Dell™ DX Object Storage Platform

12.2%
faster large object archiving
versus a leading object storage platform

The amount of digital information in today's world is growing rapidly, with one estimate suggesting a 44-fold increase, to 35 trillion gigabytes, by 2020.* How best to store it all? For healthcare organizations storing patient healthcare records, effective storage includes archiving files in a secure and timely manner. This process is not just about convenience: in the face of lawsuits and stringent regulations like HIPAA and HITECH, it's a matter of survival.

Principled Technologies tested two object-based storage solutions with Digital Imaging and Communications in Medicine (DICOM) for object archiving performance. Specifically, we used the Dell DX Object Storage Platform and a leading object storage platform to archive large healthcare DICOM files with an average size of 55 MB, testing how many objects per second each storage platform archived. We used Symantec™ Enterprise Vault™ archiving platform software on each storage solution.

In our tests, the Dell DX Object Storage Platform excelled at archiving higher amounts of data, achieving 12.2 percent better performance than a leading object storage platform.

*IDC Digital Universe Study, May 2010

MEETING THE HEALTHCARE ARCHIVING CHALLENGE

The medical information of the average adult patient often spans numerous files from a variety of sources, and can total a terabyte or more of data. To comply with federal regulations (see sidebar), healthcare organizations must now keep healthcare records for at least six years, and often longer. This means that your company must archive all its healthcare records, making them available for future retrieval. Over time, and for hundreds or thousands of patients, this becomes a substantial amount of data.

Properly archiving records prevents wasting time and employee resources sifting through a huge array of unstructured data across directories in different locations. For example, if doctors wish to compare a patient's recent MRI brain scan to one from five years ago, effective archiving enables them to easily retrieve that particular data from within the patient's files. In addition, if your company is under a strict deadline to retrieve data, such as for a lawsuit, proper archiving avoids delays that can be costly and damaging.

THE CASE FOR OBJECT-BASED STORAGE

The effective archiving of healthcare records requires more than just storage space. It also requires an intelligent, reliable storage method that is capable of archiving many objects per second. Medical files traditionally have been stored as unstructured data. That is, such data exists in myriad forms – emails, images, videos, text documents, spreadsheets, etc. – and lacks any context or metadata that would facilitate rapid search and retrieval. Very little descriptive information is available to provide a larger context. Additionally, traditional file-based storage sees the data in an unstructured file as a series of unrelated data blocks, and is more concerned with location of data within folders and subfolders than with extensive metadata.

The consequence for healthcare organizations? A lack of context about their content, and, even with a content management system, a cumbersome and time-consuming manual retrieval process. They might know that a JPEG image is stored in a certain location, is a certain size, and was created on a certain date. They won't know additional data (type of medical procedure it depicts, physician name and notes, diagnosis, type of medical equipment used, patient history, etc.) that helps them know whether to retrieve the file. This inability to differentiate between files becomes more problematic as the amount of content grows, and makes it difficult for companies to reliably locate

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File vs Object

Compared to unstructured data, structured data using object-based storage provides extensive context for each data object, which assists in the retrieval process.

the information they need in an urgent situation, such as when preparing for a lawsuit.

To combat the limitations of unstructured data and of traditional storage, companies are turning to object-based storage solutions that make use of metadata when archiving, which facilitates rapid retrieval of data.

Object-based storage saves files as structured data. (See the sidebar image for a visual comparison of traditional file storage and object-based storage.) It does so by creating data objects, which combine the file itself and metadata about the file. Simply put, metadata contains information that describes the object. Metadata provides far more contextual information about a file, which allows users to conduct context-based searches. This improves the speed of file retrieval and increases the relevance of files retrieved.

In addition to metadata, object-based storage assigns a unique ID to each data object. This enables object-based storage platforms to locate the data object without a traditional hierarchical file directory. Users can still retrieve the file, even if it changes locations. Because hospitals often store different kinds of data in different storage "silos," sometimes moving data between locations, this is especially helpful. Because archiving moves copies of data to other storage, the need for manual backups is greatly reduced.

To fully comply with regulations like HIPAA and HITECH, healthcare organizations must be able to prove that confidential data hasn't been altered. Object-based storage offers such proof. It assigns a unique hash signature that reflects the specific information in that file, and that hash will change (or no longer be allowed) if any of the information in the file is changed. In this way, data owners can be confident that an archived file always matches the original.
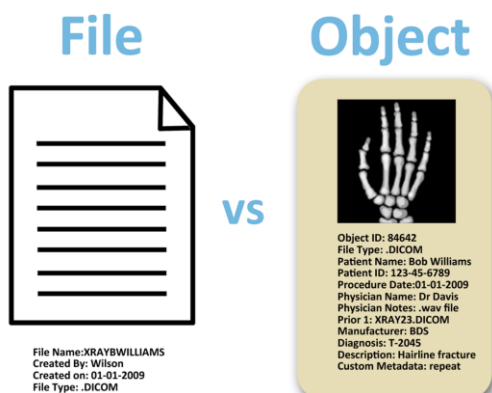
OUR TEST COMPONENTS

Dell DX Object Storage Platform

The Dell DX Object Storage Platform is an integrated software and hardware-based Content Addressed Storage (CAS) solution that handles the storage, management, and preservation of unstructured files. Because it uses an object-based approach, making use of metadata, it helps administrators archive and locate large amounts of data.

The Dell DX object based storage platform can also be used with the Dell Unified Clinical Archive (UCA), a portfolio of solutions for managing data and archiving and sharing medical images. UCA includes the Dell Cloud Clinical Archive, which provides vendor-neutral archiving for medical images. The DX

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platform serves as the on-premise storage platform for this secure hybrid cloud solution.

For a full list of features, visit http://www.dell.com/us/enterprise/p/powervault-dx6000/pd?refid=dell-dx.

Leading object storage platform

We chose a leading object storage platform to compare against the performance of Dell DX storage platform. This is a disk-based platform that addresses the need for fixed content data storage that provides features similar to DX such as fault tolerance and scalability. We set up the platform, which is certified by many application vendors, with the same capacity 7.2K RPM SATA II disk drives as the Dell DX platform.

Symantec Enterprise Vault

Symantec Enterprise Vault version 9.0.2.1061 is an email and file-archiving program designed specifically for storing, managing, and retrieving data. Symantec Enterprise Vault can store data on several different platforms, including Dell DX Object Storage and the chosen leading platform; it can also archive data from programs such as Microsoft Exchange and SharePoint®.

To learn more about Symantec Enterprise Vault, visit http://www.symantec.com/business/enterprise-vault.

ACCELERATED HEALTHCARE FILE ARCHIVING RESULTS

We used Symantec Enterprise Vault on five Dell PowerEdge™ 2950 servers to archive DICOM data from 15 Dell PowerEdge M600 blade servers onto a Dell DX Object Storage Platform, and performed this same task on a leading object storage platform.

Due to the information in DICOM files, each can vary in size. For our testing, we used an average file size of 55 MB.

In our tests, the Dell DX Object Storage Platform archived DICOM objects consistently better than the competing solution, for a 12.2 percent increase in throughput (see Figure 1), which we calculated in objects per second. We simulated a healthcare archive task by copying random groups of DICOM files to each of the Dell PowerEdge M600 servers to ensure that some servers would have more files to archive than other servers. We began testing on the five healthcare servers simultaneously, and recorded the total objects archived. We also captured the duration of the archiving, which is how long it took to perform this task. The average duration was captured as the average of the individual server's duration. We calculated objects/second as the total objects divided by

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THE DICOM STANDARD

By the mid-1980s, the need for a medical imaging standard had become clear. In response, the American College of Radiology and the National Electrical Manufacturers Association developed the Digital Imaging and Communications in Medicine.

DICOM is increasingly the standard medical professionals use when sharing, storing, and printing medical imagery. Specifically, DICOM sets a file format and network communication protocol standard so that healthcare organizations can share medical images without encountering incompatibility issues.

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duration. We calculated percentage win based on the aggregate objects/second results. Refer to Appendix A for the individual tests run on each server.

