone sets - Clonejob1 and Clonejob2. Each time Clonejob1 is scheduled, run an undo of Clonejob1 to release the disks and make them available for a new job or a repeat of Clonejob1. The example shown cycles two clone sets for six days (Monday through Saturday) each week and on Sunday runs a full database backup to disk from the SQL Server backup tool, which is then backed up to tape.

A typical rolling clone schedule looks as follows:

Monday	Tuesday	Wednesday	Thursday
Attach clone1	Attach clone2	Attach clone1	Attach clone2
Run Tape Backup	Run Tape Backup	Run Tape Backup	Run Tape Backup
Detach Database	Detach Database	Detach Database	Detach Database
Undo Clonejob1	Undo Clonejob2	Undo Clonejob1	Undo Clonejob2
Run Clonejob1	Run Clonejob2	Run Clonejob1	Run Clonejob2
Friday	Saturday	Sunday	
Attach clone1	Attach clone2	Rolling Sunday clone and tape backup	
Run Tape Backup	Run Tape Backup	OR	
Detach Database	Detach Database	Full tape backup of online SQL Server database	
Undo Clonejob1	Undo Clonejob2	and log files	
Run Clonejob1	Run Clonejob2		



Screen Shot 2 – Scheduling Using Task Scheduler

Screen Shot 2 provides an example using the Windows 2000 Task Scheduler to schedule a *SANworks* EVM job. In this case the Task Scheduler starts a batch job called evmjob1.bat three days of the week. The batch job contains two *SANworks* EVM jobs.

The *SANworks* EVM job does the following:

- Starts an attach to the SQL Server backup server named “Ulrich”
- Sequentially runs the tape backup
- Detaches the database
- Undoes Clonejob1
- Recreates clones by running CloneJob1
- Mounts clones but does not attach them to the backup server

Using the Compaq DButil Utility

Compaq developed the DButil executable to place database files in a consistent state before creating a clone. Using this utility the SQL Server database is disk write queued, suspending write activity to the disks at the time of clone creation.

Note: During the brief period when the SQL Server database is suspended, SQL Server read access is completely unaffected and read requests are processed, as they would be normally. Writes may continue to be submitted but are queued. The user may see a brief delay on write requests, waiting for the database to resume. Note that suspending the database does not affect the normal transaction isolation level. Users are not logged out of the database and active transactions can continue. All held transactions are automatically rolled forward (executed in order) once the database is resumed. Clone creation is therefore transparent to the user.

Example scripts are provided as batch files that you can use to automate these processes. You can schedule batch programs to further automate the clone process.

You can get the Script Kit download at the following Web site (which also contains the DButil application):

<http://www.compaq.com/products/storageworks/solutions/request/rrsql2kit.html>

License Statement: *The DButil software is copyrighted by Compaq Computer Corporation. Download and use of the DButil software is governed by the terms of the Compaq license agreement as provided. Any reproduction or redistribution of the DButil software not in accordance with the Compaq license agreement terms is expressly prohibited.*

Creating Scripts

You need to create scripts before you start the cloning process. You need to install SQL Server 2000 on the backup server to create a backup job that will be used for the tape backup batch. Be sure to create the scripts in the order shown.

1. -Pre and -Post Scripts (requires DButil.exe command)
2. Manually run a *SANworks* EVM clone job of the database. This provides you with a database name and location for creating a tape backup job on your backup server.
3. Attach scripts and detach scripts for attaching and detaching the previously mounted clone to the backup server as an online SQL Server database.
4. *SANworks* EVM job and *SANworks* EVM job batch files
5. Undo *SANworks* EVM job batch files
6. Tape backup batch job, which can include the attach and detach scripts created in Step 3.
7. Main job batch file which calls all the batch jobs in the following order:

- Attach.bat

```
osql -U <sa> -P <password> -i <attachscript.sql> -o <attachlog.out> -e
```

- Tape_backup.bat

```
bemcmd -ol -j<job name> -w -n<user> -p<password> -l<path for log file>
```

NOTE: this applies to Veritas Backup Exec only. For details on CommVault Galaxy, please see the section entitled **Automated Clone-Based Backup Using CommVault Galaxy**

- Detach.bat

```
osql -U <sa> -P <password> -i <detachscript.sql> -o <detachlog.out> -e
```

- Clonejob1_undo.bat

```
evmcl.exe <san_appliance_ip_address> undo <Undo Job name>
```

- Clonejob1.bat

```
evmcl.exe <san_appliance_ip_address> execute <Job name>
```

8. Automation job using Task Scheduler or *SANworks* Automation Manager

Pre and Post Scripts

You need a suspend batch file, called pre.bat, and a resume batch file, called post.bat. Create and run these files and the DButil command from the original volume that will be cloned. The directory that contains the scripts will have a Meta file created after running the suspend command. This file remains with the clone volume.

Cloning Using *-pre* and *-post* Commands

1. Set a path to DButil.exe. DButil.exe must exist in a directory within the backup source volume.
2. Create a -pre and -post batch job file. These files should be in the same directory as DButil.exe. When you run the DButil -pre command, a Meta file is created, which is required when using the -restoresns command to put the SQL Server database in a state where transactional logs can be applied for recovery. To maintain this Meta file, run the DButil command against the disk that you are going to clone. This will create the Meta file on the clone.

Example *-pre* and *-post* batch files:

Pre.bat

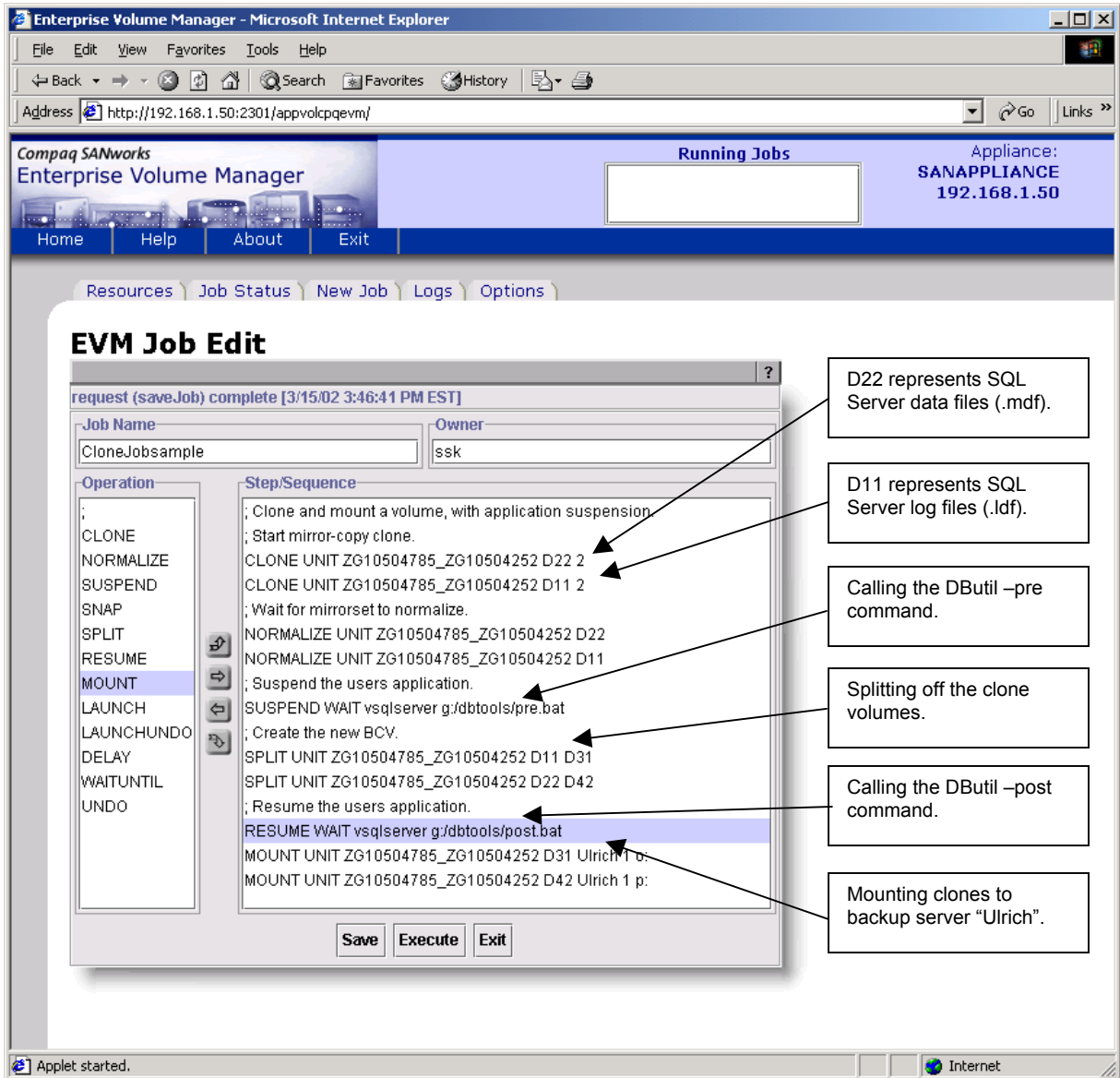
```
c:\dbutil.exe -pre <sqlserver_cluster_name\instance name> <database> <username> <password>
```

Post.bat

```
c:\dbutil.exe -post <sqlserver_cluster_name\instance name> <database> <username> <password>
```

When you create a *SANworks* EVM job, you must select the correct job template from the Create New Job screen. For clone creation, the best choice is the clone.mount.suspend job template. You can add more operations to the job but you will need to select a template to initiate the creation of a *SANworks* EVM job. The pre.bat file will be called from the suspend wait operation within the new *SANworks* EVM job. The post.bat file will be called from the resume wait operation. Example syntax for calling out both commands as executables from within *SANworks* EVM is shown. Notice these commands require quotes and path.

