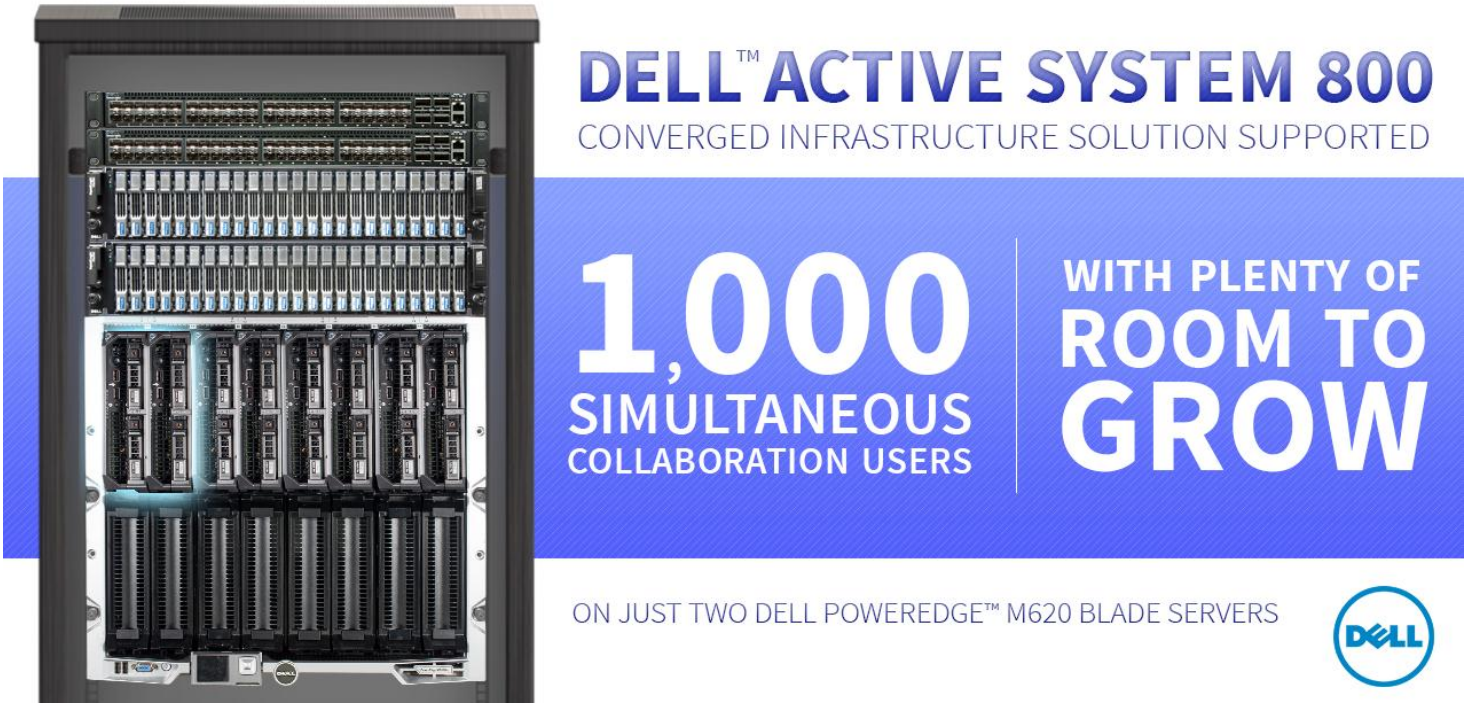
DELL ACTIVE SYSTEM 800 CONVERGED INFRASTRUCTURE SOLUTION: USER COLLABORATION PERFORMANCE



Businesses require infrastructure that is flexible, rapid to deploy, and scalable, while servicing end users with room to grow. The time required to spec, install, and configure hardware can add delays to deployment, and the management of complex networking configurations can weigh down an IT staff after deployment. The new Dell Converged Infrastructure solution, the Dell Active System 800, provides a pre-configured, pre-integrated, compatibility-tested solution, complete with compute, storage, and networking in a ready-to-deploy package.

In Principled Technologies labs, we tested the Dell Active System 800 and found that, with only two of its eight servers, it supported 1,000 simultaneous users across three server-dependent applications and several simultaneous heavy order processing applications – with plenty of resources left for business growth. In addition, when we placed an energy usage cap on the solution using Dell OpenManage™ Power Center, we determined that the solution still performed well under the same I/O intensive load – with no detrimental effects to overall performance.

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A PRINCIPLED TECHNOLOGIES TEST REPORT
Commissioned by Dell Inc.

FLEXIBLE CONVERGENCE WITH POWER

Deploying a successful and efficient blade infrastructure can be a daunting task. That's why Dell created the Dell Active System 800 converged infrastructure solution – a tested, complete solution that can provide you with the performance you need to support your workloads today and scale to meet your future needs. The Dell Active System 800 solution is preconfigured with eight to thirty-two Dell PowerEdge M620 blade servers, one or two Dell PowerEdge M1000e blade enclosures, Dell EqualLogic™ storage arrays, Dell Force10™ switches, and two PowerEdge M I/O aggregators. For organizations that require performance on a larger scale, the Active System 800 scales beyond this base configuration to accommodate a larger number of server nodes and storage arrays. For more information about the solution we tested, see Appendix A.

Enterprise-class power for collaboration users

In our tests, two Dell PowerEdge M620 blades of our Dell Active System 800 configuration supported 1,000 collaboration users (Microsoft® Exchange Server 2010, Microsoft SharePoint® Server 2010, and Microsoft Lync® Server 2010), and two heavy Microsoft SQL Server® 2012 order-processing workloads. See Appendix K for more details on the specifics of each test.

Figure 1 provides detailed information on our tests and the results from each benchmark.

Workload	Measurement
Order-processing workload	65,579 orders per minute
Microsoft Exchange	6.585ms latency (<50ms is acceptable) 1.685 messages per second
Microsoft SharePoint	8.040 requests per second
Microsoft Lync Server	8.304 IMs per second

Figure 1. Baseline results from our testing of Microsoft collaboration and database workloads.

- **What does this mean for data center managers?** The fact that 1,000 users and two very heavy order-processing workloads ran on just two of the blade servers in an Active System 800 solution means that there is great potential for server consolidation and convergence – many users can be supported on far fewer servers. With the ability to converge many applications and users on fewer servers, network fabrics, and storage arrays, data center management costs will be reduced. Platform scalability allows for vast expansion for greater numbers of users and applications – the Active System 800 supports up to 32 blade servers and multiple storage arrays.
- **What does this mean for the end user?** Our tests show that 1,000 simulated users concurrently used three collaboration applications with excellent response times

alongside multiple heavy order-processing applications, all with resources left for future expansion. This means that users can expect excellent application response on the Active System 800, even when running heavy workloads and performing simultaneous everyday application tasks.

Room to grow

In our tests, the two Dell PowerEdge M620 blade servers in our Dell Active System 800 configuration supported 1,000 collaboration users and two heavy order-processing workloads using only 45 percent of processor resources[1] on the two servers and 3,652 storage IOPS on the storage infrastructure, leaving room for growth and resources for additional business use. These performance numbers show the Dell Active System 800 can scale to add new applications, users, and content when needed.

- **What does this mean for data center managers?** The potential for future growth – using available resources on existing servers – means that you can minimize infrastructure acquisition costs, even as your business continues to grow. For example, if you experience growth in your Microsoft Exchange or Microsoft SharePoint needs, you can add further virtualized resources on the Active System 800 nodes on which you have available resources. If you must grow your infrastructure to accommodate demand, you can do so in a pre-configured, converged approach, with minimal delay and cost in adding resources.
- **What does this mean for the end user?** Resource contention on back-end data center infrastructure should never create response time or availability problems for the end-user. Our tests show that the ability of two servers in an Active System 800 to run three simultaneous collaboration applications and two heavy order-processing workloads means that our 1,000 simulated users did not have to sacrifice performance or resource availability while completing daily collaboration tasks. During our testing, the Active System 800 achieved acceptable latencies and transactions per second.

Excellent performance even with growth

When adding workloads to your infrastructure, the performance of existing applications should not suffer. To show that the Active System 800 could easily handle the addition of new workloads, we added workloads to our original configuration to simulate a spike in resource needs. We doubled the number of heavy order-processing workloads on each of our two servers and found the 1,000 simulated users still experienced excellent performance – a latency from Microsoft Exchange well within the published Microsoft acceptability range,[2] and roughly the same Microsoft Lync Server IMs per second and Microsoft SharePoint requests per second as in

[1] VMware vSphere core utilization measured over the test window.
[2] 50ms or lower, http://technet.microsoft.com/en-us/library/aa998266.aspx

our original test (see Figure 2). Additionally, the order-processing capacity approximately doubled the prior output, showing near-linear scaling.

Workload	Measurement
Order-processing workload	126,448 orders per minute
Microsoft Exchange	10.217ms latency (<50ms is acceptable) 1.662 messages per second
Microsoft SharePoint	8.004 requests per second
Microsoft Lync Server	8.302 IMs per second

Figure 2. Results from heavy workload testing of Microsoft collaboration and database workloads.

Not only did the end-user experience remain acceptable for collaboration applications and the order-processing workload scale appropriately, when we ran this heavier utilization scenario, the applications still used just 72 percent of the available processor resources[3] and 6,648 storage IOPS, leaving still more resources for additional business use. Figure 3 compares the performance of our base and heavy workloads for the collaboration applications.

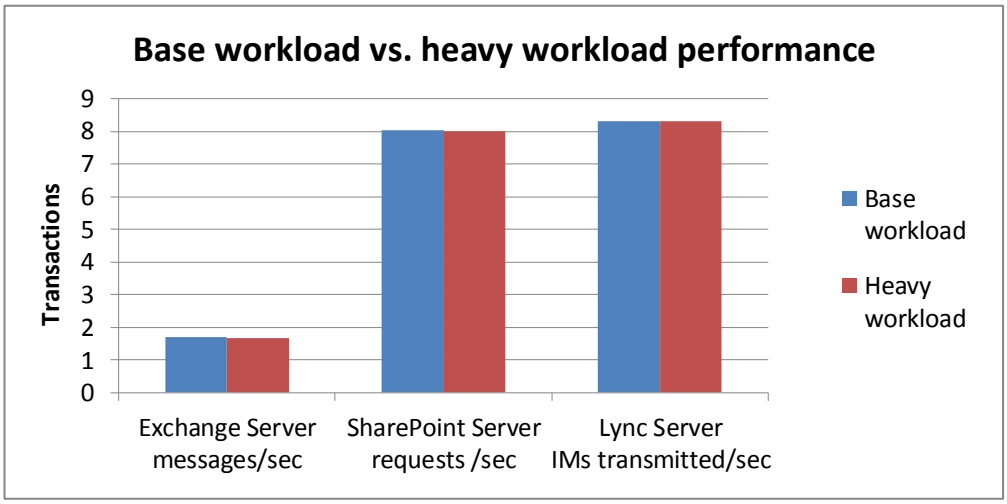

Figure 3. Exchange, SharePoint, and Lync Server performance across the two tested workloads. Increasing other workloads on the Active System 800 had no appreciable effect on application transactions.