Figure 1 presents the archiving performance, in objects per second, for the two solutions, normalized to the leading object storage platform for percentage improvement comparison.
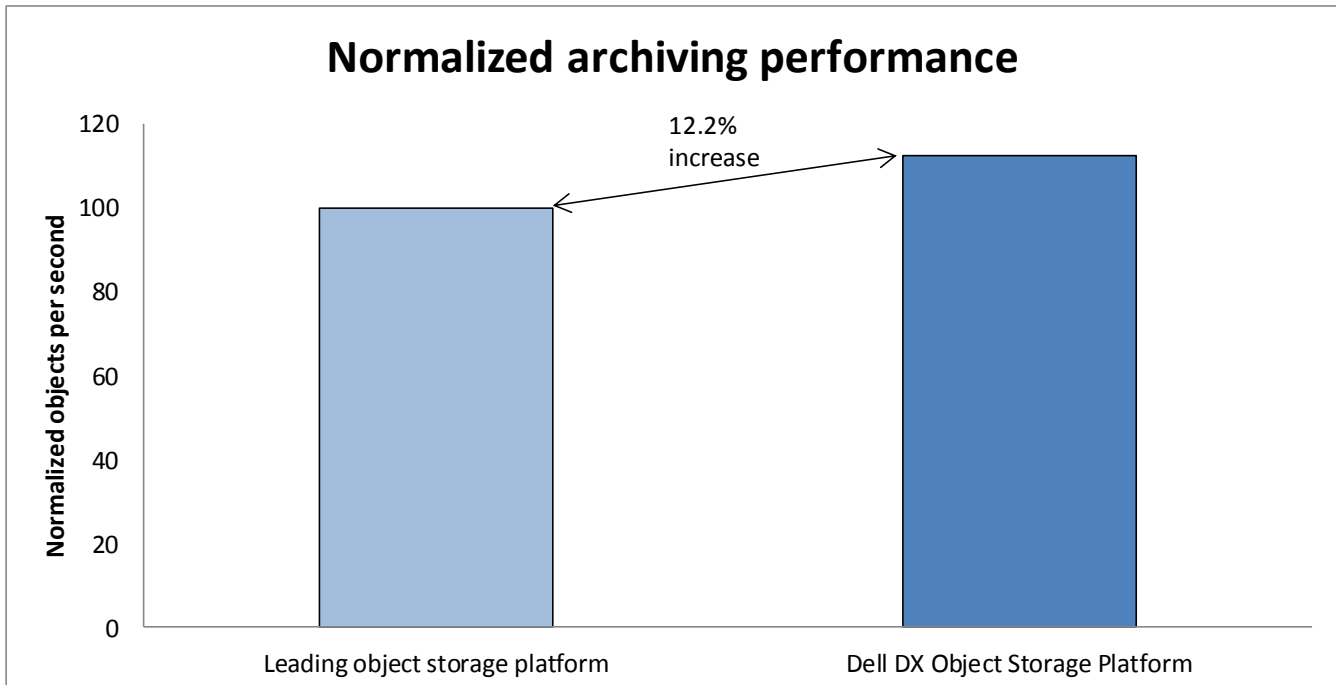

Normalized archiving performance

12.2% increase

Figure 1: Normalized performance of DICOM archiving (large files) on the Dell DX platform and a leading object storage platform.

We explain our detailed test results in Appendix A, our test methodology in Appendix B, our server and storage configuration information in Appendix C, and our healthcare files corpus in Appendix D.

FINAL THOUGHTS

Object-based storage enables companies to effectively and confidently manage their ever-expanding healthcare records by utilizing metadata and unique data identifiers for each healthcare object. While Dell DX Object Storage and the leading object storage platform we tested both provide these capabilities, DX Object Storage can save substantially more objects per second (over 12 percent, in our tests) than a leading object storage platform.

You can easily integrate the Dell DX object storage platform with other Dell Healthcare solutions such as the Unified Clinical Archive to provide a highly scalable and reliable platform for archiving medical imaging content. For more information on Dell UCA, visit www.dell.com/UnifiedClinicalArchive.

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APPENDIX A – DETAILED TEST RESULTS

Figures 2 presents our normalized test results for the entire duration of the Symantec Enterprise Vault tasks for each of the individual servers used to stream objects to the archival platform. We normalized all results to the lowest performing server for the leading object storage platform.
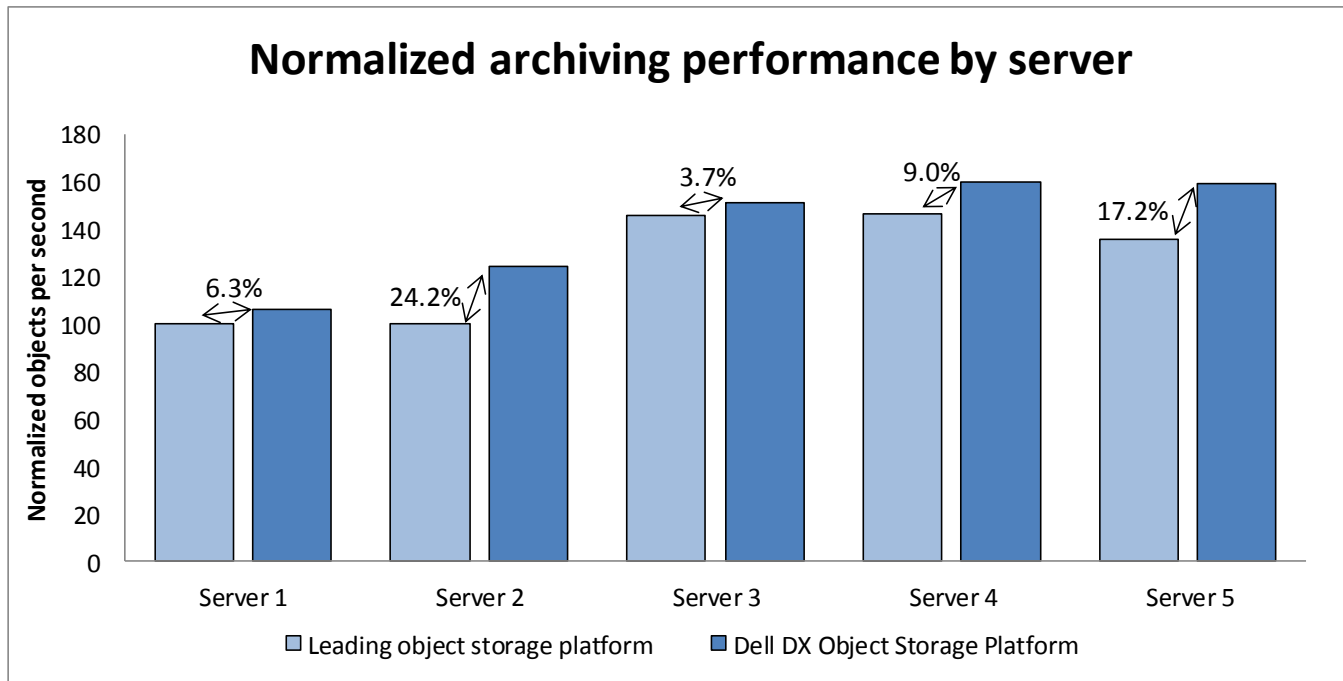

Figure 2: Normalized DICOM (large files) archiving performance on the Dell DX Object Storage Platform and a leading object storage platform, by server.

Each test bed used five Dell PowerEdge 2950 servers with healthcare data. We simulated a healthcare archive job by copying groups of the DICOM files to each of the servers. Figures 3 and 4 provide information around the test bed input data in terms of the number of objects per ingest server, average size of the object and overall amount of data output from each of the servers. Because the two test beds were independent, the total objects differ somewhat between the two test beds. Because we compare objects/second, which is a throughput metric, the results are comparable despite the total objects differing between the two test beds.

Dell DX Object Storage Platform			
	Objects	**MB**	**Average file size (MB)**
Server 1	2,010	110,391.4	54.9
Server 2	2,010	111,653.7	55.5
Server 3	2,010	109,705.7	54.6
Server 4	2,010	108,550.8	54.0
Server 5	2,010	108,960.7	54.2

Figure 3: Data sets used to test the healthcare archiving performance of the Dell DX Object Storage Platform.