Example of a suspend command within *SANworks* EVM job: “c:\dbutil-pre.bat”



Screen Shot 3 – SANworks EVM Clone Job Sample

5.3 Performing Clone-Based Backups

Attach Scripts and Detach Scripts

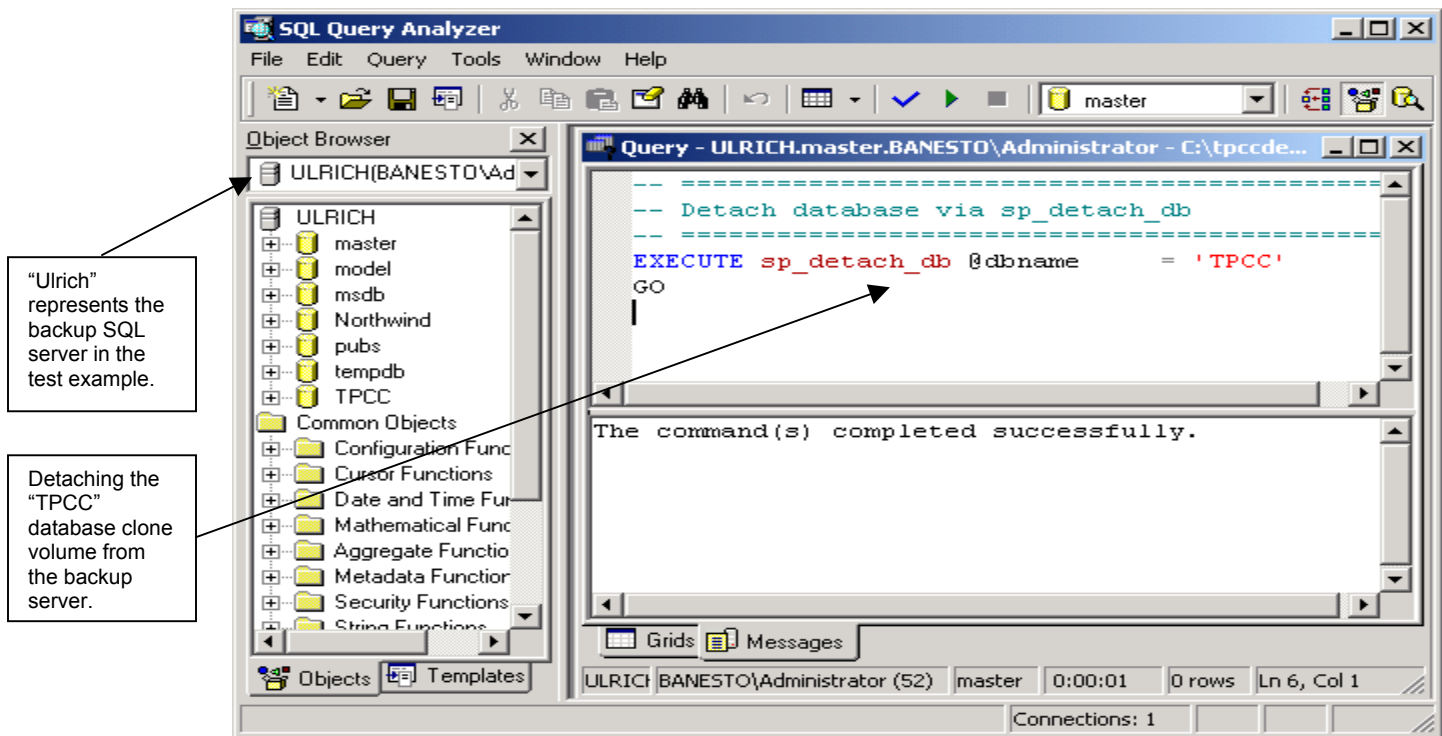
The purpose of the attach and detach scripts is to mount a database to a backup SQL server. The SQL Server scripts for attaching the database need to exist on the backup SQL server. Review the next section to learn how to create these scripts.

You must mount the clones to the backup server and perform the tape backup just before recycling the clone disks. A separate set of batch files is required for attaching each set of clones. It is recommended to use separate drive letters for each clone, to enable the mounting of a new set of disks without removing the old clone set entirely. Before attaching you need to detach the old mounted clones. One detach script is required since the database from both clones uses the same

name. Review the command line example and note that the detach command references the database name.

```
EXECUTE sp_detach_db @dbname = 'databasename'
```

Caution: Use the scripts to attach the clone to the backup server before starting a tape backup and recycling of the clone. The clone needs to be attached to the backup server as an online SQL Server database in order to provide the option of file group restores.



Screen Shot 4 – Detaching from Query Analyzer

Attaching a Clone to a Backup Server

The steps below outline how to use the OSQL command when attaching a database.

Caution: You cannot apply transaction logs to a clone that has been mounted as an online SQL Server database. Time stamps alter the database so that transactional logs will not match the time sequence. For this reason, performing an online tape backup of the database is recommended just before deleting a clone within a rotation.

1. Using SQL Query Analyzer, create two scripts with .sql extensions.

- Attach SQL-script
- Detach SQL-script

SQL Server includes attach and detach database templates. After you edit the scripts, save the attach.sql and detach.sql scripts in a directory that contains the osql.exe command. The OSQL command and the SQL script must be located in the same directory. Example scripts are shown below.

Attach source:

```
EXEC sp_attach_db @dbname = 'database_name',
@filename1 = 'F:\Program Files\Microsoft SQL Server\MSSQL
\Data\database_name.mdf',
@filename2 = 'g:\databasename_1.mdf',
@filename3 = 'g:\databasename_2.mdf',
@filename4 = 'f:\databasename_log.ldf'
GO
```

Detach source:

```
EXECUTE sp_detach_db @dbname = 'databasename'
GO
```

2. Create OSQL batch files that call these scripts. A sample osql.exe and a sample batch file are shown below. The osql.exe is installed on every SQL Server so you do not need to copy this file.

Example of the syntax of an osql batch file:

```
osql -U sa -P password -i attachscript.sql -o zattach.out -e
```

Scheduling a Clone-Based Backup Using SANworks

You can use *SANworks* Automation Manager to schedule *SANworks* EVM jobs. Using Automation Manager is the preferred method because it is aware of *SANworks* EVM and the SAN Management Appliance. *SANworks* Automation Manager can discover *SANworks* EVM servers on your subnet and present the *SANworks* EVM jobs that have been preconfigured. You can then select the job you would like to schedule. More information about *SANworks* Automation Manager can be found at:

<http://www.compaq.com/products/sanworks/sums/description.html#ro>

Screen Shot 3 provides a sample of a *SANworks* EVM clone job. Notice the scripts that are being called out. Compare clonejob1 and clonejob2 and note that in both cases the same disks are cloned but the clone volumes have different numbers.

Scheduling a Clone-Based Backup Using a Third-Party Backup Application

Depending on how a *SANworks* EVM job is executed it's often useful to initiate the beginning of a job from the command line. When using a scheduler or a third party backup application, the command line feature is essential.

Create a batch file using the following steps and have the scheduler (Task Scheduler, CommVault Galaxy, or Veritas Backup Exec) call the batch job when you want it to run. The batch job you create must exist on the *SANworks* Management Appliance or the backup server.

1. Create a clone job on the *SANworks* EVM server.
2. Copy or provide a path to the `evmcl.exe` command from a directory from where you want to run your batch job. This `evmcl.exe` exists on the *SANworks* EVM server.
3. Create a batch job to execute your *SANworks* EVM job remotely. You must save this batch job with a `.bat` extension in order to call it from a schedule. Below is an example of how to call a *SANworks* EVM job using `evmcl.exe`.

```
C:\evmcl.exe <san_appliance_ip_address> execute <Job name>
```

4. You can start *SANworks* EVM jobs from Task Scheduler or a tape backup application in order to create and mount clones to the backup server. You may subsequently schedule tape backups.

Automated Clone-Based Backup Using CommVault Galaxy

You can use the CommVault Galaxy software to schedule *SANworks* EVM jobs for creating and mounting clones to a tape backup server. Follow these steps to automate a Galaxy tape backup using a *SANworks* EVM clone as the backup source.

