



Exchange 2010 migration: Legacy HP ProLiant DL385 to Dell PowerEdge R510

Test report commissioned by Dell Inc. November 2009

Executive summary

We compare the benefits of migrating a legacy Microsoft® Exchange 2003 infrastructure to Microsoft Exchange 2010. The new Dell™ PowerEdge™ R510 solution, using only internal Near Line SAS drives, delivered multiple advantages over the legacy (approximately 4 years old) HP ProLiant DL385 solution.

KEY FINDINGS

The Dell PowerEdge R510 solution delivered **payback in under a year** and up to **\$24K per year** in annual TCO savings over the legacy HP ProLiant DL385 solution. (See Figures 6 and 7.)

The Dell PowerEdge R510 solution used up to **50% less power** than the legacy HP ProLiant DL385 solution.

The Dell PowerEdge R510 solution supported **10 times the mailbox size** while delivering equivalent performance to the legacy HP ProLiant DL385 solution.

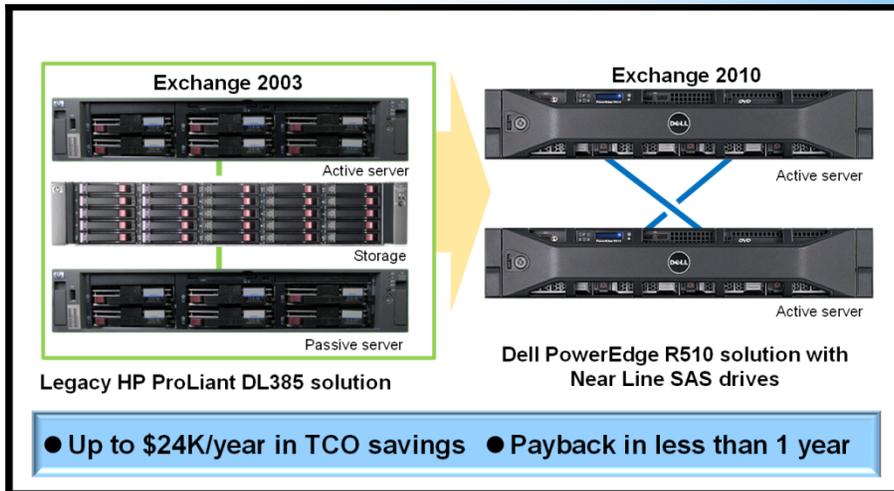


Figure 1: The two solutions in our migration testing.

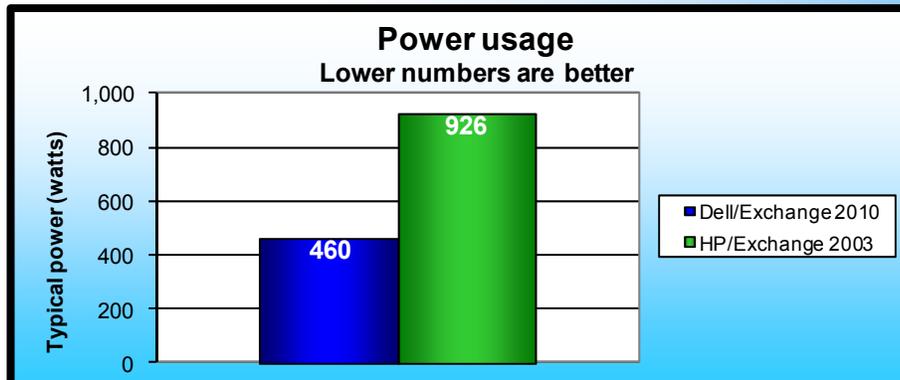


Figure 2: Power usage for the two solutions. Lower numbers are better.

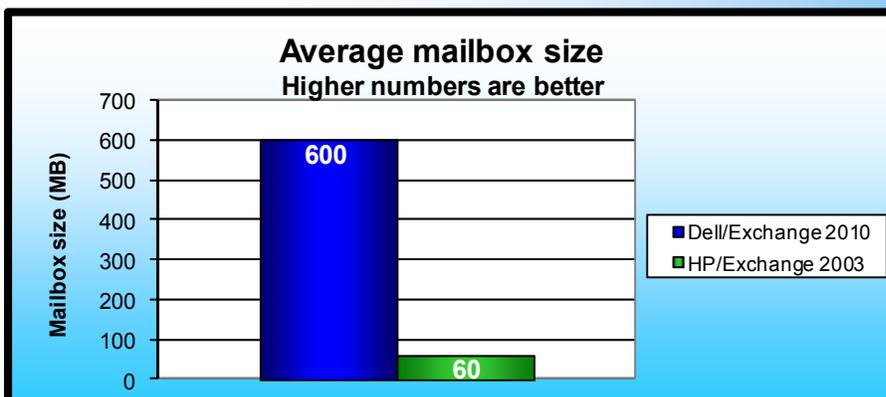


Figure 3: Average mailbox size for the two solutions. Higher numbers are better.

Our migration scenario

Components of the migration

Our migration scenario models a mid-sized enterprise supporting 3,000 Exchange users on Microsoft Exchange 2003 running on two approximately 4-year-old HP ProLiant DL385 mailbox servers and a single HP StorageWorks Modular Smart Array 1000 in an active/passive cluster. The Dell PowerEdge R510 solution can provide savings in hardware support agreements, facilities, energy usage, hardware management, and end-user productivity gains

Figure 4 summarizes the migration scenario.

	Before migration	After migration
Servers	Two HP ProLiant DL385 servers with two 2.8GHz AMD™ Opteron™ 254 processors and 4GB RAM	Two Dell PowerEdge R510 servers with two 2.53GHz Intel® Xeon® Processor E5540s and 12GB RAM
Storage per server	Internal OS drives plus HP StorageWorks Modular Smart Array 1000 connected via Fibre Channel	Internal drives only: Two 300GB 15,000RPM SCSI drives, six 1TB 7,200RPM Near Line SAS drives
Operating system	Windows Server 2003 R2 SP2 Enterprise Edition	Windows Server 2008 R2 Enterprise Edition with Hyper-V
Microsoft Exchange version	Microsoft Exchange Server 2003	Microsoft Exchange Server 2010
Database redundancy and high availability	Active/Passive Servers	Database Availability Groups, load balanced CAS/HUB roles using Hyper-V virtual machines
Number of Exchange users	3,000	3,000
Usage model	Average users	Average users
Average mailbox size (MB)	60	600

Figure 4: Components of the migration scenario.

Dell PowerEdge R510 rack servers provide high capacity, high value, and the ability to deliver the performance needed by the high-volume mailboxes in our test scenario. The Dell PowerEdge R510 with internal storage of up to eight high-capacity hard drives allowed for the mailbox expansion we needed, and delivered on return on investment (ROI) and input/output operations per second (IOPS). We took advantage of the drive capacity and installed six 1TB 7,200RPM Near Line SAS drives and two 300GB 15,000RPM SCSI drives on each of the Dell PowerEdge R510 servers. We included Intel Xeon Processor 2.53 GHz E5540s in the upgrade solution to provide high performance, power savings, and reasonable price.

Microsoft Exchange Server 2010 requires fewer IOPS for Exchange workloads than do previous Exchange versions. This change alone made Exchange 2010 a compelling choice for this migration. However, the organization also wants to increase average mailbox size from 60 MB to 600 MB for its users, a change that would not be practical in Exchange 2003 due to the increased cost of the high-speed drives required to service the IOPS of the Exchange 2003 workload. In our testing, we found that Microsoft Exchange Server 2010 could deliver comparable performance to Microsoft Exchange 2003 when running with larger mailboxes on fewer, lower-cost, higher-capacity, lower-speed drives.

Considerations

We considered a specific usage scenario for this migration: an organization with 3,000 Microsoft Exchange 2003 users with an average mailbox size of 60 MB and an immediate need to increase average mailbox size to 600 MB. Our migration scenario assumes that the main motivation for the migration is that the legacy hardware in this usage scenario is nearing end of life. Additionally, the organization has specific goals for a Microsoft Exchange migration: IT wants to increase the average Exchange mailbox size so that it can consolidate local archive Outlook personal storage files (PSTs) onto centrally managed databases. With this change, IT hopes to improve user productivity, improve organization compliance with regulations regarding email retention, improve disaster recovery, and drive down costs. To meet these goals, IT decided to upgrade to the Dell PowerEdge R510 solution

with 1TB internal Near Line SAS drives and dispense with the external array. They plan to virtualize the Exchange 2010 roles with Windows Server 2008 R2 Enterprise Edition with Hyper-V, and to migrate from their active/passive Exchange Server 2003 cluster to a fully active, highly available Exchange Server 2010 configuration. Based on our testing, the Dell PowerEdge R510 solution used 55 percent less power when idle and 46 percent less power when under load than the legacy HP ProLiant DL385 solution.

Our payback calculations scenarios depend on a parallel IT upgrade that we do not factor into this solution. We assume that the organization is switching its data backup to a solution that uses data deduplication and achieves an 11:1 deduplication ratio. Without the deduplication and the related backup costs it saves, the organization would face considerable additional expense unless it had existing infrastructure and capacity for backing up the larger user mailboxes we include in the post-migration scenario.