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Leading object storage platform			
	Objects	**MB**	**Average file size (MB)**
Server 1	2,010	110,391.4	54.9
Server 2	2,010	111,653.7	55.5
Server 3	2,010	109,705.7	54.6
Server 4	2,010	108,550.8	54.0
Server 5	2,010	108,960.7	54.2

Figure 4: Data sets used to test the healthcare archiving performance of a leading object storage platform.

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APPENDIX B – DETAILED TEST METHODOLOGY

Here, we explain the detailed steps we followed to set up our test scenario.

In order to show the differences between the Dell DX6000 Object Storage Platform and a leading object storage platform, we configured a large test bed with real-world servers and archiving solutions. We installed 15 Microsoft® Windows Server® 2008 R2 file servers and configured two shared directories: one we named CN and one we named DX. We copied our DICOM files equally across the shares and then installed five Symantec Enterprise Vault servers. We configured a task in Symantec Enterprise Vault to archive the 15 CN file shares to a leading object storage platform, and then configured another task to archive the other 15 DX file shares to the Dell DX Object Storage Platform. We ran the tasks on the leading object storage platform, verified the archive, then ran the Dell DX tests, verified the results, and compared the results from the Symantec Enterprise Vault task logs.

Figure 5 shows our test environment for the Dell DX6000. Each of the eight Dell DX nodes was configured with four 1TB 7.2K RPM SATA II drives. We configured the Dell DX6000 with system defaults. We configured all 15 Dell PowerEdge M600 blade servers with the Microsoft Windows Server 2008 R2 SP1 operating system (OS). We used the Dell EqualLogic PS5000XV storage array to house the data. To archive data on the file servers, we used five Dell PowerEdge 2950 servers running the Microsoft Windows Server 2008 R2 SP1 OS, each with a copy of Symantec Enterprise Vault 9.0.2 installed.

We configured a stacked pair of Dell PowerConnect™ 6248 switches to act as the core network for the data and CAS networks, and a dedicated Dell PowerConnect 5448 switch for ISCSI traffic.

We connected all 15 Dell PowerEdge M600 file servers with a dedicated 1Gbps link to the Dell PowerConnect 5448 switch, and another to the Dell PowerConnect 6248 stack. Each of the five Dell PowerEdge 2950 servers has four single Gbps links to the Dell PowerConnect 6248 stack: two for the data network and two to the object storage network.

We installed a Dell PowerEdge R900 with Microsoft Windows Server 2008 R2 SP1 to Host Active Directory, and connected it to the Dell PowerConnect 6248 stack with a single Gbps link.

To host the Symantec Enterprise Vault SQL database, we installed a Dell PowerEdge R515 with the Microsoft Windows Server 2008 R2 SP1 OS, and connected it to the Dell PowerConnect 6248 stack with a single Gbps link. We then installed Microsoft SQL Server® 2008 SP1. We connected the Dell DX Object Storage eight-node storage cluster to the Dell PowerConnect 6248 stack.

Figure 6 shows the corresponding leading object storage platform. Eight nodes were used for an even comparison and these nodes were connected to the same test configuration. Each of the eight nodes was installed with four 1TB 7.2K RPM SATA II drives just as with the Dell DX nodes. Best practice recommendations for obtaining the maximum performance were followed when setting up and configuring competitor's platform including the use of distinct networking and switch requirements as per vendor documentation.
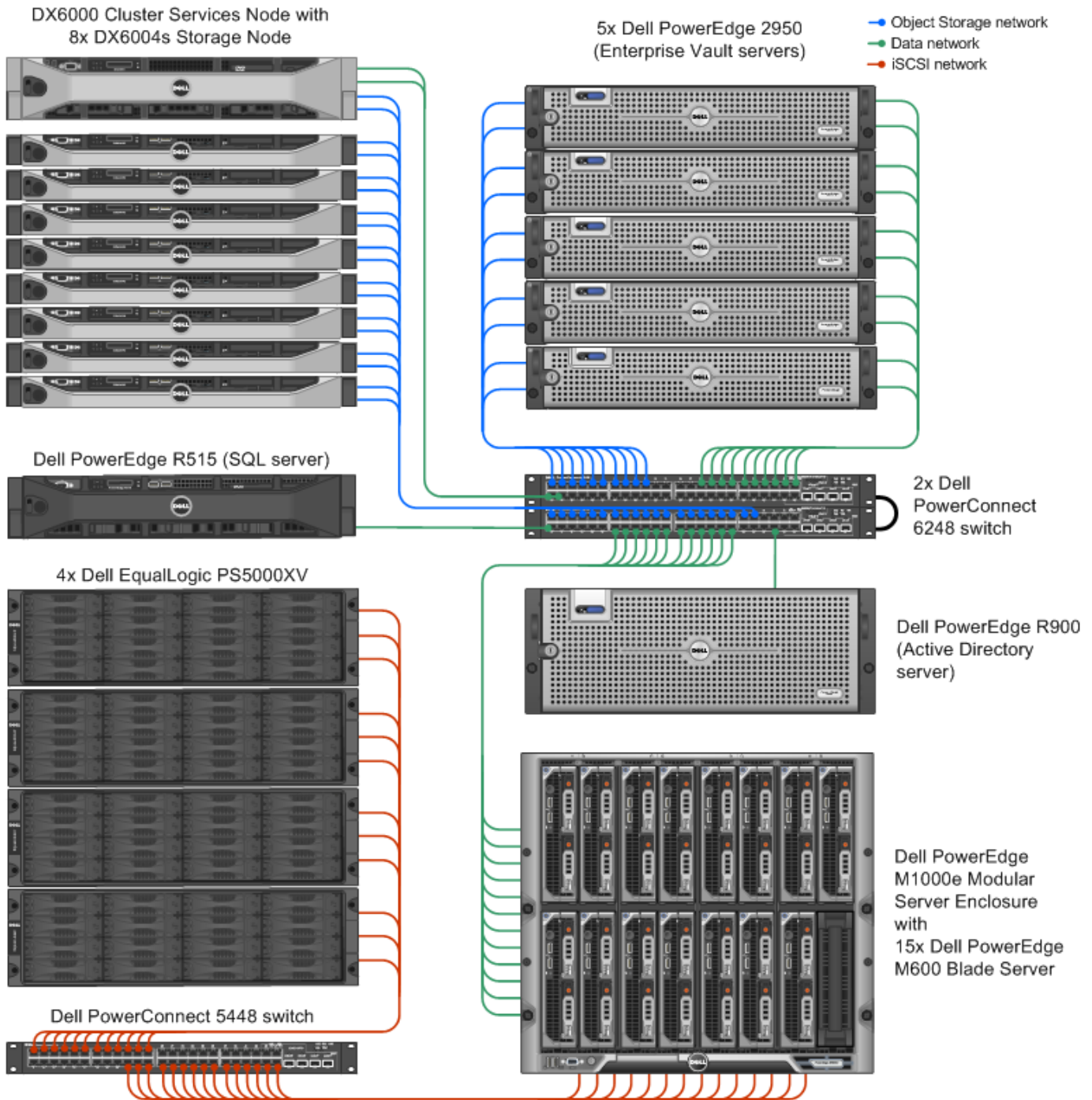
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Figure 5: Test bed configuration for Dell DX Object Storage Platform.
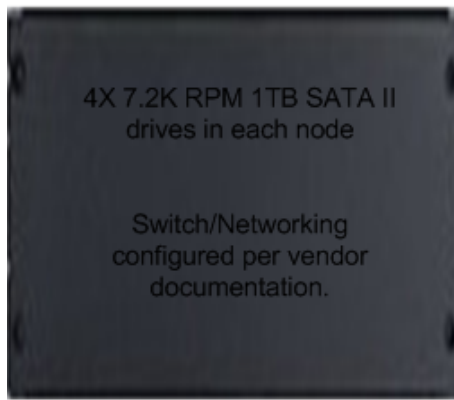
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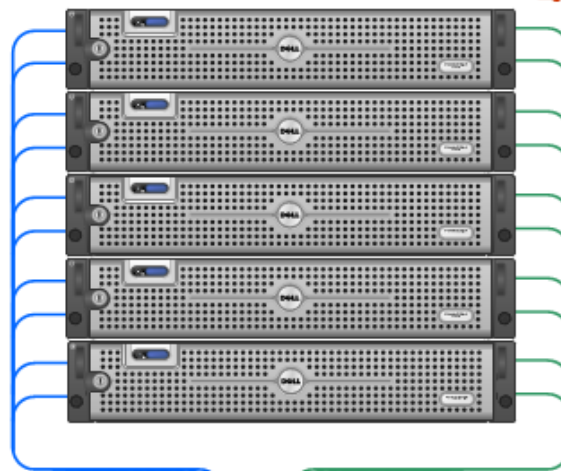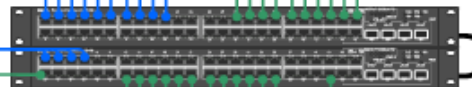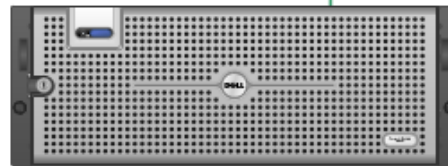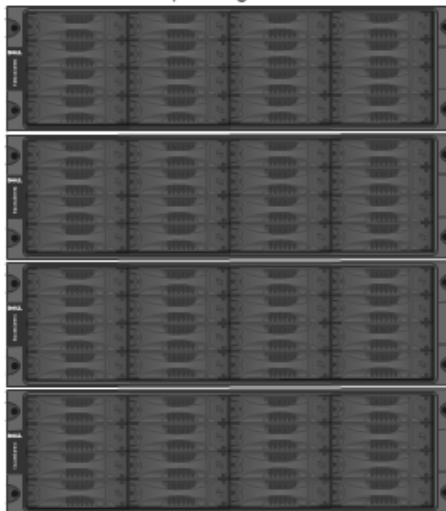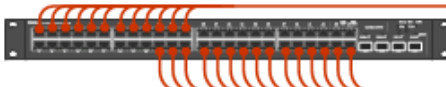
Figure 6: Test bed configuration for the leading object storage platform we tested.

