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White Paper

Secure and Consolidated 16,000 Exchange Users Solution on a VMware/EMC Environment

Applied Technology

Abstract

A virtualization-enabled platform for Microsoft Exchange 2007 can provide a number of technical and operational benefits over a similar non-virtualized configuration. The purpose of this white paper is to validate the building-block guidelines for virtualizing an Exchange 2007 Mailbox server role using a real-world deployment scenario. The design presented here enables customers considering an Exchange 2007 deployment to capitalize on the benefits of a virtualized platform with VMware Infrastructure 3 and EMC® CLARiiON® storage.

May 2008

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Executive summary

With the release of Exchange 2007, Microsoft has made a number of enhancements in functionality, availability, and performance. Notable among these enhancements is that Exchange 2007 now runs exclusively on a 64-bit platform. For customers planning a migration onto Exchange 2007, a window of opportunity exists to leverage the benefits of virtualization during this migration. A virtualization-enabled platform for Exchange 2007 can provide a number of technical and operational benefits over a similar non-virtualized configuration. These benefits include the following:

- **Reduced costs:** Virtualization can help companies lower costs associated with their Exchange server infrastructure by consolidating Exchange servers into virtual machines running on powerful 64-bit server hardware. These cost savings include server hardware and maintenance costs, reduced rack space and floor space, reduced data center power and cooling costs, and reduced infrastructure costs (host bus adapters, cables, switch ports, and so forth) among others.

- **Increased flexibility:** Virtual machines run independently of the underlying physical server hardware, providing substantial improvements in overall flexibility. Virtualized Exchange servers are no longer tied to a physical server and can be dynamically load balanced across VMware ESX servers with VMware Distributed Resource Scheduler (DRS). Or they can be manually moved across VMware ESX servers at any time with VMware VMotion, allowing the Exchange environment to rapidly adjust to changing requirements.

- **Simplified Mailbox server design:** Using the building-block approach described in this document, Exchange environments can be deployed using a modular approach. Each building block in this design supports 2,000 users and has been pre-sized and tested to ensure optimal performance. Using the building-block approach takes the guesswork out of sizing Mailbox servers and associated storage and allows the environment to scale easily using a predictable approach, where each building block has a well-understood performance profile.

- **Risk mitigation and increased design flexibility:** Splitting the Exchange user population into multiple building blocks can reduce risks associated with a single Mailbox server outage, as each building block is limited to 2,000 users. This modular approach also allows the Mailbox server design to meet different business and technical requirements for different groups of users, without requiring additional server hardware. For example, each Mailbox server virtual machine can be designed with its own unique backup solution, disaster recovery solution, high-availability solution, compliance requirements, or any other design elements.

- **Unprecedented server scalability and ROI:** Today's new 64-bit servers required for Exchange 2007 continue to be shipped with multi-core processors and increased memory density. Exchange 2007 does not scale well in an unvirtualized deployment beyond eight processor cores and 32 GB RAM. The server under test in this solution is a Dell R900 with 16 processor cores and 128 GB RAM. Running multiple virtual machines on these servers allows the full value to be unlocked from this hardware and provides scalability that far exceeds unvirtualized configurations. The design presented here demonstrates how virtualization can support up to 16,000 Exchange users on a single physical server.

Introduction

EMC has worked together with VMware to test a solution for Mailbox server consolidation using the building-block approach. The design presented here enables customers considering an Exchange 2007 deployment to capitalize on the benefits of a virtualized platform with VMware ESX 3.5 and EMC® CLARiiON® storage.

The purpose of this white paper is to validate the building-block guidelines for virtualizing an Exchange 2007 Mailbox server role using a real-world deployment scenario. VMware ESX 3.5 was used to host the Exchange Server 2007 virtual machines. All peripheral (AD, Hub, and CAS) server roles were also hosted on VMware virtual machines. EMC CLARiiON CX3-80 storage was used to host the Exchange database and log storage, and EMC Replication Manager software was used to test backup/restore functionality for the virtualized Mailbox servers.

In a real-world deployment scenario, the Replication Manager clone copies can then be backed up to tape or disk at the local site, or replicated to a secondary site using EMC SAN Copy™ software to provide disaster recovery.

This solution integrated industry-leading RSA security technology throughout the architecture. This technology builds four comprehensive elements of security into the solution: policy management, data discovery and classification, data control with access management and encryption and data leakage prevention, and finally, log and audit management

Design considerations used in this solution for the Exchange 2007 environment, EMC CLARiiON storage, VMware Infrastructure 3, and EMC Replication Manager software are discussed in the first part of this paper. Sizing for the 2,000-user building block, based on these design considerations, is covered next. The remaining sections present the results of performance testing and validation of this solution. The test results were gathered using a number of tools, including: Jetstress, LoadGen, Windows Performance Monitor, VMware ESXtop and NaviAnalyzer.

Results of this testing validate the performance and scalability of a VMware Virtualized Exchange 2007 server deployment. The test results demonstrate how Exchange 2007 can scale when virtualized to break through the eight core and 32 GB memory limitations that Exchange 2007 is subject to in a physical non-virtualized server deployment.

It is important to note that Exchange high-availability solutions were not tested as part of this configuration. Examples of ways to provide Exchange server high availability for the servers in this solution can be based solely on VMware HA in an environment that can tolerate a Mailbox server restart, or extended using application-level availability solutions. A number of options exist for providing Mailbox server high availability on the VMware platform and the decision on which solution to use should be based on the specific requirements of each organization's Exchange RPO and RTO SLAs.

Audience

This white paper is intended for Exchange administrators, Exchange architects, systems administrators, systems architects, customers, and anyone involved in the design and implementation of an Exchange 2007 solution. See the "References" section of this paper for related information, including administrator guides and white papers.

Configuration

The major components involved in the configuration of this solution include Microsoft Exchange 2007 virtualized by VMware ESX 3.5 with EMC CLARiiON CX3-80 for storage. The last component discussed is Replication Manager and its ability to back up and restore Exchange 2007 quickly and efficiently. Each of these components is described in detail next. These configuration details can be used as a reference point to begin planning similar solutions. See Figure 1.
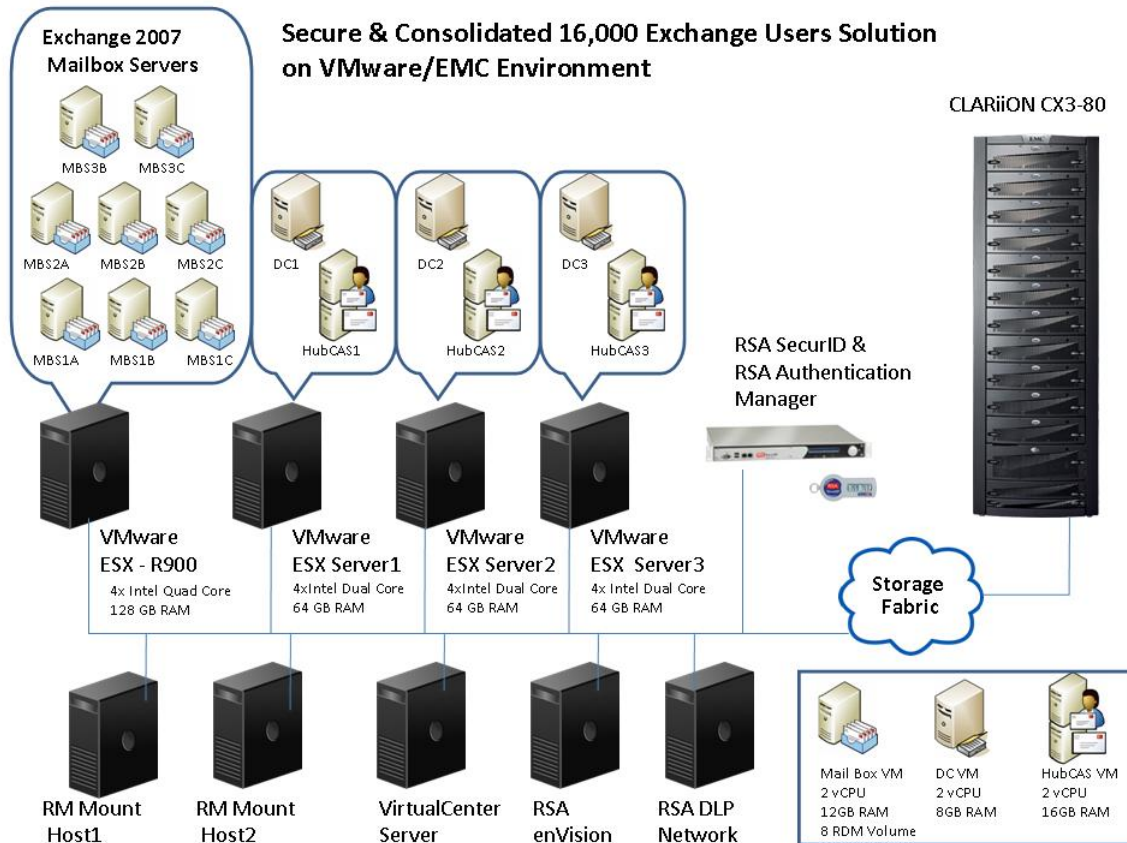
Figure 1. Secure and consolidated 16,000 Exchange users solution on a VMware/EMC environment