User productivity is the area with the largest savings. These savings reflect only a 3-minute-per-user productivity saving for the Dell PowerEdge R510 solution. Users would gain productivity because, among other things, the post-migration scenario cuts the time that users would need to spend on database and archive maintenance and would significantly cut recovery time from disasters. Actual productivity savings are likely to go well beyond this conservative estimate.

Benefits of the migration

Higher availability

Organizations and users rely on e-mail access. However, component failure, power failures, and natural disasters can affect email system availability or level of service. Highly available email systems have minimal downtime, provide acceptable performance, and aid user productivity.

Improved fault tolerance

Fault tolerance is the ability of a solution to maintain operation status after any part of the solution fails. Fault tolerance requires a high degree of redundancy across as many components as is reasonably possible. If any single component fails, the redundant component takes its place with no appreciable downtime. The clustered Microsoft Exchange 2003 solution would be able to provide fault tolerance in case of many server problems because a second server maintained a passive copy of the database that could activate in response to problems on the active server. However, the solution lacks redundancy for either the storage array or the disk controller, so it lacks fault tolerance for those components. The Dell PowerEdge R510 and Microsoft Exchange 2010 solution improves fault tolerance because it has redundancies for all hardware components, not just the servers and RAID protected disks.

Improved regulatory compliance

Exchange 2010 includes integrated e-mail retention and discovery features aimed at meeting regulatory requirements related to preventing information leaks and preserving business emails. Centrally managed emails and information control capabilities such as multi-mailbox search and immediate hold give IT the ability to store and query email across the organization more effectively.

Improved IT productivity

Exchange Server 2010 includes features designed to reduce the cost of managing e-mail infrastructure. New role-based permissions functionality enables administrators to delegate permissions to other administrators and users based on the Exchange tasks each needs to perform, and to define what users can configure on their mailboxes. The Web-based Exchange Control Panel (ECP) provides self-service options for tasks that might otherwise require a help desk call, and the role-based access control model ensures users can only access the functions to which they have access.

Improved end-user satisfaction and productivity

Additional features address end user productivity problems and disaster recovery. Features such as ignore conversation option and conversation view options give users more control over mailbox content and organization. If the organization adds mobile and Web access capability, users can access all their centrally managed emails from PC, mobile, and Web access devices using a consistent interface on Outlook on the PC, Outlook Mobile, and Outlook Web access. For the scenario we model, we anticipate some front-end productivity

costs as users learn the new features, but significant long-term end-user productivity and satisfaction gains as they use and benefit from the features.

Lower costs by using internal higher-capacity, lower-performance, lower-cost disks

Our tests showed that Microsoft Exchange 2010 could support the 3,000 mailboxes in this workload on low-cost, high-capacity 1TB 7,200RPM Near Line SAS drives installed on the server and did not require an external storage array. These high-capacity drives also supported the increase in mailbox size from 60GB to 600GB that the users in this test scenario required.

With Microsoft Exchange 2003, Microsoft recommends that organizations invest in high-performance disks as a best practice with Microsoft Exchange 2003. Microsoft states that, “It is better to have smaller capacity disks that utilize each spindle's performance than to use fewer spindles with large capacity. Fast storage with a sufficient amount of spindles is one of the most important investments you can make in your messaging infrastructure.”

With our workload, we found that Exchange 2010 could match the performance of our legacy Exchange 2003 configuration running on fewer higher-capacity, lower-performance, lower-cost disks installed internally to the servers, and could thus avoid the addition of an expensive external array. For the after migration configuration, we used 8 drives per server, for a total of 16 drives compared to the 22 drives (8 on servers and 14 on the external array) we used in the legacy configuration. We filled six of the drives on each Dell PowerEdge R510 server with 1TB 7,200RPM Near Line SAS drives and filled the remaining two drive slots on each server with 300GB 15,000RPM Serial-Attach SCSI 3.5" Cabled Hard Drive drives because our workload and performance goals did not require higher-capacity drives in all the drive slots. The 1TB drives currently list for \$579 and the 300GB drives list for \$679 on the Dell site. As that cost difference shows, Near Line drives deliver more space for less cost. The cost savings is even more significant if you compare the cost of the 1TB drive and that of a drive closer to it in capacity—the \$829 cost of the 600GB 10,000RPM Serial-Attach SCSI 3.5" Cabled Hard Drive, also available on the Dell site for the Dell PowerEdge R510 server.

The Exchange 2010 Database Availability Groups (DAG) technology also allows the use of non-redundant disk configurations, such as JBOD (“just a bunch of disks”), if the organization uses at least three Mailbox servers. This requires at least two DAG-replicated copies of each mail database in the Exchange infrastructure. This means that if we were to do this same Exchange migration using three rather than two servers, we could then use non-redundant disk configurations to gain even more useable storage space and throughput.

Payback calculations

ROI payback calculations depend largely on the specific migration scenario. Our chosen migration scenario includes hardware and software upgrades and gives users larger mailboxes and moves management of user archives from the users to IT. It adds features that can improve organizational compliance, improve manageability, and provide additional disaster protection.

We estimate a total acquisition cost for the Dell PowerEdge R510 solution of \$20,086 including costs for server hardware and for Microsoft Windows Server and Microsoft Exchange upgrades. (See Figure 5.)

Acquisition costs	Dell PowerEdge R510 solution
Servers—two Dell PowerEdge R510 servers at \$9,487 each.	\$18,974
Migration costs—costs of \$1,100 based on 20 hours of administrator time at fully loaded administrator’s annual rate of \$100,000	\$1,112
Total	\$20,086

Figure 5: Acquisition costs for the Dell PowerEdge R510 solution.

Figure 6 summarizes the overall annual costs for the two solutions.

Annual costs	HP ProLiant DL385 solution	Dell PowerEdge R510 solution	Difference
Hardware support agreements	\$1,896	\$533	\$1,363
Software assurance agreements	\$3,502	\$4,297	-\$795
Facility costs	\$1,322	\$346	\$976
Energy costs	\$1,736	\$862	\$874
Hardware management costs	\$7,500	\$5,000	\$2,500
Microsoft Exchange database administration cost	\$25,000	\$75,000	-\$50,000
Higher productivity cost of HP ProLiant DL385 solution	\$70,002	\$0	\$70,002
Total	\$110,958	\$86,038	\$24,920

Figure 6: Annual costs for the HP ProLiant DL385 solution and for the Dell PowerEdge R510 solution. See Appendix C for more details of these costs.

The Dell PowerEdge R510 solution costs more than maintaining the HP ProLiant DL385 solution in two cost categories: software costs and Microsoft Exchange database administration. Software costs are higher because the Dell PowerEdge R510 solution adds System Center Server Management Suite Enterprise software to manage the Hyper-V virtual machines. Microsoft Exchange database administration costs are higher because we estimate that the centralized administration for the pre-migration scenario requires one-fourth IT full-time equivalent (FTE) and that the post-migration administration will require three-fourths IT FTE for the much larger user databases, particularly for backup tasks. We estimate that the additional cost of one-half IT FTE is approximately \$50,000.

Backup also incurs storage hardware costs for multiple backup database copies. The 600MB average user databases would require 10 times more disk and tape backup space and media than the pre-migration 60MB databases using the same backup frequency and retention policies and a 1:1 ratio of original and uncompressed backup file size. De-duplication can help significantly reduce backup storage hardware costs. Our calculations assume that the organization is switching its data backup to a solution that uses data deduplication and expects an 11:1 deduplication ratio vs. the current 1:1 ratio and, as a result, does not expect an increase in storage disk or tape backup costs. We do not include the costs of the backup software in this analysis.

The annual cost savings for the Dell PowerEdge R510 solution we show in Figure 5 are higher than the acquisition costs (See Figure 4). As a result, the Dell PowerEdge R510 solution delivers payback in less than 1 year for our migration scenario.

Productivity savings

User productivity is the area with the largest savings. (See Figure 5.) These savings reflect a 3-minute-per-user productivity saving for the Dell PowerEdge R510 solution. Users would gain productivity because the post-migration scenario cuts the time that users would need to spend on database and archive maintenance and could cut recovery time from disasters. We would expect user productivity savings to be even higher, but we show the cost savings of 3 minutes per user per month because that is the minimum number of minutes required for payback.

We expect a short-term, front-end productivity cost for the solution as users spend time learning the features of Exchange and migrating their mailbox archives to the larger mailbox supported by the Dell PowerEdge R510 solution. The solution should then start rapidly delivering increased user productivity because IT, not the users, will be responsible for maintaining those archives, and because new features will save users time.

Savings on archiving and backup tasks

In the pre-migration Microsoft Exchange 2003 solution, users would lose productive time on tasks related to database maintenance or because of inefficiencies of the pre-migration archives. A large percentage of corporate and individual user knowledge base is in emails. Users lose productivity if they cannot access that information easily and from all the devices they use to access email including mobile, Web-based, or remote devices.

In the pre-migration Microsoft Exchange 2003 solution, each user's primary 60MB database and personal archives are separate. In that scenario, users are responsible for their own personal files and either delete emails in order to keep within the 60MB database limits or maintain archive PST files locally. Backup for local archives would be ad hoc, with users possibly backing up local databases to external media or not at all. These tasks would consume user productivity to maintain the archives or to delete emails, and the solution would cost the organization in regulatory compliance and disaster recovery.

We anticipate that the organization in the scenario we model will implement retention policies as a part of this migration and will require users to drag and drop all existing archive PSTs to the central database store. IT rather than users will then handle backup tasks. Possibly, later, the organization will add archives to the Exchange database. Initially, however, users will be able to access current and historical emails within a single live message store.