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Setting up the storage

Dell PowerEdge M600 blades, Dell PowerEdge R515, Dell PowerEdge R900, and Dell EqualLogic PS5000XV storage

We installed all five Dell PowerEdge 2950 servers to use internal storage. We configured the PERC 6i RAID controller for a RAID 1 configuration on a pair of 73GB SATA Disks for the Windows Server 2008 R2 SP1. Both drives hosted the OS.

We installed the Dell PowerEdge R900 server to use internal storage. We configured the PERC 6i RAID controller for a RAID 5 configuration with eight 73GB SAS Disks to host the Active Directory on the Windows Server 2008 R2 SP1 OS.

We installed the Dell PowerEdge R515 server to use internal storage. We configured the PERC H700 RAID controller for a RAID1 configuration on two 73GB SAS disks to host the Windows Server 2008 R2 SP1 OS, and another four 73GB SAS disks in a RAID 10 array for Microsoft SQL Server data.

We configured 15 Dell PowerEdge M600 blades to use both internal and external storage. For each Dell PowerEdge M600 blade, we configured a virtual disk on a RAID 1 array using the two internal 15K 36GB SAS drives connected to the RAID controller. We used this Virtual Disk to host the Windows Server 2008 R2 SP1 OS on each server. For data that was to be archived, we configured a dedicated 1Gb iSCSI link on each Dell PowerEdge M600 Server.

We connected all 15 iSCSI links to a Dell PowerConnect 5448 switch connected to four Dell EqualLogic PS5000XV storage arrays. Figures 5 and 6 show the layout of the test bed hardware that we used for testing both the DX Object Storage and the leading object storage platform. We followed all recommended best practices associated with the leading object storage platform. We enabled jumbo frames on all iSCSI-dedicated NICs. To do this in Windows, we adjusted the MTU to 9,000 via the NIC properties window. We enabled jumbo frames on the Dell PowerConnect 5448 switch, and on each NIC on the Dell EqualLogic PS5000XV storage.

Each Dell EqualLogic PS5000XV contained 16 drives. We configured two storage groups with two Dell EqualLogic PS5000XVs as members. We configured both groups to have single storage pools in RAID 50 mode. On the storage pool on storage group 1, we created eight 250 GB LUNS for blades 1 through 8, and on the storage pool in storage group 2, we created seven 250 GB LUNS for blades 8 through 15.

Setting up the internal storage on the Dell PowerEdge R900 for host operating system installation

1. Enter the RAID controller BIOS by pressing Ctrl+R at the relevant prompt during boot.
2. Highlight Controller 0, and press F2.
3. Select Create New VD.
4. Select all eight drives, select RAID level 5, tab to the OK button, and press Enter. Accept the warning regarding initialization.
5. Select the new virtual drive, press F2, and select Initialization, Start Init.
6. Wait for the initialization operation to complete.
7. Repeat steps 2 through 6 for the remaining internal volume, selecting drives three and four.
8. Press Escape, and choose to Save and Exit to return to the boot sequence

Setting up the internal storage on the Dell PowerEdge 2950 for host operating system installation

1. Enter the RAID controller BIOS by pressing Ctrl+R at the relevant prompt during boot.
2. Highlight Controller 0, and press F2.
3. Select Create New VD.

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4. Select both drives, select RAID level 1, tab to the OK button, and press Enter. Accept the warning regarding initialization.
5. Select the new virtual drive, press F2, and select Initialization, Start Init.
6. Wait for the initialization operation to complete.
7. Press Escape, and choose to Save and Exit to return to the boot sequence.

Setting up the internal storage on the R515 for host operating system installation and SQL data

1. Enter the RAID controller BIOS by pressing Ctrl+R at the relevant prompt during boot.
2. Highlight Controller 0, and press F2.
3. Select Create New VD.
4. Select the first two drives, select RAID level 1, tab to the OK button, and press Enter. Accept the warning regarding initialization.
5. Select the new virtual drive, press F2, and select Initialization, Start Init.
6. Wait for the initialization operation to complete.
7. Press Escape.
8. Highlight Controller 0, and press F2.
9. Select drives three through six, select RAID level 10, tab to the OK button, and press Enter. Accept the warning regarding initialization.
10. Wait for the initialization operation to complete.
11. Press Escape, and choose to Save and Exit to return to the boot sequence.

Setting up the internal storage on the M600 for host operating system installation

1. Enter the RAID controller BIOS by pressing Ctrl+R at the relevant prompt during boot.
2. Highlight Controller 0, and press F2.
3. Select Create New VD.
4. Select the first two drives, select RAID level 1, tab to the OK button, and press Enter. Accept the warning regarding initialization.
5. Select the new virtual drive, press F2, and select Initialization, Start Init.
6. Wait for the initialization operation to complete.
7. Repeat steps 2 through 6 for the remaining internal volume, selecting drives three and four.
8. Press Escape, and choose to Save and Exit to return to the boot sequence.

Setting up the external storage

1. Using the command-line console, via serial cable, reset the first Dell EqualLogic PS5000XV by using the reset command.
2. Supply a group name, group IP address, and IP address for eth0 on the first of three arrays.
3. Reset the second array in the same manner, supply the group name to join and IP address created in Step 2.
4. Repeat Steps 1 through 3 for Array three and four to create two storage groups.
5. After group creation, using a computer connected to the same subnet as the storage, use the Dell EqualLogic Web interface to do the following:
   a. Assign IP addresses on the remaining NICs (eth1 and eth2) on each array. Enable the NICs.
   b. Verify matching firmware levels on each array and MTU size of 9,000 on each NIC on each array.
   c. Create a storage pool, by right-clicking Storage pools, and choosing Create storage pool.
   d. Click each member, and choose Yes when prompted to configure the member.
   e. Choose RAID 50 for the RAID Policy for both members.
   f. Create a 250GB volume to host the data volumes for bladeserver1.
   g. For the volumes created in the previous step, limit access to ISCSI initiator name, and enter `iqn.1991-05.com.microsoft:bladeserver1.test.local` for the initiator name.

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h. Repeat steps e through g seven times for bladeserver2 through 8 for a total of eight LUNS. Be sure to adjust the iSCSI name in Step g to coincide with the server name.