Exchange 2007 configuration

Exchange 2007 Enterprise Edition was used in this solution. A detailed breakdown on the configuration of the servers and storage groups follows:

- Number of users: 16,000

- User Profile: Heavy (.32 IOPs) users

- Mailbox size: 350 MB mailbox limit with 15 days deleted item retention

- Number of Mailbox server virtual machines: Eight with 2,000 users per mailbox

- Number of ESG per Mailbox server: Four, with a total of eight LUNs – four for logs and four for DBs

- Database LUN size: 250 GB (500 users * 350 = 175 GB) plus 35% (White Space, DIR)

- Log LUN size: 30 GB, six-day retention

- Total production space: 8 TB for DB, 960 GB for logs

- Hub/CAS server configuration: Three Hub/CAS VMs (2 CPUs, 12 GB memory) and three domain controllers (2 CPUs, 8 GB memory), all on two ESX servers in a VMware HA configuration

Dell Mailbox server configuration

A new Dell Server was used to host the 16,000 Exchange users:

- Memory: 128 GB
- Server Type: Dell PowerEdge R900
- CPUs: 4 Quad-Core Intel Xeon 7350
- HBAs: 2 QLogic QLE2462
- Network Connections: eight 1 GB connections

CLARiiON configuration

A CLARiiON CX3-80 was used in the testing. A Cisco MDS 9509 was used as the SAN switch. For additional details on the CLARiiON configuration, see the following:

- Array type: CX3-80, Rel. 26
- Exchange production spindles: 64 300 GB 15k spindles for DB and 22 146 GB 15k for logs
- Guest OS spindles: 10 300 GB 10k
- Replication Manager clone spindles: 48 300 GB 10k drives
- Additional array software used: SnapView™ Rel. 26 (for clone creation)

VMware configuration

VMware's Virtualization platform simplifies IT environments so that you can leverage your storage, network, and computing resources to control costs and respond quickly to changing business needs. The VMware Virtualization approach to IT management creates virtual services out of the physical infrastructure, enabling administrators to allocate these virtual resources quickly to the business units that need them most.

The VMware Virtualization platform is the next generation of industry-leading infrastructure virtualization software. VMware Infrastructure 3 virtualizes servers, storage, and networking, allowing multiple unmodified operating systems and their applications to run independently in virtual machines while sharing physical resources.

The Exchange Mailbox VM configuration details are as follows:

- Number of VM clients used to support 16,000 mailboxes: Eight
- Number of VMware ESX servers to support the eight Mailbox server VMs: One
- Mailbox VMware ESX server details: Dell R900, four quad cores, 128 GB memory, two QLogic OLE2462
- Mailbox server VM configuration:2 vCPUs, 12 GB memory (supports 2,000 users)
- OS Swap space: 20 GB

Replication Manager configuration

In any Exchange design, backup and restore are critical components. Replication Manager and its Exchange 2007 agent were used to make VSS clone replicas. The replicas were mounted onto separate mount hosts and an integrity check was run against the Exchange data. The data can then be sent off to a tape if required. For more details on the configuration see the following:

- Replication Manager version: 5.1.1

- Number of application sets per server: One
- Number of mount hosts: Two
- Backup window: 12 hours
- Total number of RM jobs: Eight – one per Exchange Server
- Approximate amount of Exchange data per job\server: 700 GB
- Total number of disks required for clones: 48 300 GB 10k drives

Any successful Replication Manager implementation for Exchange relies on proper planning and scheduling based on requirements. See Table 1 for details around the Replication Manager jobs and the Exchange online maintenance (OLM) schedule that was used.

Table 1. RM jobs and Exchange online maintenance

Server	Mount Host	Order	RM Job Start	OLM
MBS1A	MH1	1	7:00pm	11pm-3am
MBS1B	MH2	2	8:30pm	12pm-4am
MBS1C	MH1	3	10:00pm	1am-5am
MBS2A	MH2	4	11:30pm	2am-6am
MBS2B	MH1	5	1:00am	7pm-11pm
MBS2C	MH2	6	2:30am	8pm-12am
MBS3B	MH1	7	4:00am	9pm-1am
MBS3C	MH2	8	5:30am	10pm-2pm

Solution building block

To make this solution as scalable and useful to as many implementations as possible, a concept was used that for the purposes of this document is referred to as the *Exchange 2007/VMware building block*. The building-block approach defines the amount of resources required to support a certain number of Exchange 2007 users. The building block tested and documented here is based on 2,000 Heavy Exchange 2007 users with 350 MB mailboxes. Each of the 2,000 users occupied a single Exchange 2007 Mailbox server virtual machine and was divided among four Exchange storage groups. Each Mailbox server's Exchange data was backed up using a single Replication Manager job to a single (SnapView) clone replica.

The major resources that are defined for the building block include the VMware client (see Table 2) as well as the CLARiiON spindle breakdown (see Table 3). While this exact building block may not be appropriate for all environments, the concept should be helpful as a starting point for most medium-to-large implementations looking to consolidate their Exchange users. Each virtual machine building block had CPU and memory sized based on Microsoft recommendations[1]. Table 2 illustrates how the 2,000-user building block was constructed and tested.

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[1]   http://technet.microsoft.com/en-us/library/bb738142.aspx

Table 2. Virtual machine building block

Parameter	Value
Number of mailboxes supported	2,000
Virtual machine OS	Windows 2003 x64 R2 SP2
Virtual machine memory	12 GB
Virtual machine CPU	2 vCPU
Mailbox I/O profile	0.48 (Heavy)[2]
Mailbox size limit	350 MB
Server under test	Dell R900, 16 core/128 GB RAM
CPU type on test system	Intel Xeon 7350

Table 3 illustrates how the CLARiiON storage was configured as the design scaled out from one building block supporting 2,000 users, all the way up to eight building blocks supporting 16,000 users. Table 3 also includes the required disks to support one local Replication Manager clone of the production Exchange data. The Exchange database and log LUNs were placed on separate RAID groups. The production database disks increased by a factor of eight per building block, while the log incremented unevenly based on the RAID group configuration.

Table 3. CLARiiON storage building blocks

# of VM building blocks	Number of users	Production disks	Backup clone disks
1	2,000	12 disks (8 DB, 4 log)	6 disks
2	4,000	22 disks (16 DB 6 log)	12 disks
3	6,000	32 disks (24 DB 8 log)	18 disks
4	8,000	44 disks (32 DB 12 log)	24 disks
5	10,000	54 disks (40 DB 14 log)	30 disks
6	12,000	64 disks (48 DB 16 log)	36 disks
7	14,000	76 disks (56 DB 20 Log)	42 disks
8	16,000	86 disks (64 DB 22 Log)	48 disks

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[2]   http://technet.microsoft.com/en-us/library/bb738147(EXCHG.80).aspx

Storage building-block validation

Microsoft JetStress was used to validate the storage subsystem's capability to handle the I/O per second (IOPS) load. Jetstress version 08.01.0177.000 was used to simulate an I/O profile of 0.48 IOPS per user. See Table 4 for a breakdown of the JetStress results. The building blocks were validated using the same testing methodology required for the Exchange Solution Reviewed Program (ESRP): a two-hour performance test and 24-hour performance test. Each test is designed to validate the subsystem using different methods, with a two-hour burst test and a 24-hour test designed to show any issues a subsystem could have over a long period of time. JetStress testing passed both the performance and stress tests, and the results were very similar to the results in a physical environment.
Table 4 shows the breakdown of the JetStress results.