- **What does this mean for data center managers?** These tests show that the additional resource availability on the Active System 800 can be used to host additional business applications, potentially further reducing infrastructure acquisition costs and minimizing data center sprawl.
- **What does this mean for the end user?** The ability of two servers in an Active System 800 to run three simultaneous collaboration applications and four heavy order-processing workloads means that users need not worry about resource availability while doing their daily tasks.

[3] VMware vSphere core utilization measured over the test window.

Power management without compromise

Using Dell OpenManage Power Center, which allows data center managers to place energy usage caps on resources, we restricted the available power to the Dell PowerEdge M620 servers at 58 percent of their upper bound energy usage. The solution still delivered close to the same performance for the collaboration users and four heavy order-processing workloads (see Figures 4 and 5).

Workload	Measurement
Order-processing workload	127,753 orders per minute
Microsoft Exchange	14.341ms latency (<50ms is acceptable) 1.685 messages per second
Microsoft SharePoint	7.684 requests per second
Microsoft Lync Server	8.775 IMs per second

Figure 4. Results from capped power testing of Microsoft collaboration and database workloads.

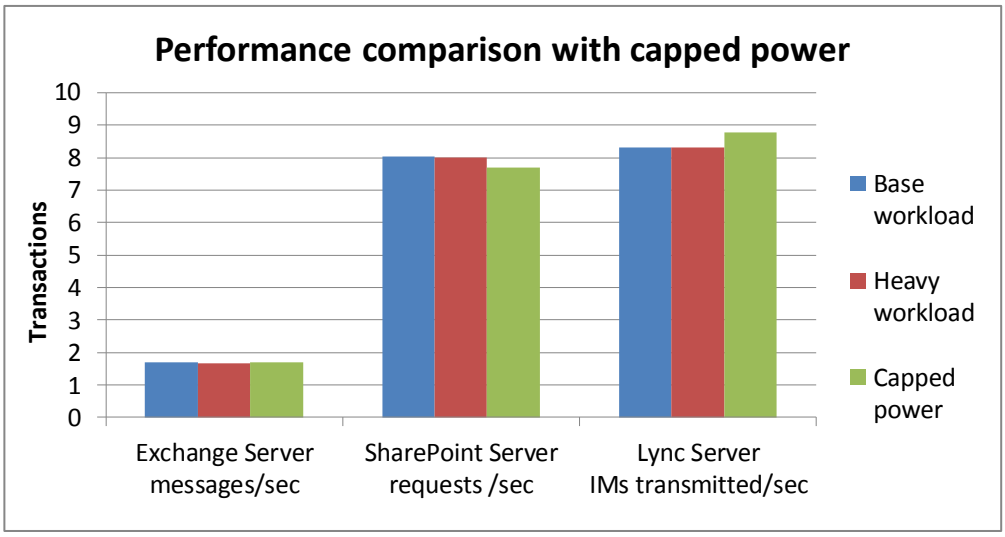

Figure 5. Performance comparison showing that adding a power cap had no negative impact on the performance of the applications we tested.

- **What does this mean for the data center manager?** This power capping capability gives data center managers the flexibility they need to reduce costs through increased server and circuit density, as well as the reduction of physical circuits and cabling and power-related downtime.
- **What does this mean for the end user?** This power capping capability means back-end infrastructure energy decisions will not affect end-user application performance, as tested in our three collaboration workloads and four order-processing workloads.

ABOUT THE ACTIVE SYSTEM 800

A member of the Active Infrastructure converged infrastructure framework family, the Active System 800 is a comprehensive solution for rapid deployment of a pre-integrated enterprise data center solution. Available in a number of configurations, Dell aims for the Active System 800 to be simple to purchase, configure and maintain, as well as expand to meet additional requirements in the future. The solution features:

- Unified management, via Dell Active System Manager software
- Converged LAN/SAN fabrics, using the Dell Force10 S4810 and Dell M I/O Aggregators
- Industry-standard Data Center Bridging (DCB) protocols for interoperability with 3rd party infrastructure, which maximizes traffic performance for protocols such as iSCSI
- Flexible scalability using the Dell PowerEdge M1000e blade chassis
- Enhanced TOR switch functionality and coordination with Dell PowerEdge M I/O Aggregators
- Dell PowerEdge M620 servers for compute
- Dell EqualLogic PS6110 storage
- Support for VMware®-based enterprise virtualization

Active System 800 base specifications

- Dell PowerEdge M1000e blade chassis (1 or 2)
- Dell PowerEdge M620 blade server (8 or 16, 24, 32)
  - Intel® Xeon® processors E5-2660 (Upgradeable)
  - 128G RAM (Upgradeable)
- Dell Force10 S4810 TOR switch (2)
- Dell Force10 S55 management switch
- EqualLogic PS6110
- PowerEdge M I/O Aggregator

Active System Manager

Active System Manager provides centralized management for the solution, through:

- Template-based configuration for provisioning and management, resulting in less manual configuration for administrators
- Automated discovery, inventory, deployment, and management of blade infrastructure
- Guided user workflows, multi-level views of I/O topology
- Rapid workload migration

About the Dell PowerEdge M620 blade server

The Dell PowerEdge M620 is a half-height two-socket blade server powered by the Intel Xeon processor E5-2600 series that can hold up to 768 GB of RAM in 24 DIMM slots. The PowerEdge M620 comes standard with several management features, including iDRAC7 Express

with Lifecycle Controller for Blades, which allow administrators to manage environments locally or remotely. Along with other members of the M-series PowerEdge server line, the PowerEdge M620 integrates with the power-efficient Dell PowerEdge M1000e blade enclosure.

Features of the PowerEdge M I/O Aggregator

The PowerEdge M I/O aggregator enables the PowerEdge M1000e blade enclosure to communicate with other devices on your network using fewer physical connections, while providing increased performance. The PowerEdge M I/O Aggregators also enable administrators to push complex network requirements to the top of rack switch, allowing for automatic configuration.

Features of the Dell EqualLogic PS6110

The Dell EqualLogic PS6110 10GbE iSCSI family provides high-performance, cutting-edge rack storage, capable of supplying both the I/O and storage needed to run a high-end virtualized data center environment. Its benefits include the following:

- **Reliability.** Options for hot-swap, incremental expansion, dual power and network controllers, and port sharing for failover scenarios all ensure increased uptime.
- **Connectivity.** Connect via 10GbE SFP+ module or cost-effective 10GBASE-T copper.
- **Capacity.** Each array supports a variety of drive configurations to meet your company's growing storage needs.
- **Performance.** Each backplane provides top-of-the-line disk I/O, while 10GbE technology maximizes throughput to and from the array.
- **Management.** EqualLogic Host Software and Host Integration Tools ease configuration and enhance communications between array and host.

Features of the Dell Force10 S4810P top-of-rack switch

The Dell Force10 S4810P High-Performance 10/40 GbE Switch enables high-bandwidth, low-latency communications for the demanding conditions of a modern performance-driven server environment. Its benefits include the following:

- **Performance.** Capable of 1.28Tbps, full-duplex, L2 and L3 forwarding through a full-duplex, non-blocking, cut-through switching architecture, the S4810 is able to deliver sub-700ns latency and 960 Mpps in a full-load scenario.
- **Capacity.** Occupying only a single rack unit, the S4810 provides 48 dual-speed 1/10GbE (SFP+) ports and 4 x 40GbE (QSFP+) uplink ports. Breakout cables enable the uplink ports to deliver 64 x 10GbE ports.
- **Reliability.** The modular Dell Force10 operating system is custom-engineered for stability, advanced monitoring, and serviceability, while redundant power supplies and fans mitigate risk for single-point-of-failure issues on the hardware.

PowerEdge M1000e and Fabric

The Dell PowerEdge M1000e blade chassis and its fabric interconnects are designed for large-scale consolidation and enterprise infrastructure. Features of the PowerEdge M1000e include:

- **Management.** Reduces administrative demand by providing a secure centralized management interface for the chassis and blades within, using proven Web (SSL-encrypted) and CLI (SSH/Telnet) technologies.
- **Simplified configuration.** The Chassis Management Controller allows administrators to control up to nine enclosures and 144 server blades, including BIOS/firmware change management and updates, thermal monitoring, and power threshold configuration.
- **Flexible I/O.** Six interconnect sockets with the capability to support three fully-redundant fabrics, a passive midplane with more than 8Tbps in I/O bandwidth capacity, and FlexIO support provides a number of connectivity options for your servers.
- **Reliability and efficiency.** Six power supplies and nine fans, all hot-swappable, allowing for no-downtime maintenance of key chassis components. All components are tuned for maximum power efficiency to reduce data center power consumption.

About the Intel Xeon processor E5 family

The Intel Xeon processor E5 family, which comes standard in new Dell PowerEdge servers, incorporates new technology and features to meet the computing demands of the present and future. The Intel Xeon processor E5 family delivers intelligent and adaptive performance using such features as Intel Turbo Boost Technology 2.0, Intel Advanced Vector Extension, Intel Integrated I/O, and Intel Data Direct I/O Technology. These new processors also feature Intel Trusted Execution Technology (Intel TXT) and utilize Intel Advance Encryption Standard New Instructions (Intel AES-NI) to help keep your data safe.

For more information about the Intel Xeon processor E5 family, visit http://www.intel.com.

TESTING ENVIRONMENT

About Microsoft SQL Server 2012

SQL Server 2012 is the latest release of Microsoft's database management platform. Microsoft has added new features to enhance performance, security, and management. SQL Server 2012 introduces Data Quality Services (DQS) to improve the usability of collected data, both locally and from cloud-based data service providers. In addition, SQL Server 2012 is more tightly-integrated with both Microsoft Office client applications and with SharePoint Server, providing greater ease-of-use to users.

About Microsoft Exchange Server 2010 SP2

Microsoft Exchange Server 2010 SP2 equips you with a robust communications platform that can also give your users anywhere access, increasing their mobility. Some other key features of Exchange Server 2010 SP2 include Unified Mailbox Resiliency, archiving, and access to the improved Outlook Web Application.

About Microsoft SharePoint Server 2010 SP1

Microsoft SharePoint Server 2010 SP1 is the latest version of Microsoft's collaboration software. It allows users to create collaborative Web sites and to create and manage their own workspaces. Some of its key features include SharePoint 2010 Communities, which lets users share ideas and information from a single platform; the SharePoint Search feature, which lets users find other people and information quickly; and SharePoint 2010 Insights, which gives users an improved ability to access databases, reports, and business applications.

About Microsoft Lync Server 2010

Microsoft Lync Server 2010, the latest in collaborative communication software, brings voice, video, application sharing, instant messaging (IM), and Web conferencing together into a single unified platform.

