VBLOCK™ SOLUTION FOR MICROSOFT EXCHANGE 2010

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Introduction

About this document

This document describes the architecture and validation for deploying and scaling Microsoft Exchange Server 2010 with SP1 on Vblock™ Systems. Specifically, this solution is built on the Vblock System 700.

Solution overview

As enterprises migrate to virtualized environments for Exchange 2010 mailbox administration, a new solution is required to manage larger mailbox sizes and number of users, while maintaining low per-user mailbox costs. Exchange 2010 virtualization and consolidation significantly reduces cost, power, and footprint, while providing application mobility and agility to add more resources as needed.

Using Vblock Systems with Exchange Server 2010 can support greater input operations per second (IOPS) than Direct Attached Storage configurations, resulting in fewer spindles needed to produce the desired performance.

The Vblock™ Solution for Exchange 2010 provides an efficient path to meet the increased demands of knowledge workers while maximizing performance for end users, and balancing storage and compute resources.

The architecture and provisioning strategy for Exchange 2010 described in this paper outlines how Vblock Systems can scale your messaging infrastructure to provide 20,000 users with greater mailbox size and features, while maintaining a low cost per mailbox.

This solution is based on a building block approach to designing and operating Exchange 2010. The building block approach is a scaling model for Exchange 2010 roles and their required compute and storage resources. With this solution, an organization can leverage the EMC Ionix Unified Infrastructure Management (UIM) in Vblock Systems to provision Cisco Unified Computing System (UCS) blade servers and VMware virtual servers, and to orchestrate other automated tasks using templates to roll out all the required Exchange 2010 components as it scales.

This building block approach reduces the time to deploy Exchange 2010 to production and ensures hardware and software policies are applied, even if Exchange 2010 is moved to new hardware. As business requirements change, IT departments can adjust their resource allocation strategy seamlessly and predictably by using the Vblock Systems scaling model to provision, or even reallocate, compute and storage resources.
Objectives

The objectives for this solution architecture are to validate Exchange 2010 on a Vblock System 700 while meeting the following objectives:

- Successfully meets performance goals within the stated requirements, across user bands, for 150 messages sent and received per mailbox per day
- Meets end-to-end performance requirements at 100% capacity and 100% concurrency, using Microsoft JetStress 2010 and Microsoft Exchange Load Generator 2010
- Demonstrates:
  - Sizing Vblock System 700 to meet the stated requirements for Exchange 2010
  - Using virtual provisioning to easily scale storage from 5,000 to 20,000 users
  - Maintaining two copies of each database within a single Database Availability Group¹ and within a single data center
  - Using best practices for designing Exchange 2010 per VCE, EMC, VMware, and Microsoft

Scope

This solution architecture describes, validates, and offers best practices for deploying Exchange 2010 on a Vblock System 700.

Audience

This document is intended for technical engineering staff, managers, IT planners, administrators, and other IT professionals evaluating, managing, operating, or designing Exchange 2010 deployments on Vblock Systems.

Feedback

To suggest documentation changes and provide feedback on this paper, send email to docfeedback@vce.com. Include the title of this paper, the name of the topic to which your comment applies, and your feedback.

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¹ Database availability group (DAG): an Exchange 2010 cluster, intended to provide high availability and site resiliency for Exchange 2010 mailbox servers. A DAG can contain up to 16 mailbox servers. The servers host databases and can provide automatic database-level recovery from failures affecting individual databases. Any server in a DAG can host a copy of a mailbox database
Technology overview

This section summarizes technologies used in the solution.

**Vblock™ Systems**

The Vblock System from VCE is the world's most advanced converged infrastructure—one that optimizes infrastructure, lowers costs, secures the environment, simplifies management, speeds deployment, and promotes innovation. The Vblock System is designed as one architecture that spans the entire portfolio, includes best-in-class components, offers a single point of contact from initiation through support, and provides the industry's most robust range of configurations.

**Vblock System 720**

The Vblock System720 is an enterprise, service provider class mission-critical system in the Vblock System 700 family, for the most demanding IT environments—supporting enterprise workloads and SLAs that run thousands of virtual machines and virtual desktops. It is architecturally designed to be modular, providing flexibility and choice of configurations based on demanding workloads. These workloads include business-critical enterprise resource planning (ERP), customer relationship management (CRM), and database, messaging, and collaboration services. The Vblock System 720 leverages the industry's best director-class fabric switch, the most advanced fabric based blade server, and the most trusted storage platform. The Vblock System 720 delivers greater configuration choices, 2X performance and scale from prior generations, flexible storage options, denser compute, five 9s of availability, and converged network and support for a new virtualization platform that accelerates time to service and reduces operations costs.