In the pre-migration scenario, users also lose productive time searching across multiple individual archives, or finding alternative sources for information that is in deleted emails or in archives located on their main work system but inaccessible from other devices.

The savings on archiving and backup tasks could be considerable. For example, a not-unreasonable lost productivity cost estimate of 1 hour per month for each of the 3,000 users in the pre-migration scenario could add up to a 1.4 million dollar-per-year cost to the organization, assuming an average annual fully loaded cost per user of \$70,000. The actual amount of time per user per month required by otherwise unproductive archive tasks will vary from organization to organization, so each organization's savings for this migration scenario would vary. To break even on acquisition costs for this migration scenario and achieve payback in under 1 year, the organization only needs to see a total of 3 minutes productivity savings per user each month from a combination of savings on these or other tasks or from disaster recovery savings we discuss in the next section.

Disaster recovery savings

The Dell PowerEdge R510 solution can provide organizational disaster recovery protection beyond that of the HP ProLiant DL385 solution both because it moves user-managed archives under centralized management and because it provides redundancy for all hardware components.

The Dell PowerEdge R510 solution moves user-managed and localized Outlook database archives to a central database store and brings those files under IT management and subject to IT backup policies. IT can protect the files from losses that could occur through end-user deletions or local hardware failures. Additionally, the new solution provides redundancy for all server and storage hardware components. The pre-migration solution does not have a redundant storage array, leaving the possibility of significant user downtime in case of a storage array failure. The Dell PowerEdge R510 has redundant servers, redundant RAID 10 drives and redundant virtual machines, offering protection from failures of all those components.

The Dell PowerEdge R510 solution in this migration scenario can significantly reduce the productivity loss of storage array failures. A single failure of the 4-year-old storage array over the course of the year would likely cost each user more than the 3 minutes of productivity savings per month required to achieve payback within 1 year.

Cost avoidance could also bring payback in under 1 year

In the scenario we model in this report, the HP ProLiant DL385 solution has been in place for 4 years and is at the end of its life and in need of replacement. As a result, it makes sense to compare costs of alternative solutions. An obvious alternative would be to replace HP ProLiant DL385 servers and storage arrays with newer server and storage array models.

The Dell PowerEdge R510 solution that we propose for our migration avoids the costs of a storage array and provides savings and benefits over an alternative solution that would migrate from the HP ProLiant DL385 solution to a storage array plus a pair of lower-priced servers than we propose for the server-only solution. Hardware costs for the new servers plus array would total approximately \$19,523 based on an estimate of \$4,092 for each server and \$11,339 for the array configured with 73GB 15,000RPM SCSI drives (and including 3-year

support costs for the array).¹ That cost exceeds the estimated \$18,974 hardware expense of the Dell PowerEdge R510 server-only solution that we propose, and is only slightly less than the server-only solution including support costs. The Dell PowerEdge R510 server-only solution provides immediate payback compared to an alternative solution of replacing the HP ProLiant DL385 servers and storage arrays with newer servers and storage array models.

In addition, the array would add migration costs, power costs, data center costs, and management costs, making it an even more expensive solution. It would also not support the migration from 60MB to 600MB databases that the organization wants without the addition of higher-capacity, more expensive drives.

Figure 7 shows that the Dell PowerEdge R510 solution can deliver payback within 1 year through savings for hardware support agreements, facilities, energy, hardware management, and end-user productivity savings.

¹ For this hypothetical comparison, we configured a server and array using tools at the Dell online store. The server was a Dell PowerEdge R510 server with a single Intel® Xeon® Processor E5520, 4GB Memory (1x4GB), and four 146GB 15,000RPM Serial-Attach SCSI hard drives; the array was a Dell™ PowerVault™ MD3000i with 14 73GB 15,000RPM SCSI drives, the least expensive drives available for that array using the online store configuration tool. The tool included 3 Year ProSupport for your Enterprise with NBD On-site Service costs as the only support option for the array.

Dell PowerEdge R510 solution can deliver payback within one year with productivity savings of 3 or more minutes a month per user

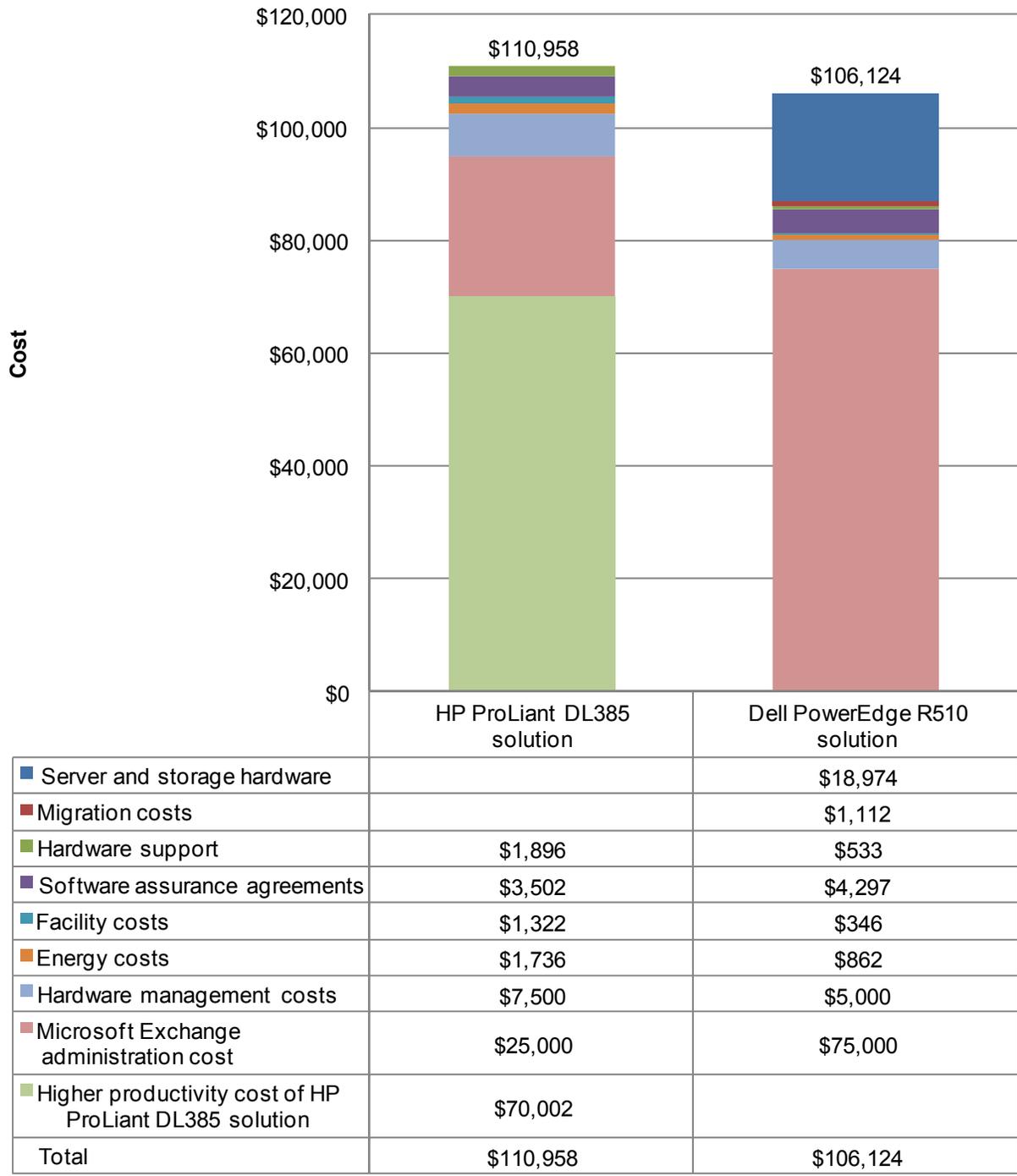


Figure 7: Payback for the Dell PowerEdge R510 solution is within 1 year when it can deliver productivity cost savings of 3 or more minutes per user per month. We estimate that productivity savings should well exceed that breakeven minimum. We show the productivity savings for the Dell PowerEdge R510 solution as a cost for the HP ProLiant DL385 solution.

What we tested

LoadGen

Our goal was to see how many messages per second the servers processed while handling a realistic Exchange 2003 workload. To reach that goal, we created a new custom workload that reflected existing standards.

To build the workload, we used Microsoft Exchange LoadGen 2010, an industry-standard tool for benchmarking an Exchange Mail Server. We used the LoadGen Exchange 2003 Online/Average mode workload as a basis for our workload. We modified the Average workload so it would not use the public folders in Exchange. Our workload consisted of 3,000 users per solution. During the tests, LoadGen performs tasks to simulate a standard user generating mail activity. When the workload finishes, LoadGen 2007 reports the response time, which is the number of seconds necessary to complete the task. LoadGen 2010 does not report response times by default. We ran this workload for 30 minutes.

For more information on LoadGen 2007, visit

<http://www.microsoft.com/downloads/details.aspx?FamilyId=DDEC1642-F6E3-4D66-A82F-8D3062C6FA98&displaylang=en>.

For more information on LoadGen 2010, visit

<http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=cf464be7-7e52-48cd-b852-ccfc915b29ef>.