Table 4. JetStress results

Parameter	Value
Average of the database disks read latency (ms)	16 ms
Average of the database disks write latency (ms)	4 ms
Average of the log disks write latency (ms)	1 ms
Average database disk read I/O per second	127 Reads/Sec
Average database disk write I/O per second	114 Writes/Sec
Average log disk write I/O per second	65 Writes/Sec
Max database page fault stalls per second	0

Performance of the virtualized Exchange environment

Microsoft LoadGen was used to determine the configuration's ability to home 16,000 users with the heavy Outlook user profile (.32 IOPS). LoadGen is a utility used to simulate the impact of MAPI, OWA< IMAP, POP, and SMTP clients on the Exchange servers. These simulations test the:

- Exchange Mailbox servers' ability to home the mailboxes.
- Hub Transport servers' ability to send and receive e-mail.
- CAS capability to accept the total number of clients' connections for the configuration.
- DC/GC ability to handle the global catalog lookups during the test run.

Table 5. LoadGen test profile

Setting	Value
Simulated day	8 hours
Total length of simulation	10 hours
Stress mode	Disabled
Users per storage group	500
Number of storage groups per server	4
Number of Exchange Mailbox servers on R900 ESX	8
Distribution list	100 (Minimum size 10; average 25; maximum 50)
Dynamic distribution list	Yes
Contacts	No
External outbound SMTP mails	No
Action profile	Heavy with pre-test logon
Store profile	Custom (Heavy with 4416 messages on Inbox)
Number of users per LoadGen client	2000

During these tests Microsoft and VMware performance data was logged for analysis. This data presents an account of how the Microsoft Exchange Mailbox servers, Hub/CAS servers, and domain controllers within each VMware guest performed. In addition, the Microsoft LoadGen reports were used to show the 95th percentile results of the LoadGen tasks.

It is important that the Exchange Mailbox server, the DC/GCs, and Hub/CAS servers within the virtual machines all performed well during these tests. It is also important that the VMware ESX server is not overcommitted. These dependency servers must also perform to high standards to ensure a very good overall user experience.

The LoadGen tests reported latencies for all tasks across the mailbox virtual machines and maintained equal performance across all eight building blocks. No single server over- or under-performed the other. This shows VMware ESX's capability to handle the high I/O for all servers and shows that all the servers were properly sized for the user count and I/O.

While running LoadGen it is important to monitor performance of not only the Exchange servers, but the Hub/CAS servers and DC/GCs as well. The Mailbox servers should be monitored to ensure that the processors are not overwhelmed and that the RPC latencies and RPC requests remain below Microsoft recommended levels. Exceeding the levels indicates there is a bottleneck within memory, processor, disk, or the network.

Perfmon and ESXtop showed the Exchange server's processors were not over- or under-committed. In the physical world, Exchange servers often have more processing power and/or RAM than is required. The servers remained at a steady state, never becoming processor-bound or constantly idle. Hub/CAS % processor utilization remained between 10-20 percent, and DC/GC % processor time remained around 2 percent, showing that virtualizing the infrastructure servers for Exchange is not only possible but will run with very good performance. An added benefit is that, if required, processors and RAM can be added as needed at a later time.

RPC average latency
The average RPC latency during the LoadGen run for all Exchange servers remained around 10—within normal client spikes. The RPC Averaged Latency counter signifies the amount of time taken to handle Outlook RPC Requests (tasks such as Sending Mail, Browsing the Calendar, and so forth). During normal high operations the VMware Guest with Exchange 2007 is capable of handling the high I/O load, and during spikes continues to quickly handle those loads.

RPC requests
RPC requests remained below 25 percent and averaged around 5 percent. During a peak load, the RPC requests did not reach above 25 percent. The RPC Requests counter signifies the number of RPC requests being handled by the system. Outlook MAPI clients use RPC to communicate with the Exchange server. If this counter reaches higher numbers, it will directly impact the Outlook users. The most common reasons for this counter rising are network, CPU, disk or memory bottlenecks. In this testing, the systems were able to handle all requests throughout the entire run.

Total items delivered

Figure 2 shows the total items delivered. It is important to note here that the VMware guest Hub/CAS servers are capable of delivering over 800,000 messages during a normal workday.
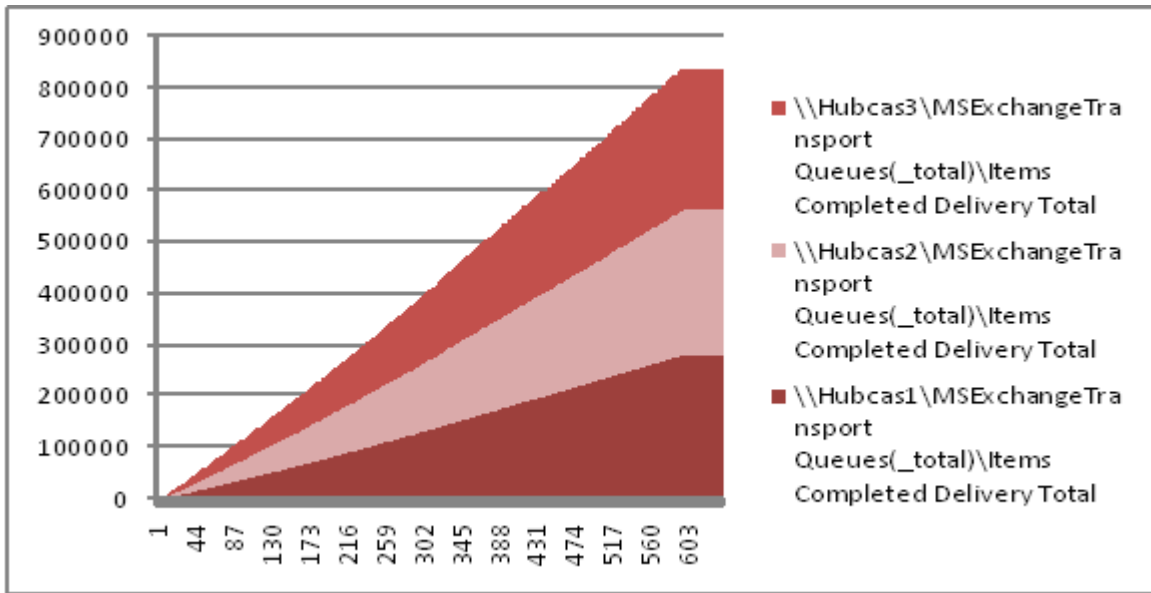
Figure 2. Total items delivered

A VMware guest Hub/CAS server was capable of handling the load during the entire LoadGen run. The queues remained low throughout the test and recovered quickly during high mail flow periods.

Replication Manager performance

The key to a successful RM job performance is to evenly distribute the load and avoid contention as much as possible. The local RM job test ran successfully and completed within the backup window. See Table 6 for a breakdown on how the RM jobs performed during testing.

Table 6. RM job performance

Task	Average time to complete
Clone resynch	27 minutes
Mount\unmount replicas	3 minutes
Eseutil integrity check	62 minutes (approximately 700 GB)
Total time for job to complete	1 hour 38 minutes

Security

The EMC Secure Virtual Exchange solution integrates industry leading RSA security technology throughout the architecture, which builds four comprehensive elements of security into the EMC Secure Exchange Virtual solution:

- Policy management
- Data discovery and classification
- Data control with access management and encryption and data leakage prevention
- Log and audit management

RSA SecurID® Authenticators and RSA® Authentication Manager provide strong authentication of users accessing e-mail, performing remote administration, and connecting to network resources remotely. RSA Authentication Manager support for Microsoft Windows Server, Terminal Services and Internet Information Server (IIS), and Outlook Web Access (OWA) provides strong two-factor authentication across multiple solution layers. Proven integration with Cisco network devices (VPN, firewall, routers and switches) provides even greater access control capabilities for secure remote access and management.

The RSA Data Loss Prevention (DLP) Suite provides unified, seamless data policy orchestration across the EMC Secure Virtual Exchange solution, allowing customers to discover and monitor sensitive data and apply the appropriate enforcement mechanisms to secure sensitive data across the solution stack. The integrated RSA DLP Suite enables organizations to continuously monitor all incoming and outgoing e-mail messaging communications to help ensure that no data transfers take place that violate policy.

In addition, the RSA DLP Suite is engineered into the EMC solution both to regularly scan the environment to detect content that is out of compliance with defined policies and to notify administrators or take action—such as quarantining sensitive data—depending upon the rules established by the organization.

The EMC Secure Virtual Exchange solution offers strong compliance capabilities with the inclusion of RSA enVision® technology, a market-leading log management solution for simplifying compliance, enhancing security operations and optimizing IT and network operations. The RSA enVision platform provides the capabilities necessary to:

- Monitor solution components.
- Correlate events.
- Monitor network components for security incidents and events.
- Manage and protect event logs.
- Detect security events.
- Alert administrators when policy requires.