**Vblock System 320**

The Vblock System 320 is an enterprise and service provider ready system in the Vblock System 300 family, designed to address a wide spectrum of virtual machines, users, and applications. It is ideally suited to achieve the scale required in both private and public cloud environments. The Vblock System 320 has been engineered for greater scalability and performance to support large enterprise deployments of mission-critical applications, cloud services, VDI, mixed workloads and application development and testing. The Vblock System 320 delivers greater configuration choices, 2X performance and scale from prior generations, flexible storage options, denser compute, five 9s of availability, and converged network and support for a new virtualization platform that accelerates time to service and reduces operations costs. Every Vblock System 320 is available with the market-leading EMC VNX storage arrays.

**Vblock System 200**

The Vblock System 200 is right-sized to meet the capacity, workload, and space requirements of mid-sized data centers and distributed enterprise remote offices. By leveraging the Vblock System 200, companies experience the repeatability, architecture standardization, implementation flexibility, and business results synonymous with Vblock Systems.
With pre-defined, variable configurations, the Vblock System 200 balances real workload requirements with fastest time to value, reducing risk and complexity. The Vblock System 200 is designed to:

- Bring the power and benefits of the Vblock System family into a value-focused solution
- Deliver core IT services (file/print and domain) for mid-sized data centers and distributed enterprise remote locations
- Provide development/test and co-location data center support
- Efficiently handle mixed workload requirements for mid-sized data centers
- Offer business applications with data segregation requirements (such as eDiscovery and eArchive) with predictable performance and operational characteristics

**Vblock System 100**

The Vblock System 100 is right-sized to meet the capacity, workload, and space requirements of mid-sized data centers and distributed enterprise remote offices. By leveraging the Vblock System 100, companies experience the repeatability, architecture standardization, and business results synonymous with Vblock Systems.

With pre-defined fixed configurations, the Vblock System 100 is designed to:

- Bring the power and benefits of the Vblock System family into a value-focused solution
- Deliver core IT services (file/print and domain) for mid-sized data centers and distributed enterprise remote locations in industries such as healthcare and advanced manufacturing
- Offer dedicated local instance business application support including VDI, SharePoint, and Exchange
- Provide predictable performance and optional characteristics

For more information, go to www.vce.com/vblock.

**Cisco Unified Computing System**

UCS is a next-generation data center platform that unites compute, network, storage access, and virtualization into a cohesive system designed to reduce total cost of ownership and increase business agility. The system integrates a low-latency, lossless 10 Gigabit Ethernet unified network fabric with enterprise-class, x64-architecture servers. The system is an integrated, scalable, multi-chassis platform in which all resources participate in a unified management domain.

The following sections describe the main system components of Unified Computing System. Working as a single, cohesive system, these components unify technology in the data center. They represent a radical simplification in comparison to traditional systems, helping to simplify data center operations while also reducing power and cooling requirements. The system amplifies IT agility for improved business outcomes.
Compute

Blade servers based on Intel Xeon 5500, 5600, and 7500 series processors. The blade servers offer patented Cisco Extended Memory Technology to support applications with large datasets and allow more virtual machine density per blade.

Network

Low-latency, lossless, 10 Gbps unified network fabric that consolidates Ethernet and storage area network (SAN) fabric networks into one. The unified fabric reduces the number of network adapters, switches, and cables, and decreases the power and cooling requirements.

Storage

Provides consolidated access to both SAN storage and network attached storage over the unified fabric. Unifying storage access means that the Unified Computing System can access storage over Ethernet, Fibre Channel over Ethernet, and iSCSI, providing customers with choice and investment protection. Administrators can pre-assign storage-access policies for system connectivity to storage resources, simplifying storage connectivity and management while helping to increase productivity.

Virtualization

Virtualization unleashes the full potential of hardware by maximizing the scalability, performance, and operational control of virtual environments. Cisco security, policy enforcement, and diagnostic features are now extended into virtualized environments to better support ever changing business and IT requirements.

Management

Unified Computing System Manager provides an intuitive graphical user interface, a command-line interface, and a robust application-programming interface to manage all system configuration and operations. Unified Computing System Manager helps increase IT staff productivity, enabling storage, network, and server administrators to collaborate on defining service profiles for applications. Service profiles are logical representations of desired physical configurations and infrastructure policies. They help automate provisioning and increase agility, allowing for the provisioning of resources in minutes instead of days.

EMC Symmetrix VMAX

The VMAX is built on the strategy of simple, intelligent, modular storage and incorporates a new Virtual Matrix interface that connects and shares resources. This allows the storage array to seamlessly grow from an entry-level configuration into the world’s largest storage array that provides the highest levels of performance and availability.
EMC Symmetrix Virtual Provisioning

Symmetrix Virtual Provisioning is an integrated Symmetrix array feature enabling organizations to present a certain amount of virtual capacity to a host, allowing it to consume storage as needed. With it, virtual provisioning can:

- Improve storage capacity utilization by reducing the need to provision new storage frequently, and help avoid the cost associated with allocated but unused storage
- Simplify the data layout with automated wide striping, enabling organizations to achieve equivalent or better performance than standard storage provisioning, with less planning and effort required
- Automate storage pool rebalancing, which allows users to nondestructively balance workloads and extend storage pool capacity in small increments if required, while maximizing performance

This technology allows an organization to reduce their total cost of acquisition and ownership of storage.