What we found

For this comparison, we used two Microsoft-provided tools for benchmarking an Exchange Mail Server, Microsoft Exchange Load Generator (LoadGen) 2010 Beta on the Dell PowerEdge R510 and Microsoft Exchange Load Generator 2007 on the HP ProLiant DL385. Each server-and-storage solution served 3,000 users. However, we deployed Exchange 2010 RC via two servers, each running two virtual machines creating a highly available scenario. We ran Exchange 2010 Release Candidate on Microsoft Windows Server 2008 R2 and Exchange 2003 on Microsoft Windows Server 2003 R2 SP2.

In general, larger Exchange mailboxes generate more I/O than smaller databases. Therefore, some of the performance benefits, such as lower I/O, are absorbed into this size difference. We sized our after-migration solution to match the I/O demands of the new workload and to provide slightly better performance than that of the smaller Exchange Server 2003 workload.

Figure 8 compares the number of messages per second that the Dell PowerEdge R510 solution processed while running a Microsoft Exchange 2003 workload against Microsoft Exchange Server 2010 using 600MB user mailboxes and the number of messages/sec that the HP ProLiant DL385 solution processed while running a Microsoft Exchange 2003 workload against Microsoft Exchange Server 2003 using 60MB user mailboxes. We gathered these results by using the MExchangeIS Mailbox\Messages Delivered/sec counter in Windows Performance Monitor on Windows Server 2008 R2 and the MExchangeIS Mailbox\Messages Delivered/min counter in Windows Performance Monitor on Windows Server 2003 SP2 R2 and averaging the results over the duration of the test. The Dell PowerEdge R510 processed 4.14 messages per second, while the HP ProLiant DL385 processed 4.02 messages per second.

Each Exchange solution ran with a total of 3,000 users. Thus, the Exchange 2010 solution provided equivalent performance to the Exchange 2003 solution.

Server	Messages/sec
Dell PowerEdge R510 solution	4.14
HP ProLiant DL385 and HP StorageWorks Modular Smart Array 1000 solution	4.02

Figure 8: The messages/sec both solutions processed. Higher numbers are better.

Figure 9 details the combined power consumption, in watts, of the servers and storage (storage only applies to the HP ProLiant DL385 solution) while idle and during the median run of the virtualized Microsoft Exchange 2003

workloads. We multiplied the HP ProLiant DL385's idle power by two for the sake of emulating a highly available environment for both setups. Similarly, we found the HP ProLiant DL385's average power by adding the server's idle power to the server's average power during the median run, and then by adding the storage's power to that. We base energy costs estimates of an average cost per kWh of power of \$0.1072 and calculated energy costs for the typical power value and an equal cost for cooling.

Solution	Idle power (watts)	Average power (watts)	Typical power (watts)	Energy costs per year for typical power
2 x Dell PowerEdge R510	419.2	500.6	460	\$862
2 x HP ProLiant DL385 and 1 x HP StorageWorks Modular Smart Array 1000	923.1	929.2	926	\$1,736

Figure 9: Average power usage (in watts) of the solutions while idle and during the median run of the Microsoft Exchange 2010 and Exchange 2003 workloads. We estimated typical power as the midpoint between idle and average power and round that result to the nearest whole number. Lower numbers are better.

How we tested

Setting up and configuring the storage

We attached the HP ProLiant DL385 server to a Modular Smart Array 1000 (MSA1000). We connected the MSA1000 to the HP ProLiant DL385 server via a QLogic QLA2352 placed in the server. The I/O module on the MSA1000 was a single port I/O module.

The MSA1000 contained 14 146GB 10,000RPM SCSI drives. We configured the MSA1000 volumes in a RAID 10 array for all drives, resulting in approximately a 980GB volume.

Adjusting BIOS settings

To allow for virtualization for the Dell PowerEdge R510 server, we adjusted the BIOS settings as follows:

- Dell PowerEdge R510 server: We enabled virtualization.
- HP ProLiant DL385 server: Default.

Setting up the 2003 Active Directory server

Installing the domain controller

1. Select Start→Administrative Tools→Manage Your Server.
2. Click Add or remove a role.
3. At the Configure Your Server window, click Next.
4. At the Configuration and Options screen, select Custom Configuration, and click Next.
5. At the Server Role screen, select Domain Controller, and click Next.
6. At the Summary of Selections screen, click Next.
7. At the Welcome pop-up window, click Next.
8. At the Operating System Compatibility screen, click Next.
9. For the Domain Controller Type, leave the default option (Domain controller for a new domain), and click Next.
10. At the Create New Domain screen, leave the default (Domain in a new forest), and click Next.
11. At the Install or Configure DNS window, select No, and click Next.
12. At the New Domain Name screen, type a domain name (`loadgen.com`), and click Next.
13. At the NetBIOS Domain Name screen, type a NETBIOS domain name (`loadgen`), and click Next.
14. Click Next through the following screens: Database and Log Folders, Shared System Volume, and Permissions. Doing so accepts the default options for each of those screens.
15. At the Directory Services Restore Mode Administrative Password screen, type a password (`Password1`), and click Next.

16. When the installation software prompts you to do so, insert the OS CD, and click OK.
17. At the Completing the Active Directory Installation Wizard screen, click Finish.
18. When the system prompts you to reboot the server, click Restart Now.
19. After the server reboots, log into the system.
20. At the This Server is Now a Domain Controller window, click Finish.

Setting up the 2003 Exchange server

Installing Internet Information Services 6.0

1. Select Start→Control Panel→Add or Remove Programs.
2. Click Add/Remove Windows Components.
3. Select Application Servers, and click Details.
4. Click ASP.NET, and make sure a check appears in the check box.
5. Select Internet Information Services (IIS), and click Details.
6. Click NNTP Services and SMTP Services, make sure a check appears in both check boxes, and click OK.
7. Click OK to close the Application Server window.
8. At the Windows Components Wizard, click Next to begin the installation.
9. When the system prompts you to do so, insert the OS CD, and click OK.
10. At the Completing the Windows Components Wizard window, click Finish.
11. Close the Add or Remove Programs window.

Installing Exchange Server 2003

1. Insert the Microsoft Exchange Server 2003 CD. The CD should automatically launch the installation software.
2. Select Exchange Server Enterprise Edition.
3. Run the Setup application.
4. Click the Exchange Deployment Tools link.
5. Click the Deploy the first Exchange 2003 Server link.
6. Click the New Exchange 2003 Installation link.
7. Click the Run ForestPrep now link.
 - a. When the compatibility issue notice appears, click Continue, and check Don't display this message again.
 - b. At the Welcome screen, click Next.
 - c. Accept the End User License Agreement, and click Next.
 - d. At Component Selection Screen, keep the defaults, and click Next.
 - e. Leave the default account information, and click Next.
Installation should start. (This process may take upwards of 30 minutes to complete.)
 - f. When the installation completes, click Finish.
8. Return to the Exchange Server Deployment Tools screen, and click the Run DomainPrep now link.
 - a. At the Welcome screen, click Next.
 - b. Accept the End User License Agreement, and click Next.
 - c. At Component Selection Screen, keep the defaults, and click Next.
 - d. At the insecure domain notice, click OK.
 - e. When the installation completes, click Finish.
9. Return to the Exchange Server Deployment Tools screen, and click Run Setup Now.
 - a. At the Welcome screen, click Next.
 - b. Accept the End User License Agreement, and click Next.
 - c. At the Component Selection screen, the action for Microsoft Exchange should by default be Typical. If it is not, use the drop-down box to set it to Typical.
 - d. Click Next.
 - e. For the Installation Type, select Create new Exchange Organization, and click Next.
 - f. Type `loadsim` as the Organization Name, and click Next.
 - g. Accept the Microsoft Exchange Server Licensing Agreement, and click Next.
 - h. Review the installation summary, and click Next.
 - i. The installation should start. (This process may take upwards of 30 minutes to complete.)
 - j. When the installation completes, click Finish.

10. Close the Exchange Server Deployment Tools window.
11. Install Microsoft Exchange Server 2003 Service Pack 2.
 - a. Insert the SP2 CD, and double-click setup.exe.
 - b. Accept the default location to extract the file, and click OK.
 - c. After the extraction finishes, open Windows Explorer, and browse to the update.exe executable.
 - d. At the Welcome screen, click Next.
 - e. Select I agree to accept the License Agreement, and click Next.
 - f. At the Component Selection window, leave the default option (Update), and click Next.
 - g. Verify the installation Summary, and click Next.
 - h. When the installation completes, click Finish.
12. Select Start→All Programs→Microsoft Exchange→System Manager.
13. In the left windowpane, expand Servers and MailServer so the First Storage Group is visible.
14. Right-click First Storage Group, and select Properties.
15. Check the Enable circular logging box.
16. Click Apply.
17. Right-click Mailbox Store under First Storage Group, and select Properties.
18. Select the Database tab.
19. Next to Maintenance interval, click Customize.
20. Remove all blue from the boxes so the system will not perform maintenance, and click OK.

Installing and configuring the 2003 mail client

To create the mail client, you must install several software components. Before following these instructions, make sure to statically assign an IP address for the client, and to then plug that port into the system under test. This allows the client to join the Active Directory domain. We followed this process for each installation:

1. Install Microsoft Windows Server 2003 R2 Enterprise Edition Service Pack 2 on the client.
2. Assign a computer name of `MailClient` for the mail client.
3. For the licensing mode, use the default setting of five concurrent connections.
4. Enter a password for the administrator log on.
5. Select Eastern Time Zone.
6. Use typical settings for the Network installation.
7. Type `Testbed` for the workgroup.