6. Repeat Step 5, e though g, and create seven more 250GB LUNS for bladeserver 9 through 15.

Setting up the Active Directory server (DC1)

Installing Windows Server 2008 R2 SP1

1. Insert the installation DVD for Windows Server 2008 R2 into the DVD drive.
2. Choose the language, time and currency, and keyboard input. Click Next.
3. Click Install Now.
4. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Accept the license terms, and click Next.
6. Click Custom.
7. Click the Disk, and click Drive options (advanced).
8. Click New→Apply→Format, and click Next.
9. After the installation completes, click OK to set the Administrator password.
10. Enter the administrator password twice, and click OK.
11. Connect the machine to the Internet and install all available Windows updates. Restart as necessary.
12. Enable remote desktop access.
13. Change the hostname and reboot when prompted.
14. Set up networking for the data network:
    a. Click Start, Control Panel, right-click Network Connections, and choose Open.
    b. Right-click the VM traffic NIC, and choose Properties.
    c. Uncheck TCP/IP (v6).
    d. Select TCP/IP (v4), and choose Properties.
    e. Set the IP address, subnet, gateway, and DNS server.

Installing Active Directory and DNS services on DC1

1. Click Start→Run, type `dcpromo` and click OK.
2. At the Active Directory Domain Services Installation Wizard welcome screen, check the Use advanced mode installation option, and click Next.
3. In the Choose a Deployment Configuration dialog box, select Create a new domain in a new forest, and click Next.
4. At the FQDN page, type `test.com` and click Next.
5. At the NetBIOS name prompt, leave the name `test` and click Next.
6. At the Forest Functionality level, select Windows Server 2008 R2, and click Next.
7. At the additional Domain Controller Options, leave DNS server selected, and click Next.
8. At the System Folder Location screen, leave the default options, and click Next.
9. Assign a Directory Services Restore Mode Administrator account password, and click Next.
10. At the Summary screen, review your selections, and click Next.
11. Once Active Directory Domain Services finishes installing, click Finish, and restart the system.

Setting up the Symantec Enterprise Vault SQL Server (SQL-1)

Installing Windows Server 2008 R2 SP1

1. Insert the installation DVD for Windows Server 2008 R2 into the DVD drive.
2. Choose the language, time and currency, and keyboard input. Click Next.
3. Click Install Now.
4. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.

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5. Accept the license terms, and click Next.
6. Click Custom.
7. Click the Disk, and click Drive options (advanced).
8. Click New→Apply→Format, and click Next.
9. After the installation completes, click OK to set the Administrator password.
10. Enter the administrator password twice, and click OK.
11. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
12. Enable remote desktop access.
13. Change the hostname and reboot when prompted.
14. Set up networking for the data network:
    a. Click Start, Control Panel, right-click Network Connections, and choose Open.
    b. Right-click the VM traffic NIC, and choose properties.
    c. Uncheck TCP/IP (v6).
    d. Select TCP/IP (v4), and choose Properties.
    e. Set the IP address, subnet, gateway, and DNS server.
15. Open Disk manger: start, run and type `diskmgmt.msc`
16. Right-click Disk 1, and click Format.
17. Assign as `E` drive, label as `SQL-data` and close the disk manager.
18. Join the test.com domain, and reboot.
19. Log in as `test\administrator`

Installing SQL Server 2008 x64 edition on SQL-1

1. Insert the DVD into the physical DVD drive.
2. Click Run SETUP.EXE on the AutoPlay menu.
3. When the application prompts you to install the .NET Framework, click OK.
4. Select the Accept radio button, and click Install.
5. When the installation finishes, click Exit.
6. If any warnings appear about compatibility, accept them, as installing SP1 in the next section should solve them.
7. If the application prompts you, click OK to install a hotfix for Windows (KB942288).
8. Click Restart now to restart the server upon completion.
9. After rebooting, log into the server.
10. Click Start, and click Computer.
11. Double-click the CD/DVD drive.
12. Click Installation.
13. Click New SQL Server stand-alone installation.
14. On the Setup support rules screen, click OK.
15. Specify the Enterprise Evaluation free edition, and click Next.
16. Click the checkbox to accept the license terms, and click Next.
17. Click Install to install the setup support files.
18. You may see a Windows Firewall warning. For now, ignore this, and click Next.
19. On the Feature Selection screen, select Database Engine Services, Full-Text Search, Analysis Services, Reporting Services, Client Tools Connectivity, Client Tools Backward Compatibility, Management Tools –Basic, and Management Tools – Complete. Click Next.
20. On the Instance configuration screen, leave the default selection of default instance, and click Next.
21. On the Disk space requirements screen, change this install directory to `e:\SQLdata` and click Next.
22. On the Server configuration screen, choose NT AUTHORITY\SYSTEM for SQL Server Agent, and choose NT AUTHORITY\SYSTEM for SQL Server Database Engine. Click Next.
23. On the Database Engine Configuration screen, select Mixed Mode.

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24. Enter a password for the system administrator (sa) account.
25. Click Add Current user. Note: This may take several seconds.
26. Click Next.
27. On the Error and usage-reporting screen, click Next.
28. On the Installation rules screen, click Next.
29. On the Ready to Install screen, click Next.
30. After installation completes, click Start, All Programs, Microsoft SQL Server 2008, Configuration Tools, SQL Server Configuration Manager.
31. Expand the Network Configuration node, and select the relevant instance.
32. In the right pane, right-click TCP/IP, and choose Enable.
33. In the right pane, right-click Named Pipes, and choose Enable.
34. In the left pane, click SQL Server Services.
35. In the right pane, right-click the SQL Server service, and select Restart.
36. Click Start, Run and type `Services.msc` and press Enter.
37. Change SQL server Analysis Services, and click Properties.
38. Click the login tab and change to domain\administrator, type the Password for the account, confirm the password, and click OK.
39. Restart the SQL server Analysis Services service.
40. Repeat Steps 37 through 39 for the SQL Reporting Service.

Installing SQL Server 2008 SP1

Service Pack 1 is available for download from
http://www.microsoft.com/downloads/details.aspx?FamilyID=66ab3dbb-bf3e-4f46-9559-ccc6a4f9dc19&displaylang=en.

1. Run SQLServer2008SP1-KB968369-x64-ENU.exe.
2. On the Welcome screen, click Next.
3. On the License terms screen, accept the license terms, and click Next.
4. On the Features screen, select available features, and click Next.
5. On the Check files in use screen, click Next.
6. On the Update screen, click Next.
7. When the update completes, click Next, and click Close.

Setting up the file servers (file-1)

This section outlines how to install and prepare a Dell PowerEdge M600 blade server to be a Microsoft Windows file server named file-1.

Installing Windows Server 2008 R2 SP1

1. Connect an external DVD drive to the Blade 1 in the Chassis, and power on the Dell PowerEdge M600.
2. Insert the installation DVD for Windows Server 2008 R2 into the DVD drive.
3. Choose the language, time and currency, and keyboard input. Click Next.
4. Click Install Now.
5. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
6. Accept the license terms, and click Next.
7. Click Custom.
8. Click the Disk, and click Drive options (advanced).
9. Click New→Apply→Format, and click Next.
10. After the installation completes, click OK to set the Administrator password.
11. Enter the administrator password twice, and click OK.
12. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.