IN CONCLUSION

When searching for a converged infrastructure solution to quickly deploy to your data center, choosing a complete solution that requires no additional testing and configuration before deployment can be a great asset to your organization. An easy-to-deploy, highly scalable solution that has the ability to meet your workload requirements and provides administrators with flexibility is vital to running an efficient data center.

In our tests, the Dell Active System 800 provided ample performance to drive the needs of a 1,000-person organization using multiple collaboration applications and order-processing applications, even using only two Dell PowerEdge M620 blade servers in the configuration. Adding more I/O intensive workloads to the configuration and placing power caps on the servers did not negatively affect performance; the Dell Active System 800 was able to perform well for all end-users while providing flexibility for administrators.

APPENDIX A - DETAILED CONFIGURATION INFORMATION

Figure 6 provides detailed configuration information about the test server blades and chassis.

Server	Dell PowerEdge M620
Enclosure	
Blade enclosure	Dell PowerEdge M1000e
General dimension information of blade enclosure	
Height (inches)	17.25
Width (inches)	19.00
Depth (inches)	29.50
U size in server rack (U)	10
Power supplies of blade enclosure	
Total number	6
Wattage of each power supply (W)	2,360
Cooling fans of blade enclosure	
Total number	9
Dimensions (h x w) of each	3-1/4” x 3-1/4 “
Voltage (V)	12
Amps (A)	5
General processor setup	
Number of processor packages	2
Number of cores per processor package	6
Number of hardware threads per core	2
System power management policy	Balanced
CPU	
Vendor	Intel
Name	Xeon E5-2680
Stepping	C2
Socket type	Socket 2011 LGA
Core frequency (GHz)	2.70
Bus frequency	8 GT/s
L1 cache	32 KB + 32 KB (per core)
L2 cache	256 KB (per core)
L3 cache	20 MB (shared)
Platform	
Vendor and model number	Dell PowerEdge M620
Motherboard model number	0GVN4C
Motherboard chipset	Intel ID3C00 Rev. 07
BIOS name and version	Phoenix ROM BIOS PLUS Version 1.10 1.2.6
BIOS settings	Default
Memory modules	
Total RAM in system (GB)	128

Server	Dell PowerEdge M620
Number of types of memory modules	2
Memory module in first blade	
Vendor and model number	Samsung M393B1K70DH0-CK0
Type	PC3-12800
Speed (MHz)	1,600
Speed in the system currently running @ (MHz)	1,600
Timing/latency (tCL-tRCD-iRP-tRASmin)	11-11-11-28
Size (GB)	8
Number of RAM modules	16
Chip organization	Double-sided
Memory module in second blade	
Vendor and model number	Hynix HMT31GR7CFR4C-PB
Type	PC3-12800
Speed (MHz)	1,600
Speed in the system currently running @ (MHz)	1,600
Timing/latency (tCL-tRCD-iRP-tRASmin)	11-11-11-35
Size (GB)	8
Number of RAM modules	16
Chip organization	Double-sided
RAID controller	
Vendor and model number	PERC H710 Mini
Firmware version	21.0.1-0132
Cache size	1 GB
Hard disk	
Vendor and model number	Dell MBE2147RC
Number of disks in system	2
Size (GB)	146
Buffer size (MB)	16
RPM	15,000
Type	SAS
Operating system	
Name	VMware vSphere 5.1
Build number	799733
File system	VMFS
Language	English
Network card/subsystem	
Vendor and model number	Intel Ethernet X520 10GbE Dual Port KX4-KR Mezzanine card*
Type	PCI

Figure 6. Detailed configuration information for the two Dell PowerEdge M620 blades we used in our tests.

*Note: The Dell Active System 800 uses the Broadcom Converged Network Daughter Card instead of the Intel Ethernet X520 card. However, because of availability constraints at time of testing, Intel cards were used in lieu of the Broadcom card. Because this testing was not network-limited at the host level, the modification did not appreciably impact the results.

APPENDIX B - TEST STORAGE INFORMATION

Figure 7 provides detailed information for the test storage. We used two of each of the storage arrays for the test configuration.

Storage array	Dell EqualLogic PS-6110XV
Number of storage controllers per array	2
RAID level	10
Number of drives per array	24 (22 active data drives, 2 spares)
Drive vendor and model number	Seagate ST9900805SS
Drive size (GB)	900
Drive buffer size (MB)	64
Drive RPM	10,000
Drive type	6Gb SAS

Figure 7. Detailed configuration information for the two Dell EqualLogic PS-6110XV storage arrays.

APPENDIX C - STORAGE CONFIGURATION FOR PERFORMANCE TESTING

We used two Dell EqualLogic PS6110XV arrays, configured in a single group. Each array was cabled to the Dell Force10 S4810 TOR switch via 10Gb network cables. On the group we configured volumes as follows.

- Lync Server – 100 GB
- Exchange Data – 2 TB
- Exchange Log – 50 GB
- Exchange OS – 100 GB
- SharePoint Data – 250 GB
- SharePoint OS – 100 GB
- SQL Data 1 – 300 GB
- SQL Data 2 – 300 GB
- SQL Data 3 – 300 GB
- SQL Data 4 – 300 GB
- SQL Logs 1 – 200 GB
- SQL Logs 2 – 200 GB
- SQL Logs 3 – 200 GB
- SQL Logs 4 – 200 GB
- SQL OS 1 – 200 GB
- SQL OS 2 – 200 GB

Setting up the Dell EqualLogic PS6110XV storage array

Connect to the storage array using serial port and terminal utility and complete the following steps:

1. Power on the array and enter the login credentials.
2. When prompted to configure the array, type `y`.
3. When asked Do you want to proceed?, type `Yes`.
4. Enter a member name and press Enter. For our testing we chose `tray1`.
5. Press Enter for the eth0 network interface.
6. Enter an IP address, and press Enter. For our testing, we chose `192.10.11.11`.
7. Leave the default netmask, and press Enter.
8. Leave the default gateway, and press Enter.
9. Enter a group name and press Enter. For our testing, we chose `group`.
10. Enter an IP address for the group, and press Enter. For our testing, we chose `192.10.11.1`.
11. Enter a password for this group, and press Enter.
12. Confirm all configurations and finish the group creation.
13. Open a web browser using a machine on the storage network and browse to the group IP address.
14. Provide the appropriate login credentials when prompted.
15. Select the unconfigured member in the group, and click Yes to configure it.
16. At the General Settings screen, click Next.
17. Select the RAID policy, and click Next. For our testing, we selected RAID 10.
18. At the Summary screen, click Finish.

Adding the second Dell EqualLogic PS6110XV storage array

Connect to the storage array using serial port and terminal utility and complete the following steps:

1. Enter the login credentials.
2. When prompted to configure the array, type `y`.
3. When asked Do you want to proceed?, type `Yes`.
4. Enter a member name and press Enter. For our testing we chose `tray2`.
5. Press Enter for the eth0 network interface.
6. Enter an IP address, and press Enter. For our testing, we chose `192.10.11.22`
7. Leave the default netmask, and press Enter.
8. Leave the default gateway, and press Enter.
9. For group name, enter the name of the existing group you created when you configured the first PS6110XV storage array. For our testing, this was `group`.
10. Verify that the group IP address is correct, and press Enter.
11. Enter the password for the group manager, and press Enter.
12. When asked to add the array to the group, type `yes`.
13. Open a web browser using a machine on the storage network and enter the group IP address.
14. Provide the appropriate login credentials when prompted.
15. Select the un-configured member in the group, and click Yes to configure it.
16. At the General Settings screen, click Next.
17. Select the RAID policy, and click Next. For our testing, we selected RAID 10.
18. At the Summary screen, click Finish.

APPENDIX D – NETWORK CONFIGURATION FOR PERFORMANCE TESTING

We configured the network cabling of the hardware as shown in Figure 8. We used components in an Active System 800 configuration for our network. Auxiliary machines for testing, such as client machines, Active Directory server, and vCenter Server, ran on the LAN.

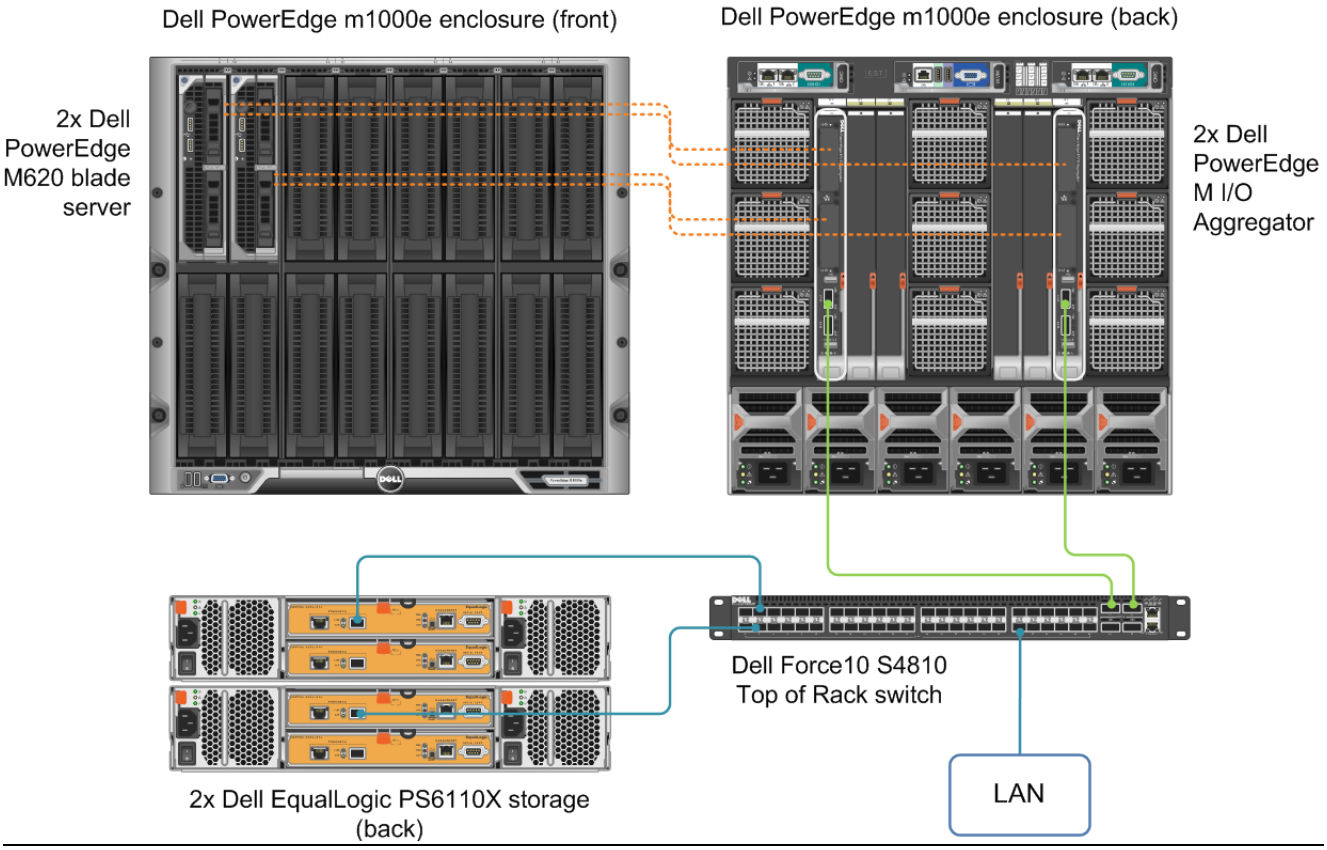

Figure 8. Physical cabling we used in testing. Note in full Active System 800 configuration, multiple ToR switches and further redundancy would be configured.