1. Create the required clone job within *SANworks* EVM and save the job with a `.evm` job name. To learn how to define *SANworks* EVM jobs, refer to the *SANworks* EVM Job and Scripts section.
2. Create PreScan and PostScan `.bat` files

These batch files initiate a *SANworks* EVM clone job prior to backup and undo the EVM job at the completion of the backup job. The backup agent type on the backup server will determine whether the data is backed up as flat FS data or as database data.

prescan.bat

```
"C:\Program Files\Compaq\SANworks\Enterprise Volume Manager\bin\evmcl.exe" <SAN Appliance IP Address> execute <evm_job_name>
```

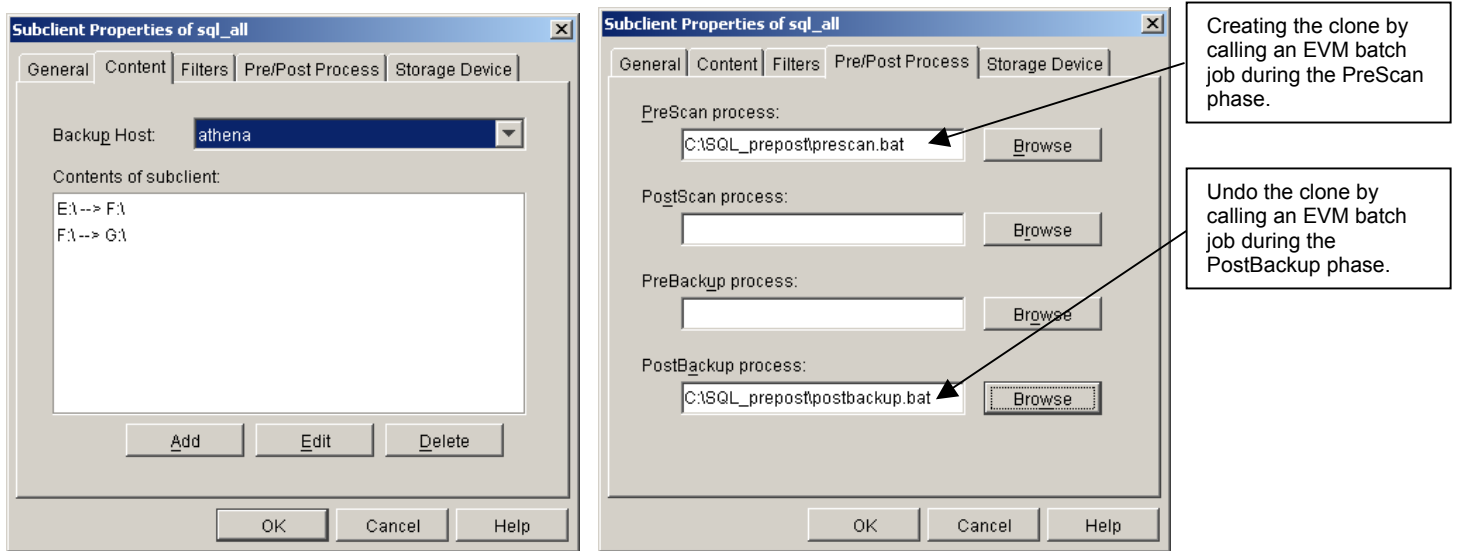
postbackup.bat

```
"C:\Program Files\Compaq\SANworks\Enterprise Volume Manager\bin\evmcl.exe"  
<SAN Appliance IP Address> undo <evm_job_name>
```

3. Initialize the .evm job within the PreScan phase of Galaxy backup. Refer to Screen Shot 5 - PreScan process.

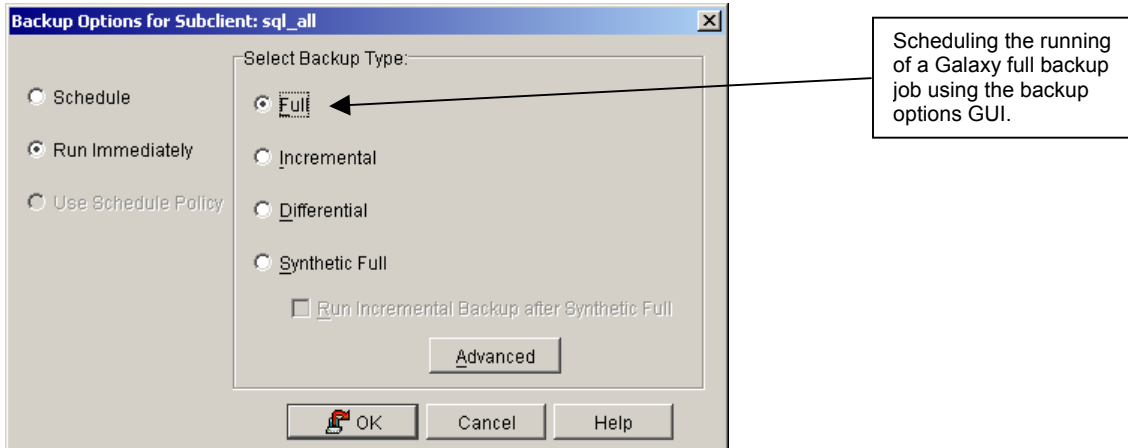
After the clones are mounted to the backup server, during the PreScan phase, the Galaxy CommServer will initiate the backup agent on the backup server to scan the mounted file system and backup the associated data. There is no backup burden on the production server.

4. Undo the .evm job within the post-backup phase of Galaxy. Refer to Screen Shot 5 - PostScan process.



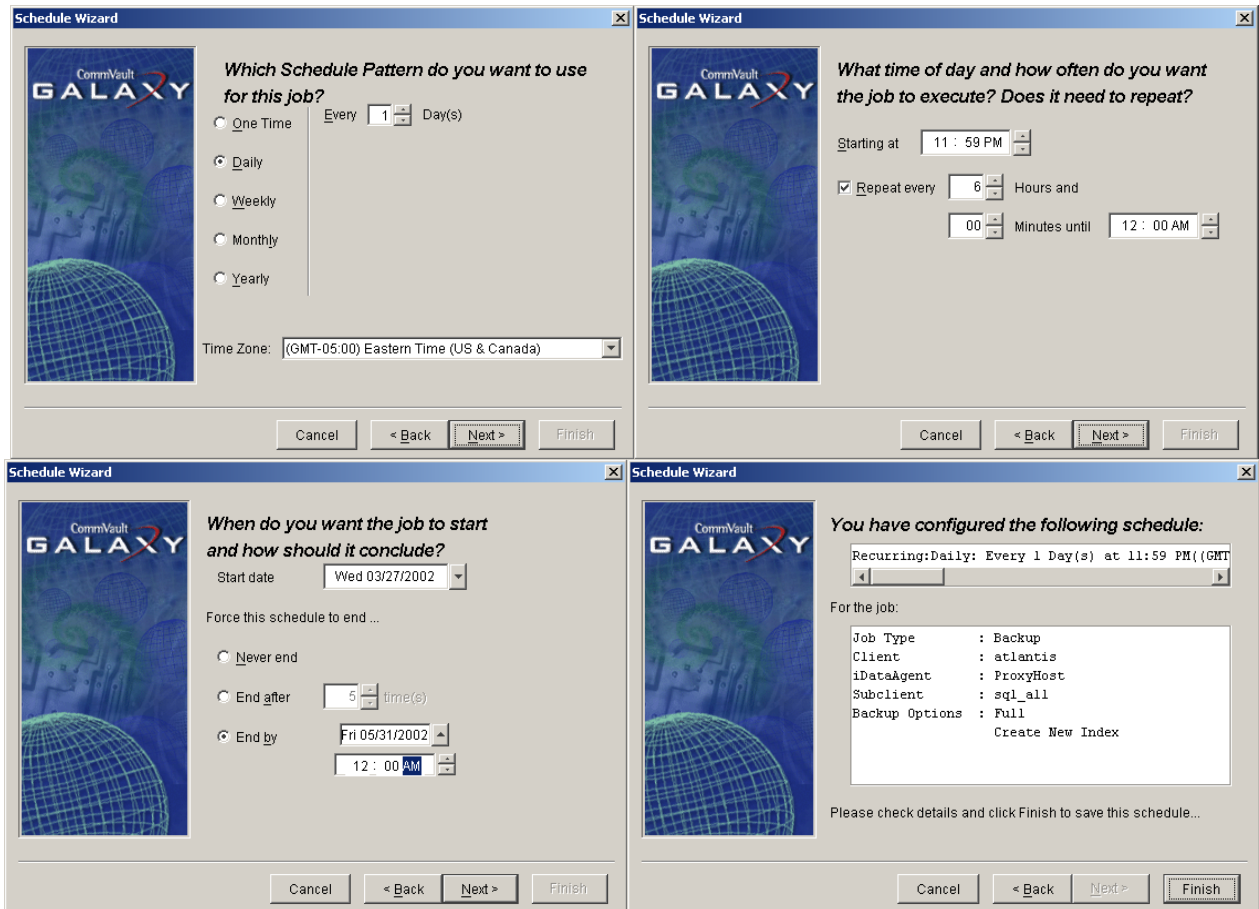
Screen Shot 5 – CommVault Galaxy Subclient Configuration for Loading Performance Test

All the CommVault Galaxy backup and restore jobs can be either started on-demand or scheduled. Screen Shot 6 displays the GUI window for backup options. Additional backup options (for example, starting new media for this backup) are available on the “Advanced” backup option window.

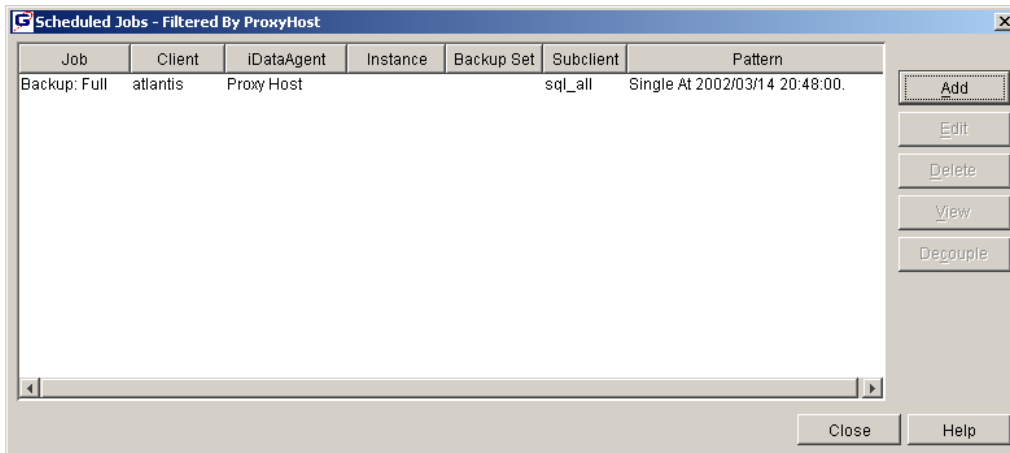


Screen Shot 6 – Backup Options GUI

CommVault Galaxy backup jobs can be scheduled using the Schedule Wizard available at the various levels of CommCell Browser. As shown in Screen Shot 7, schedules can be defined as a one-time, daily, weekly, monthly or yearly schedule with *Start* and *End* date. As long as a job has been scheduled, the schedule can be viewed from the CommCell GUI, as shown in Screen Shot 8.