With these security capabilities, the EMC Secure Virtual Exchange solution offers one of the most robust Exchange offerings to manage your corporate information risk, information governance policies and compliance requirements.

Conclusion

This solution validated the building-block approach to virtualizing an Exchange 2007 Mailbox server role with VMware and EMC CLARiiON storage. VMware ESX 3.5 was used to host the Exchange Server virtual machines, and EMC CLARiiON CX3-80 was used to host the Exchange database and log storage. EMC Replication Manager software was used for local backup and restore. Additionally, the solution can be secured by industry-leading RSA security technology throughout the architecture.

The Exchange 2007/VMware building block that was tested was based on 2,000 Heavy Exchange users with 350 MB mailboxes, and scaled out to eight building blocks, supporting 16,000 users on one Dell R900. The results of the testing validate the performance and scalability of a VMware Exchange server

deployment. The test results demonstrate how Exchange 2007 can be consolidated when virtualized to break through the eight core and 32 GB memory limitations that Exchange 2007 is subject to in a physical server deployment that does not leverage VMware ESX Server.

The local Replication Manager backup test ran successfully and completed within the backup window.

The performance results of the testing illustrate that a customer considering an Exchange 2007 deployment will benefit greatly by employing a virtualized platform with VMware and EMC CLARiiON storage. For instance:

- **Reduced costs:** This solution resulted in the consolidation of servers: from 14 down to 4. By consolidating Exchange servers into virtual machines running on powerful 64-bit server hardware, companies will lower the costs associated with their Exchange server infrastructure. The cost savings are numerous: server hardware and maintenance costs, reduced rack and floor space, reduced data center power and cooling costs, and reduced infrastructure costs (host bus adapters, cables, switch ports), just to name a few.

- **Increased flexibility:** Virtualized Exchange servers are no longer tied to a physical server and can be dynamically load balanced across VMware ESX servers. The 2,000 Heavy Exchange user building block proved to be well suited to a dynamically load-balanced virtual environment.

- **Simplified Mailbox server design:** Using the building-block approach validated in this solution, Exchange environments can be deployed using a modular approach resulting in predictable performance for all Mailbox servers. The building-block approach takes the guesswork out of sizing Mailbox servers and associated storage. Note that in this solution, Exchange I/O *exceeded* requirements for 16,000 users.

- **Risk mitigation and increased design flexibility:** Splitting the Exchange user population into multiple building blocks can reduce risks associated with a single Mailbox server outage, as each building block is limited to 2,000 users. This modular approach also allows the Mailbox server design to meet different business and technical requirements for different groups of users, without requiring additional server hardware. For example, each Mailbox server virtual machine can be designed with its own unique backup solution, disaster recovery solution, high-availability solution, compliance requirements or any other design elements.

- **Unprecedented server scalability and ROI:** The server tested in this solution was a Dell R900 with 16 processor cores and 128 GB RAM. Running multiple virtual machines on these servers allows the full value to be unlocked from this hardware and provides scalability that far exceeds unvirtualized configurations.

Using EMC's work with VMware on this solution—which illustrates the many benefits of a virtualization-enabled platform for Exchange 2007 using the building-block approach—customers can begin to design and implement an Exchange 2007 virtualized environment.

References

The following is a list of support documents and links to documents that provide further information about virtualizing an Exchange 2007 environment:

The VMware webpage for Exchange virtualization includes the following technical documentation:

- *SAN System Design and Deployment Guide*
- *Performance Tuning Best Practices for ESX Server 3*
- *CLARiiON Integration with VMware ESX Server*
- *VMware Certified Compatibility Guides*

Appendix A: ESX top data

Processor information

An ESX host is running on four Quad-Core Intel Xeon X7350 CPUs. It hosts eight Exchange Mailbox VMs, each with two virtual CPUs. In the test environment, 2000 MHz was reserved for each VM. Figures A-1 and A-2 show the total CPU utilization for the ESX host during the LoadGen test run (8:13 A.M. to 6:13 P.M.) and also during online maintenance (7 P.M. to 7 A.M.).
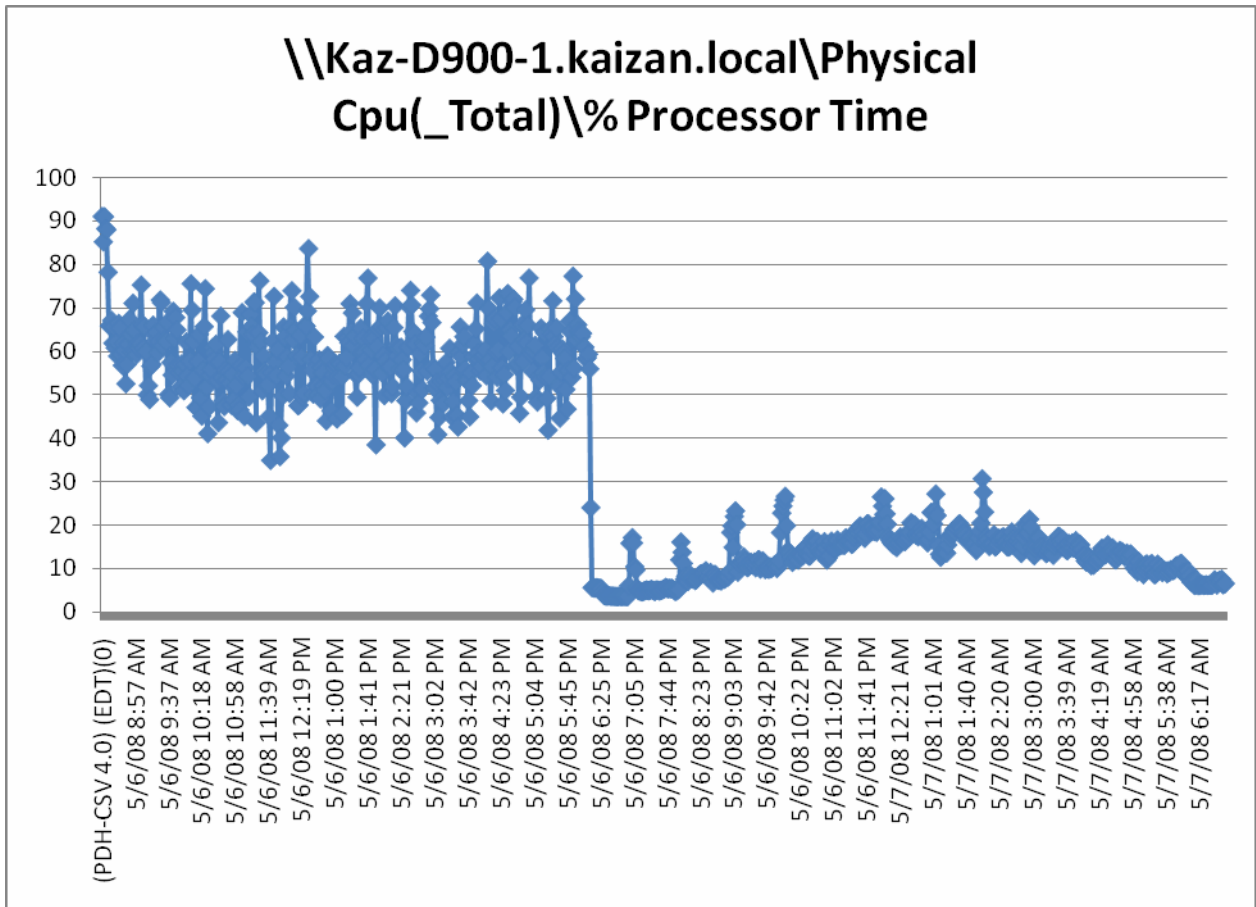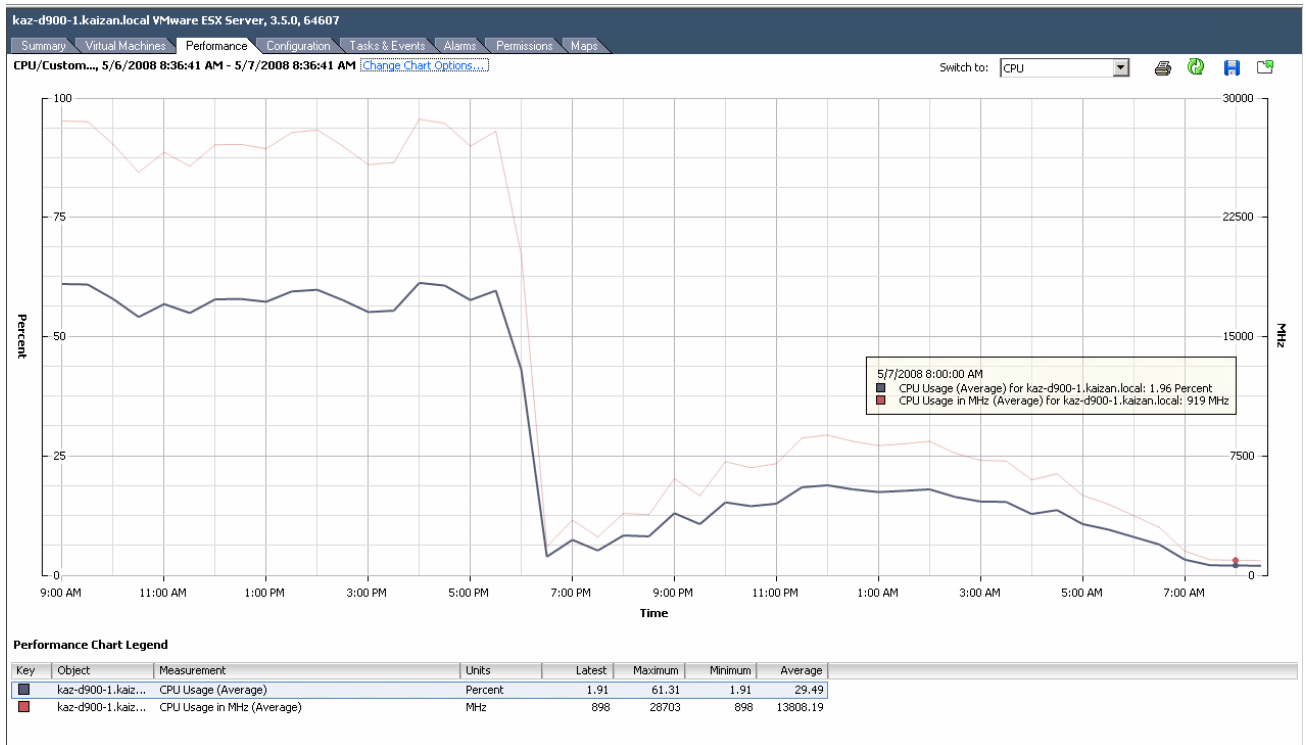