VMware vSphere

VMware ESXi 4.1, update 1, was used for three virtualization hosts. VMWare vCenter server 4.1, update 1, was used for managing the virtual infrastructure in this solution. PowerPath/VE was used for multipathing and load balancing.
Architecture overview

The following sections identify and describe the Vblock System 700 components used in this solution.

Network layout

Each Unified Computing System server used is a full width blade with a mezzanine-connected converged network adapter for up to 20 Gbps of I/O throughput. The converged network adapter provides dual-port connectivity to the server chassis midplane and presents the host operating system with two 10 Gigabit Ethernet adapters and two QLogic 4-Gbps Fibre Channel host bus adapters.

Each Unified Computing System chassis includes two fabric extenders. A fabric extender has four 10-Gigabit Ethernet ports, which are Fibre Channel over Ethernet–capable, with several Small Form-Factor Pluggable Plus (SFP+) ports that connect the blade chassis to the Fabric Interconnect, and eight 10-Gigabit ports connected through the mid-plane to each half-width slot in the chassis. The two fabric extenders provide redundancy and up to 80 Gbps of I/O to the chassis.
Logical layout

Exchange 2010

The logical layout of the solution components is displayed in Figure 1, below.

Figure 1. Logical layout of Exchange 2010 on Vblock System 700
Storage

Figure 2 shows the virtual storage configuration on the VMAX in the Vblock System 700.

**Figure 2. Storage layout on VMAX in Vblock System 700**
Hardware and software

This solution was validated using a Vblock System 700 with the following hardware and software.

Table 1. Hardware

<table>
<thead>
<tr>
<th>Category</th>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute</td>
<td>Fabric Interconnects</td>
<td>Cisco 6120 or 6140</td>
</tr>
<tr>
<td></td>
<td>Blades</td>
<td>B250-M2</td>
</tr>
<tr>
<td></td>
<td>Processors</td>
<td>2 x Intel Xeon x5680 (3.33GHz)</td>
</tr>
<tr>
<td></td>
<td>Memory</td>
<td>256 GB RAM per blade</td>
</tr>
<tr>
<td></td>
<td>Converged network adapter</td>
<td>M81KR (VIC) adapter</td>
</tr>
<tr>
<td></td>
<td>Chassis</td>
<td>5108 (6RU)</td>
</tr>
<tr>
<td></td>
<td>Fabric Interconnect</td>
<td>2 x 6120XP</td>
</tr>
<tr>
<td></td>
<td>Fabric Interconnect expansion module</td>
<td>2 x 8-port 4 Gb/s Fibre Channel</td>
</tr>
<tr>
<td>Network</td>
<td>Access layer</td>
<td>Cisco Nexus 5000</td>
</tr>
<tr>
<td></td>
<td>Aggregation</td>
<td>Cisco Catalyst 6500 series</td>
</tr>
<tr>
<td>Storage</td>
<td>SAN storage</td>
<td>VMAX</td>
</tr>
</tbody>
</table>

Table 2. Software

<table>
<thead>
<tr>
<th>Category</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>Cisco MDS SAN director</td>
</tr>
<tr>
<td>Virtualization</td>
<td>VMware vSphere/vCenter 4.1</td>
</tr>
<tr>
<td>Management</td>
<td>• UIM 1.0</td>
</tr>
<tr>
<td></td>
<td>• VMware vCenter 4.1</td>
</tr>
<tr>
<td></td>
<td>• EMC Symmetrix Management console</td>
</tr>
<tr>
<td></td>
<td>• EMC PowerPath/VE</td>
</tr>
<tr>
<td></td>
<td>• Cisco Unified Computing System Manager</td>
</tr>
<tr>
<td></td>
<td>• Cisco Fabric Manager</td>
</tr>
<tr>
<td>Solution</td>
<td>• Microsoft Exchange Server 2010 SP1</td>
</tr>
<tr>
<td></td>
<td>• Windows Server 2008 R2</td>
</tr>
<tr>
<td></td>
<td>• Active Directory</td>
</tr>
</tbody>
</table>
Design considerations

Symmetrix Virtual Provisioning

Virtual provisioning was used in the VMAX configuration per EMC recommendations.

For the virtual provisioning storage pool:

- 238 1TB SATA disks were used across 4 x engines
- 476 x 228 GB RAID 1 thin data devices were created as the data device and put into one storage pool. This provided a 100 TB storage pool.