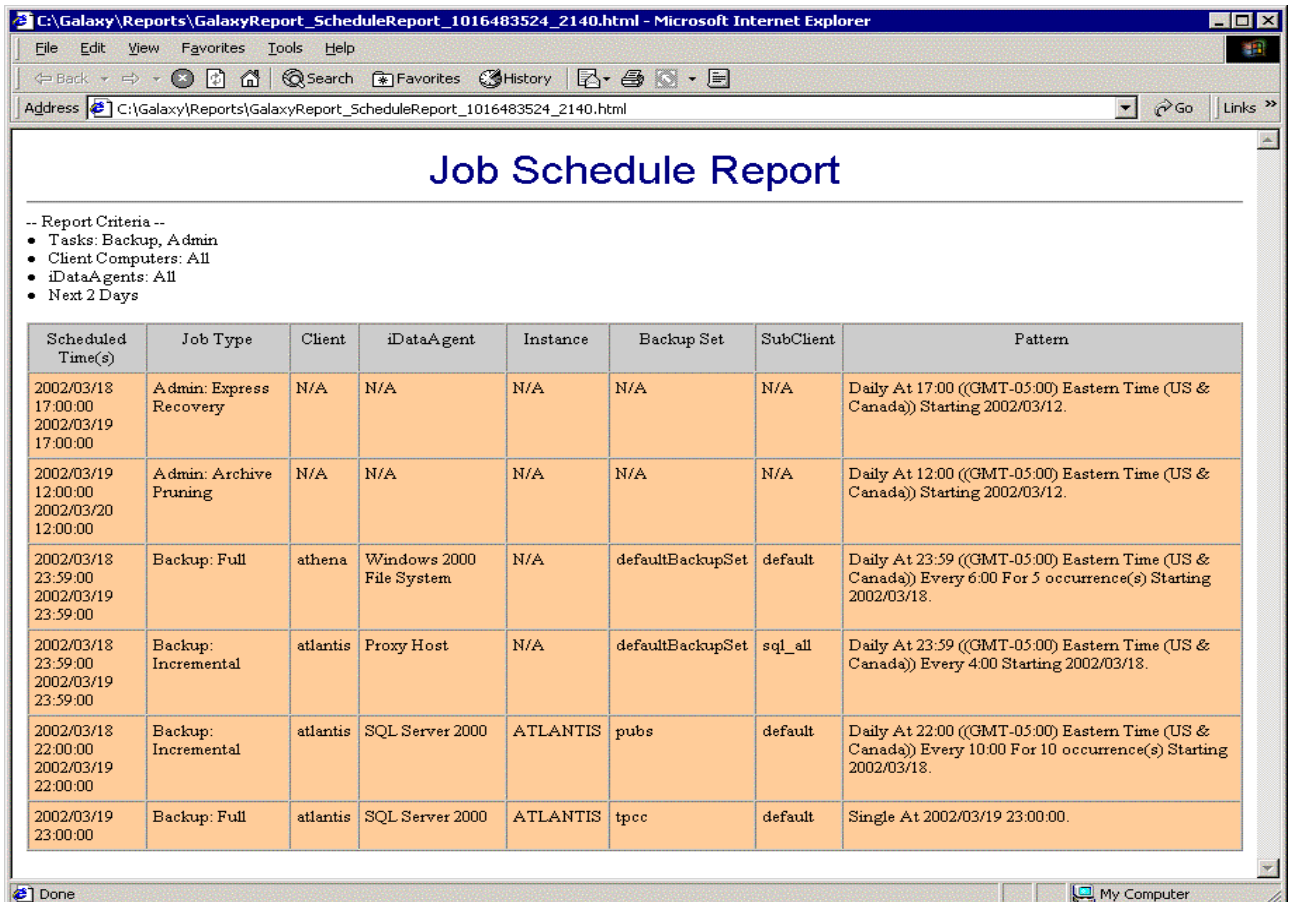


Screen Shot 7 – Scheduling a Recurring Backup Job Using CommVault Galaxy



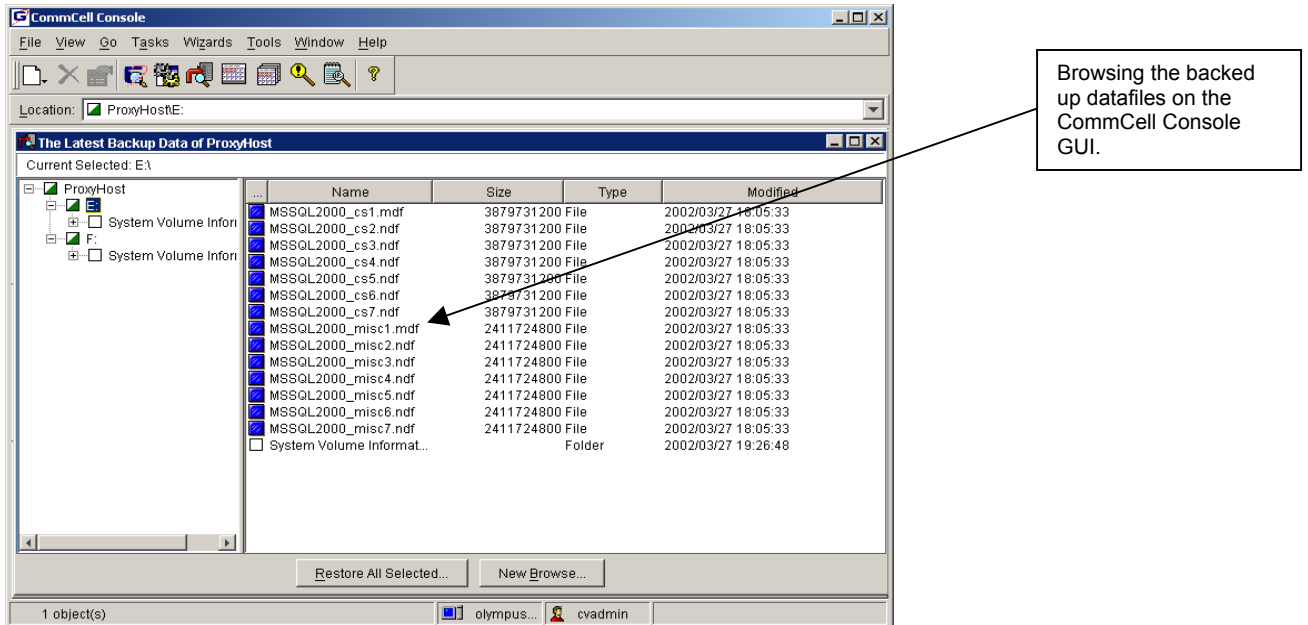
Screen Shot 8 – Viewing a Scheduled Backup Job

Detailed backup job scheduling information can be viewed through the Web-based CommVault Galaxy report utility. The filter setting allows the user to view the job schedules for any machine, application, job type, or period of time.



Screen Shot 9 - Viewing Job Schedules through Web-Based Reports

Using the browse GUI window (see Screen Shot 10), you can browse through the backed-up data on the production server file system structure instead of the backup server. You do not need to remember the data path mapping between two hosts. A default restore can restore the data in-place on the production server. Additional restore options (as well as "Advanced" options) allow a user to restore data to a different machine (for example, the backup server), restore to a different location on the same machine, overwrite or append, restore from different copies, or restore with a filter.



Screen Shot 10 – Using the CommCell Console to Browse Backed-up Database Files

More detailed information about CommVault Galaxy supported backup types can be obtained from the CommVault on-line help or published documents.