Dell Force10 S4810P switch configuration

For our testing, we used version 8.3.12.0. Connect to each switch with a serial cable and terminal utility, but do not connect the switches with each other, and complete the steps below:

Configuring the out-of-band management port

1. In the first switch's terminal, type `enable` and press Enter.
2. Type `config` and press Enter.
3. Type `interface ManagementEthernet 0/0` and press Enter.
4. Type `no shut` and press Enter.
5. Type `IP address 192.168.11.254 255.255.255.0` and press Enter.

6. Type `no shut` and press Enter.
7. Type `exit` and press Enter.

Configuring login credentials

1. Type `username admin privilege 15 password 0 password` and press Enter, where *password* is the password you wish to set.
2. Type `enable password level 15 0 password` and press Enter.

Configuring the remaining ports

1. Type `interface range tengigabitethernet 0/0 – 43` and press Enter.
2. Type `mtu 12000` and press Enter.
3. Type `portmode hybrid` and press Enter.
4. Type `switchport` and press Enter.
5. Type `flowcontrol rx on tx on` and press Enter.
6. Type `no shut` and press Enter.
7. Type `exit` and press Enter.
8. To save these settings, type `copy run start` and press Enter.
9. To apply these settings, type `reload` and press Enter. When asked if you want to proceed with the reload, type `yes` and press Enter. After the switches reboot, the settings will have all taken effect.

APPENDIX E – SERVER INSTALLATION, CONFIGURATION, AND GUEST OPERATING SYSTEM INSTALLATION

We installed both PowerEdge M620 servers with VMware vSphere 5.1 build 799733 from the Dell Recovery CD, available from dell.com at http://www.dell.com/support/drivers/us/en/04/DriverDetails/Product/poweredge-m620?driverId=XWYR5&osCode=XI51&fileId=3005015335.

We installed vSphere to each server's internal SD card.

Adjusting BIOS settings

We used the latest released BIOS updates on the Dell PowerEdge M620, version 1.2.6. We used the default BIOS settings.

Installing VMware vSphere 5.1 (ESXi) on the PowerEdge M620

1. Mount the installation ISO to the iDRAC of the server, and boot the server.
2. On the Welcome screen, press Enter.
3. On the End User License Agreement (EULA) screen, press F11.
4. On the Select a Disk to Install or Upgrade Screen, select the SD card to install ESXi on and press Enter.
5. On the Please Select a Keyboard Layout screen, press Enter.
6. On the Enter a Root Password Screen, assign a root password and confirm it by entering it again Press Enter to continue.
7. On the Confirm Install Screen, press F11 to install.
8. On the Installation complete screen, press Enter to reboot.
9. Configure the latest version of Dell EqualLogic's multi-path extension module on the server according to Dell documentation.
10. Repeat the installation for the remaining server.

Configuring ESXi after Installation

1. On the PowerEdge M620, press F2, enter the root password, and press Enter.
2. On the System Customization screen, select troubleshooting options, and press Enter.
3. On the Troubleshooting Mode Options screen, select enable ESXi Shell, and press Enter.
4. Select Enable SSH, press Enter, and press ESC.
5. On the System Customization screen, select Configure Management Network.
6. On the Configure Management Network screen, select IP Configuration.
7. On the IP Configuration screen, select set static IP, enter an IP address, subnet mask, and default gateway, and press Enter.
8. On the Configure Management Network screen, press Esc. When asked to apply the changes, press Y.
9. Repeat steps 1 through 9 for the remaining server.

Setting up vCenter Server

1. Install ESXi on a utility server using the instructions above. We used a PowerEdge R620.
2. Import the OVF containing the Linux-based vCenter Server appliance from VMware.

3. Start the vCenter Server VM and perform basic installation steps, such as setting the name, IP, credentials, and so on.
4. Connect to the vCenter Server via the vSphere web client, create a cluster, and add each Dell PowerEdge M620 to the cluster.

Configuring the external volumes in VMware vSphere 5.1

1. In the vSphere web client, select the host.
2. Click the Configuration tab.
3. Click Storage, and click Add Storage…
4. Choose Disk/LUN.
5. Select the first LUN assigned to ESX and click Next.
6. Accept the default of VMFS-5 for the file system.
7. Review the disk layout, and click Next.
8. Enter the datastore name, and click Next.
9. Accept the default of using maximum capacity, and click Next.
10. Click Finish.
11. Repeat steps 3 through 10 for the remaining LUNs.

Creating the base VM

1. In your web browser, connect to the vCenter Server, and browse to the ESXi host.
2. Right-click on the ESXi host, and choose New Virtual Machine.
3. Choose Create a new virtual machine, and click Next.
4. Assign a name to the virtual machine, and click Next.
5. Select the relevant OS Datastore on the external storage, and click Next.
6. Select ESX 5.1 and later compatibility and click Next.
7. Choose Windows, and choose Microsoft Windows Server 2008 R2, and click Next.
8. Choose the VM's virtual hardware options, and click Next (see each VM's section below for additional VM configuration data).
9. Click Finish.
10. Start the VM.
11. Attach the installation DVD for Windows Server 2008 R2 SP1 Enterprise to the VM.
12. At the Language Selection Screen, click Next.
13. Click Install Now.
14. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
15. Click the I accept the license terms checkbox, and click Next.
16. Click Custom.
17. Click Next.
18. At the User's password must be changed before logging on warning screen, click OK.
19. Enter the desired password for the administrator in both fields, and click the arrow to continue.
20. At the Your password has been changed screen, click OK.
21. Repeat this procedure for Windows Server 2012

Cloning the base VM

1. In the vSphere Client, connect to the vCenter Server, and browse to the ESXi host.
2. Right-click on the VM you wish to clone and click Clone.
3. Name your VM and click Next.
4. Select your host and click Next.
5. Select the appropriate OS datastore and click Next.
6. Select Do not customize and click Next.
7. Review your settings and click Finish.

APPENDIX F – ACTIVE DIRECTORY INSTALLATION AND CONFIGURATION

We installed an Active Directory domain controller on a virtual machine connected to the testing network.

Installing Windows Server 2008 R2 SP1 Enterprise Edition

1. Mount the installation DVD for Windows Server 2008 R2 SP1 Enterprise to the VM.
2. At the Language Selection Screen, click Next.
3. Click Install Now.
4. Select Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
5. Click the I accept the license terms checkbox, and click Next.
6. Click Custom.
7. Click Next.
8. At the User's password must be changed before logging on warning screen, click OK.
9. Enter the desired password for the administrator in both fields, and click the arrow to continue.
10. At the Your password has been changed screen, click OK.
11. Reboot the VM and install VMware tools.

Installing Active Directory

1. On the VM, set a static IP, and set the DNS server to 127.0.0.1.
2. Click Start→Run, and type `DCPROMO` in the Run field.
3. Leave defaults, and click Next on the Welcome window.
4. Click Next on the Operating System Compatibility window.
5. Choose Create a new domain in a new forest, and click Next.
6. Type in the name of your domain, and click Next.
7. At the Domain NetBIOS name, enter a name and click Next.
8. Set the Forest Functional Level to Windows Server 2008, and click Next.
9. Set the Domain Functional Level to Windows Server 2008, and click Next.
10. Leave defaults on the Additional Domain Controller Options window, and click Next.
11. Choose Yes on the pop-up asking if you want to continue.
12. Leave defaults on the Location for Database, Log Files and SYSVOL window, and click Next.
13. Enter a domain password, and click Next.
14. Click Next on the summary page.
15. Click Finish.
16. Click Restart Now.

Installing IIS on Active Directory server

1. Click Start→Administrative Tools→Server Manager.
2. Click Roles→Add Roles.
3. At the Before You Begin screen, click Next.
4. Check Web Server (IIS) and click Next.
5. At the Introduction screen, click Next.
6. At the Select Role Services screen, click Next.

7. Click Install.
8. Click Close.

Installing Certificate Services on Active Directory server

1. Click Start→Administrative Tools→Server Manager.
2. Click Roles→Add Roles.
3. Click Next on the Before You Begin window.
4. Check Active Directory Certificate Services, and click Next.
5. Click Next on the Introduction window.
6. Check Certification Authority and Certification Authority Web Enrollment, and click Add Required Role Services on the pop-up window. Click Next.
7. Choose Enterprise, and click Next.
8. Choose Root CA, and click Next.
9. Choose Create a new private key, and click Next.
10. Leave defaults on the Configure Cryptography for CA window, and click Next.
11. Leave defaults on the Configure CA Name window, and click Next.
12. Leave defaults on the Set Validity Period, and click Next.
13. Leave defaults on the Configure Certificate Database window, and click Next.
14. Click Next on the Web Server (IIS) window.
15. Leave defaults on the Select Role Services window, and click Next.
16. Click Install.
17. Click Close.

Prepping Active Directory for Lync Server testing

A number of steps must be performed on the Active Directory server for Lync Server testing. We cover these in detail below.

Prepping Schema

1. Insert the installation DVD for Lync Server 2010 into the DVD drive.
2. Double-click the CD-DVD drive in Windows to start the installation wizard.
3. Click Yes on the prompt to install the Visual C++ Redistributable Package.
4. When prompted, click Install to start the Deployment Wizard.
5. Accept the terms in the license agreement, and click OK.
6. Click Prepare Active Directory.
7. Click Run for Step 1: Prep Schema.
8. Click Next on the wizard welcome screen.
9. Click Finish.

Prepping Forest

1. Back on the Active Directory Preparation window, click Run for Step 3: Prep Forest.
2. Click Next on the Wizard welcome window.
3. Leave the local domain selected on the Universal Group Location window, and click Next.
4. Click Finish.

Verifying Replication

1. On the domain controller, click Start→Administrative Tools→Active Directory Users and Computers
2. Expand the domain name and click Users.
3. In the right pane, confirm that there are nine CS groups (shown below) within the Users to verify that the replication of the Forest Preparation was successful.
    - CSAdministrator
    - CSArchivingAdministrator
    - CSHelpDesk
    - CSLocationAdministrator
    - CSResponseGroupAdministrator
    - CSServerAdministrator
    - CSUserAdministrator
    - CSViewOnlyAdministrator
    - CSVoiceAdministrator

Prepping the current domain

1. Back on the Active Directory Preparation window, click Run for Step 5: Prep Current Domain.
2. Click Next on the Wizard welcome window.
3. Click Finish.