For the Exchange 2010 environment:

- 64 x 900 GB thin devices (each device is a 10-way meta device containing 10 x 90 GB members) were created for Exchange 2010 servers used as database LUNs (logical unit number). 64 x 90GB thin devices were created for Exchange 2010 as Log LUNs. This was provisioned so that each Exchange 2010 database server had 16 x 900G database LUNs, and 16 x 90G log LUNs, for a total of 4 x Exchange 2010 database servers.
- 2 x 900G and 2 x 90G thin devices are created and used for two Exchange 2010 Hub Transport server/Client Access server servers. Each has a 1 x 900 GB thin LUN and a 1 x 90 GB thin LUN.

The above thin LUNs are bound to the storage pool created above.

EMC has done extensive work with virtual provisioning in the VMAX platform. More detail can be obtained from their white paper listed in the References section of this document.

Symmetrix VMAX

The following VMAX configurations were used in this solution:

Table 3. VMAX configuration

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engines</td>
<td>4</td>
</tr>
<tr>
<td>SATA hard drives using RAID 1/0</td>
<td>238 1 TB 7.2k rpm</td>
</tr>
<tr>
<td>Global memory</td>
<td>256 GB (64 GB on each engine)</td>
</tr>
<tr>
<td>FA ports</td>
<td>8 x 4 GB</td>
</tr>
</tbody>
</table>

Note: If Exchange 2010 is exclusively running on the VMAX platform, do not use flash disk.
Microsoft Exchange 2010

Best practices

Microsoft recommends the following best practices for Exchange 2010 SP1:

- Follow the sizing guidelines for storage, processor and memory, per the current TechNet articles for Exchange 2010 SP1 (links are provided in the References section of this document).
- Design your systems as if they were running on bare metal hardware and then port your requirements over to virtualization following virtualization guidelines accordingly.
- Storage calculation: always calculate spindles for performance first, and then for capacity.

Microsoft Server Virtualization Validation Program

Microsoft has created the Server Virtualization Validation Program (SVVP) for the purpose of providing full support for Windows Operating Systems running in a virtualized environment. The goal and outcome of the certification program is to ensure that Microsoft can provide full support for the OS and Microsoft applications sitting on top of the OS when virtual guests are hosted on different hypervisors. This solution is running on Windows Server 2008 R2 with ESXi 4.1. This combination is certified by the SVVP, and customers can expect Microsoft to provide full supportability of the Windows 2008 R2 and Exchange 2010 SP1 applications in this solution.

Exchange 2010 roles, subsystems, and sizing

The Exchange 2010 server roles used in this solution are the mailbox role, Hub Transport server role, and the Client Access server role. All Exchange 2010 roles are virtualized using ESXi 4.1. Table 4 shows the different Exchange 2010 roles and their respective subsystems and how they were sized.

Table 4. Exchange 2010 roles, subsystems, and sizing

<table>
<thead>
<tr>
<th>Roles</th>
<th>Subsystems</th>
<th>Sizing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mailbox role</td>
<td>Processor</td>
<td>- The megacycles required per mailbox is 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The megacycles required for a 4 core mailbox server is 16,500.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The specint2006 ratio for the B250 M2 blades is estimated at 380, based on the Intel Xeon 5600 processor architecture.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 10% processor overhead was factored into the overall requirements to compensate for the hypervisor overhead, per VMware guidance.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- With this configuration, the server would run at 74 percent utilization.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The Microsoft mailbox role calculator was used to determine the processor requirements.</td>
</tr>
<tr>
<td>Roles</td>
<td>Subsystems</td>
<td>Sizing</td>
</tr>
<tr>
<td>-------</td>
<td>------------</td>
<td>--------</td>
</tr>
</tbody>
</table>
| Storage | ▪ The VMAX calculator recommends 212 1GB 7.2K SATA drives to meet the I/O requirements of 20,000 users with 150 messages sent/received per mailbox per day, with a 2GB mailbox quota. Single item retention and calendar version storage are included in this calculation. The IOPS per mailbox is 0.18. There is no IOPS or disk capacity buffer included.  
▪ The Microsoft Exchange 2010 Mailbox Role calculator recommends 240 1GB 7.2K SATA drives to meet the I/O requirements of 20,000 users with a 150 messages sent/received per mailbox per day, with a 2GB mailbox quota. Single item retention and calendar version storage is included in this calculation. The IOPS per mailbox is 0.15. There is no IOPS or disk capacity buffer included.  
▪ The Vblock System 700 VMAX virtual storage pool was configured with 238 1GB 7.2K SATA, and successfully passed the JetStress test goals of 900 IOPS.  
▪ RAID 1/0 was the best fit for capacity and I/O with this configuration. |
| Memory | ▪ The amount of database cache required per mailbox is 9 MB. The amount of memory required per server is 64 GB.  
▪ The Microsoft mailbox role calculator was used to determine the memory requirements. |

<table>
<thead>
<tr>
<th>Summary of each mailbox server</th>
<th></th>
</tr>
</thead>
</table>
| ▪ 4 virtual CPUs  
▪ 64 GB RAM  
▪ 4 x virtual host bus adapters  
▪ 32 LUNs  
▪ 16 900 GB database LUNs  
▪ 16 90 GB LOG LUNs  
▪ 2 virtual network interface cards |