Figure A-1. ESX top data for host CPU utilization

Figure A-2. VirtualCenter performance chart

Figure A-3. VirtualCenter CPU performance data for one of the mailbox virtual machines

The CPU utilization during the LoadGen test run averaged about 55 percent and it remained very low for the duration of the test. During the online maintenance CPU utilization reached a maximum of 26 percent.

Memory

Table A-1. Memory

Setting	Value
ESX Host Total Memory	128 GB
System	9.15 GB
Service Console	272 MB
Allocated Memory per VM	12288 MB
Memory Overhead	435 MB
Reservation per VM (in our test environment)	12288 MB
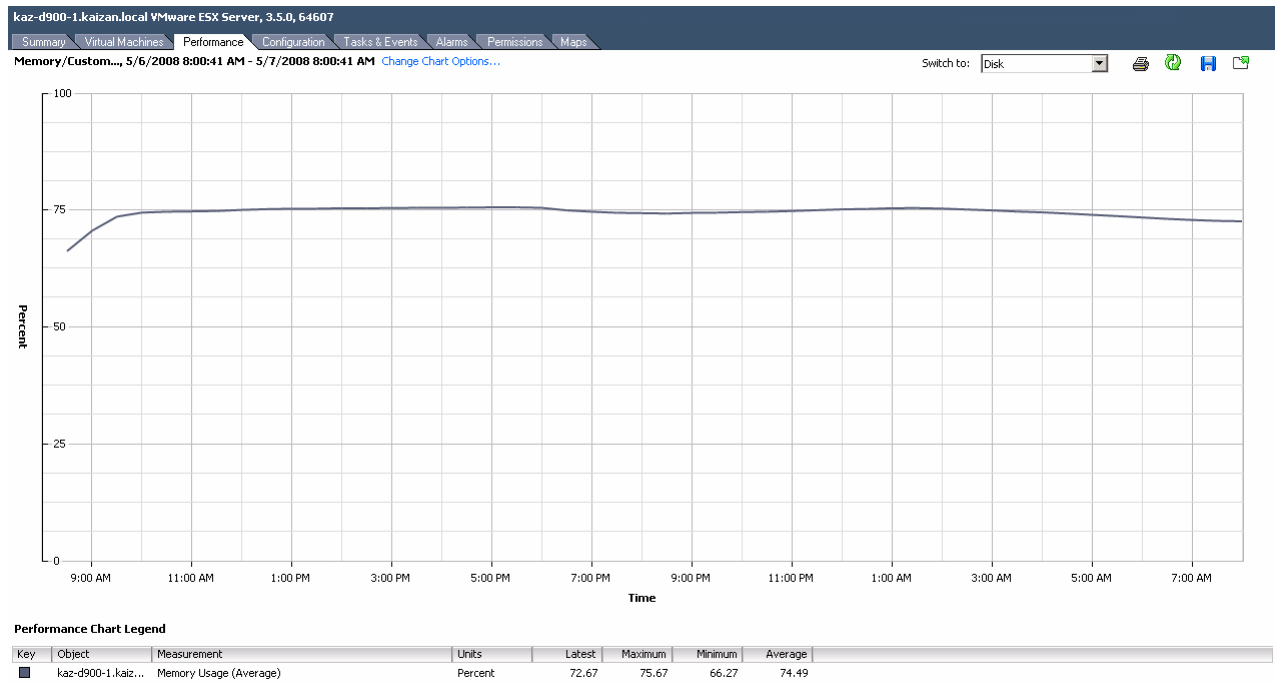
Figure A-4. VirtualCenter memory performance chart for the ESX host

There was no swapping of memory, and the ESX host memory remained constant throughout the day.
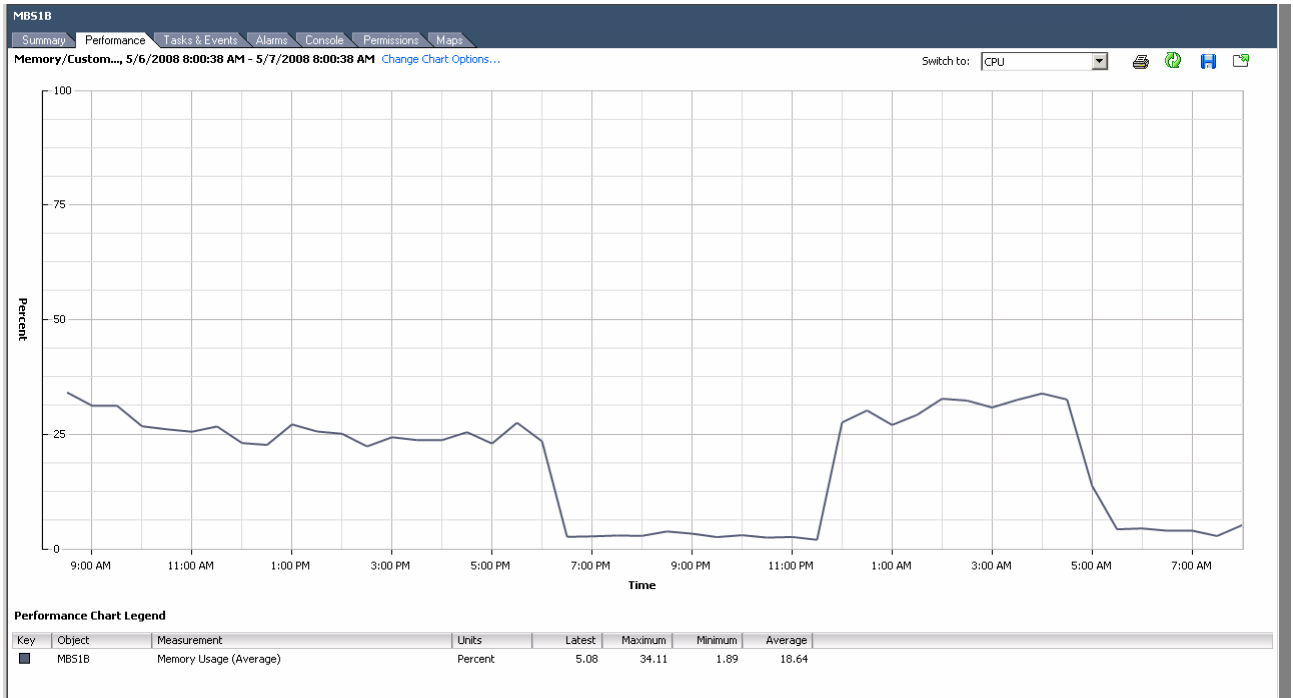
Figure A-5. VirtualCenter memory performance for one mailbox VM

For the VM, the memory consumption remained constant during the test, and it freed up once the LoadGen test completed. As expected, memory consumption increased during online maintenance.