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13. Enable remote desktop access.
14. Change the hostname and reboot when prompted.
15. Set up networking for the data network:
    a. Click Start, Control Panel, right-click Network Connections, and choose Open.
    b. Right-click the VM traffic NIC, and choose Properties.
    c. Select TCP/IP (v4), and choose Properties.
    d. Set the IP address, subnet, gateway, and DNS server.
16. Repeat Step 15 for the ISCSI network.
17. For iSCSI NICs, open the connection properties. Click Configure for The ISCSI NIC, and modify the advanced properties of each NIC, setting the MTU to 9000.
18. Join the test.com domain, and reboot.
19. Log in as `test\administrator`

Installing Dell EqualLogic Host Integration Tools for MPIO

1. Log into Windows, and start the Dell EqualLogic Host Integration Tools installer.
2. At the Welcome screen, click Next.
3. At the License Agreement screen, click Next.
4. At the Installation Type screen, select Typical (Requires reboot on Windows Server platforms), and click Next.
5. In the Microsoft iSCSI Initiator service is not running window, click Yes to start the service and enable iSCSI traffic through the firewall.
6. In the Microsoft iSCSI service window, click Yes.
7. When the iSCSI Initiator Properties window pops up, accept the defaults, and click OK.
8. If a Windows Firewall Detected window appears, click Yes to enable echo requests.
9. At the Ready to install the components screen, click Install.
10. In the Microsoft Multipath I/O feature is not detected window, click Yes to install the feature.
11. At the Installation Complete screen, click Finish.
12. In the System Restart Required window, select Yes, I want to restart my computer now, and click OK.
13. After reboot, open the Dell EqualLogic Host Integration Toolkit remote setup wizard, and click configure MPIO. Under Subnets included for MPIO, ensure only the iSCSI subnet is included in the "include" section.

Connecting to the volumes with Microsoft iSCSI Initiator

1. Using the Dell EqualLogic Web UI, ensure the data volumes are online.
2. Click Start→Administrative Tools→iSCSI Initiator.
3. Select the Discovery Tab, and click Discover Portal.
4. Enter the IP address for the Dell EqualLogic Storage Group, and click OK.
5. Select the Targets tab, and click Refresh.
6. Select the first Inactive Target listed, and click Connect.
7. Ensure that Add this connection to the list of Favorite Targets is selected, check the Enable multi-path check box, and click OK.

Configuring the external volumes in Windows Server 2008 R2 SP1

1. Click the Server Manager icon in the taskbar.
2. In the left pane, expand Storage, and click Disk Management.
3. Right-click the first external volume, and choose Initialize Disk.
4. In the right pane, right-click the volume, and choose New Simple Volume...
5. At the welcome window, click Next.
6. At the Specify Volume Size window, leave the default selection, and click Next.
7. At the Assign Drive Letter or Path window, choose a drive letter, use drive letter E, and click Next.
8. At the Format Partition window, choose NTFS and 64K allocation unit size, and click Next.

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9. At the Completing the New Simple Volume Wizard window, click Finish.
10. Open the E drive in windows explorer a create a new folder called `DX-dicom`
11. Share the DX-dicom folder by right clicking it and selecting properties.
12. Click the sharing tab, and click Share.
13. Type the name `everyone` and click Add.
14. Select the everyone permissions, and change them to read/write.
15. Open the E drive in Windows Explorer, and create a new folder called `ALeadingObjectStoragePlatform-dicom`
16. Share the ALeadingObjectStoragePlatform-dicom folder by right-clicking it and selecting Properties.
17. Click the sharing tab, and click Share.
18. Type the name `everyone` and click Add.
19. Select the Everyone permissions and change them to read/write.
20. Important: Repeat the section Setting up the file servers for each of the remaining 14 Dell PowerEdge M600 blade servers. When completed, there will be two shares for each of the 15 servers.

Setting up the Enterprise Vault servers (EV-1)

This section outlines how to install and prepare a Dell PowerEdge 2950 to be a Symantec Enterprise Vault Server.

Installing Windows Server 2008 R2 SP1

1. Insert the installation DVD for Windows Server 2008 R2 into the DVD drive.
2. Choose the language, time and currency, and keyboard input. Click Next.
3. Click Install Now.
4. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Accept the license terms, and click Next.
6. Click Custom.
7. Click the Disk, and click Drive options (advanced).
8. Click New→Apply→Format, and click Next.
9. After the installation completes, click OK to set the Administrator password.
10. Enter the administrator password twice, and click OK.
11. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
12. Enable remote desktop access.
13. Change the hostname and reboot when prompted.
14. Install Broadcom Advanced Control suite.
15. Create a network team called data-net.
16. Set up networking for the data network:
    a. Click Start, Control Panel, right-click Network Connections, and choose Open.
    b. Right-click the VM traffic NIC, and choose properties.
    c. Select TCP/IP (v4), and choose Properties.
    d. Set the IP address, subnet, gateway, and DNS server.
17. Right click Intel® PRO/1000 PT Port Server adaptor#1, and select Configure.
18. Click the teaming tab, click Team this adapter with other adaptors, and select New team.
19. Name the TEAM CAS-net add Intel PRO/1000 PT Port Server adaptor#2.
20. Select IEEE 802.3ad Dynamic Link Aggregation.
21. Click Finish.
22. Set up networking for the CAS network:
    a. Click Start, Control Panel, right-click Network Connections, and choose Open.
    b. Right-click the VM traffic NIC, and choose Properties.

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       c.   Uncheck TCP/IP (v6).

       d.   Select TCP/IP (v4), and choose Properties.

       e.   Set the IP address, subnet, gateway, and DNS server.

       f.   Click OK

23. Join the test.com domain, and reboot .
24. Log in as `test\administrator`
25. Repeat Steps 1 through 24 for the remaining four Enterprise Vault Servers.

Installing Symantec Enterprise Vault – Creating a new Vault Directory Server (EV-1)

Note: Before installing, ensure that IIS, Microsoft .net framework, and MSMQ are installed on the Windows 2008 R2 server. Refer to page 38 and 39 of the Installing and configuring guide:

http://www.symantec.com/business/support/index?page=content&id=DOC2845

1. Insert the installation DVD for Symantec Enterprise Vault into the DVD drive.
2. Run evault_setup\Symantec Enterprise Vault 9.0.2\Server\setup.exe.
3. At the Enterprise Vault – Install Shield, Welcome screen, click Next.
4. Accept the license agreement by clicking Yes.
5. Accept the default install location, and click Next.
6. Keep the default features, and click Next.
7. At Prerequisites check, click Next.
8. In the Best practices screen, leave the recommended setting box checked, and click Next.
9. Enter the license key for Enterprise vault, and click Next.
10. The install wizard will warn you that several services need to be restarted. Click Next.
11. Allow the installation wizard to install Enterprise Vault.
12. When completed, allow the install wizard to reboot.
13. Open the Enterprise Vault administrator console, Click start→Enterprise Vault→Configuration Wizard.
14. In the Enterprise Vault Configuration Wizard, click Yes to create a new vault directory on this computer.
15. Click the English for the control language, and click Next.
16. When prompted for account details, use test\administrator, and confirm the password. Click Next.
17. Enter `SQL-1` for the SQL server name.
18. Enter `\\SQL-1\e$\sqldata` for the database and transaction log locations, and click Next.
19. Enter `EV-1` for name and description of the enterprise vault site, and click Next
20. Enter `EV-1` for the DNS alias of the server, and click Next.
21. Click Yes to use the DNS name.
22. Enter the domain Administrator Password for the Vault Service account, and click OK.
23. To add EV-1 to the site, click Next.
24. Click Add to add additional services.
25. Select all four Enterprise Vault Services, and click Next.
26. For confirmation and informational pages, click Next.
27. Click the radio button next to Just close this wizard when done, and click Finish.

Installing Symantec Enterprise Vault – Adding additional servers to the Vault Directory (EV-2)

1. Log into EV-2 as `test\administrator`
2. Insert the installation DVD for Symantec Enterprise Vault into the DVD drive.
3. Run evault_setup\Symantec Enterprise Vault 9.0.2\Server\setup.exe.
4. At the Enterprise Vault – Install Shield, Welcome screen, click Next.
5. Accept the license agreement by clicking Yes.
6. Accept the default install location, and click Next.
7. Keep the default features, and click Next.

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8. At Prerequisites check, click Next.
9. In the Best practices screen, leave the recommended setting box checked, and click Next.
10. Enter the license key for Enterprise vault, and click Next.
11. The install wizard will warn you that several services need to be restarted. Click Next.
12. Allow the installation wizard to install Enterprise Vault.
13. When completed, allow the install wizard to reboot.
14. Open the Enterprise Vault administrator console, Click Start→Enterprise Vault→Configuration Wizard.
15. In the Enterprise Vault Configuration Wizard, join an existing Directory, and select EV-1. Click Next.
16. Enter `ev-2` for the DNS alias of the server, and click Next.
17. Enter the domain Administrator Password for the Vault Service account, and click OK.
18. Click Add to add additional services.
19. Select all four Enterprise Vault Services, and click Next.
20. Click the radio button next to Just close this wizard when done, and click Finish.
21. Repeat steps 1 through 20 for each of the remaining three Enterprise Vault servers.