<table>
<thead>
<tr>
<th>Notes</th>
<th></th>
</tr>
</thead>
</table>
| The backup and restore of Exchange 2010, outside of a JetStress test, is not covered in this solution architecture.  
EMC has a proven and documented backup and restore solution using the Replication Manager. A document link is provided in the References section. |

| Hub Transport server and Client Access servers | Processor | A 1:1 ratio was used for mailbox cores to combined Hub Transport server and Client Access server cores. 16 mailbox cores means 16 Hub Transport server and Client Access server cores. |
| Storage | The Client Access server role does not consume much storage space, and does not require a certain amount of IOPS or capacity. The Hub Transport server role does have this requirement, based on the message volume per day to determine the IOPS and capacity required. There are other factors that influence the Hub Transport server storage capacity requirements, such as the transport dumpster and shadow redundancy. |
| Memory | Memory was sized by using 2GB of memory for every processor in the system, following Microsoft recommendations for memory starting points for Hub Transport server and Client Access server combinations. |
## Roles

<table>
<thead>
<tr>
<th>Subsystems</th>
<th>Sizing</th>
</tr>
</thead>
</table>
| Summary of each Hub Transport server/Client Access server server | - 6 virtual CPUs  
- 12 GB RAM  
- 2 virtual network interface cards |

Notes: Hardware or software load balancing was not used at the Client Access server tier in the solution testing. Although a real Exchange 2010 solution would include this, it is outside the scope of this solution testing.

### Domain controllers/global catalogs

<table>
<thead>
<tr>
<th>Processor</th>
<th>Three processor cores are recommended to support the 20,000 mailboxes per the Microsoft role calculator. 4 cores were used for each virtual machine, and there were 2 DCs/GCs used in this solution.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>100 GB LUNs were used for storage.</td>
</tr>
<tr>
<td>Memory</td>
<td>4 GB of RAM was used.</td>
</tr>
</tbody>
</table>

| Summary   | 4 virtual CPUs  
- 4 GB RAM  
- 2 virtual network interface cards |

Notes: A single Active Directory site is used, with two domain controllers and global catalogs.

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### Unified Computing System

The following are Cisco best practices for using Exchange 2010 with Unified Computing System.

- Implement redundant components to avoid downtime in case of component failure. Optional redundancy is available for the following components:
  - Fabric Interconnect
  - Fabric Interconnect power supply
  - Fabric extender
  - Chassis power supply

- Configure dual host bus adapter ports and PowerPath for storage path redundancy. Configure one host bus adapter port for Fabric A, and another host bus adapter for Fabric B.

- Configure the Fabric Interconnects for end-host-mode. This option enables fabric failover for LAN adapters.


- Configure redundant network links for the Fabric Interconnect uplink Ethernet ports using virtual port channel or similar technologies.

- Separate DAG replication traffic from client MAPI (Messaging Application Programming Interface) traffic on different adapters. Configure one adapter for database replication and
seeding, and a different adapter for MAPI traffic. Each adapter resides on its own subnet. Use Unified Computing System Manager service profile pools to allocate WWPN (World Wide Port Name), WWNN (World Wide Node Name), MAC addresses, and server UUIDs (universally unique identifier). This option enables these attributes to move from one server blade to another server blade with the service profile. One benefit of this approach is a case where a blade server fails and needs to be replaced with new hardware. You can replace the blade server without reconfiguring the SAN zoning, LUN masking, virtual LAN assignments, or static DHCP reservations.

VMware ESXi hosts

- ESXi hosts were clustered; however, vMotion, VMware vSphere Distributed Resources Scheduler (DRS) and VMware vSphere High Availability (HA) were not used for the Exchange 2010 mailbox role. VMware does not recommend enabling these features for servers that are part of a failover cluster; hence, there is no mixing of vSphere HA and Exchange High Availability.
- Do not oversubscribe virtual processor cores to physical processor cores more than 2:1, respectively. Processor oversubscription is an estimate around the concurrency of Exchange 2010 load. VMware recommends a 1:1 ratio for high workloads or where the concurrency fluctuates greatly or is not known for certain.
Solution validation

This section describes the solution validation and test results. Exchange 2010 solutions were validated using JetStress 2010 and Load Generator 2010. Together, the JetStress and Load Generator tools are used as an industry standard to validate Exchange 2010 solutions and the hardware on which they are run.

Test environment design

JetStress

JetStress provides four tests that stress different I/O patterns experienced by Exchange 2010. JetStress takes input and based on the requirements creates databases and tests these databases from an extensible storage engine perspective (the database engine on which Exchange 2010 runs). After successfully completing the JetStress disk performance and stress tests in a non-production environment, you will have ensured that your Exchange 2010 disk subsystem is adequately sized for performance and capacity requirements.