To set up this server, we had to install several additional software components. The following subsections detail the necessary installation processes.

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 DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
5. Right-click My Computer, and select Properties.
6. Under the Computer Name tab, click Change.
7. In the Computer Name Changes window, under the Member of section, select the Domain radial box, and type `loadgen.com`
8. Select OK to start joining the domain.
9. When the window appears asking for a person qualified on the domain, type `Tester` as the username and `Password1` as the password.
10. At the welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
11. At the System Properties window, click OK.
12. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Internet Information Services 6.0

1. Select Start→Control Panel→Add or Remove Programs.
2. Click Add/Remove Windows Components.
3. Select Application Servers, and click Details.
4. Click ASP.NET, and make sure a check appears in the check box.
5. Select Internet Information Services (IIS), and click Details.
6. Click OK to close the Application Server window.
7. At the Windows Components Wizard, click Next to begin the installation.
8. When the system prompts you to do so, insert the OS CD, and click OK.
9. At the Completing the Windows Components Wizard window, click Finish.
10. Close the Add or Remove Programs window.

Installing Microsoft Exchange Server 2007 and Load Generator

1. Insert the Microsoft Exchange Server 2007 CD. The CD should automatically launch the installation software.
2. Click the link to Step 1: Install .NET Framework 2.0.
3. When you arrive at the download link, download the x64 version of the .NET Framework, and install.
4. Click the link to Step 3: Install Microsoft Windows PowerShell; this takes you to the download link.
5. When you arrive at the download link, download Microsoft Windows PowerShell, and install with defaults.
6. Search for and download SP1 for .NET Framework 2.0.
7. Install SP1 with all defaults.
8. Click the link to Step 4: Install Microsoft Exchange Server 2007 SP1.
9. Click Next to go past the introduction screen.
10. Accept the license agreement, and click Next.
11. Select No for error reporting, and click Next.
12. Select Custom Exchange Server Installation, and click Next.
13. Check Management Tools, and click Next.
14. After the check finishes, click Install to start the installation process.
15. Once installation is complete, click Finish.
16. Download and install Load Generator using all defaults.

Preparing Load Generator

1. Log into the MailClient using the tester account.
2. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator.
3. When the Load Generator window appears, select Start a new test.
4. Select Create a new test configuration, and click Continue.
5. Type `tester` as the account name.
6. In the Specify test settings window, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
7. Create 3,000 users in the available Mailbox Database, and click Continue.
8. To accept defaults for Advanced recipient settings, click Continue.
9. In the Specify test user groups window, select the plus sign to add a user group.
10. Change the Client Type to Outlook 2003 Online and the Action Profile to Average.
11. Uncheck the PreTestLogon check box, and click Continue.
12. Leave defaults in Remote configurations, and click Continue.
13. Click Save the configuration file as, and name it `Exchange2003.xml`
14. After saving the configuration file, browse to `C:\Program Files\Exchange Load Generator`, right-click `Exchange2003.xml`, and click Edit.
15. Edit the config file to set up 60MB mailboxes.
16. Save and close the config file.
17. Click Start, and type `cmd`
18. In the command prompt, type `cd C:\Program Files\Exchange Load Generator` and press Enter.
19. Type `loadgencmd.exe /i /add trace.log /c "C:\Program Files\Exchange Load Generator\Exchange2003.xml"` and press Enter to start initializing.

Setting up the 2010 Active Directory server

Installing Windows Server 2008 R2

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 Enterprise (Full Installation). 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. Click Start, type `change power-saving settings` and press Enter.
12. Click Change plan settings.
13. Change the Turn off the display drop-down menu to Never.
14. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.

Installing the domain controller

1. Set a static IP address using the following steps:
 - a. Right-click the network icon in the quick-launch bar, and choose Network and Sharing Center.
 - b. Click Manage network connections.
 - c. Right-click the local area connection, and choose Properties.
 - d. Select Internet Protocol Version (TCP/IPv4), and click Properties.
 - e. Select the Use the following IP address radio button, and type `192.168.27.1` in the IP address field.
 - f. Press Tab to auto-fill `255.255.255.0` in the Subnet mask field.
 - g. In the Preferred DNS server field, type `127.0.0.1` and click OK to close the IPv4 properties window.
 - h. Click Close.
2. Give the computer a name using the following steps:
 - a. Click Start, right-click Computer, and select Properties.
 - b. Click Change Settings.
 - c. Click Change.
 - d. Type `domainserver` in the Computer name field, and click OK.
 - e. In the Computer Name/Domain Changes pop-up window, click OK.
 - f. Click OK.
 - g. In the Microsoft pop-up window, click Restart Now.
3. Promote the mail server to domain controller by following these steps:
 - a. Select Start→Command Prompt.
 - b. Type `dcpromo`
 - c. At the Welcome pop-up window, click Next.
 - d. At the Operating System Compatibility screen, click Next.
 - e. At the Choose a Deployment Configuration screen, select the Create a new domain in a new forest radio button, and click Next.
 - f. At the Name the Forest Root Domain screen, type a domain name (i.e., `mailserver.com`), and click Next.
 - g. At the Set Forest Functional Level screen, choose Windows Server 2003 from the drop-down menu, and click Next.
 - h. At the Additional Domain Controller Options screen, accept the defaults, and click Next.
 - i. When the Static IP assignment window pops up, click Yes, the computer will use a dynamically assigned IP address.
 - j. When the Active Directory domain Services Installation Wizard window pops up, click Yes.
 - k. At the Location for Database, Log Files, and SYSVOL screen, click Next.

- l. At the Directory Services Restore Mode Administrator Password screen, enter a password, and click Next.
- m. At the Summary screen, review the selections, and click Next.
- n. When the installation software prompts you to do so, insert the OS CD, and click OK.
- o. At the Completing the Active Directory Installation Wizard screen, click Finish.
- p. When the system prompts you to reboot the server, click Restart Now.
- q. After the server reboots, log into the system.

Setting up the 2010 Exchange servers

For the purposes of creating a realistic, highly available Exchange 2010 solution, we used two identical servers each running individual mailserver and client access services/hub transport (CAS/HUB) virtual machines.

Installing Windows Server 2008 R2

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 Enterprise (Full Installation). 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. Click Start, type `change power-saving settings` and press Enter.
12. Click Change plan settings.
13. Change the Turn off the display drop-down menu to Never.
14. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.

Adding the Hyper-V role to Windows Server 2008

Note: Make sure you have installed all the latest critical and recommended updates for Windows Server 2008 from Windows Update.

1. Click Server Manager→Roles→Add Roles.
2. Check the box beside the Hyper-V role, and click Next.
3. Click Next.
4. Check the box beside the Ethernet card you wish to use, and click Next.
5. Click Install. Installation begins.
6. When installation finishes, click Close.
7. When the system prompts you to restart, click Yes.
8. Once the system finishes rebooting (this might happen twice), log in. The Resume Configuration Wizard should start automatically.
9. Once the Resume Configuration Wizard completes, the installation results should appear with a message that the installation succeeded.
10. Click Close.
11. Restart the server.

Adding storage volumes

1. Click Server Manager→Storage→Disk Management.
2. When the wizard prompts you to initialize new disks, click OK. Note: If you must select a partition table, select MBR.
3. Right-click the first unallocated disk partition, and select New Simple Volume...
4. Click Next.
5. Use the entire storage space (this should be the default), and click Next.
6. Select the drive letter to assign to the new partition, and click Next.
7. Label the volume appropriately (e.g., DB1 and DBBackup), make sure Perform a quick format is checked, and click Next.

8. Click Finish.

Creating a virtual machine

1. Click Start→Administrative Tools→Hyper-V Manager.
2. From the Actions menu, select New→Virtual Machine...
3. Click Next.
4. Enter a name for the virtual machine, and browse to the location where you want to store the VM files. (The New Virtual Machine Wizard will automatically create a subfolder with the name of the VM.)
5. Click Next.
6. Specify the amount of memory to allocate to the virtual machine, and click Next.
7. Select the network connection for the virtual machine to use, and click Next.
8. Select Attach a virtual hard disk later, and click Next.
9. Click Finish.

Modifying the Virtual Machine (Creating the virtual HDD)

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the virtual machine on which you want to install Windows, and click Settings...
3. From the menu on the left, select IDE Controller 0, and click Add to add a new hard drive to the IDE Controller.
4. Click New to create a new virtual hard disk file.
5. Click Next.
6. Select Fixed size, and click Next.
7. Specify the name and location of the virtual hard disk file.
8. Specify the size of the new blank virtual hard disk (in GB).
9. Click Finish. The server begins creating the new virtual hard disk.
10. Once it finishes creating the new virtual hard disk, click OK.

Modifying the Virtual Machine (adding an additional hard disk)

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the virtual machine on which you want to install Windows, and click Settings...
3. From the menu on the left, select Add Hardware.
4. Choose the SCSI Controller device, and click Add.
5. Click Add to add a new hard drive to the virtual SCSI Controller.
6. Select Physical hard disk, browse to the hard disk you would like to add to your mailserver virtual machine, and click OK.