Installing Symantec Enterprise Vault – Configuring the Enterprise Vault Storage service to use 10 threads

1. Log into EV-1 as `test\administrator`
2. Browse to Enterprise vault→Directory on EV-1→EV-1→Enterprise Vault Servers→EV-1→Services.
3. Right-click the Enterprise Vault Storage service, and click Properties.
4. Change the archive processes box to 10, and click OK.
5. Repeat steps 1 through 4 for all five Symantec Enterprise Vault Servers.

Installing Symantec Enterprise Vault – installing client agents on the target servers

1. Log into EV-1 as `test\administrator`
2. Open the Enterprise vault administrator Console.
3. Browse to Enterprise vault→Directory on EV-1→EV-1→Targets→File Servers.
4. Right-click file servers, and select New file server.
5. In the new file server wizard, click Next.
6. In the name, type `file-1.test.local`
7. Select the checkbox next to Install the FSA Agent on the new file server, and click Next.
8. Click Next to add the fileserver, and install the agents.
9. When prompted for the Vault service account, enter the domain administrator password, and click OK.
10. When the wizard is done installing the FSA agent, click Next.
11. Click Next to allow data collection.
12. Repeat steps 1 through 11 for all 15 file servers.

Configuring the archive stores on the leading object storage platform

1. Log into EV-1 as `test\administrator`
2. Open the Enterprise vault administrator Console.
3. Browse to Enterprise vault→Directory on EV-1→EV-1→Vault Store Groups, right-click and select New Vault Store Group.
4. Click Next when the new Vault store Group wizard begins.
5. For the Name and description, type `ALeadingObjectStoragePlatform` and click Next.
6. Create a SQL fingerprint for the Vault store group, leave the SQL Server default name SQL-1, and click Next.
7. Browse to e:\sqldata for both file group, and transaction log locations, and click Next.
8. Create the vault store group named `ALeadingObjectStoragePlatform` by clicking Next.
9. Begin the creation of the vault group, and click Next.

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10. Select server EV-1 as the storage server, and click Next.
11. Enter the name `ALeadingObjectStoragePlatform-1` for the vault store and description, and click Next.
12. Accept the default SQL server name (SQL-1), and click Next.
13. Browse to e:\sqldata for both file group, and transaction log locations, and click Next.
14. In the remove safety copies dropdown box, select Immediately after backup, and click Next.
15. Click Next to create vault store `ALeadingObjectStoragePlatform1` on EV-1.
16. Begin the creation of the vault store partition, and click Next.
17. Accept the defaults for name and description, ensure the new partition is open, and click Next.
18. Select the appropriate vendor for the storage type, and click Next.
19. Add the IP address of all vendor's nodes, and click Test.
20. Ensure the platform is responsive, and click Next.
21. Select a retention period by selecting the radio button next to never, and click Next.
22. Leave the scan period at 60 minutes, and click Next.
23. Leave remaining options at default
24. Confirm the new partition creation by clicking Finish.
25. VRight-click the vault store group ALeadingObjectStoragePlatform, and click New vault store.
26. Repeat steps 9 through 16 four times to create vault stores and partitions for the leading object storage platform on all five Enterprise Vault servers.

Configuring the archive stores on the Dell DX

1. Log into EV-1 as `test\administrator`
2. Open the Enterprise vault administrator console.
3. Browse to Enterprise vault→Directory on EV-1→EV-1→Vault Store Groups, right-click and select New Vault Store Group.
4. Click Next when the new Vault store Group wizard begins.
5. For the name and description, type `DX` and click Next.
6. Create a SQL fingerprint for the Vault store group, leave the SQL Server default name SQL-1, and click Next.
7. Browse to e:\sqldata for both file group and transaction log locations, and click Next.
8. Create the vault store group named DX by clicking Next.
9. Begin the creation of the vault group, and click Next.
10. Select server EV-1 as the storage server, and click Next.
11. Enter the name `DX-1` for the vault store and description, and click Next.
12. Accept the default SQL server name (SQL-1), and click Next.
13. Browse to e:\sqldata on sql-1 for both file group, and transaction log locations, and click Next.
14. In the remove safety copies dropdown box, select after backup, and click Next.
15. Click Next to create vault store DX-1 on EV-1.
16. Begin the creation of the vault store partition, and click Next.
17. Accept the defaults for name and description, ensure the new partition is open, and click Next.
18. Select Dell DX Object Storage Platform for the storage type, and click Next.
19. Enter the 16 IP addresses for each of the DX storage nodes, and click OK.
20. Enter the Primary DX CD publisher IP address, and click OK.
21. Test the Dell DX settings by clicking Test.
22. Click OK to accept the Dell DX Settings.
23. Leave the checkbox next to store data in compliance mode as unchecked, and click Next.
24. Run a connectivity test, and click Next when successful.
25. Do not enable Partition rollover, and click Next.
26. Select a retention period by selecting the radio button next to Never, and click Next.
27. Leave the scan period at 60 minutes, and click Next.

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28. Confirm the new partition creation by clicking Finish.
29. Right-click the vault store group Dell-DX, and click New vault store.
30. Repeat steps 9 through 16 four times to create vault stores and partitions for the Dell DX on all five Enterprise Vault servers.

Configuring archive volume policy

1. Browse to Enterprise vault→Directory on EV-1→EV-1→Policies→volume.
2. Right-click and select New Policy.
3. Click Next to create a new Policy.
4. Name the policy `FSA Volume Policy` and click Next.
5. Deselect the quotas checkbox, and click Next.
6. Keep the default retention period, and click Next.
7. Click the radio button next to Placeholder, and click Next.
8. Leave archiving rules blank, and click Next.
9. Click the radio button next to Ignore them for permissions, and click Next.
10. Click Finish to create the policy called FSA Volume Policy.

Configuring archive tasks

1. Browse to Enterprise vault→Directory on EV-1→EV-1→Enterprise Vault Servers.
2. Click EV-1→tasks, right-click and select New File system Archiving Task.
3. Name the task `DX-dicom` and click OK.
4. Click EV-1→tasks, right-click and select New File system Archiving Task.
5. Name the task `ALeadingObjectStoragePlatform-dicom` and click OK.
6. Repeat steps 2 through 5 on the remaining four Symantec Enterprise vault servers so that each of the five Enterprise Vault servers has two tasks called ALeadingObjectStoragePlatform-dicom and DX-dicom.

Configuring the archive Symantec Enterprise Vault – setup volumes

1. Browse to Enterprise vault→Directory on EV-1→EV-1→Targets→File Servers→\\file-1.
2. Right-click file-1, and select New volume.
3. Click Next when the new volume wizard begins.
4. Select the files share on file-1 by clicking the browse button.
5. Click the radio button for regular share, and click OK.
6. Click the share named DX-dicom, and click Next.
7. Select the appropriate vault store. See Figure 6 to select the correct store, depending on the file server and storage platform, and click Next.
8. Select the File system archiving task called DX-dicom.
9. Select the volume policy titled FSA Volume Policy from the drop-down box, and click Next.
10. Click Finish to create the volume.
11. Right-click file-1, and select New volume.
12. Click Next when the new volume wizard begins.
13. Select the files share on file-1 by clicking the browse button.
14. Click the radio button for regular share, and click OK.
15. Click the share named ALeadingObjectStoragePlatform-dicom, and click Next.
16. Select the appropriate vault store. See Figure 7 to select the correct store, depending on the file server and storage platform, and click Next.
17. Select the File system archiving task called ALeadingObjectStoragePlatform-dicom.
18. Select the volume policy titled FSA Volume Policy from the drop-down box, and click Next.
19. Click Finish to create the volume.
20. Repeat steps 1 through 20 for all 15 file servers.