Disk

An ESX host was installed on a local disk and the virtual machines were hosted on a VMFS partition. Each VM had eight RDM physical mode volumes (four for the Exchange database and four for the log). The ESX host had two dual-port HBAs. One port was zoned to SP A and the other port to SP B.

Figure A-6 shows the disk usage during the LoadGen run and during OLM. During the LoadGen run, the disk usage remained constant.
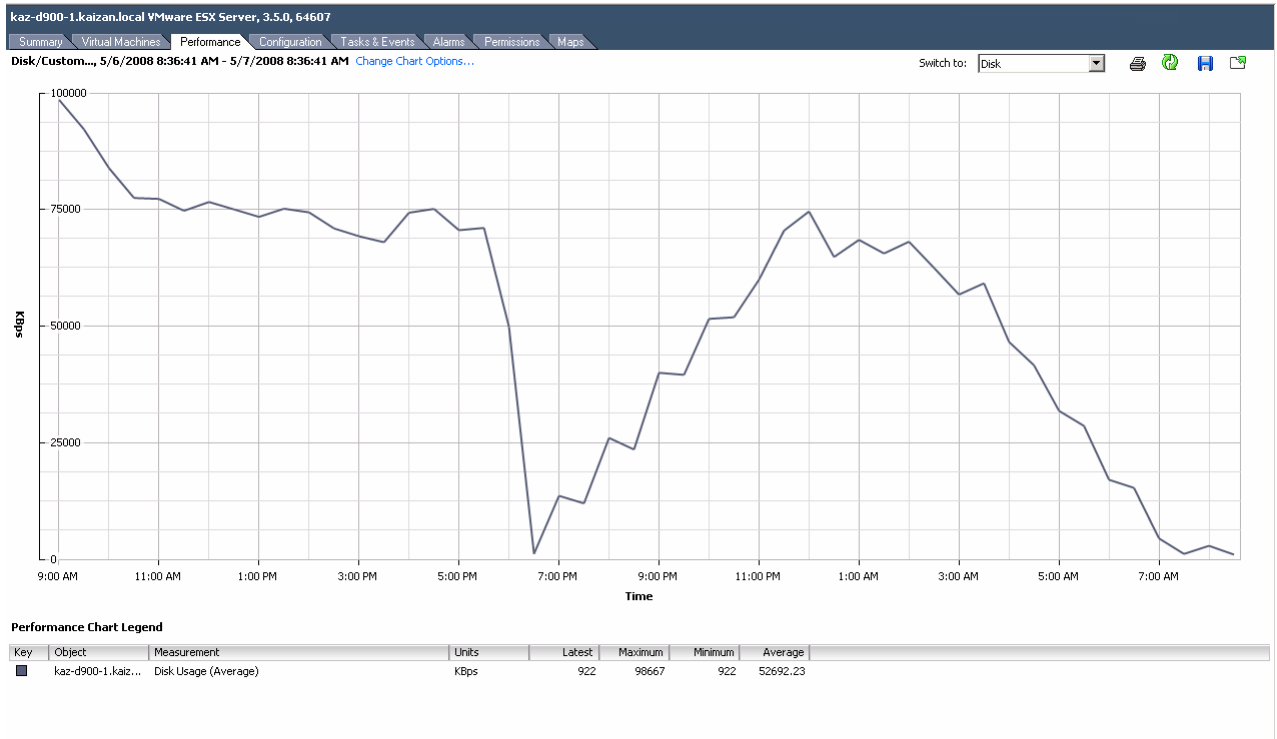
Figure A-6. VirtualCenter disk performance for the ESX host

Figure A-7 shows the disk usage of an individual VM during the LoadGen run and during OLM (12 A.M. to 4 A.M.).

Figure A-7. VirtualCenter disk performance data for one of the Mailbox Virtual Machines

Figure A-8 shows the total IOPS during the test run and during the OLM.
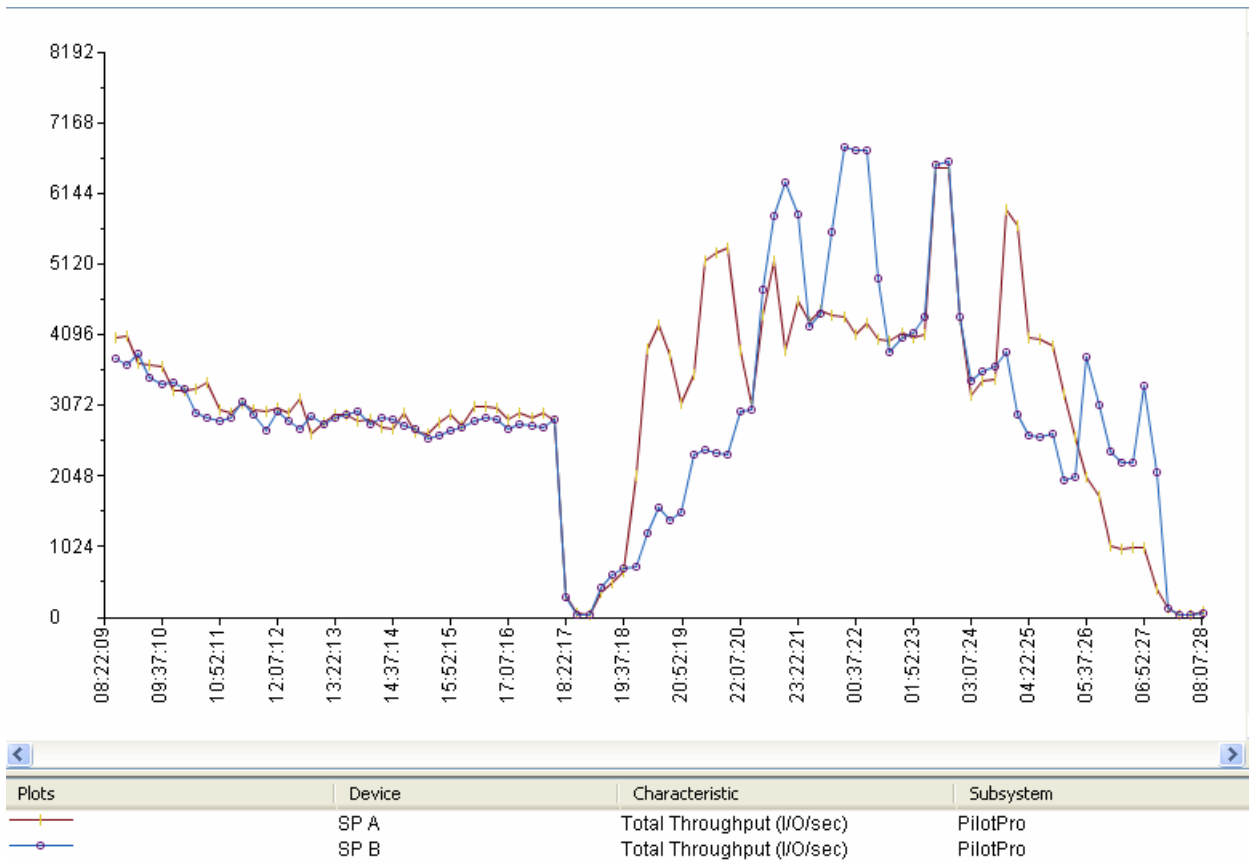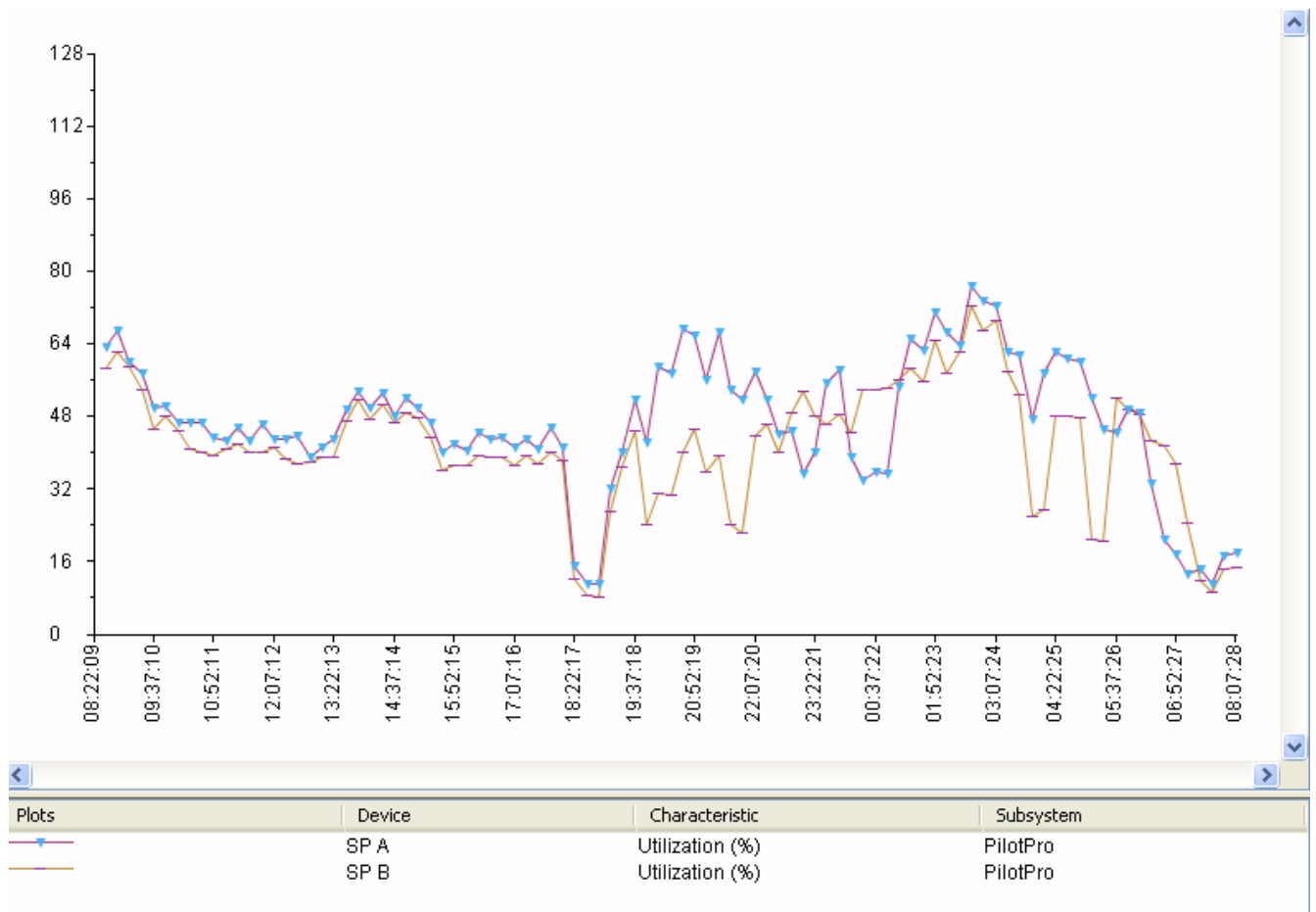