Providing administrative access to the Lync Server Control Panel

1. Click Start→Administrative Tools→Active Directory Users and Computers.
2. Expand Forest, and select Users.
3. Right-click CSAdministrator, and select Properties.
4. Select the Members tab and add user from Domain that needs rights to make changes on the Lync Server. (i.e., administrator). Click OK.
5. Click OK and close the window.

Modifying password complexity

1. Click Start→Run.
2. Type gpmc.msc and click OK.
3. Expand the Forest and Domain Tabs.
4. Click your domain.
5. In the right pane, under the Linked Group Policy Objects, right-click the Default Domain Policy, and click Edit.
6. Expand Policies→Windows Settings→Security Settings, and click Account Policies.
7. Right-click Password Policy, and click Open.
8. Right-click Password must meet complexity requirements, and click Properties.
9. Change the properties to Disabled, and click OK.
10. Close the Management Editor.

APPENDIX G – MICROSOFT LYNC SERVER INSTALLATION AND CONFIGURATION

We installed Microsoft Lync Server 2010 on a VM residing on the second of two Dell PowerEdge M620 servers.

Configuring the Lync Server VM

After cloning, modify the Lync Server VM to contain the following settings:

- Memory: 8GB
- Virtual processors: 4

Joining the domain

1. Power on the VM.
2. Click Start→Control Panel→Network Connections→Local Area Connection.
3. Click Properties.
4. Highlight Internet Protocol (TCP/IP), and click Properties.
5. Select the Use the following IP address radio button, and enter the desired IP for your VM.
6. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
7. Right-click My Computer, and select Properties.
8. Under the Computer Name tab, click Change.
9. In the Computer Name Changes screen, under Computer name, type `exchange` as your computer name.
10. In the Computer Name Changes screen, under the Member of section, select the Domain radio button, and type `test.local`
11. Select OK to start joining the domain.
12. When the screen appears asking for a person qualified on the domain, type `administrator` as the username and `Password1` as the password.
13. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
14. At the System Properties screen, click OK.
15. When a pop-up appears asking if you want to restart now, click Yes to restart your VM.

Installing Web Server (IIS)

1. Click Start→Administrative Tools→Server Manager.
2. Click Roles, scroll to Web Server (IIS), and click Add Role Services
3. Select the following:
   - Windows Authentication
   - IIS 6 Management Compatibility
   - ASP.NET
   - Client Certificate Mapping Authentication
   - IIS Management Scripts and Tools with any required services they need, and Click Next.
4. Click Install.
5. Click Close.

Adding Desktop Experience

1. Click Start→Administrative Tools→Server Manager.
2. Click Features→Add Features.
3. Select Desktop Experience, add the required role services, and click Next.
4. Click Install.
5. Reboot when prompted
6. Click Close after rebooting.

Adding Directory Service Integration

1. Click Start→Administrative Tools→Server Manager.
2. Click Features→Add Features.
3. Expand Message Queuing, expand Message Queuing Services, and check Directory Service Integration and HTTP Support.
4. Click Add Required Features on the pop-up windows.
5. Click Next.
6. Click Next on the IIS introduction window.
7. Click Next on the Role selection window.
8. Click Install.
9. Reboot when prompted.
10. Close Server Manager.

Installing .NET Framework 3.5.1 Features

1. Click Start→Administrative Tools→Server Manager.
2. Click Features.
3. Click Add Features.
4. At the Select Features screen, select .NET Framework 3.5.1 Features, and add the required features when prompted. Click Next.
5. Click Install.
6. Click Close.

Starting the Lync Server Pre-installation menu

1. Mount the Microsoft Lync Server 2010 ISO to the VM.
2. Double-click the CD-DVD drive in Windows to start the installation wizard.
3. Click Yes on the prompt to install the Visual C++ Redistributable Package.
4. Leave the default Installation Location, and click Install.
5. Accept the terms of the License Agreement, and click OK.

Preparing the single Standard Edition Server

1. In the Lync Server 2010 Deployment Wizard menu, click Prepare first Standard Edition server.
2. Click Next to start installation.
3. Click Finish.

Creating a share for the topology

1. Go to My Computer→C:

2. Right-click and select New→Folder.
3. Name the folder `share`.
4. Right-click the newly created folder, and select Share with → Specific people…
5. Enter `Everyone`, and click Add.
6. Change the permission level for Everyone to Read/Write.
7. Click Share.
8. Click Done.

Installing the Topology Builder and preparing the topology

1. Install Topology Builder, and click Next.
2. Click Start→ All Programs→Microsoft Lync Server 2010, and launch Lync Server Topology Builder.
3. Select New Topology, and click OK.
4. Name file, and choose location to save file.
5. Enter primary SIP domain, and click Next.
6. At the Specify additional supported domains screen, click Next.
7. In Define First site enter site name, and click Next.
8. At the Specify site details screen, click Next.
9. Click Finish, leaving the Open the New Front End Wizard when this wizard closes box checked.
10. At the Define the New Front End pool, click Next.
11. Enter FQDN, select Standard Edition Server, and click Next.
12. At the Select Features screen, Check Conferencing, which includes audio, video and application sharing.
13. Click Next.
14. At the Select collocated server roles screen, accept the default selection, and click Next.
15. At the Associate server roles with this Front End pool screen accept defaults, and click Next.
16. At the Define the SQL store screen, click Next.
17. At the Define the file share screen, leave the defaults, and click Next.
18. At the Specify the Web Services URL, leave the default, and click Finish.
19. Right-click Lync Server 2010 and select Edit Properties.
20. Enter URL for administrative access, select the Central Management Server, and click OK.
21. Right-click Lync Server 2010 and select Publish Topology.
22. Click Next on Publish the topology screen.
23. On the Select Central Management Server screen, click Next.
24. When publishing is completed, click Finish, and close the Lync Server Topology builder application.

Installing Lync Server

1. Back in the Deployment wizard, click Install or Update Lync Server System to launch the Lync Server deployment wizard.
2. Click Run on Step 1 – Install Local Configuration Store.
3. On Configure Local Replica or Central Management Store screen, keep defaults and click Next.
4. When installation is complete, click Finish.
5. Click Run on Step 2 – Setup or Remove Lync Server Components.
6. Click Next.

7. When installation is complete, click Finish.
8. Click Run on Step 3 – Request, Install, or Assign Certificates.
9. Keep defaults, and click Request.
10. At the Certificate Request screen, click Next.
11. On Delayed or Immediate Request screen, accept the default and click Next.
12. Leave the default selection in the Choose a Certification Authority (CA) screen, and click Next.
13. At the Certification Authority Account, click Next.
14. At the Specify Alternate Certificate Template screen, click Next.
15. Enter a name for your certificate, and click Next.
16. On the Organization Information screen enter organizational information, and click Next.
17. Enter Geographical information on Geographical Information screen, and click Next.
18. Accept defaults on Subject Name/Subject Alternate Names screen, and click Next.
19. At the SIP Domain setting on Subject Alternate Names (SANs) screen, select the SIP domain, and click Next.
20. At the Configure additional Subject Alternate Names screen, click Next.
21. On the Certificate Request Summary screen, click Next.
22. When request for certificates has completed, click Next.
23. Click Finish.
24. At the Certificate Assignment screen, click Next.
25. At the Certificate Assignment Summary screen, click Next.
26. Click Finish.
27. At the Certificate Wizard screen, click Close.
28. Click Run on Step 4 – Start Services.
29. At the Start Services screen, click Next.
30. After services are started, click Finish.
31. Click Exit to close the Deployment Wizard.

Configuring Web Component certificate

1. Click Start→Administrative Tools→Server Manager.
2. Expand Roles, expand Web Server (IIS) and click Internet Information Services.
3. Expand your server list and the sites folder, and click Default Web Site.
4. Under IIS, click Authentication.
5. Under the actions menu on the right, choose Bindings…
6. Click Add…
7. Change the Type to HTTPS.
8. Choose the certificate you made in the last section from the SSL certificate drop-down menu, and click OK.
9. Click Close.
10. Close the Server Manager window.

Installing Lync Stress and Performance tool

1. Download the stress and performance tool here http://www.microsoft.com/download/en/details.aspx?id=25005
2. Double-click the .msi file, and click Run.
3. Click Next on the Welcome window.

4. Accept the license agreement, and click Next.
5. Keep the default location, and click Next.
6. Leave defaults to install all features, and click Next.
7. Click Next on the Confirmation window.
8. Click Close.

Running the stress configuration

1. Navigate to C:\Program Files\Microsoft Lync Server2010\LyncStressAndPerfTool\StressConfig.
2. Double-click the StressConfig application.
3. Click Load Configuration File.
4. Choose the SampleData files, and click Open.
5. On the Server tab, enter your FQDN, and your Lync server name in the SQL BE Machine field.
6. On the General Settings tab, enter your domain in the SIPDomain for users' URI and User account domain fields.
7. On the General Settings tab, change the Max number of contacts per user to 500.
8. On the VoIP tab, enter your Area Code, and change the UC Policy to Default Policy.
9. On the Users Tab, click Create Users.
10. On the Contacts Tab, click Create Contacts.
11. Click OK.
12. On the distribution list type 2000 in the DistributionListNumber field, MyDL in the DistributionListPrefix field, and OCSUsers in the DistributionListOU field.
13. Click Create Distribution Lists.
14. Click Save & Exit.

Generating test scripts

1. Navigate to C:\Program Files\Microsoft Lync Server2010\LyncStressAndPerfTool\LyncStress.
2. Double-click User Profile Generator.
3. Make the following changes on the Common Configuration tab:
4. Set Client Machine Settings to 1.
5. Type OCSUser in the Prefix for User Names field.
6. Change Number of users to 1000.
7. Enter your domain in the User and Account domain fields.
8. Enter the FQDN of your server in the Access Proxy or Pool FQDN field.
9. On the General Scenarios tab, change the following fields from None to High:
   a. Instant Messaging
   b. Audio Conferencing
   c. Address Book Web Query
10. Leave defaults on the Voice Scenarios tab.
11. Click Generate Files on the Summary tab.
12. Choose where the generated files should be saved, and click OK.
13. Click OK.
14. Click Exit, and click Yes on the prompt to save the form.
15. Enter a name, and click Save.
16. Copy the generated files to the appropriate client machine.