Installing Windows on the VM

1. Click Start→Administrative Tools→Hyper-V Manager.
2. Right-click the virtual machine on which you want to install Windows, and click Connect...
3. From the menu, select Media→DVD Drive→Insert Disk...
4. Select the ISO image file for the version of Windows you are installing, and click Open.
5. To start the virtual machine, select Start from the Action menu.
6. Click the screen, and begin installing Windows as you normally would.
7. Once installation is complete, select Action→Ctrl+Alt+Delete.
8. Enter your password, and press Enter.
9. At the prompt to restart, click Yes.
10. Once the system has restarted, log in, and verify that all configured devices (mouse, keyboard, video, network, etc.) are working.

Setting up the CAS/HUB virtual machine

Installing .NET Framework 3.5.1 Features

1. Select Start→Administrative Tools→Server Manager.
2. Click Features.
3. Click Add Features.
4. Select .NET Framework 3.5.1 Features, and click Install.

5. When the installation has finished, click OK.

Installing Internet Information Services

1. Select Start→Administrative Tools→Server Manager.
2. Click Add Roles.
3. At the Select Server Roles screen, click Web Server (IIS), and click Next.
4. At the Introduction to Web Server (IIS) screen, click Next.
5. At the Select Role Services screen, select the IIS 6 Metabase Compatibility, IIS 6 Management Console, Basic Authentication, Windows Authentication, Digest Authentication, and Dynamic content Compression checkboxes, and click Next.
6. At the Confirm Installation Selections screen, click Install.
7. At the Installation Results screen, click Close.

Installing Microsoft Filter Pack 1.0

1. Download the Microsoft Filter Pack 1.0 (<http://www.microsoft.com/downloads/details.aspx?familyid=60c92a37-719c-4077-b5c6-cac34f4227cc&displaylang=en>)
2. Run FilterPackx64.EXE.
3. Click Next.
4. Click I accept the terms in the License Agreement, and click Next.
5. Click OK once installation is complete.

Installing Exchange Server 2010

1. Click Start, type `services` 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. Double-click Exchange2010-RC1-x64.EXE.
5. Select a folder to extract the installation files to, and click OK.
6. Run Setup.EXE.
7. The installer should consider Steps 1 and 2 complete, and gray them out.
8. Click the link to Step 3: Choose Exchange Language Option.
9. Click Install only languages from the DVD.
10. Click the link to Step 4: Install Microsoft Exchange Server 2007 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 Custom Exchange Server Installation, and click Next.
15. Select Client Access Services and Hub Transport (Exchange will automatically select Exchange Management Tools as well).
16. Leave the organization name at default (First Organization), and click Next.
17. At the question about client computers running Outlook 2003 and earlier, select Yes, and click Next.
18. Click Next to accept defaults for Configure Client Access server external domain.
19. At the Customer Experience Improvement Program screen, select I don't wish to join the program at this time, and click Next.
20. If a warning about a lack of SMTP appears after the check finishes, ignore it.
21. Click Install to start the installation process.
22. Once installation is complete, click Finish. Exchange should automatically open the Exchange Management Console.

Configuring Exchange Server 2010 CAS/HUB roles

1. If Exchange does not automatically open the Exchange Management Console, select Start→All Programs→Microsoft Exchange Server 2010→Exchange Management Console.
2. In the left pane, expand Organization Configuration, and select Hub Transport.
3. In the action pane on the far right, select New Send Connector.
4. Name the send connector `SMTP`, select the intended use as Internet, and click Next.

5. In the Address space window, click Add.
6. In the SMTP Address Space window, type * as the address, ensure that the installer has checked Include all subdomains, and click OK.
7. Click Next.
8. Accept defaults for the next two pages by clicking Next.
9. At the New Connector page, click New to create the connector.
10. Click Finish to close the New SMTP Send Connector wizard.
11. Right-click the SMTP send connect, and select properties.
12. Click the source server tab.
13. Click Add and select the other CAS/HUB virtual machine.
14. Click OK.
15. Close the Exchange Management Console, and reboot the server.

Configuring Network Load Balancing for the CAS/HUB VMs

1. Run dnsmgmt.msc on your 2010 domain controller.
2. Expand Forward Lookup Zones.
3. Right-click your domain name, and click New host (A or AAAA).
4. Fill in the host name field with the name of mail.x where x is your domain name (e.g., mail.mailserver.com). Fill in the IP address field with the IP address that you're planning to use as your consolidated IP for Windows Network Load Balancing (NLB), and click Add Host.
5. Return to your first CAS/HUB virtual machine.
6. Click Start→Administrative Tools→Server Manager.
7. Click Features in the left panel, and click Add Features.
8. Select the Network Load Balancing check box, and click Install.
9. When the Install has finished, click Finish.
10. Complete steps 6 through 9 on your second CAS/HUB virtual machine.
11. Click Start→Administrative Tools→Network Load Balancing Manager.
12. Right-click Network Load Balancing Cluster, and select New Cluster.
13. Enter the hostname of the CAS/HUB virtual machine you are on in the Host field, and click Connect.
14. Select the NIC you wish to use as your client-facing NIC, and click Next.
15. Leave defaults, and click Next.
16. Click Add, and enter the IP address and subnet mask that you have bound to mail.x as your Host IP address.
17. Once you have selected your IP, click OK to close the Add IP address window.
18. Click Next.
19. At the New Cluster:Cluster Parameters screen, fill in the Full Internet Name field with mail.x DNS name, and click Next.
20. At the New Cluster:Port Rules screen, add all ports that you wish to use NLB with, and click Finish.
21. Once you have completed Step 20, NLB will give you an error. Ignore this for now.
22. Right-click your new NLB name, and select Add Host To Cluster.
23. Enter the hostname of your other CAS/HUB server in the Host field, and click Connect.
24. Select the NIC you wish to use as your client-facing NIC, and click Next.
25. Leave defaults, and click Next.
26. Click Finish.
27. Both CAS/HUB servers should now be in your NLB cluster but they will both have errors due to issues with MAC addresses and virtual machines.
28. Shutdown both CAS/HUB virtual machines.
29. Click Start→Administrative Tools→Hyper-V Manager.
30. Right-click your CAS/HUB virtual machine, and select Settings...
31. Click your client-facing network adapter.
32. Click the Enable spoofing of MAC addresses check box.
33. Repeat steps 30 through 32 on your other CAS/HUB virtual machine.
34. Turn both CAS/HUB virtual machines on.
35. Click Start→Administrative Tools→Network Load Balancing Manager.
36. Right-click your cluster, and select Cluster Properties.

37. Click OK without making any changes. This will force NLB to start again, this time the errors should disappear.

Configuring a Client Access Services array

1. On one of your CAS/HUB virtual machines, click Start→All Programs→Microsoft Exchange Server 2010→Exchange Management Shell.
2. Type `new-clientaccessarray -name CASarray -fqdn mail.mailserver.com` and press Enter.
3. If the application prompts you for a site, enter your Active Directory site name and press Enter. You can find the Active Directory site name under Active Directory Sites and Services on the domain controller.
4. Type `get-mailboxdatabase | set-mailboxdatabase -rpcclientaccessserver mail.mailserver.com` and press Enter.
5. Type `get-mailboxdatabase | select name,rpcclientaccessserver | fl` and press Enter to verify that Exchange accurately assigned your rpcclientaccessservers.

Setting up the Mailbox virtual machine

Installing .NET Framework 3.5.1 Features

1. Select Start→Administrative Tools→Server Manager.
2. Click Features.
3. Click Add Features.
4. Select .NET Framework 3.5.1 Features, and click Install.
5. When the installation has finished, click OK.

Installing Internet Information Services

1. Select Start→Administrative Tools→Server Manager.
2. Click Add Roles.
3. At the Select Server Roles screen, click Web Server (IIS), and click Next.
4. At the Introduction to Web Server (IIS) screen, click Next.
5. At the Select Role Services screen, select the IIS 6 Metabase Compatibility, IIS 6 Management Console, Basic Authentication, Windows Authentication, Digest Authentication, and Dynamic content Compression checkboxes, and click Next.
6. At the Confirm Installation Selections screen, click Install.
7. At the Installation Results screen, click Close.

Installing Microsoft Filter Pack 1.0

6. Download the Microsoft Filter Pack 1.0 (<http://www.microsoft.com/downloads/details.aspx?familyid=60c92a37-719c-4077-b5c6-cac34f4227cc&displaylang=en>)
7. Run FilterPackx64.EXE
8. Click Next.
9. Click I accept the terms in the License Agreement, and click Next.
10. Click OK once installation is complete.

Installing the Exchange Server 2010 Mailbox role

1. Double-click Exchange2010-RC1-x64.EXE.
2. Select a folder to extract the installation files to, and click OK.
3. Run Setup.EXE.
4. The installer should consider Steps 1 and 2 complete, and gray them out.
5. Click the link to Step 3: Choose Exchange Language Option.
6. Click Install only languages from the DVD.
7. Click the link to Step 4: Install Microsoft Exchange Server 2007 SP1.
8. Click Next to go past the introduction screen.
9. Accept the license agreement, and click Next.
10. Select No for error reporting, and click Next.

11. Select Custom Exchange Server Installation, and click Next.
12. Select Mailbox Role (Exchange will automatically select Exchange Management Tools as well).
13. At the Customer Experience Improvement Program screen, select I don't wish to join the program at this time, and click Next.
14. If a warning about a lack of SMTP appears after the check finishes, ignore it.
15. Click Install to start the installation process.
16. Once installation is complete, click Finish. Exchange should automatically open the Exchange Management Console.