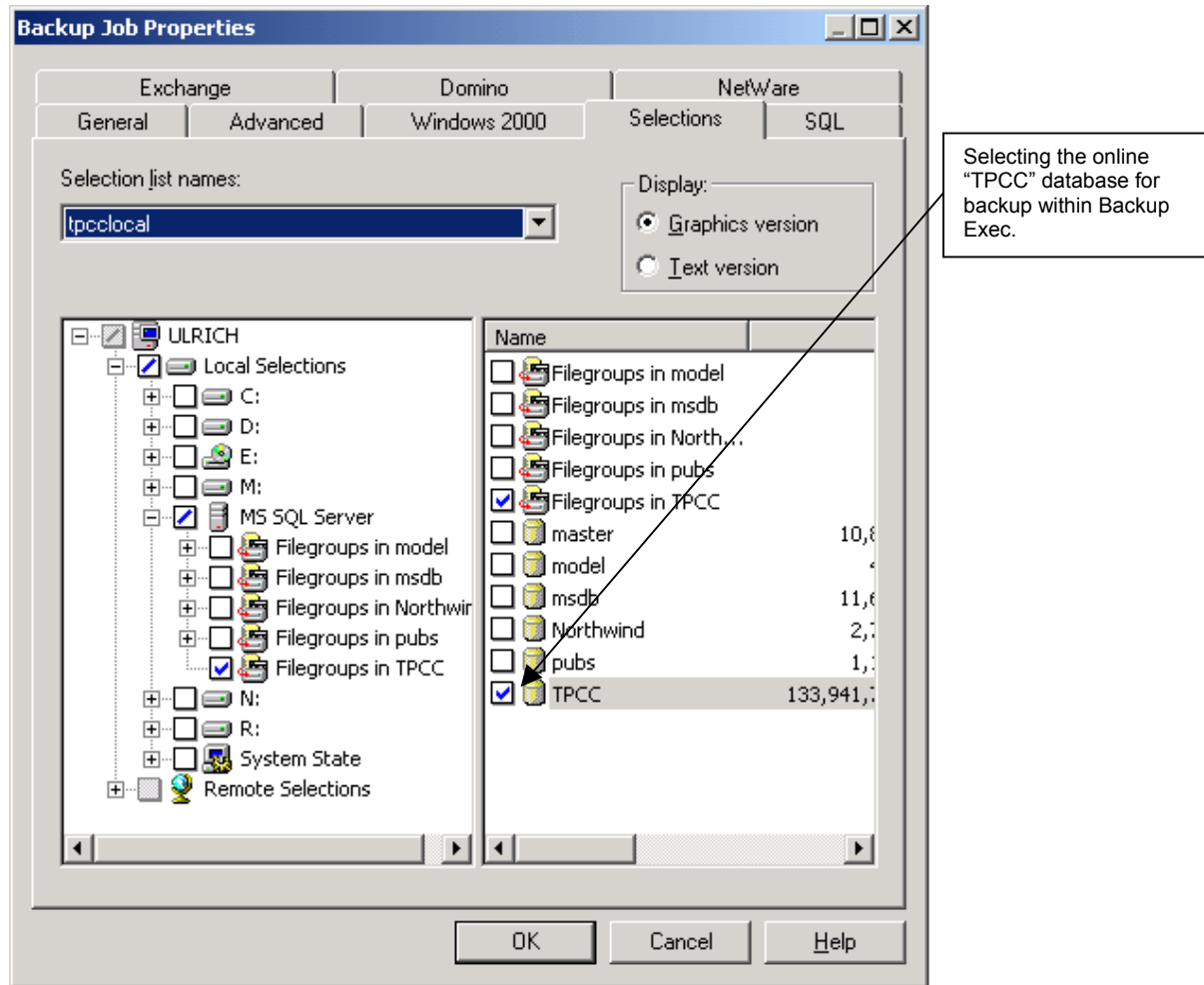
Automated Clone-Based Backup Using VERITAS Backup Exec

VERITAS Backup Exec supports two *SANworks* EVM integrated backup methods; Backup Exec can be called from a command line backup script within *SANworks* EVM, and Backup Exec can launch pre/ post commands to schedule *SANworks* EVM jobs for creating and mounting clones to a tape backup server.

SANworks EVM lets you start a tape backup job on a server where a *SANworks* EVM client is installed remotely. Follow these steps to automate a VERITAS Backup Exec tape backup within a *SANworks* EVM job.

1. Create a tape backup job on the VERITAS Backup Exec Server.
 - For offline backups, the entire volume, file system, or offline databases can be selected (see Screen Shot 11).
 - For an online backup, mount the database clone volume to the backup SQL Server and then create a tape backup job within VERITAS Backup Exec that includes the databases to be protected.

2. Determine the default backup methods for the job and define if a Database Consistency Check (DBCC) will be performed before or after the backup. It is recommended that a DBCC be performed either before or after the backup to validate the integrity of the data (see Screen Shot 12).
3. Name the configured backup job and save the configuration.

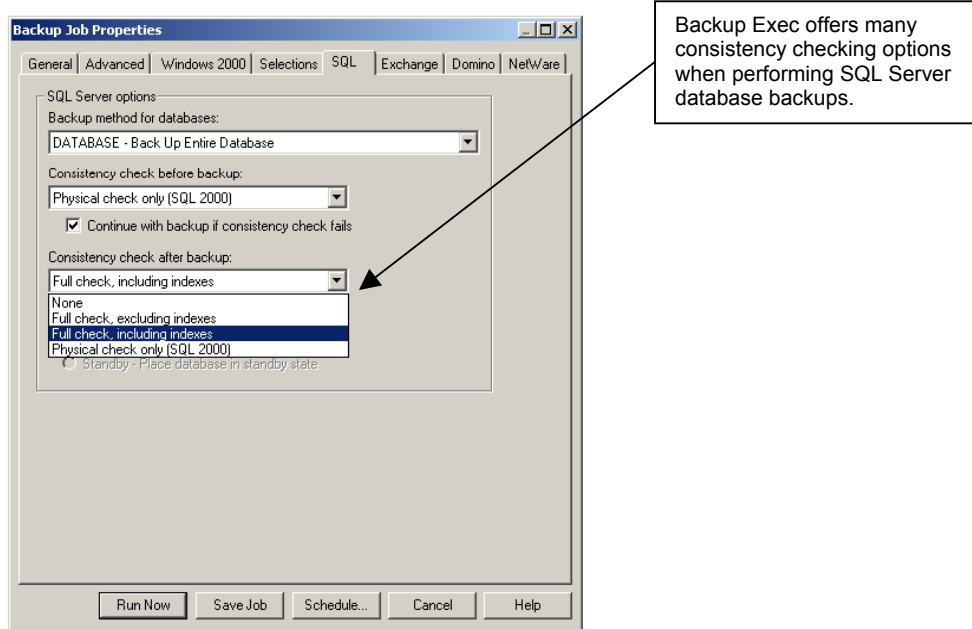


Screen Shot 11 – Selecting the Online Database for Tape Backup with VERITAS Backup Exec

4. Select the directory on the VERITAS Backup Exec server from where you would like to run the batch job. Verify the directory. You need a path to bemcmd.exe or copy the executable from its current location.
5. Create a batch file to execute the tape backup. In this batch file you can include the attach and detach batch files as well as consistency checking options. A copy of a sample batch file is attached that executes a Backup Exec job from the command line. This batch file would be called by Task Scheduler following the SANworks EVM clone creation script. To display a help file, enter bemcmd at the prompt.

```
bemcmd -o1 -j<job name> -w -n<user> -p<password> -l<path for log file>
```

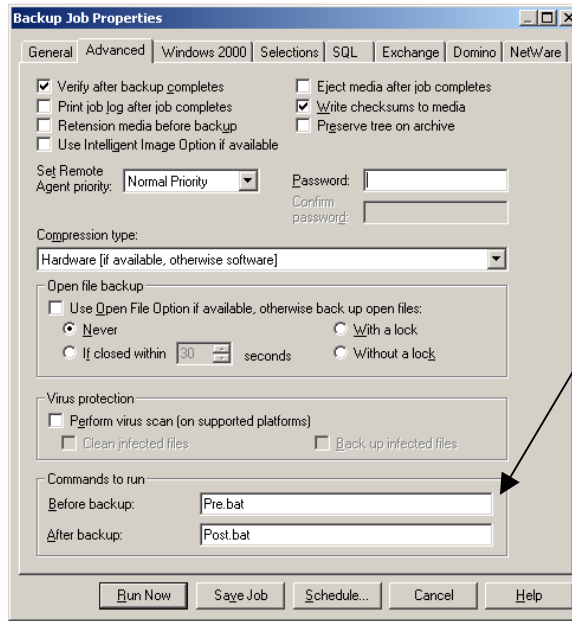
The `-o1` option within the command line executes a previously saved job. Refer to the Backup Exec Administrators Guide or the online help file for additional syntax.



Screen Shot 12 – Backup Exec Consistency Checking Options

You can also choose to schedule clone events through the Backup Exec User Interface (UI) and allow Backup Exec to execute the *SANworks* EVM scripts to create the clone and mount it as a backup source. (Note that this procedure was not specifically tested during solution validation.)

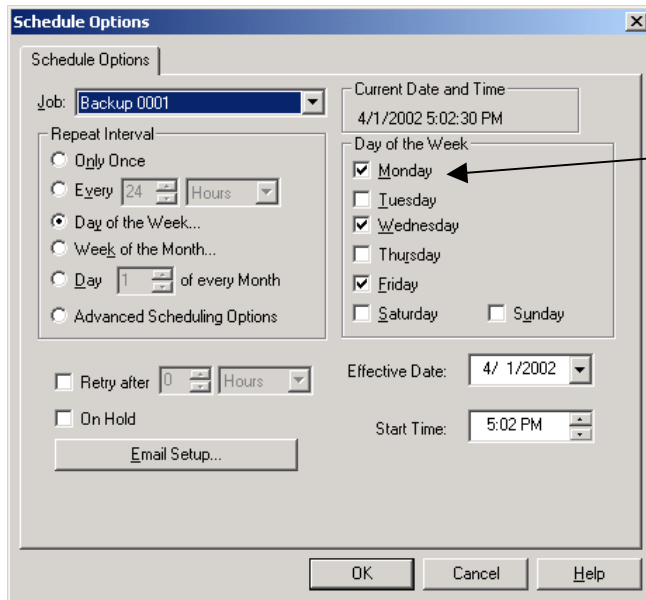
1. Create the required clone job within *SANworks* EVM and save the job with a .evm job name.
2. Create Pre and Post .bat files and configure these files to be executed before and after the backup process (see Screen Shot 13).