Configuring Microsoft Lync Client

For our testing, we used one physical client machine for the Microsoft Lync Server client. To create this client, we installed Windows Server 2008 R2 SP1 and several other software components. We followed this process for the configuration:

Joining the domain

1. Select Start→Control Panel→Network Connections→Local Area Connection.
2. Click Properties.
3. Highlight Internet Protocol (TCP/IP), and click Properties.
4. Select the Use the following IP address radio button, and enter the desired IP for your VM.
5. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
6. Right-click My Computer, and select Properties.
7. Under the Computer Name tab, click Change.
8. In the Computer Name Changes screen, under Computer name, type `lyncclient` as your computer name.
9. In the Computer Name Changes screen, under the Member of section, select the Domain radio button, and type `test.local`
10. Select OK to start joining the domain.
11. When the screen appears asking for a person qualified on the domain, type `administrator` as the username and `Password1` as the password.
12. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
13. At the System Properties screen, click OK.
14. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing .NET

1. Open Server Manager.
2. Click Features→Add Features.
3. Check .NET 3.5 and accept the required features. Click Next.
4. Click Next on the welcome window.
5. Click Next on Select Role Services.
6. Click Install.
7. Click Close.

Enabling Desktop Experience

1. Open Server Manager.
2. Click Features→Add Features.
3. Check Desktop Experience, and click Next.
4. Click Install.
5. Click Close.
6. Click Yes on the prompt to reboot.
7. When the installation finishes, click Close.

Installing Microsoft Visual C++ Redistributable Package

1. Download the Microsoft Visual C++ Redistributable Package here: http://www.microsoft.com/download/en/confirmation.aspx?id=15336
2. Double-click the application to start the install.
3. Click Run.
4. Click Next on the Welcome window.
5. Accept the license agreement, and click Install.
6. Click Finish.

Installing Lync Server Stress and Performance Tool

1. Download the stress and performance tool here http://www.microsoft.com/download/en/details.aspx?id=25005
2. Double-click the .msi file, and click Run.
3. Click Next on the Welcome window.
4. Accept the license agreement, and click Next.
5. Keep the default location, and click Next.
6. Leave defaults to install all features, and click Next.
7. Click Next on the Confirmation window.
8. Click Close.

Running MaxUserPorts

1. Navigate to Microsoft Lync Server 2010→LyncStressAndPerfTool→LyncStress.
2. Double-click MaxUserPorts.
3. Click Yes on the Registry Editor warning.
4. Click OK.

Registering the perfmon counters

1. Open a command window, and navigate to the LyncStress folder.
2. Type regsvr32 /i /n LyncPerfToolPerf.dll, and press Enter.
3. Click OK on the confirmation popup window.
4. Type regsvr32 /i /n S4Perf.dll, and press Enter.
5. Click OK on the confirmation popup window.
6. Close the command window.

APPENDIX H – MICROSOFT EXCHANGE INSTALLATION AND CONFIGURATION

We installed Microsoft Exchange 2010 SP2 on a VM residing on the first of two Dell PowerEdge M620 servers.

Configuring the Exchange 2010 VM

After cloning, modify the Exchange 2010 VM to contain the following settings:

- Memory: 32GB
- Virtual Processors: 4
- Additional virtual disks:
  - 1 x 2 TB virtual disk for mailbox storage (Thick provision lazy zeroed)
  - 1 x 30 GB virtual disk for mailbox logs (Thick provision lazy zeroed)

Joining the domain

1. Power on the VM.
2. Select Start→Control Panel→Network Connections→Local Area Connection.
3. Click Properties.
4. Highlight Internet Protocol (TCP/IP), and click Properties.
5. Select the Use the following IP address radio button, and enter the desired IP for your VM.
6. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
7. Right-click My Computer, and select Properties.
8. Under the Computer Name tab, click Change.
9. In the Computer Name Changes screen, under Computer name, type `exchange` as your computer name.
10. In the Computer Name Changes screen, under the Member of section, select the Domain radio button, and type `test.local`
11. Select OK to start joining the domain.
12. When the screen appears asking for a person qualified on the domain, type `administrator` as the username and `Password1` as the password.
13. At the Welcome pop-up window and the window warning that you must restart the computer for the changes to take effect, click OK.
14. At the System Properties screen, click OK.
15. When a pop-up appears asking if you want to restart now, click Yes to restart your VM.

Installing .NET Framework 3.5.1 Features and Internet Information Services

1. Select Start→Administrative Tools→Server Manager.
2. Click Features.
3. Click Add Features.
4. Select .NET Framework 3.5.1 Features
5. Click Add Required Role Services.
6. Click Next.
7. Click Next.

8. At the Select Role Services screen, select the IIS 6 Metabase Compatibility, IIS 6 Management Console, Basic Authentication, Windows Authentication, Digest Authentication, Static content compression, and Dynamic content Compression checkboxes, and click Next.
9. At the Confirm Installation Selections screen, click Install.
10. At the Installation Results screen, click Close.

Installing Microsoft Filter Pack 2.0

1. Download the Microsoft Filter Pack 2.0. (http://www.microsoft.com/downloads/en/details.aspx?FamilyID=5cd4dcd7-d3e6-4970-875e-aba93459fbee)
2. Run FilterPackx64.EXE.
3. Click Next.
4. Click I accept the terms in the License Agreement, and click Next.
5. When the installation is complete, click OK.

Installing Exchange Server 2010

1. Click Start, type `services.msc` and press Enter.
2. Right-click the Net.Tcp Port Sharing service, and click Properties.
3. Change the Net.Tcp Port Sharing startup type to Automatic, and click OK.
4. Open command prompt and type `ServerManagerCmd –i RSAT-ADDS`, and press Enter.
5. Reboot the VM.
6. Mount the installation ISO to the VM and click Setup.EXE when prompted.
7. The installer should consider steps 1 and 2 complete, and gray them out.
8. Click the link for Step 3: Choose Exchange Language Option.
9. Click Install only languages from the DVD.
10. Click the link for Step 4: Install Microsoft Exchange Server 2010 SP1.
11. Click Next to go past the introduction screen.
12. Accept the license agreement, and click Next.
13. Select No for error reporting, and click Next.
14. Select Typical Exchange Server Installation, and click Next.
15. Leave the organization name at default (First Organization), and click Next.
16. At the question about client computers running Outlook 2003 and earlier, select Yes, and click Next.
17. Click Next to accept defaults for Configure Client Access server external domain.
18. At the Customer Experience Improvement Program screen, select I don't want to join the program at this time, and click Next.
19. If a warning about a lack of SMTP appears after the check finishes, ignore it.
20. Click Install to start the installation process.
21. Once installation is complete, click Finish.
22. Click OK when prompted to reboot.
23. Click Close.
24. Click Yes to confirm exit.
25. Reboot the VM.

Installing SP2 for Microsoft Exchange 2010

1. Download Service Pack 2 for Microsoft Exchange 2010 (Exchange2010-SP2-x64.exe) from http://www.microsoft.com/download/en/details.aspx?id=28190 to c:\SP2 on the VM.
2. Double-click the downloaded file to extract the installation files.
3. Click OK to accept the destination directory for the extracted files.
4. Double-click setup.exe to launch the installer.
5. Click Install Microsoft Exchange Server upgrade.
6. At the Introduction screen, click Next.
7. Accept the terms in the license agreement, and click Next. The Readiness Checks will now run.
8. Install any roles in Server Manager that the Readiness Checks prompt you to install.
9. When the checks successfully complete, click Upgrade.
10. Click Finish, and reboot the VM.

Configuring Exchange Server 2010 connector

1. In the VM, Select Start→All Programs→Microsoft Exchange Server 2010→Exchange Management Console.
2. In the left pane, click Microsoft Exchange On-Premises.
3. In the left pane, expand Organization Configuration, and select Hub Transport.
4. In the action pane on the far right, select New Send Connector.
5. Name the send connector `SMTP`, select the intended use as Internet, and click Next.
6. In the Address space screen, click Add.
7. In the SMTP Address Space screen, type `*` as the address, ensure that the installer has checked Include all subdomains, and click OK.
8. Click Next.
9. Accept defaults for the next two pages by clicking Next.
10. At the New Connector page, click New to create the connector.
11. Click Finish to close the New SMTP Send Connector wizard.

Configuring the Exchange Server 2010 Mailbox role

1. Select Start→All Programs→Microsoft Exchange Server 2010→Exchange Management Console.
2. In the left pane, expand Organization Configuration, and click Mailbox.
3. Click the Database Management tab.
4. Right-click Mailbox Database, and select Properties.
5. Select the Maintenance tab.
6. Check the Enable circular logging box.
7. Check the box beside This database can be overwritten by a restore.
8. Next to Maintenance interval, click Customize.
9. Remove all blue from the boxes so the system will not perform maintenance, and click OK.
10. Click OK.
11. Click OK to any warnings about circular logging being applied after the database is remounted.
12. On the far right panel, click Move Databases.
13. Change the Database file and Log folder path locations to point to the two additional attached virtual disks, and click Move.

14. If the application prompts you to dismount, click Yes.
15. Click Finish.
16. Right-click Public Folder Database, and select Properties.
17. Check the Enable circular logging checkbox and uncheck the ESE scanning checkbox.
18. Click Customize next to Maintenance interval.
19. Remove all blue from the boxes so the system will not perform maintenance, and click OK.
20. Click OK.
21. On any warnings about circular logging being applied after the database is remounted, click OK.
22. Click Move Database on the far right panel.
23. Change the Database file and Log folder path locations to point to the two additional attached virtual disks respectively, and click Move.
24. If the application prompts you to dismount, click Yes.
25. Click Finish.

Installing and configuring the Exchange 2010 mail test client (LoadGen)

For our testing, we used one physical client machine for the LoadGen workload. To create this client, we installed Windows Server 2008 R2 SP1 and several other software components. We followed this process for the configuration:

Joining the domain

1. Select Start→Control Panel→Network Connections→Local Area Connection.
2. Click Properties.
3. Highlight Internet Protocol (TCP/IP), and click Properties.
4. Select the Use the following IP address radio button, and enter the desired IP for your VM.
5. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
6. Right-click My Computer, and select Properties.
7. Under the Computer Name tab, click Change.
8. In the Computer Name Changes screen, under Computer name, type `loadgen` as your computer name.
9. In the Computer Name Changes screen, under the Member of section, select the Domain radio button, and type `test.local`
10. Select OK to start joining the domain.
11. When the screen appears asking for a person qualified on the domain, type `administrator` as the username and `Password1` as the password.
12. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
13. At the System Properties screen, click OK.
14. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Internet Information Services

1. Click Start→Administrative Tools→Server Manager.
2. On the left pane, click Roles.

3. Click Add Roles.
4. Click the Application Server checkbox.
5. When the Add features required for Application Server? screen appears, click Add Required Features.
6. Click Next.
7. Click Next.
8. At the Select Role Services page for Application Server, click the Web Server (IIS) Support checkbox.
9. Click Add Required Support Role Services.
10. Click Next.
11. Click Next.
12. At the Select Role Services page for Web Server (IIS), click IIS 6 Management Compatibility, ASP, and CGI checkboxes; and click Next.
13. Click Install.
14. Click Close.

Installing Load Generator 2010

Download and install Load Generator 2010 using all defaults.