Configuring Exchange Server 2010 Mailbox role

1. Once the server successfully reboots, log in, and select Start→All Programs→Administrative Tools→Active Directory Users and Computers.
2. In the Active Directory Users and Computers window, select mailserver.com in the left pane, and open Users in the right pane.
3. Right-click a blank area in the Users folder, and select New→User.
4. In the New Object - User window, complete the name fields as you wish (we used first name: test, last name: tester, logon name: tester), and select Next.
5. Enter a secure password (we used Password1), and check Password never expires.
6. In the pop-up information window, click Accept.
7. Select Next to close the New Object – User window.
8. Double-click the new user to bring up the Properties window.
9. Under the Member Of tab, click Add.
10. In the Enter the object names to select dialog box, type Domain Admins; Enterprise Admins; Organization Management select Check Names to verify, and click OK.
11. Click OK to close the User Properties window and close Active Directory Users and Computers window.
12. Select Start→All Programs→Microsoft Exchange Server 2007→Exchange Management Console.
13. In the left pane of the Exchange Management Console window, select Recipient Configuration; and in the right pane, select New Mailbox.
14. In the New Mailbox window, select User Mailbox, and click Next.
15. In the User Type page, select Existing users, and click Add.
16. Select the new account you created earlier, and click OK to add it to selection box.
17. Click Next.
18. In the Mailbox Settings page, type `tester` in the Alias textbox, check the box next to Specify the mailbox database rather than using a database automatically selected, and select Browse in the Mailbox database selection spot.
19. In the Select Mailbox database window, select Mailbox Database, and click OK.
20. Click through the next screens to create the new mailbox, and close when you have done so.
21. In the left windowpane, expand Organization Configuration and Mailbox so Database Management tab is visible.
22. Right-click Mailbox Database, and select Properties.
23. Select the Maintenance tab.
24. Check the Enable circular logging box.
25. Check the box beside This database can be overwritten by a restore.
26. Click Customize next to Maintenance interval.
27. Remove all blue from the boxes so the system will not perform maintenance, and click OK.
28. Click OK.
29. Click OK to any warnings about circular logging being applied after the database is remounted.
30. Click Move Database on the far right panel.
31. Change the Database file and Log folder path locations to E:\Database\`(filename)` and D:\Maillogs respectively, and click Move.
32. Click Yes if the application prompts you to dismount.
33. Click Finish.
34. Right-click Public Folder Database, and select Properties.
35. Check the Enable circular logging box.
36. Check the box beside This database can be overwritten by a restore.

37. Click Customize next to Maintenance interval.
38. Remove all blue from the boxes so the system will not perform maintenance, and click OK.
39. Click OK.
40. Click OK to any warnings about circular logging being applied after the database is remounted.
41. Click Move Database on the far right panel.
42. Change the Database file and Log folder path locations to E:\Database\- 43. Click Yes if the application prompts you to dismount.
- 44. Click Finish.

Configuring a Database Availability Group (DAG)

1. Click Start→All Programs→Microsoft Exchange Server 2010→Exchange Management Console.
2. In the left pane, expand Organization Configuration, and select Mailbox.
3. Click the Database Availability Group tab.
4. Right-click and click New Database Availability Group.
5. Enter a name in the Database availability group name field (e.g., testDAG), and click Next. Exchange will automatically select one of the CAS/HUB virtual machines as a witness server.
6. Click Finish once the setup has completed.
7. Click Start→All Programs→Microsoft Exchange Server 2010→Exchange Management Shell.
8. After the shell has logged into your server, type `Set-DatabaseAvailabilityGroup -Identity testDAG -DatabaseAvailabilityGroupIpAddress 192.168.27.6`
9. Type `Add-DatabaseAvailabilityGroupServer -Identity testDAG -MailboxServer mailboxserver1` and press Enter.
10. Type `Add-DatabaseAvailabilityGroupServer -Identity testDAG -MailboxServer mailboxserver2` and press Enter.
11. The DAG should automatically add your existing NICs to the DAG. Browse back to the Exchange Management Console, and right-click the network that hosts your client-facing NICs.
12. Select Properties.
13. Uncheck the Replication Enabled checkbox, and click OK.
14. Right-click your Mailbox Database on mailboxserver1, and select Add Mailbox Database Copy.
15. Click Browse.
16. Select mailboxserver2 if you are on mailboxserver1 or mailboxserver1 if you are on mailboxserver2, and click OK.
17. Click Add. (Note: You must disable circular logging to create a mailbox database copy. You can re-enable circular logging after creating the copy.)
18. After the copy completes, click Finish.
19. Repeat steps 13 through 17 on mailboxserver2.

Installing and configuring the 2010 mail client

To create the mail client, you must install several software components. Before following these instructions, make sure to statically assign an IP address for the client, and to then plug that port into the system under test. This allows the client to join the Active Directory domain. We followed this process for each installation:

Installing Windows Server 2008 SP2 x64

1. Insert the installation DVD for Windows Server 2008 SP2 x64 into the DVD drive.
2. Choose the language, time and currency, and keyboard input. Click Next.
3. Click Install Now.
4. Choose Windows Server Enterprise (Full Installation). 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. Click Start, type `change power-saving settings` and press Enter.
12. Click Change plan settings.
13. Change the Turn off the display drop-down menu to Never.
14. Click Save changes, and close the Power Options, Screen Saver Settings, and Personalization windows.

To set up this server, we had to install several additional software components. The following subsections detail the necessary installation processes.

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 DNS server addresses radio button, and enter the IP of the DNS server in the Preferred DNS server field. Click OK.
5. Right-click My Computer, and select Properties.
6. Under the Computer Name tab, click Change.
7. In the Computer Name Changes window, under the Member of section, select the Domain radial box, and type `exchange2010.com`
8. Select OK to start joining the domain.
9. When the window appears asking for a person qualified on the domain, type `Tester` as the username and `Password1` as the password.
10. At the welcome pop-up window and the window warning that you must reset the computer for the changes to take effect, click OK.
11. At the System Properties window, click OK.
12. When a pop-up appears asking if you want to restart now, click Yes to restart your computer.

Installing Internet Information Services

1. Select Start→Administrator Programs→Server Manager.
2. Click Add a role.
3. Select Application Servers, and click Details.
4. Select Internet Information Services (IIS), and click OK to close the Application Server window.
5. At the Windows Components Wizard, click Next to begin the installation.
6. When the system prompts you to do so, insert the OS CD, and click OK.
7. At the Completing the Windows Components Wizard window, click Finish.
8. Close the Add or Remove Programs window.

Installing Load Generator

Download and install Load Generator using all defaults.

Preparing Load Generator

1. Log into the MailClient using the tester account.
2. Select Start→All Programs→Microsoft Exchange→Exchange Load Generator.
3. When the Load Generator window appears, select Start a new test.
4. Select Create a new test configuration, and click Continue.
5. Type `tester` as the account name.
6. In the Specify test settings window, type `Password1` as the Directory Access Password and Mailbox Account Master Password, and click Continue with recipient management.
7. Make 1,500 users in each Mailbox Database, and click Continue.
8. To accept defaults for Advanced recipient settings, click Continue.
9. In the Specify test user groups window, select the plus sign to add a user group.
10. Change the Client Type to Outlook 2003 Online, the Action Profile to Average, and the Mailbox size to 1GB.
11. Uncheck the PreTestLogon check box, and click Continue.
12. Leave defaults in Remote configurations, and click Continue.
13. Click Save the configuration file as, and name it `Exchange2010.xml`

14. After saving the configuration file, browse to C:\Program Files\Exchange Load Generator, right-click Exchange2010.xml, and click Edit.
15. Edit the config file to setup 600MB mailboxes.
16. Save and close the config file.
17. Click Start, and type `cmd`
18. In the command prompt, type `cd C:\Program Files\Exchange Load Generator` and press Enter.
19. Type `loadgencmd.exe /i /add trace.log /c "C:\Program Files\Exchange Load Generator\Exchange2010.xml"` and press Enter to start initializing.

Power measurement procedure

To record each server's power consumption during each test, we used an Extech Instruments (www.extech.com) 380803 Power Analyzer/Datalogger. We connected the power cord from the server under test to the Power Analyzer's output load power outlet. We then plugged the power cord from the Power Analyzer's input voltage connection into a power outlet. We used the same methods to record power on the HP storage array.

We used the Power Analyzer's Data Acquisition Software (version 2.11) to capture all recordings. We installed the software on a separate Intel processor-based PC, which we connected to the Power Analyzer via an RS-232 cable. We captured power consumption at one-second intervals.

We then recorded the power usage (in watts) for each system during the testing at 1-second intervals. To compute the average power usage, we averaged the power usage during the time the system was producing its peak performance results. Because we measured the power of the server and storage separately, we added the average power of both together to get the total power. We call this time the power measurement interval. See Figure 9 (idle and average peak power) for the results of these measurements.

Testing procedure

To perform the test, we used a command-line input. First, we powered on all virtual machines. Then, we started our monitoring programs (both power and performance monitors). To start the test, we ran the following command `Loadgencmd.exe /r /c "C:\Program Files\Exchange Load Generator\workload.xml"` where workload.xml is the intended LoadGen workload. After LoadGen finished, we copied the results from our client machine. Once a run finished, we restored the MailStore to the original state. This allowed us to start from the same point in testing.