Table 5 presents the variables used for the tests.

Table 5. JetStress test configuration

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange 2010 mailboxes simulated</td>
<td>20,000 mailboxes</td>
</tr>
<tr>
<td>ESXi hosts</td>
<td>1 physical server</td>
</tr>
<tr>
<td>Virtual Machines per ESXi Server</td>
<td>4</td>
</tr>
<tr>
<td>Database copies</td>
<td>2</td>
</tr>
<tr>
<td>Active mailboxes per server</td>
<td>5,000</td>
</tr>
<tr>
<td>Databases per host</td>
<td>64</td>
</tr>
<tr>
<td>Mailboxes per database</td>
<td>312</td>
</tr>
<tr>
<td>Mailbox size</td>
<td>2GB</td>
</tr>
<tr>
<td>User profile</td>
<td>150 messages sent and received per day per mailbox</td>
</tr>
<tr>
<td>Database read/write ratio</td>
<td>3:2</td>
</tr>
<tr>
<td>Database maintenance configuration</td>
<td>24x7 BDM</td>
</tr>
<tr>
<td>Database LUN size</td>
<td>900 GB</td>
</tr>
<tr>
<td>Log LUN size</td>
<td>90 GB</td>
</tr>
</tbody>
</table>
Microsoft Exchange Load Generator 2010

Load Generator is a simulation tool that measures the impact of MAPI, OWA, IMAP, POP and SMTP clients on Exchange 2010 servers. Load Generator is used to validate the end to end e-mail infrastructure.

After completing the storage validation with JetStress and determining that the storage meets the performance goals, the next step in the validation process is to use Load Generator to simulate client workload against the end to end Exchange 2010 infrastructure. Load Generator testing is necessary to determine how each Exchange component performs under a simulated product load. Load Generator tests the client facing components of the Exchange 2010 solution, and tests the processor and memory subsystems of the Exchange 2010 infrastructure.

**Test name and objectives**

**JetStress**

**Performance and stress**

Four JetStress tests were run to size and stress test the databases, as described in Table 6.

**Table 6. JetStress tests**

<table>
<thead>
<tr>
<th>Test</th>
<th>Test name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JetStress 2-hour performance test</td>
<td>Measures baseline storage I/O performance and how long it takes for the storage to respond to an I/O under load. Primary storage performance testing is designed to exercise storage with the maximum Exchange 2010 type of I/O for a period of two hours. The test is designed to show how long it takes for the storage to respond to an I/O under load.</td>
</tr>
<tr>
<td>2</td>
<td>JetStress 24-hour stress test</td>
<td>Validates how storage responds to a high I/O load for an extended period of time.</td>
</tr>
<tr>
<td>3</td>
<td>JetStress database backup Vblock Systems Virtual Switching System test</td>
<td>Measures the maximum rate at which databases can be backed up using Virtual Switching System.</td>
</tr>
<tr>
<td>4</td>
<td>JetStress soft recovery test</td>
<td>Measures the maximum rate at which the log files can be played against the databases.</td>
</tr>
</tbody>
</table>

**Database backup and recovery performance**

Two JetStress tests were performed with a single ESXi server and 20,000 users to measure storage backup performance, as follows:

- Database Read-only Performance measures the sequential read rate of the database files.
- Transaction Log Recovery/Replay Performance measures the recovery/replay performance by playing transaction logs into the database.
Load Generator

Load Generator requires a complete Exchange 2010 infrastructure. We completed all Load Generator validation testing using a non-production environment. Load Generator created users, groups, OUs, Exchange 2010 databases, and mailboxes; and executed workload testing against the Exchange 2010 Hub Transport server, Client Access server, and Mailbox roles, as well as the network and storage components.

In this test, we used Load Generator to simulate mailboxes using Outlook 2007 online mode with the following characteristics:

- Action profile of 150 messages sent/received per mailbox per day
- Mailbox size 2 GB
- 313 mailboxes in each database

To simulate a normal operation, the simulated workload duration was set to eight hours and each simulation was run for eight hours.

The 150-messages profile sent 50 messages and received 100 messages per mailbox per day. It was expected that during an eight-hour simulated day the Mailbox server with 5000 active users would log approximately 8.7 sent messages per second and 17.4 received messages per second. We used the formula below to calculate the expected number of sent and received messages per second.

\[
\text{Messages sent per second} = \frac{\text{Number of mailbox users} \times 50 \text{ messages sent}}{8 \text{ hours} \times 60 \text{ minutes} \times 60 \text{ seconds}}
\]

\[
\text{Messages received per second} = \frac{\text{Number of mailbox users} \times 100 \text{ messages received}}{8 \text{ hours} \times 60 \text{ minutes} \times 60 \text{ seconds}}
\]

Mailbox server response times for client requests were tracked to determine the amount of time it took a mailbox server to respond to a client request. The response time average per request should not exceed 10 milliseconds on average. We used the following system monitor counters on the mailbox role to monitor response time:

- MSExchangeIS\RPC averaged latency
- MSExchangeIS Mailbox\RPC averaged latency
- MSExchangeIS Client (*)\RPC average latency

As a best practice, it is recommended to disable Hyper Threading on the ESXi hosts. This required entering the BIOS, disabling hyper threading, and doing a cold shutdown of the server. The validity of each test was determined by comparing the results of the performance counters to Microsoft performance thresholds. Performance counter data was collected at 10-second intervals for the duration of each test run. The results of the first and last hours were discarded. Results were averaged over the remaining duration of the test.