Preparing Load Generator

1. Log into the mail client using the tester account.
2. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator 2010.
3. When the Load Generator screen appears, select Start a new test.
4. Select Create a new test configuration, and click Continue.
5. Change the total length of simulation to 1 hour.
6. In the Specify test settings screen, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
7. Make 1,000 users in the Mailbox Database, and click Continue.
8. To accept defaults for Advanced recipient settings, click Continue.
9. In the Specify test user groups screen, select the plus sign to add a user group.
10. Change the Client Type to Outlook 2007 Cached, the Action Profile to Average, and the Mailbox size to 250 MB.
11. In Remote configurations, click Continue.
12. Click Save the configuration file as, and name it `testcfg.xml`
13. After saving the configuration file, check the Initialize public store as well checkbox, and click Start the initialization phase (recommended before running the test).

APPENDIX I – MICROSOFT SHAREPOINT INSTALLATION AND CONFIGURATION

We installed Microsoft SharePoint 2010 on a VM residing on the second of two Dell PowerEdge M620 servers.

Configuring the SharePoint VM

After cloning, modify the SharePoint VM to contain the following settings:

- Memory: 8GB
- Virtual Processors: 4
- Additional virtual disks:
  - 1 x 250GB virtual disks for database storage (Thick provision lazy zeroed)

Joining the domain

1. Select Start→Control Panel→Network Connections→Local Area Connection.
2. Click Properties.
3. Highlight Internet Protocol (TCP/IP), and click Properties.
4. Select the Use the following IP address radio button, and enter the desired IP for your VM.
5. Select the Use the following DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
6. Right-click My Computer, and select Properties.
7. Under the Computer Name tab, click Change.
8. In the Computer Name Changes screen, under Computer name, type `sharepointvm` as your computer name.
9. In the Computer Name Changes screen, under the Member of section, select the Domain radio button, and type `test.local`
10. Select OK to start joining the domain.
11. When the screen appears asking for a person qualified on the domain, type `administrator` as the username and `Password1` as the password.
12. At the Welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
13. At the System Properties screen, click OK.
14. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Microsoft SQL Server 2012

1. Mount the installation ISO to the VM.
2. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2012 DVD, and double-click.
3. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
4. In the left pane, click Installation.
5. Click New SQL Server stand-alone installation or add features to an existing installation.
6. At the Setup Support Rules screen, wait for the rule check to complete. If there are no failures or relevant warnings, click OK.
7. Select the Specify a free edition and select Evaluation from the drop-down menu. Click Next.

8. Click the checkbox to accept the license terms, and click Next.
9. If no failures are displayed after the setup support files are installed, click Next.
10. At the Setup Role screen, choose SQL Server Feature Installation.
11. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Click Next.
12. At the Installation Rules screen, click Next after the check completes.
13. At the Instance configuration screen, leave the default selection of default instance, and click Next.
14. At the Disk Space Requirements screen, click Next.
15. At the Server Configuration screen, check that NT AUTHORITY\SYSTEM is selected for SQL Server Agent and SQL Server Database Engine. Click Next.
16. Assuming there are no failures, click Next.
17. At the Database Engine Configuration screen, select Mixed Mode.
18. Enter and confirm a password for the system administrator account.
19. Click Add Current user. This may take several seconds.
20. Click the Data Directories tab and enter the appropriate drive and folder to which you eventually deploy the SharePoint databases.
21. Click Next.
22. At the Error and usage reporting screen, click Next.
23. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
24. At the Ready to Install screen, click Install.
25. After installation completes, click Close.
26. Close the installation window.

Installing Microsoft SharePoint Server 2010

1. Mount the installation media to the VM.
2. Launch setup.exe, and click Install software prerequisites.
3. Review the list of software, and click Next.
4. Accept the EULA, and click Next.
5. When the prerequisites finish installing, click Finish.
6. On the main SharePoint installation menu, click Install SharePoint Server.
7. Enter your product license key, and click Continue.
8. Accept the EULA, and click Continue.
9. Choose the Complete server type, and click Install.
10. When the installation finishes, check the box for Run the SharePoint Products Configuration Wizard now, and click Close.
11. On the Welcome to SharePoint Products screen, click Next.
12. On the pop-up warning about services that will need to be restarted during the configuration, click Yes.
13. Choose Create a new server farm, and click Next.
14. Enter the name of your existing database instance on the same application server.
15. Specify a username and password, and click Next.

16. Enter a passphrase into the Passphrase and Confirm Passphrase fields, and click Next.
17. Leave the default settings on the Configure SharePoint Central Administration Web Application screen, and click Next.
18. Verify your settings, and click Next.
19. When the wizard has completed the configuration, click Finish.
20. Choose Run the farm configuration wizard on the Central Administration site.
21. Choose the services you wish to include in your server farm, and click Next.
22. Enter the specifications for the new site, and click OK.
23. Click Finish.

Preparing the SharePoint test client

For our testing, we used one physical client machine for the SharePoint client. To create this client, we installed Windows Server 2008 R2 SP1, joined the client to the domain, and installed several other software components. We followed this process for the configuration:

Installing Microsoft Visual Studio 2010 Ultimate Edition

1. Download vs_ultimateweb.exe from www.microsoft.com/download/en/details.aspx?id=12752
2. Double-click vs_ultimateweb.exe to run the installer.
3. Uncheck the box beside Yes, send information about my computer, and click Next.
4. If you see a pop-up requiring a Windows Imaging component, click the Windows Imaging Component is Required link.
5. Click Download on the appropriate Imaging component, and choose Run.
6. Accept the EULA, and click Next.
7. Close the pop-up window.
8. Click Next.
9. Accept the EULA, review the components to be installed, and click Next.
10. Choose the Full installation and location for the install, and click Install.
11. Click Finish.
12. Reboot the machine.
13. Click Start→All Programs→Microsoft Visual Studio 2010→Microsoft Visual Studio 2010.
14. When prompted, select General Development Settings and click Start Visual Studio.

Setting up and running WSSDW 1.0.0.0 Beta

1. Complete the following steps on the Domain Controller machine:
   a. Click Start→Administrative Tools→Active Directory Users and Computers.
   b. Right-click the domain name and select New→Group.
   c. Enter testdomaingroup1 for the group name.
   d. Repeat steps a through c and create another group named testdomaingroup2
2. Download the following from http://sptdatapop.codeplex.com/releases/view/1141
   - To the SharePoint 2010 VM
     - WSS Data Population Tool RunTime.zip
     - WSS Data Population Tool.chm

- WSS Data Population Tool Sample.zip
    - To the SharePoint 2010 test client
    - WSS Performance Load Tests

3. Complete the following steps on the SharePoint 2010 VM:
   a. Extract the contents of WSS Data Population Tool RunTime.zip and WSS Data Population Tool Sample.zip.
   b. Copy the contents of both extracted .zip folders (WSS Data Population Tool Run Time and WSS Data Population Tool Sample) into the root of C:
4. Download SharePtServerDeployment.doc from: http://www.microsoft.com/en-us/download/details.aspx?id=10009 and place it into the c:\wssdw folder.
   a. Rename WSS Data Population Sample File.xml to `WSS_Data_Population_Sample_File.xml` so that there are no spaces in the name. This allows the script to execute from the command prompt.
   b. Right-click WSS_Data_Population_Sample_File.xml and click Edit to open the document in Notepad. Scroll down to line 55 and remove ".txt" from the document name in the destfile parameter. Then, change any applicable parameters to match the following:

```
<setproperty NumberOfSiteCollections="100" />
<setproperty SiteNameBase="testsite" />
<setproperty NumberOfGroups="2" />
<setproperty GroupNameBase="testgroup" />
<setproperty TargetDomain="test.local" />
<setproperty DomainGroupRoot="testdomaingroup" />
<setproperty DomainUserName="administrator" />
<setproperty DomainUserPassword="Password1" />
<setproperty DesignerGroup="design" AdminGroup="full control" />
<setproperty NumberOfDocumentLibraries="5" />
<setproperty DocumentLibraryNameBase1="testdoclib_A" />
<setproperty NumberOfDocuments="10" />
<setproperty SourceFileLocation="c:\wssdw\SharePtServerDeployment.doc" />
<setproperty DestFile="test" />
<setproperty NumberOfFileVersions="3" />
<setproperty DocumentLibraryNameBase2="testdoclib_B" />
<setproperty NumberOfLists="10" />
<setproperty ListNameBase="testlist" />
<setproperty NumberOfListItems="20" />
<setproperty webpartpath="webpartpagesfolder" />
```

   c. Open the command prompt and execute the script:

```
C:\>WSSDW.exe WSS_Data_Population_Sample_File.xml
```

5. Complete the following steps on the SharePoint 2010 test client:
   a. Extract the contents of WSS Performance Load Test to C: drive on the SharePoint test client.
   b. On the SharePoint test client, open the WSSTransactions folder, right-click→Edit, and modify the following files as follows:
      - users.csv

      Under `username,password` enter `test.local\administrator,Password1` and remove the remaining entries.

- serverUrl.csv

Under `serverUrl` replace `http://server` with `http://spserver` to match the server name of the SharePoint 2010 VM.

- HierarchyManagerUsers.csv

Under `username,password` replace domain`\username,password` with `test.local\administrator,Password1`

c. Open the WssTestProject.sln file in Visual Studio 2010 Ultimate.
d. When prompted, click Next.
e. Click Finish.
f. When prompted, leave the Retarget the project to .NET Framework 4. After the project opens, you can retarget it to another Framework or Profile radio button selected, and click OK.
g. Click Close.
h. In the Solution Explorer pane, scroll to WSSDispForm, and double-click it.
i. Expand the top menu under WSSDispForm in the left pane, expand Validation rules, and delete the FindText entry that references mysite.aspx.
j. Click Save.
k. Repeat steps h through j for WSSHomePage and WSSSmallDocLibAllItems.
l. Click Project→Add Load Test.
m. At the Welcome to the Create New Load Test Wizard, click Next.
n. Enter `Test` for the load test scenario name, change the think time between test iterations to 45 seconds, and click Next.
o. At the Load pattern settings for a load test scenario screen, select Constant load, enter `67` for the User Count, and click Next.
p. Click Next at the Select a test mix model for the load test.
q. At the Add test to a load test scenario and edit the test mix, click Add and select the following tests from the list below. Additionally, modify the distribution as follows:
    - WSSDispForm 10%
    - WSSDocHTTPFetch 30%
    - WSSHomePage 20%
    - WSSSmallDocLibAllItems 30%
    - WSSPutDocumentCoded 10%
r. Click OK.
s. At the Network types screen, select LAN, and click Next.
t. At the Browser screen, click Next.
u. At the Specify computers to monitor with counters sets during load test run screen, click Next.
v. At the Review and edit run settings for load test screen, enter 15 minutes for the Warm-up duration, enter 30 minutes for Run duration, 15 minutes for the Cool down duration, and click Finish.