Pre and Post batch files allow Backup Exec to execute the required SANworks EVM cloning scripts before and after the backup process.

Screen Shot 13 – Adding Pre and Post Commands to the Backup Exec Backup Job

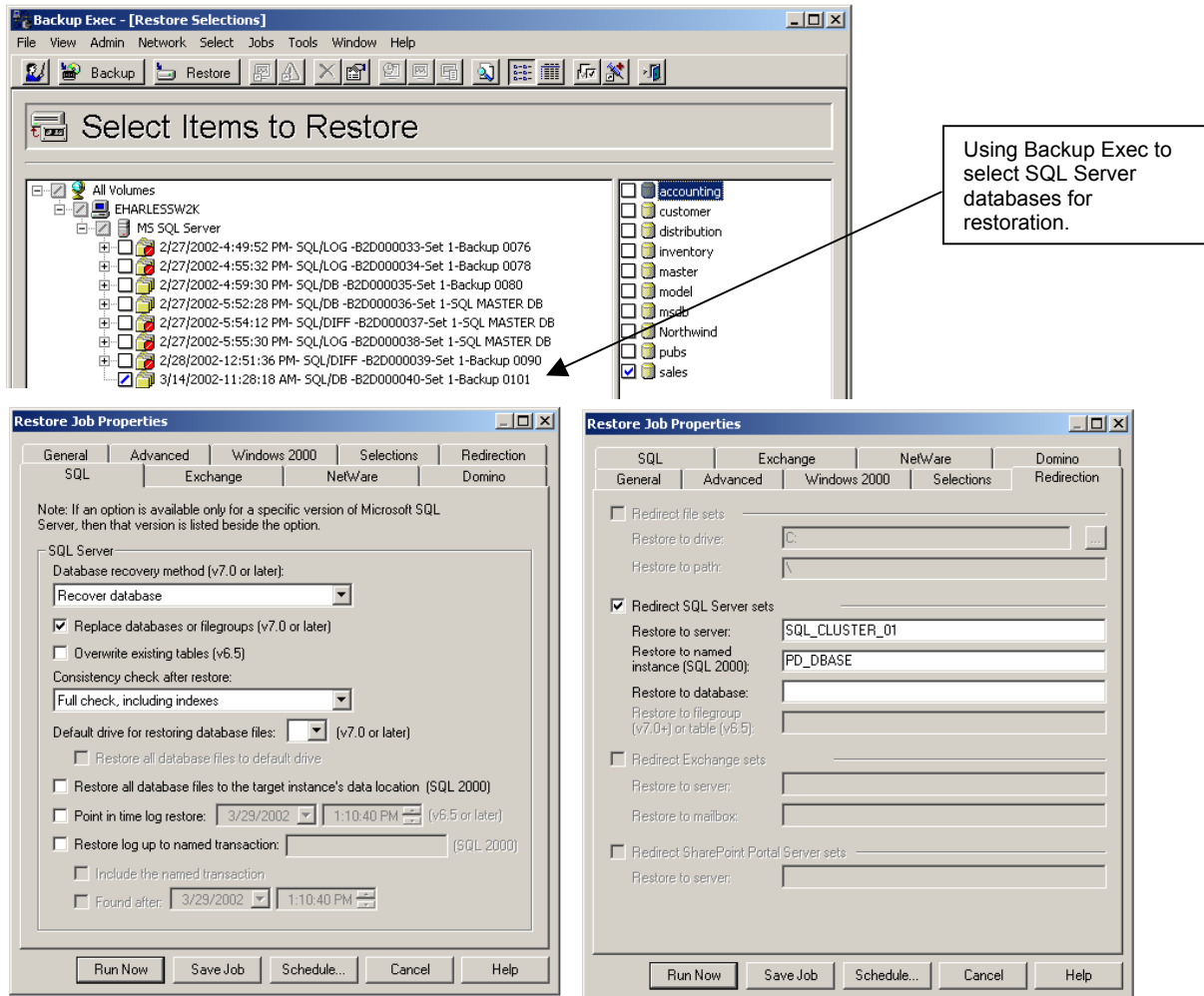
3. In order to perform online backups of SQL databases, include the attach and detach scripts, referenced earlier, in the pre and post .bat files.
4. Schedule reoccurring backup jobs of the clone using the Backup Exec UI (see Screen Shot 14).



Flexible scheduling options can be applied to backup jobs protecting clone volumes.

Screen Shot 14 – Scheduling a Reoccurring Job Using Backup Exec

- Flexible restore options allow for selective database restoration to the original or alternate SQL Server. Databases can be recovered or placed in a loading or standby mode (see Screen Shot 15).



Screen Shot 15 – Backup Exec Restore Options

5.4 Backup Strategies

The best backup strategy depends on each specific business environment. You need to determine the amount of data that you can afford to have unprotected and the length of time. Once a tape backup or clone has been completed, any new data written since that time is vulnerable to loss. The frequency of cloning and backup operations depends on the value of the data. If you want to provide for a short recovery point, it may be necessary to create more frequent clones or to utilize incremental backups of transaction logs as often as every ten minutes.

Caution: A transaction log backup makes a copy of only the log file. Log files alone cannot be used for full database restoration. When restoring transaction log backups, the log files need to be applied sequentially to a previously restored database that is in a loading state in order to recover the database to the point of the latest log backup. A full database recovery requires access to a set of continuous transaction log backups, from the time of the last clone or database backup, in order to recover from time of the failure.

Microsoft has published many best practices documents on backup and restore, which you may reference to determine which backup scenario works best for you. Every environment is different and you need to alter the frequency of your backups to meet your own specific needs.

For additional data protection, it is recommended that you perform an online incremental transactional log backup, that compliments the cloning schedule, with a frequency greater than once per day. Incremental transaction logs can be backed up to tape or disk using any third party backup software or the built in SQL Server Backup application.

Whatever method you choose to backup incremental transactional logs (disk or tape), you always need to supplement these log-based backups with an initial full database backup, as both the database and transactional logs are required for full database recovery.

Backing up the transaction logs every X minutes only reduces your risk of losing X minutes of data. You should determine a successful recovery point for your business and increase the frequency of backups to match this recovery point.

A transaction log backup provides a reset of the transaction log archive bit. This is important to reset after a certain period of activity, as SQL Server does not perform any transactions if it believes that transaction logs are full. When SQL Server finishes backing up the transaction log, it automatically truncates the inactive portion of the transaction log. SQL Server reports an error and requests that a full backup be performed. If you experience this situation you can either perform a transaction log backup or grow the size of the transaction log space by altering the properties of the database within Enterprise Manager.

5.5 Clone-Based Restore and Recovery

The cases below assume that the server is up and the SQL Server application is running. If a system failure has caused the server to go down and the SQL server services will not start, you will need to rebuild the server or use an alternative SQL Server instance before proceeding.

Rapid Database Restoration

You can perform a database restore with any of the following methods. Choose the best method based on the type of failure that occurred, the condition of the database and logs at the time of failure, and the time available for recovery.

Database recovery options:

- Restore database from clone (no further transaction log backups can be applied)

Choose this option when you want to restore only to the point in time when the clone was created and no further.

- Restore database from clone and apply transactional logs

Choose this option in cases when you want to restore incremental transactional log backups.

Caution: Be sure to choose the appropriate restore method. Applying the incorrect restore procedure may prevent transactional logs from being applied for recovery, resulting in the inability to apply future transaction logs.

The cases below assume that the server is up and the SQL Server application is running. If a system failure has caused the server to go down, you need to rebuild the server or use an alternative SQL server instance before proceeding.

Restore Database from Clone

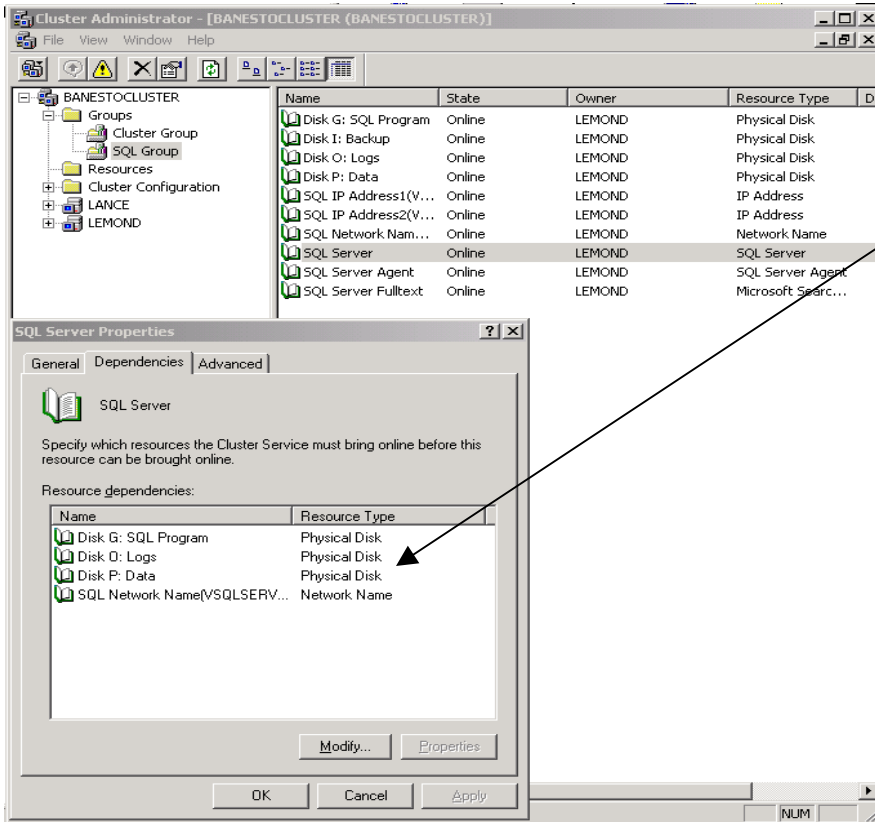
Restore Scenario: Database disks have crashed. Transactional logs are intact or the cloned transactional logs are current. You do not need to apply any incremental transaction logs to the restored database.