Table 7 lists the primary counters and their validation criteria.
Table 7. Primary counters and validation criteria

<table>
<thead>
<tr>
<th>Performance monitor counter</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor(total)% processor time</td>
<td>Not to exceed 80% during peak load</td>
</tr>
<tr>
<td>MExchangeIS\RPC averaged latency</td>
<td>Not to exceed 10 ms</td>
</tr>
<tr>
<td>MExchangeIS mailbox(total)\messages sent/sec</td>
<td>Approximately 0.002083 messages/second/mailbox</td>
</tr>
<tr>
<td>MExchangeIS mailbox(total)\messages received/sec</td>
<td>Approximately 0.008333 messages/second/mailbox</td>
</tr>
<tr>
<td>Logical disk sec/read</td>
<td>Not to exceed 20 ms</td>
</tr>
<tr>
<td>Logical disk sec/write</td>
<td>Not to exceed 20 ms</td>
</tr>
</tbody>
</table>

For additional information about monitoring Exchange 2010 performance and other key performance counters, see Performance and Scalability Counters and Thresholds at [technet.microsoft.com](http://technet.microsoft.com).

During heavy operations at peak load, we ran the test with a 100\% concurrency test with 150 Outlook messages online with a MAPI profile. The objective was to validate the entire Exchange 2010 environment under heavy operating conditions with the peak load. ESXi host and virtual machine performance were measured against Microsoft recommended performance targets. All Exchange 2010 virtual machines were under normal operating conditions. Load Generator was configured to simulate heavy user profile (150), which doubles the send and receive messages per second.

**Test results**

The following sections provide summary and detailed JetStress and Load Generator test results.

**Summary of results**

The following JetStress and Load Generator results, presented in Tables 8 and 9, validate at 100\% capacity and 100\% concurrency the end-to-end performance requirements of the Exchange 2010 on Vblock System 700 solution.

Table 8. Summary of the four JetStress test results

<table>
<thead>
<tr>
<th></th>
<th>JetStress 2-hour performance test</th>
<th>JetStress 24-hour test</th>
<th>Database backup test</th>
<th>Soft recovery test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database I/Os</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total disk transfers/sec</td>
<td>924.512</td>
<td>924.848</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total disk reads/sec</td>
<td>547.088</td>
<td>545.92</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total disk writes/sec</td>
<td>377.424</td>
<td>378.928</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Average database disk read latency</td>
<td>11.838 ms</td>
<td>12.127 ms</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
JetStress 2-hour performance test

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target</th>
<th>Tested results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Messages delivery rate/mailbox</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td>IOPs/mailbox</td>
<td>0.15</td>
<td>0.18</td>
</tr>
<tr>
<td>Megacycles/mailbox</td>
<td>3</td>
<td>3.35</td>
</tr>
</tbody>
</table>

Detailed results

JetStress 2-hour performance test

The JetStress 2-hour performance test demonstrated the solution met performance requirements for acceptable response under a 5,000-user load. Table 10 presents the results.

Table 10. Mailbox virtual machine performance results (5,000 users)

<table>
<thead>
<tr>
<th>Database I/Os</th>
<th>Average performance per mailbox virtual machine (5,000 users)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database disk transfers/s</td>
<td>924.512</td>
</tr>
</tbody>
</table>

2 Background database maintenance (BDM): process of the Exchange 2010 database maintenance that involves performing a checksum value on both active and passive database copies.
Database disk reads/s 547.088
Database disk writes/s 377.424
Average database disk read latency 11.838
Average database disk write latency 9.226

**Transactional log I/Os**
Log disk writes/s 320.944
Average log disk write latency (ms) 0.812

**BDM IOPS**
Total BDM IOPS 477.504
Total IOPS per mailbox virtual machine 1722

Table 11 demonstrates the solution scaled to and met performance requirements for acceptable response under a 20,000-user load.