Figure A-8. Navisphere Analyzer showing total IOPS

Figure A-9 shows the storage processor utilization during the test run and during OLM.
In this test environment, two physical NICs were allocated for the service console and the rest were used
for the virtual machine network.

Figure A-9. Navisphere Analyzer showing SP utilization

Figure A-10 shows the ESX host's network utilization during the LoadGen run. This figure shows that there was little network activity during OLM.
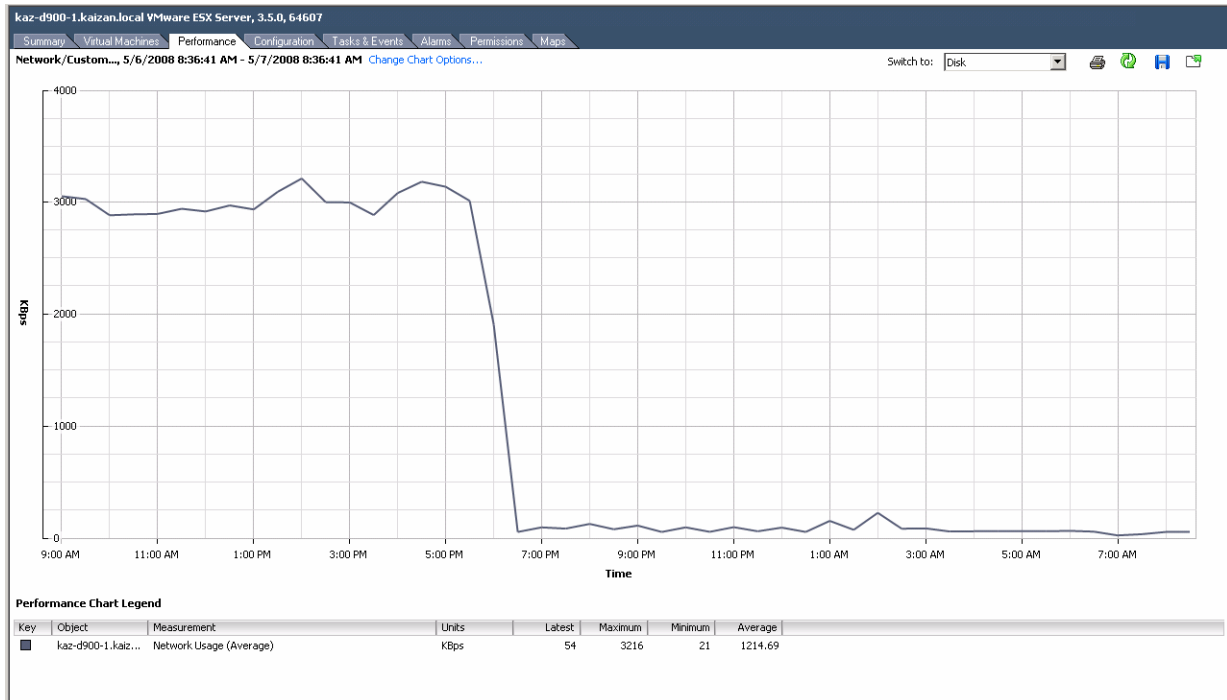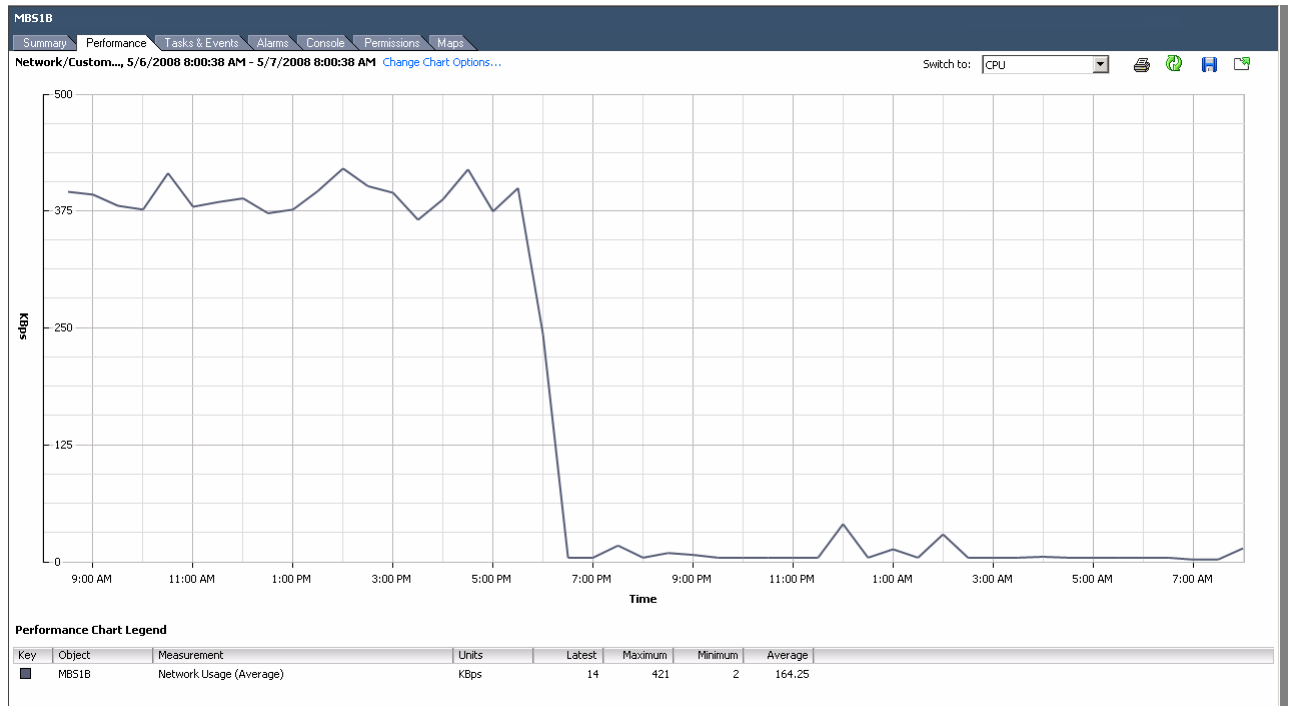

Figure A-10. VirtualCenter network performance chart for the ESX host

Figure A-11 shows network utilization during the LoadGen run. It shows no activity during the Replication Manager backup (8:30 P.M.) and also no activity during OLM (12 A.M. to 4 A.M.)