Procedure

- a) Backup transactional logs
- b) Detach the failed database from SQL Server (if present) in Enterprise Manager (refer to Screen Shot 4 for performing this from Query Analyzer). This can be scripted or performed through Enterprise Manager.
- c) Stop the SQL Server cluster service.
- d) Swap the bad database disks with the clone volume.
- e) From the *SANworks* Appliance Element Manager, un-present the failed disks. Present/mount the clone volume you would like to restore and have it assume the identity/drive letter of the failed disks you are restoring.
- f) If the transactional logs are good, then retain the original log disks and mount the clone disks, which contain data (.mdf) files only and the original potentially more current LOG disk. If you are restoring additional transaction logs, do not attach the database (Use Scenario 2 instruction below).

In a cluster configuration, the fastest way to restore the cluster is to use the same drive letters as the original disk. Use the original drive letters for the new data volumes. When you use different drive letters, you are adding the new clone disks as cluster resources and possibly removing old drive letters as resources.

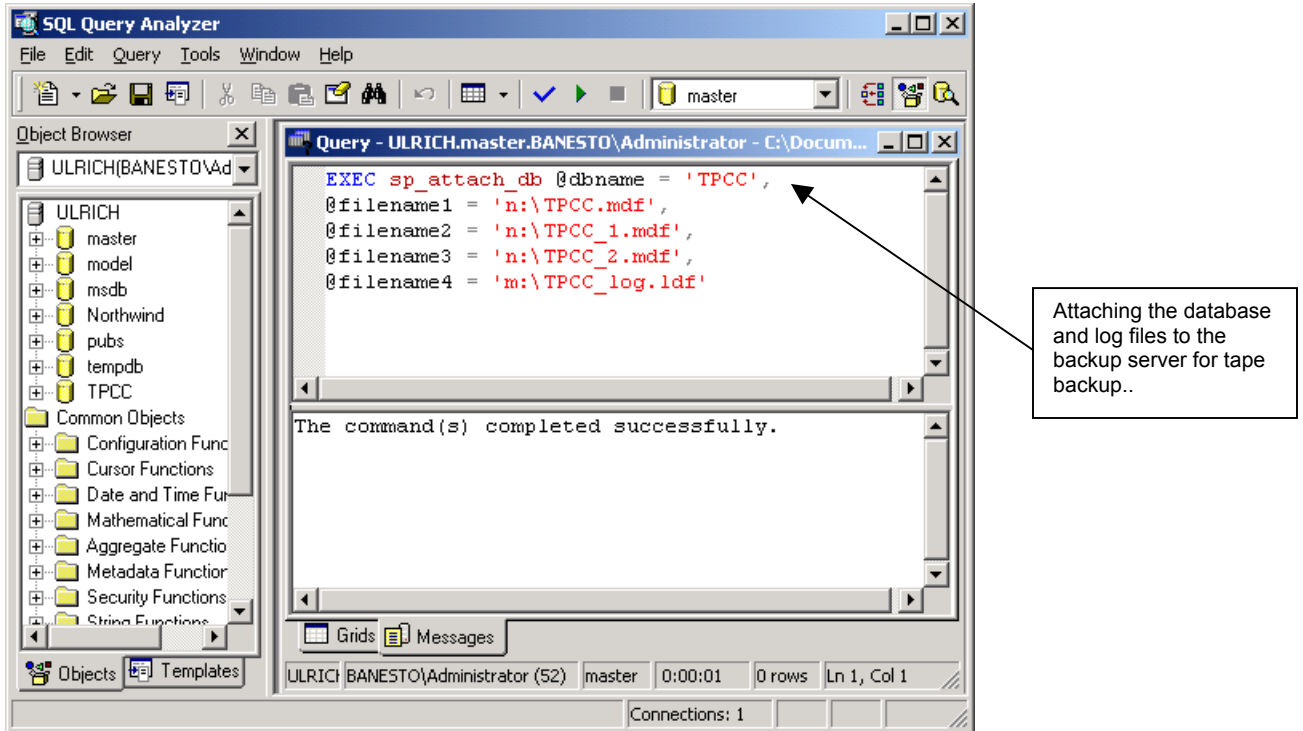
Screen Shot 16 demonstrates where the disk resources need to exist on the cluster. Drives O: and P: are cluster disks that SQL Server uses as a resource, where the logs and database are stored. Disk P: was added as a resource. If the original database disk that is being replaced is present, remove it as a resource. You could also un-present the database disk from the storage array, which would fail the resource until the clone disk assumed the database disk identity.



Viewing log and data files as cluster resources.

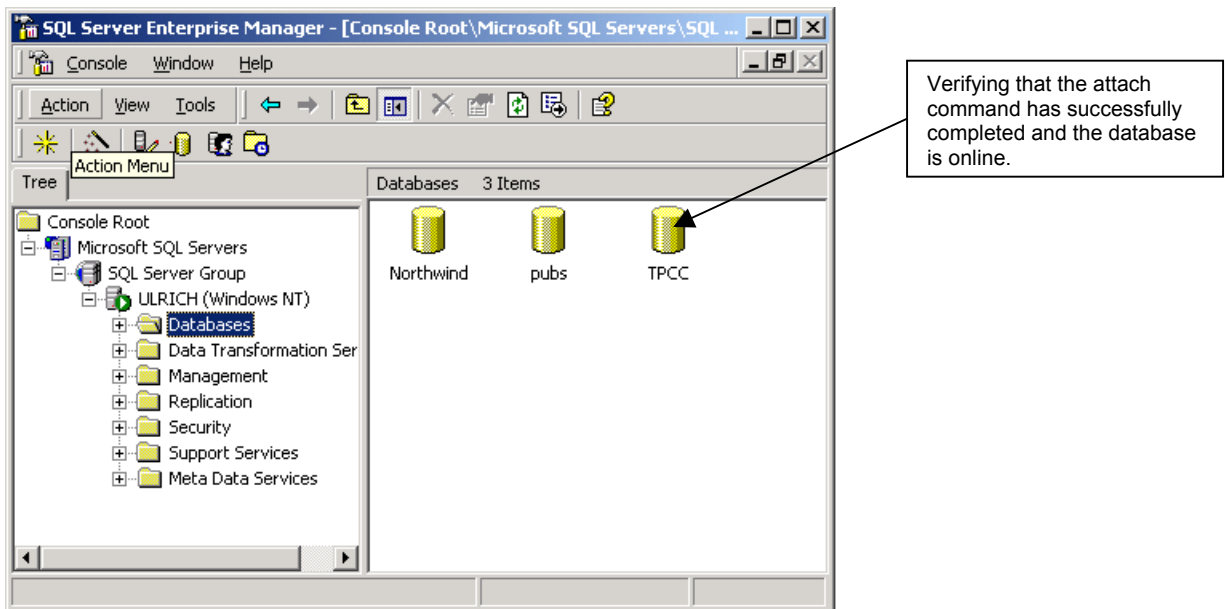
Screen Shot 16 – SQL Server Cluster Server Disk Resources

- g) Start cluster and SQL Server
- h) Attach the clone volume as a SQL Server database disk with existing/original logs. You can attach the clone volume using Query Analyzer as shown in Screen Shot 17.



Screen Shot 17 – Attaching Database with Query Analyzer

- i) Verify that the operation was successful. View the bottom window of Query Analyzer and note the appearance of the database icon in Enterprise Manager. If attaching a cloned data volume with the newer and original log disk, transactional log updates are applied during the attach, but once the database is running, logs can no longer be applied.
- j) Enterprise Manager displays the database online once the database has been attached as seen in Screen Shot 18. If you do not see the database icon appear, refresh the screen (F5).



Screen Shot 18 – Enterprise Manager Database Present

Restore Incremental Transaction Logs

Restore Scenario: Data and log files need to be restored. Multiple transaction log backups need to be restored, which will roll forward the database when it is attached.