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Symantec Enterprise Vault Store configuration		
File server	Vault store for the leading object storage platform	Vault store for the Dell DX Object Storage Platform
File-1	ALeadingObjectStoragePlatform-1	DX-1
File-2	ALeadingObjectStoragePlatform-2	DX-2
File-3	ALeadingObjectStoragePlatform-3	DX-3
File-4	ALeadingObjectStoragePlatform-4	DX-4
File-5	ALeadingObjectStoragePlatform-5	DX-5
File-6	ALeadingObjectStoragePlatform-1	DX-1
File-7	ALeadingObjectStoragePlatform-2	DX-2
File-8	ALeadingObjectStoragePlatform-3	DX-3
File-9	ALeadingObjectStoragePlatform-4	DX-4
File-10	ALeadingObjectStoragePlatform-5	DX-5
File-11	ALeadingObjectStoragePlatform-1	DX-1
File-12	ALeadingObjectStoragePlatform-2	DX-2
File-13	ALeadingObjectStoragePlatform-3	DX-3
File-14	ALeadingObjectStoragePlatform-4	DX-4
File-15	ALeadingObjectStoragePlatform-5	DX-5

Figure 7: The Symantec Enterprise Vault Store configuration we used for testing.

Running the archive tasks

Running Symantec Enterprise Vault DX-DICOM archive tasks

1. Log into EV-1 as `test\administrator`
2. Browse to Enterprise vault→Directory on EV-1→EV-1→Enterprise Vault Servers→EV-1→tasks.
3. Right-click the DX-DICOM task, and click Run now.
4. Leave the radio button in normal mode selected and click the OK button.
5. Click OK once the task has begun processing.
6. Repeat steps 1 through 5 for each of the five enterprise vault servers until all five DX-DICOM tasks have a processing status.
7. Wait for all five tasks to finish processing.
8. Record the results for each server by viewing the Enterprise Vault log files. The Enterprise vault log files are located on each of the Enterprise Vault servers in the c:\Program Files (x86)\Enterprise Vault\Reports\FSA\DX-dicom\ArchiveRunNow\Completed\ directory.

Running Symantec Enterprise Vault ALeadingObjectStoragePlatform-DICOM archive tasks

1. Log into EV-1 as `test\administrator`
2. Browse to Enterprise vault→Directory on EV-1→EV-1→Enterprise Vault Servers→EV-1→tasks.
3. Right-click the ALeadingObjectStoragePlatform-dicom task, and click Run now.
4. Leave the radio button in normal mode selected, and click the OK button.
5. Click OK once the task has begun processing.
6. Repeat steps 1 through 5 for each of the five enterprise vault servers until all five ALeadingObjectStoragePlatform-DICOM tasks have a processing status.
7. Wait for all five tasks to finish processing.
8. Record the results for each server by viewing the Enterprise Vault log files. The Enterprise vault log files are located on each of the Enterprise Vault servers in the c:\Program Files (x86)\Enterprise Vault\Reports\FSA\ALeadingObjectStoragePlatform-dicom\ArchiveRunNow\Completed\ directory.

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APPENDIX C – SERVER AND STORAGE CONFIGURATION INFORMATION

Figure 8 provides detailed configuration information about the test servers.

Servers	Dell PowerEdge 2950	Dell PowerEdge M600	Dell PowerEdge R900	Dell PowerEdge R515
General processor setup				
Number of processor packages	2	2	4	2
Number of cores per processor package	4	4	6	6
Number of hardware threads per core	1	1	6	6
CPU				
Vendor	Intel	Intel	Intel	AMD
Name	Intel® Xeon® processor E5405	Intel Xeon processor E5345	Intel Xeon processor E7450	Opteron™ 4180
Stepping	E0	B	A1	HY-D1
Socket type	LGA 771	LGA 771	LGA 771	Socket C32 (1207)
Core frequency (GHz)	2.00	2.33	2.40	2.60
Bus frequency	1,333 MHz	1,333 MHz	1,066 MHz	2,000 MHz HyperTransport Technology
L1 cache (KB)	128	128	32 KB instruction 32 KB data	64 KB + 64 KB (per core)
L2 cache	12 MB	8 MB	3 x 3,072 KB	6 x 512 KB (per core)
Thermal design power (TDP, in watts)	80	80	90	115
Platform				
Vendor and model number	Dell PowerEdge 2950	Dell PowerEdge M600	Dell PowerEdge R900	Dell PowerEdge R515
Motherboard model number	0M332H	Dell 0MY736	0X947H	03X0MN
Motherboard chipset	Intel 5000X	Intel 5000P	7300	ID5A12
BIOS name and version	Dell 2.7.0	Dell 2.4.0	Dell BIOS 1.1.10	Dell Inc. 1.2.5
BIOS settings	Default	Default	Default	Default
Memory modules				
Vendor and model number	Samsung M395T5750EZ4-CE66	Samsung M395T2953EZA-CE65	Samsung M395T5750EZ4-CE65	Samsung M391B5273CH0-CH9
Type	PC2-5300	PC2-5300	PC2-5300F	PC3-10600E
Speed (MHz)	667	667	667	667

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Servers	Dell PowerEdge 2950	Dell PowerEdge M600	Dell PowerEdge R900	Dell PowerEdge R515
Speed in the system currently running @ (MHz)	667	667	667	667
Timing/Latency (tCL-tRCD-iRP-tRASmin)	5-5-5-15	5-5-5-15	5-5-5-15	9-9-9-24
Size (GB)	2	1	2	4
Number of RAM modules	8	8	32	4
Chip organization	Double-sided	Double-sided	Double-sided	Double-sided
Hard disk				
Vendor and model number	Western Digital WD1602ABKS	Fujitsu MAY2073RC	Seagate ST973451SS	Seagate ST3146855SS (RAID 1) 1 x Seagate St373454SS 3 x Fujitsu Max3073RC (Raid10)
Number of disks in system	2	2	8	6
Size (GB)	160	73	73	146 (RAID 1)/73 (RAID 10)
Type	SATA	SAS	SAS/Serial Attached SCSI	SAS 3Gbps
Controller	Dell SAS 6/iR	Dell SAS 6/iR	PERC 6/i	LSI PERC H700 Integrated
Controller driver	LSI 1.28.3.52	LSI 1.28.3.52	LSI 4.5.0.64	LSI 3.18.00
Operating system				
Name	Microsoft Windows Server 2008 R2, Enterprise Edition SP1	Microsoft Windows Server 2008 R2, Enterprise Edition SP1	Windows Server 2008 R2, Enterprise Edition SP1	Windows Server 2008 R2, Enterprise Edition SP1
Build number	7601	7601	7601	7601
File system	NTFS	NTFS	NTFS	NTFS
Language	English	English	English	English
Network card/subsystem				
NIC one				
Vendor and model number	Broadcom® BCM5708C NetXtreme® II	Broadcom BCM5708S NetXtreme II	Broadcom NetXtreme II BCM57710 10 Gigabit PCIe	Broadcom NetXtreme II BCM57710 10 Gigabit PCIe
Type	Integrated	Integrated	4 x Discrete	Integrated
Driver	Broadcom 6.2.9.0	Broadcom 6.2.9.0	Microsoft 4.8.4.1	Microsoft 4.8.4.1 (12/23/2008)

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Servers	Dell PowerEdge 2950	Dell PowerEdge M600	Dell PowerEdge R900	Dell PowerEdge R515
NIC two				
Vendor and model number	Intel PRO/1000 PT	N/A	Broadcom NetXtreme II BCM5708 Gigabit Ethernet	Intel Pro 1000 PT
Type	PCI Express	N/A	PCI-e	PCI-e
Driver	Intel 9.13.41.0	N/A	Microsoft 4.8.4.1	9.14.180.0
USB ports				
Number	4	2	4	4
Type	USB 2.0	USB 2.0	USB 2.0	USB 2.0

Figure 8: Detailed configuration information for the test servers.

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APPENDIX D – ABOUT THE FILE CORPUS (LARGE)

DICOM files vary in size depending on the imaging manufacture, content, resolution, sample width, and image compression, if any. For our testing, we simulated large DICOM files with the Linux DD command. We created a corpus of unique urandom files. For more information on how to create files with the DD command, visit http://www.redhat.com/mirrors/LDP/LDP/abs/html/extmisc.html.

Healthcare archiving: DICOM storage performance of Dell DX
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ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies®

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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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