6. To ensure that the WSSDW workload evenly selects different SharePoint sites at random, create .csv lists of a number of categories within each test and addthe following parameters to each:
    - WSSD WSSDispForm: Site name, list name, and list IDs.
    - WSSDocHTTPFetch: Site name, doc revision, document library name, and document name.

- WSSHomePage: Site name
- WSSSmallDocLibAllItems: Site name, and document library name
- WSSPutDocumentCoded: Site name

7. Add the following lines of code to the WSSPutDocumentCoded test:

```
[DeploymentItem("officeservertransactions\\siteNames.csv",
"officeservertransactions")]

[DataSource("Sites", "Microsoft.VisualStudio.TestTools.DataSource.CSV",
"|DataDirectory|\\officeservertransactions\\siteNames.csv",
Microsoft.VisualStudio.TestTools.WebTesting.DataBindingAccessMethod.Random,
Microsoft.VisualStudio.TestTools.WebTesting.DataBindingSelectColumns.SelectO
nlyBoundColumns, "siteNames#csv")]

[DataBinding("Sites", "siteNames#csv", "siteName",
"Sites.siteNames#csv.siteName")]
```

8. At the "WebTestRequest request1" line, add:

```
+ this.Context["Sites.siteNames#csv.siteName"].ToString() +
```

APPENDIX J – INSTALLING AND CONFIGURING THE DATABASE WORKLOAD

For our medium utilization scenario, we installed Microsoft SQL Server 2012 on two VMs, one VM residing on the first of our two Dell PowerEdge M620 servers, and the second VM residing on the second of our two Dell PowerEdge M620 servers. For our high utilization scenario, we installed Microsoft SQL Server 2012 on two additional VMs, one VM residing on the first of our two Dell PowerEdge M620 servers, and the second VM residing on the second of our two Dell PowerEdge M620 servers.

Configuring the SQL Server VMs

After cloning, modify the four SQL VMs to each contain the following settings:

- Memory: 48GB
- Virtual Processors: 8
- Additional virtual disks:
  - 1 x 295GB virtual disks for SQL database data (Thick provision lazy zeroed)
  - 1 x 195GB virtual disks for SQL log data (Thick provision lazy zeroed)

Installing SQL Server 2012

1. Open the console for the VM or connect to the VM with RDP.
2. Mount the installation ISO to the VM.
3. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2012 DVD, and double-click.
4. If the installer prompts you with a .NET installation prompt, click Yes to enable the .NET Framework Core role.
5. In the left pane, click Installation.
6. Click New SQL Server stand-alone installation or add features to an existing installation.
7. At the Setup Support Rules screen, wait for the rule check to complete. If there are no failures or relevant warnings, click OK.
8. Select the Specify a free edition and select Evaluation from the drop-down menu. Click Next.
9. Click the checkbox to accept the license terms, and click Next.
10. If no failures are displayed after the setup support files are installed, click Next.
11. At the Setup Role screen, choose SQL Server Feature Installation.
12. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Click Next.
13. At the Installation Rules screen, click Next after the check completes.
14. At the Instance configuration screen, leave the default selection of default instance, and click Next.
15. At the Disk Space Requirements screen, click Next.
16. At the Server Configuration screen, check that NT AUTHORITY\SYSTEM is selected for SQL Server Agent and SQL Server Database Engine. Click Next.
17. Assuming there are no failures, click Next.
18. At the Database Engine Configuration screen, select Mixed Mode.

19. Enter and confirm a password for the system administrator account.
20. Click Add Current user. This may take several seconds.
21. Click the Data Directories tab and enter the appropriate drive and folders for database and logs.
22. Click Next.
23. At the Error and usage reporting screen, click Next.
24. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
25. At the Ready to Install screen, click Install.
26. After installation completes, click Close.
27. Create a SQL Server login for the ds2user (see the Configuring the database server (DVD Store) section for the specific script to use).
28. Copy the pre-created DVD Store backup to the specified backup volume.
29. Download and install any available updates for Microsoft SQL Server 2012.

Configuring database workload client

For our testing, we used two to four client machines for the Microsoft SQL Server client, depending on whether we were running the medium or high utilization scenario. To create these clients, we installed Windows Server 2008 R2 SP1, assigned a static IP address, and installed .NET 3.5.

Configuring the database

Data generation overview

We generated the data using the Install.pl script included with DVD Store version 2.1 (DS2), providing the parameters for our 40GB database size and the database platform on which we ran: Microsoft SQL Server. We ran the Install.pl script on a utility system running Linux. The database schema was also generated by the Install.pl script.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2012. We built the 40GB database in SQL Server 2012, and then performed a full backup, storing the backup file on the C: drive for quick access. We used that backup file to restore the server between test runs.

The only modification we made to the schema creation scripts were the specified file sizes for our database. We explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Besides this file size modification, the database schema was created and loaded according to the DVD Store documentation. Specifically, we followed the steps below:

1. We generated the data and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 40GB database and the appropriate changes to drive letters.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server.
3. We created database tables, stored procedures, and objects using the provided DVD Store scripts.
4. We set the database recovery model to bulk-logged to prevent excess logging.

5. We loaded the data we generated into the database. For data loading, we used the import wizard in SQL Server Management Studio. Where necessary, we retained options from the original scripts, such as Enable Identity Insert.
6. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
            DEFAULT_DATABASE=[master],
            DEFAULT_LANGUAGE=[us_english],
            CHECK_EXPIRATION=OFF,
            CHECK_POLICY=OFF
GO
```

9. We set the database recovery model back to full.
10. We created the necessary full text index using SQL Server Management Studio.
11. We created a database user and mapped this user to the SQL Server login.
12. We then performed a full backup of the database. This backup allowed us to restore the databases to a pristine state relatively quickly between tests.

    Figure 9 shows our initial file size modifications.

Logical name	Filegroup	Initial size (MB)
Database files		
primary	PRIMARY	2
cust1	DS_CUST_FG	12,288
cust2	DS_CUST_FG	12,288
cust3	DS_CUST_FG	12,288
cust4	DS_CUST_FG	12,288
ind1	DS_IND_FG	5,355
ind2	DS_IND_FG	5,355
ind3	DS_IND_FG	5,355
ind4	DS_IND_FG	5,355
ds_misc	DS_MISC_FG	200
orders1	DS_ORDERS	6,144
orders2	DS_ORDERS	6,144
orders3	DS_ORDERS	6,144
orders4	DS_ORDERS	6,144
Log files		
ds_log	Not Applicable	20,480

Figure 9. Our initial file size modifications.

APPENDIX K – RUNNING THE TEST

To run the test, we configured a 60 minute test window, allowing each benchmark 15 minutes to warm up prior to the measurement window for performance and latency on each of the solutions.

1. Shut down all VMs, and using the EqualLogic management interface, create a snapshot of each volume. These snapshots were used to restore to a pre-test state so additional identical runs could be performed.
2. Begin running the LoadGen benchmark. LoadGen was set to run for 1 hour, with a 15-minute allotted warm-up period, 30-minute performance measurement window, and 15-minute cool-down period.
3. Immediately after beginning the LoadGen benchmark, start the WSSDW workload. This workload was set to run for 1 hour, with a 15-minute warm up period, 30-minute run period and measurement window, and 15-minute cool-down period.
4. Immediately after beginning the WSSDW workload, start the three LyncPerfTool workloads using the generated script. These workloads were set to have a 15 minute warmup time and then run for 30 minutes of recorded performance.
5. Immediately after beginning all three LyncPerfTool workloads, start the DVD Store benchmark. DVD Store was set to warm up for 15 minutes, and then run for 30 minutes of recorded performance.
6. On completion of all of the test loads, collect the test results for each test and shut down all of the VMs.
7. Using the EqualLogic management interface, revert to the snapshot of each volume taken before the test started to restore all databases and workloads to an initial state.

About running the LoadGen test

Microsoft Exchange Load Generator (LoadGen) is an industry-standard tool for benchmarking Microsoft Exchange Server 2003, 2007, or 2010 mail servers. LoadGen simulates standard mail activity from a set number of users. When the workload finishes, LoadGen calculates the number of milliseconds necessary to complete its predefined tasks and reports these response times.

LoadGen measures the impact that mail clients using the MAPI, OWA, IMAP, POP, and SMTP protocols have on Exchange servers. We can test how effectively a server or guest running Exchange responds to email loads. The simulator, running on a client machine, generates mail load by sending multiple requests from many users to the Exchange server.

To run the test, we installed the LoadGen client and server components and simulated 1,000 Exchange users targeting the Exchange VM using LoadGen's Average Workload profile. We ran the LoadGen benchmark for 60 minutes, and beginning at the 15 minute mark, we used a 30 minute measurement window for performance monitoring.

For more details about LoadGen, see http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=14060.

About running the SharePoint Server test

To simulate the traffic of 1,000 SharePoint Server 2010 users, we used a customized version of the WSSDW 1.0.0.0 Beta test. This test creates sample data, populates the server with it, and simulates SharePoint Server users completing everyday tasks.

We used Visual Studio 2010 to execute the test workload, generating a realistic user workload where each of the simulated users performed a task approximately every minute. The load test was 60 minutes long, consisting of a 15-minute warm-up time, 30-minute measurement window.

While the test was running, we recorded CPU utilization and total requests per second on our SharePoint server using Windows Performance Monitor. We also recorded latency using the Web Page Response Time counter in Visual Studio load test parameters.

About running the Lync Server test

We ran a load test composed of three commonly used tasks that Lync provides: IM messaging, Audio/Video conferencing, and Address Book Search functionality. We ran 1,000 users, with 960 users dedicated to instant messaging, 30 users dedicated to Audio/Video conferencing, and 10 users dedicated to searching. This was the default user allocation by the Lync Server Stress And Performance Tool generator. We ran the test for 60 minutes and calculated the total number of actions completed for each task using the 30 minute block of time coinciding with the other tests. We used Windows Performance Monitor to record results using the Lync counters provided by the testing software. Where appropriate, we divided the number of tasks by the 1,800 second run time to get a task/second score.

About running the DVD Store tests

We created a series of batch files, SQL scripts, and shell scripts to automate the complete test cycle. DVD Store outputs an orders-per-minute metric, which is a running average calculated through the test. In this report, we report the last OPM reported by each client/target pair.

Each complete test cycle consisted of the general steps listed below.

1. Clean up prior outputs from the host system and all client driver systems.
2. Drop all databases from all target VMs.
3. Restore all databases on all target VMs.
4. Shut down all VMs.
5. Reboot the host system and all client systems.
6. Wait for a ping response from the server under test (the hypervisor system), all client systems, and all VMs.
7. Let the test server idle for 20 minutes.
8. Start the DVD Store driver on all respective clients.

   We used the following DVD Store parameters for testing the virtual machines in this study:

   ```
   ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=30 --
   n_threads=36 --db_size=40GB --think_time=0.005 --detailed_view=Y --
   warmup_time=15
   ```

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Principled Technologies, Inc.
1007 Slater Road, Suite 300
Durham, NC, 27703
www.principledtechnologies.com

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