Procedure

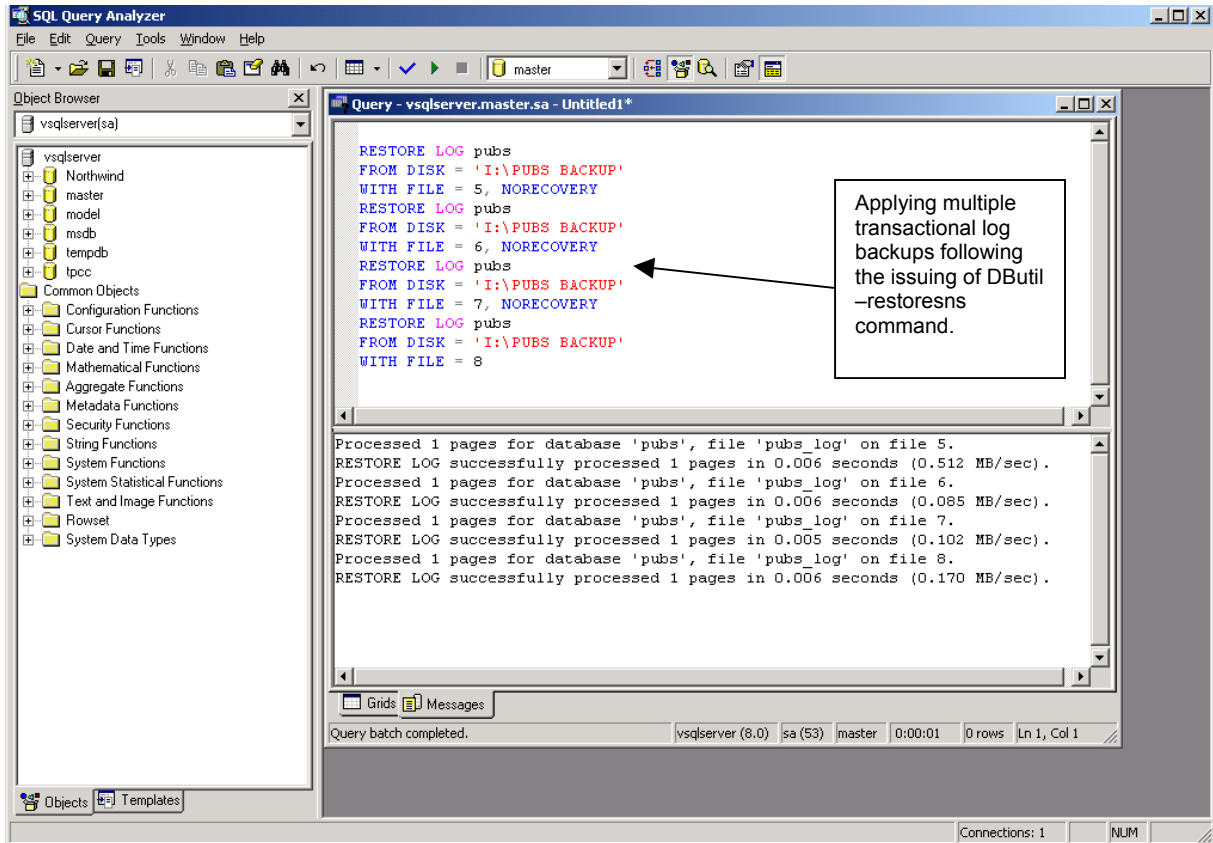
- a) Backup transactional logs.
- b) Detach the bad database disks from SQL server using Enterprise Manager.
- c) Stop the SQL Server cluster service.
- d) Un-mount the bad disks using Element Manager from the *SANworks* Management Appliance.
- e) Mount the clone volume to your SQL server with the original drive letter assignment. Use the original drive letter for clusters so you do not have to edit cluster resources later.

Note: Compaq recommends that you run DButil on the original LUN that is being cloned. This creates the meta file on the original LUN. Then the meta file exists on the clone when it is split off. When you run DButil, information is passed to the SQL server from the meta file. The SQL server uses this information to create a Virtual Device (placing the database in a loading state). You can then mount the clone database disks under the assigned drive letters. After you run the restore command and the clone is mounted to the correct drive letter, you can optionally restore sequential transactional logs from tape in order, starting with the earliest from clone creation. For each transactional log restore, select the No Recovery option for all but the very last transactional log.

- f) Run the DButil `-restoresns` command using the script shown below to put the database into a loading state. In the loading state, the database is ready to accept a restore of the transactional logs. When you previously ran the DButil `-pre` command, a meta file was created. The DButil `-restoresns` command uses this meta file to put the database in a loading state. If you are restoring a SQL Server database to a new SQL server with a different SQL server name, you need to edit the name of the meta file to match the new name of the SQL server.

```
g:\dbutil.exe -restoresns <server_name_or_sql_cluster_name>  
<database> <username> <password>
```

- g) After you have verified the database is in a loading state, apply the sequential transactional logs. This can be done from Enterprise Manager, Query Analyzer, or a third party backup application. Screen Shot 19 is an example of how to apply a series of transactional log backups from Query Analyzer. Note that the No Recovery option is selected for each log file but the last.
- h) Enterprise Manager displays the online database.



Screen Shot 19 - Query Analyzer Log Restore

5.6 Solution Management and Maintenance

Consistency / Database Verify

You should check the consistency of the database while backing it up. Most tape backups let you select a verify job for data integrity before or after tape backup. If you are running clone-based tape backups from the backup server, it is important to perform a verify job on each backup. By running SQL Server 2000 on the backup server, you are able to perform a full SQL Server database consistency check on the database backup.

Restore Verifications

Always perform restore drills to test your recovery strategy from time to time. Practice restoring a SQL Server database to a backup server from backups once initially and then at least once a month.

Recycling Clones

Since clones need to be undone and recycled, it is also a good idea to incorporate running undo jobs into the automation process so that disks remain available for new clone jobs. It is your responsibility to monitor disk usage and maintain enough spare disks. Keep in mind that single disks are unprotected and your backup strategy needs to plan for hardware failure. Keep a good supply of spare disks in your array at all times.

Log Maintenance

SQL Server does not process I/O if the transaction log is full. When setting up your transaction log size, choose sufficient space. You may wish to use the auto-grow option with a limit to allow SQL Server to grow the database as needed. When transaction log backups are performed the transaction logs get marked as backed up and space can be re-used. It is important that transaction log backups happen frequently enough to prevent the logs from filling to capacity and halting transactions. Database backups will not truncate the log files and therefore will not free up additional log space.

Restoring Failed Undo Jobs Caused by Windows 2000 Host Restarts

The ability of *SANworks* Enterprise Volume Manager to undo a job can be disrupted if the host that the clone is mounted on is rebooted before the job is undone. When Windows 2000 starts, the volume space is reorganized so that disk numbers and drive letters, which are not hard assigned by users, become contiguous. This change occurs even to the disk number and drive letter that a dynamically assigned volume uses. Since *SANworks* EVM tracks clones by their disk number and drive letter, restarting Windows 2000 may cause *SANworks* EVM to lose track of how a clone is mounted, which may result in an undo job that does not execute correctly.

Use the following procedures to enable an undo job to be performed:

1. Using the Log Reporting page, open the current job log for the *SANworks* EVM job to be updated. Search the log to find the unit numbers used by *SANworks* EVM to create the clone. The unit number should be displayed after the add unit command in a *SANworks* EVM job script / log. Be sure to identify the unit number for each clone within the job.
2. Using the CLI utility in the *StorageWorks* HSG Element Manager, manually delete each clone unit identified in the previous step. Be sure to also delete any underlying containers such as mirror sets or stripe sets that the units may be based on.
3. From the Windows 2000 mount-on host, open the Computer Management console application and expand the Storage entry to display the Disk Management utility. Initiate a bus rescan by right clicking on the Disk Management folder and selecting Rescan Disks. Within a minute or two, the drive letters that correspond to the clone devices should be removed from the host.
4. From the Windows 2000 mount-on host, go to a DOS prompt. To place the *SANworks* EVM job into the state, change to the following directory:

```
\Program Files\Compaq\SANworks\Enterprise Volume Manager\bin
```

Execute the following command:

```
evmcl <appliance_name> reset <job_name>
```

<appliance_name> is the name of the *SANworks* Management Appliance where the *SANworks* EVM Server instance is running.

<job_name> is the name of the *SANworks* EVM job that is being restored.

5. From the *SANworks* EVM Resources page, right-click anywhere on the left side of the frame to display the Refresh box. Select Refresh Subsystems. When the refresh is complete, which may take several minutes depending on the number of subsystems being refreshed, the *SANworks* EVM job will be fully recovered and ready for execution.

6.0 Related Information

6.1 Web / Documentation Links

[Compaq ActiveAnswers for Microsoft SQL Server for Business Operations – Quick Specs](#)

Compaq ActiveAnswers Microsoft SQL Server for Business Operations is a set of information and methodologies for planning, deploying, and operating a business operations environment based on the Microsoft SQL Server database. Whether it's an order entry, human resources, or accounting solution, this ActiveAnswers area provides proven guidance for the most time-consuming and complex issues that impact a customer's ability to rapidly and effectively implement a business operations environment, including support for Web-based transactions.

SANworks Enterprise Volume Manager by Compaq

<http://www.compaq.com/products/sanworks/evm/index.html>

StorageWorks Disk Arrays by Compaq

<http://www.compaq.com/storage/siteindex.html#raid>

Compaq ENSA2 Vision

<http://www.compaq.com/storage/ensa2vision.html>

Compaq Microsoft SQL Server Solutions

<http://www.compaq.com/solutions/showroom/sqlserver.html>

SANworks Secure Path by Compaq

<http://www.compaq.com/products/sanworks/softwaredrivers/securepath/index.html>

6.2 Related Solutions Offerings

Virtualized Storage Management for SQL Server 2000

Based on *SANworks* Virtual Replicator by Compaq, this solution shows how administrators can use snapshot technology to recover a SQL Server 2000 environment in far less time than with conventional tape restore methods.

Additionally, the solution guide that supports this solution describes how virtual storage pools can be centrally managed and expanded without impacting users or application availability.

<http://www.compaq.com/products/storageworks/solutions/vsm-sql2000/index.html>

6.3 Feedback

Forward comments, questions, and related feedback to

Microsoft_Storage_Solutions@hp.com