Figure A-11. VirtualCenter network performance for one Mailbox VM

Appendix B: Perfmon data from Mailbox servers, Hub/CAS, and domain controllers

The following figures and graphs show Perfmon data collected from Mailbox servers, Hub/CAS, and domain controllers.

Figure B-1 shows the output of the LoadGen report of the eight VMware guest servers homing the 16,000 mailboxes. Using a base 10 logarithmic scale, what this chart shows is that all of the servers performed at the same levels for all tasks. This is important to point out since all servers are within a single ESX server— ESX maintained the performance across the board for all servers. No single server outperformed or underperformed the others.
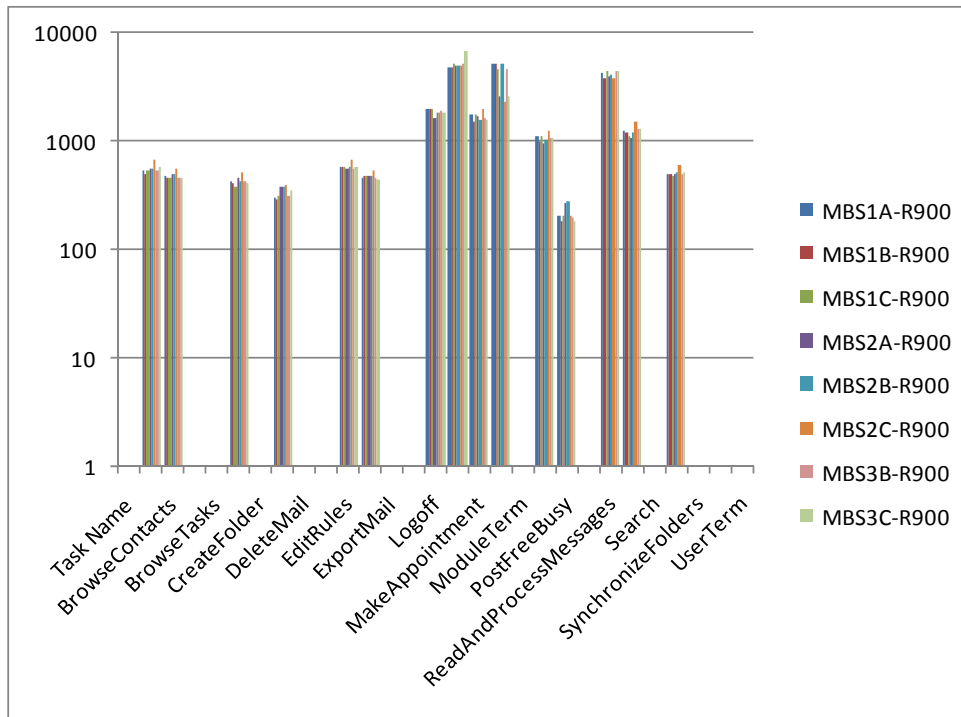

Figure B-1. LoadGen output 12 GB with OLM 95th-percentile results

Figure B-2 shows the items completed for delivery per second, validating that the servers were properly sized to keep messaging queues around 10 per second. The items queued for delivery also stayed at the same level, proving the server is sized properly not only to receive high amounts of e-mail but also to deliver them at the same speed.
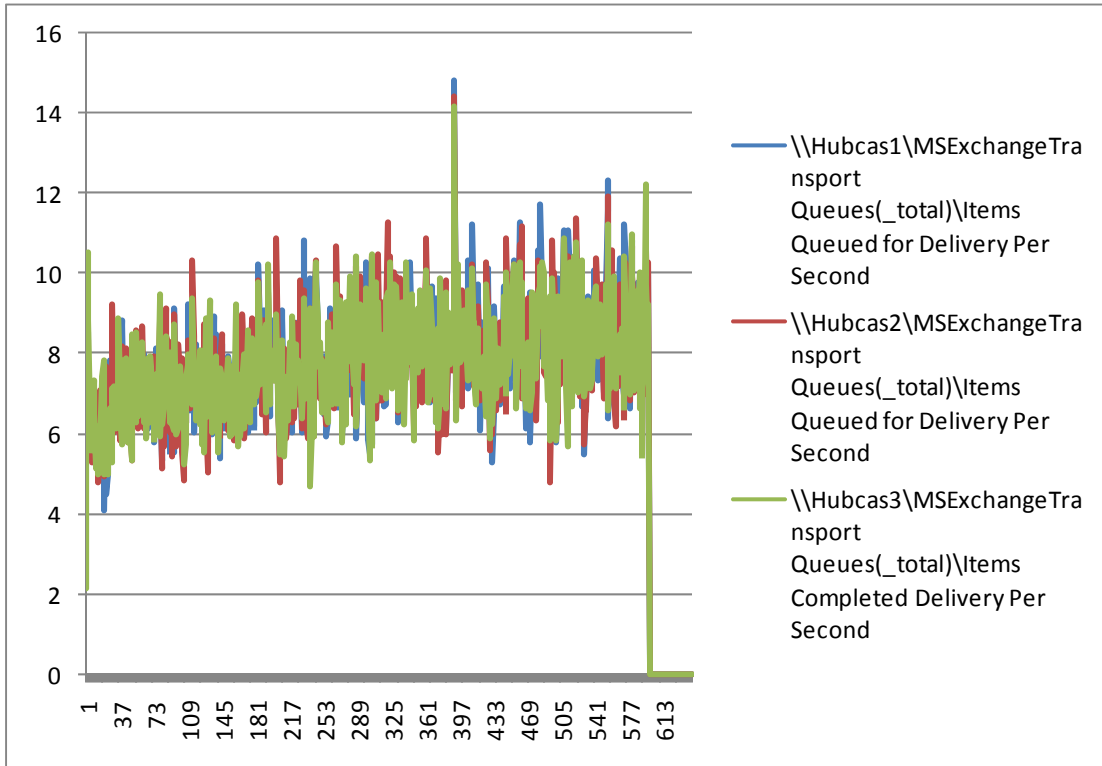
Figure B-2. Items queued for delivery per second and items completed for delivery per second

Figure B-3 shows the largest delivery queue length. What is important to note is that a VMware guest Hub/CAS server was capable of handling the load during the entire LoadGen run and that the queues remained low throughout the test and even during high mail flow periods quickly recovered.
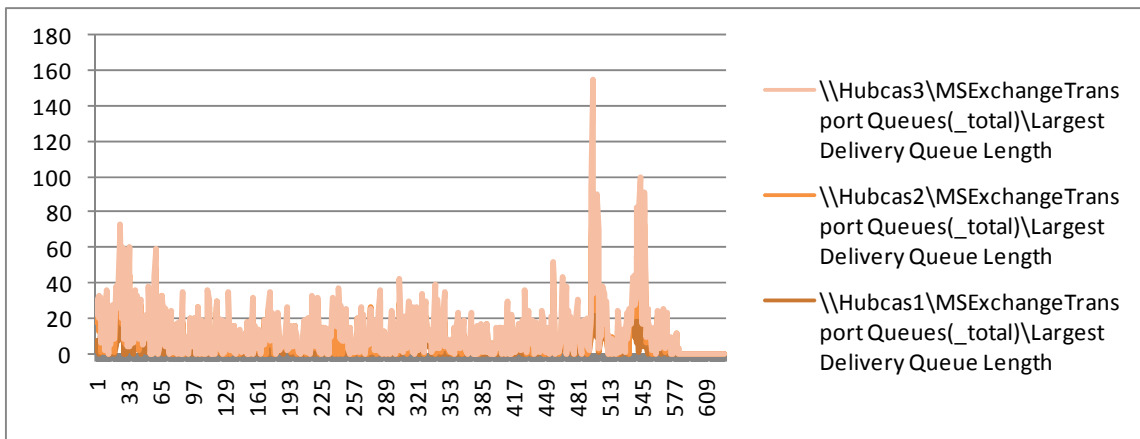
Figure B-3. Largest delivery queue length