Appendix A – Server configuration information

This appendix provides detailed configuration information about the servers, which we present in alphabetical order. Figure 10 provides detailed system configuration information.

Servers	Dell PowerEdge R510	HP ProLiant DL385
General dimension information		
Height (inches)	3.4	3.4
Width (inches)	18.0	17.5
Depth (inches)	27.0	26.0
U size in server rack (U)	2	2
Power supplies		
Total number	2	2
Wattage (W)	1,100	575
Cooling fans		
Total number	5	7
Dimensions (height x width)	2.5" x 2.5"	2.5" x 2.5"
Voltage (V)	12	12
Amps (A)	1.68	1.10
General processor setup		
Number of processor packages	2	2
Number of cores per processor package	4	1
Number of hardware threads per core	2	1
System power management policy	Balanced	Always On
CPU		
Vendor	Intel	AMD
Name	Xeon E5540	Opteron 254
Stepping	D0	E4
Socket type	LGA1366	Socket 940
Core frequency (GHz)	2.53	2.80
L1 cache	32 KB + 32 KB (per core)	64 KB + 64 KB
L2 cache (MB)	1	1
Platform		
Vendor and model number	Dell PowerEdge R510	HP ProLiant DL385 G1
Motherboard model number	Dell 0W844P	HP 4K0585
BIOS name and version	Dell 1.0.0 (08/03/2009)	HP A05
BIOS settings	Virtualization enabled	Default

Servers	Dell PowerEdge R510	HP ProLiant DL385
Memory modules		
Total RAM in system (GB)	12	4
Vendor and model number	Samsung M393B5673DZ1-CF8	Hynix HYMD512G726CFP4Q-D43
Type	PC3-8500	PC-3200
Speed (MHz)	1,066	200
Speed in the system currently running @ (MHz)	800	200
Timing/latency (tCL-tRCD-iRP-tRASmin)	6-6-6-18	3-3-4-8
Size (GB)	2	1
Number of RAM modules	6 x 2 GB	4 x 1 GB
Chip organization	Double-sided	Double-sided
Hard disk		
Vendor and model number	2 x Seagate ST3300656SS/ 6 x Seagate ST31000640SS	HP BF072863BA
Number of disks in system	8	4
Size (GB)	300/1,024	72
Buffer size (MB)	16/16	8
RPM	15,000/7,200	15,000
Type	SCSI/Near Line SAS	SCSI
Operating system		
Name	Windows Server 2008 R2	Windows Server 2003 Enterprise Edition x32 R2 with SP2
Build number	7600	3790
File system	NTFS	NTFS
Language	English	English
Network /storage subsystem		
Vendor and model number	Broadcom® BCM5709C NetXtreme® II Gigabit Ethernet Card, 2 x Broadcom BCM5716C NetXtreme II Gigabit Ethernet Card	Broadcom NetXtreme Gigabit Ethernet
Type	PCI-E, Integrated	Integrated
USB ports		
Number	4	3
Type	USB 2.0	USB 2.0

Figure 10: Detailed system configuration information for the test servers.

Appendix B – Storage array configuration information (legacy solution only)

Figure 11 presents detailed configuration information for the legacy storage array.

	HP StorageWorks Fibre channel SAN
Arrays	HP StorageWorks Modular Smart Array 1000 Enterprise Virtual Array with one full disk shelf
Disks	14 active 10,000RPM FC disks total
Active storage cache (MB)	256
Number of active storage controllers	1
Number of passive storage controllers	0
Number of active storage ports	1
Firmware revision	4.48
Disk vendor and model number	HP BD1468856B
Disk size (GB)	146
Disk buffer size (MB)	8
Disk RPM	10,000
Disk type	Fibre channel
RAID type	RAID 10

Figure 11: Detailed configuration information for the legacy storage array.

Appendix C: Cost analysis

To calculate payback, we made the following assumptions about the target business environment:

- The data center has management servers in place that administrators could use to deploy management software.
- The data center fills racks to capacity and has adequate power and cooling capacity for those full racks.
- Our payback calculations depend on a parallel IT upgrade that we do not factor into this solution – we assume that the organization is switching its data backup to a solution that uses data deduplication and achieves an 11:1 deduplication ratio. We do not include the costs of backup or deduplication software.

We include the following cost categories in the analysis:

- Acquisition costs include the costs to purchase the servers, as well as the one-time setup costs.
- Annual costs include the following:
 - Hardware support
 - Software costs
 - Facility costs
 - Energy costs
 - Hardware management costs
 - Microsoft Exchange administration cost
 - Productivity costs

We base power costs on our test results. We use vendor quotes, research, or our experience as the basis for other cost data. We used list prices for all purchase costs because discounts vary by buyer and by vendor; this approach provides the most level playing field possible for our comparison. Costs do not include taxes or shipping costs.

The rest of this section describes the individual cost categories and the cost assumptions we made specific to each of them.

Cost categories

Acquisition costs

We configured the Dell PowerEdge R510 server we describe in Appendix A using tools in the Dell store on the Dell Web site and report the \$9,487 list price the store gives for that server. Acquisition costs include an estimated migration cost of \$1,100 based on 20 hours of administrator time at an administrator's annual rate of \$100,000. Costs include migration of the OS and Exchange software and the 60MB databases from the HP ProLiant DL385 solution hardware to the Dell PowerEdge R510 solution.

Hardware support

Our support prices for the Dell solution include non-mission critical support available 24 hours a day and 7 days a week with a 4-hour response time. Dell offers a higher-cost mission-critical support that provides additional coverage. The Dell non-mission critical support is a closer match to the support with 24-hour-a-day, 7-day-a-week service with a 4-hour response time that is available from the other vendors. Under these agreements, the vendor, not the data center staff, does the majority of hardware maintenance. We did not include any additional maintenance costs. We divide 3-year support costs by 3 to get first-year support costs.

We assume that, at the end of 3-year support agreements, the organization moves hardware support in house. We estimate a \$400-per-year support cost for each of the HP ProLiant DL385 servers, and \$300 for the storage array. We also include an estimate of disk replacement costs that we base on the assumption that 4 percent of disks require replacement each year for the HP ProLiant DL385 solution. The 4-percent replacement would cost \$495.12 per solution, or \$247.56 per server.

Software costs

We include 1-year costs for software assurance agreements for Windows Server Software Assurance and Microsoft Exchange Software assurance for both the HP ProLiant DL385 solution and the Dell PowerEdge R510 solution. We assume that because the organization maintains software assurance agreements, it is able to upgrade to current software versions at no additional cost. We include one-third the cost of System Center Server Management Suite Enterprise for the Dell PowerEdge R510 solution.

Facilities costs

Facilities costs include rack costs that reflect rack footprint, including clearances and port costs.

We made the following assumptions about facilities costs:

- The data center costs \$910 per rack per year for data center space. We based this on a cost of \$65 per square foot per year for data center space and an average of 14 square feet per rack, including both the space the rack occupies and the necessary clearances around it.
- We include costs for a single port per server on a Fibre channel switch connecting the HP ProLiant DL385 solution servers and storage. We estimate these costs at \$400 per port.

Energy costs

We tested and measured power using a single HP ProLiant DL385 server. Our cost analysis assumes a second server acting as a passive role in a clustered mailbox solution. To calculate idle power for the full solution, we multiplied the idle power for the tested server by 2 and added the idle power for the storage array. To calculate active power for the full solution, we added the idle server power measurement (as a stand-in for the passive server power usage), the active power measurement, and the storage array active power measurement.

We made the following assumptions about energy costs:

- The hardware is busy one-half of the time and idle the remaining time, and it runs all day, every day. We average the active and idle times to get a power usage value to use in the power cost calculations.
- For each dollar the business spends on electricity for server power, it spends an additional dollar on power to cool the server and to power auxiliary equipment.² Data centers may have different proportions of these costs because cooling efficiency and technology, rack densities, and other factors affect cooling costs.
- The data center costs for power and cooling are \$0.11 per KWh. We base this estimate on the Department of Energy's data³ on average commercial charges for July 2009, of \$0.1072.

Hardware management costs

- We assume a manager can manage 40 servers or 40 storage arrays.

Microsoft Exchange administration cost

- We assume 2 hours per day of IT time (one-fourth IT FTE) devoted to backup for the pre-migration solution and 6 hours per day (three-fourths IT FTE) for backup of larger database stores using deduplication for the after-migration solution.
- An average cost per IT FTE of \$100,000 per year.

Productivity cost savings

We make the following assumptions about archive migration costs:

- Users spend on average 30 minutes to upload archive PSTs from local systems to the central Exchange database for the after-migration solution. Some users will have no PSTs to upload, others will upload up

²Estimating Total Power Consumption by Servers in the U.S. and the World, Jonathan G. Koomey, PhD, February 15, 2007
<http://enterprise.amd.com/Downloads/svrpwrusecompletefinal.pdf>

³Energy Information Association: Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State
http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html

to 540 MB of archives to the after-migration solution. Uploads can run as background tasks so the time commitment for each user should be minimal.

- Users spend at least 30 minutes per year managing local archives for the pre-migration solution.
- Users gain at least an additional 3 minutes per month in productivity due to time saving features of Microsoft Exchange 2010.
- An average fully loaded user salary is \$70,000.

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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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