**Table 11. Mailbox virtual machines performance results (20,000 users)**

<table>
<thead>
<tr>
<th>Database I/Os</th>
<th>Average performance per ESXi server (four mailbox virtual machines/20,000 users)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database disk transfers/s</td>
<td>3699</td>
</tr>
<tr>
<td>Database disk reads/s</td>
<td>2188.352</td>
</tr>
<tr>
<td>Database disk writes/s</td>
<td>1509.696</td>
</tr>
<tr>
<td>Average database disk read latency (ms)</td>
<td>11.838</td>
</tr>
<tr>
<td>Average database disk write latency (ms)</td>
<td>9.226</td>
</tr>
<tr>
<td>Transactional log I/Os</td>
<td></td>
</tr>
<tr>
<td>Log disk writes/s</td>
<td>1283.776</td>
</tr>
<tr>
<td>Average log disk write latency (ms)</td>
<td>0.812</td>
</tr>
<tr>
<td>BDM IOPS</td>
<td></td>
</tr>
<tr>
<td>Total BDM IOPS (261 K)</td>
<td>1910</td>
</tr>
<tr>
<td>Total Transactional IOPS</td>
<td>6892.776</td>
</tr>
</tbody>
</table>

**Database backup test**

The backup Virtual Switching System JetStress test measures the maximum rate at which databases can be backed up using Virtual Switching System. Table 12 shows test results for the average rate for a single database file.
Table 12. Average rate for single database file

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB read/s per database</td>
<td>59.8</td>
</tr>
<tr>
<td>MB read/s total per server</td>
<td>956.47</td>
</tr>
</tbody>
</table>

Note: Database recovery and read-only performance tests results are the same for both configurations and are combined in a single table for easy review.

Soft recovery test

The Soft Recovery JetStress test measured the maximum rate at which the log files can be played against the databases. The test results for the average rate for 500 log files played in a single database. Each log file 1 MB in size was 5.3 seconds.

Load Generator 2010 results

Table 13 shows results achieved with Exchange 2010 virtual machines within the target goals. During peak loads, the average CPU utilization on the Mailbox virtual machines was approximately 65 percent and the Unified Computing System ESXi host utilization was about 68 percent. On the Client Access server/Hub Transport server virtual machines, CPU utilization was approximately 38 percent.
Table 13. Validation of expected load for test

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Target</th>
<th>Test results</th>
</tr>
</thead>
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<tr>
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</tr>
<tr>
<td>Megacycles/mailbox</td>
<td>3</td>
<td>3.35</td>
</tr>
</tbody>
</table>

Figure 3. Unified Computing System ESXi host CPU utilization
Figure 4. Mailbox virtual machine CPU utilization
Conclusion

The Vblock Solution for Exchange 2010 successfully validated performance and resilience for a scalable solution to provide Exchange for 5,000 to 20,000 users using a Vblock System 700. Results indicated the solution processed significantly more IOPS than previous Direct Attached Storage configurations, reducing costs for spindles while providing desired performance.

The solution described here is easy to implement, manage, and scale—with state-of-the art virtualization and management tools that streamline, standardize, and automate Vblock Systems provisioning and configuration. This helps enterprise datacenters reduce operational costs, improve responsiveness, and scale without increasing headcount.

Additionally, the solution described here leverages VMware features, such as:

- VMware vCenter Chargeback, which maps infrastructure costs to business units, cost centers, or external customers
- CapacityIQ, which helps determine resource utilization and help with capacity monitoring
- vSphere HA, VMware vMotion, and DRS for the Hub Transport server and Client Access server roles, as well as other servers that are not clustered using Microsoft Failover Clustering

The solution validation described here met the following objectives:

- Disk performance tests
- Stress tests to prove that the sizing is adequate for performance and capacity requirements
- Tests of the client facing components, processor and memory subsystems
- Tests of the client impacts on the Exchange 2010 servers
- Tests to validate the entire e-mail infrastructure

The successful JetStress results provided here demonstrated:

- Utilization of 20,000-user building blocks by spreading loads in blocks of 5,000 users across four virtualized mailbox servers running on a single blade, achieving a 4:1 consolidation ratio
- Implementation of virtually provisioned storage helped with on-demand Exchange 2010 database growth, including deployments of additional virtualized Exchange 2010 mailbox servers, without outage
- Validation per end-to-end performance requirements at 100% capacity and 100% concurrency
References

The following additional information is available from VMware, EMC, and Microsoft.

VMware

You can access the following VMware resources at www.vmware.com

- Exchange 2010 on VMware – Best Practices Guide
- Exchange 2010 on VMware – Design and Sizing Examples

EMC Powerlink

You need a Powerlink account access the following Unified Infrastructure Manager resources at powerlink.emc.com:

- EMC Virtual Infrastructure for Microsoft Exchange 2010 Enabled by EMC Symmetrix VMAX, VMware vSphere 4 and EMC Replication Manager
- Performance, and Availability at Scale Enabled by EMC VMX, VP and VMware vSphere

Microsoft TechNet

You can access the following Microsoft resources at technet.microsoft.com.

- Mailbox Storage Design Process
- Mailbox Server Processor Capacity Planning
- Exchange 2010 Mailbox Server Role Requirements Calculator
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