

Best Practices for Virtualizing Exchange Server 2010 with Windows Server® 2008 R2 Hyper‑V™

Version 1.1

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# Version History

This table provides a history of changes made to this paper.

| **Version** | **Changes** |
| --- | --- |
| V1.1 | Updated memory sizing guidance for Unified Messaging role. |

# Terminology

This table provides definitions for the technical terms used throughout this paper.

Table 1. Terminology and Definitions

| **Term** | **Definition** |
| --- | --- |
| Failover Clustering | The Failover Clustering feature enables you to create and manage failover clusters. A failover cluster is a group of independent computers that work together to increase the availability of applications and services. The clustered servers (called nodes) are connected by physical cables and by software. If one of the cluster nodes fails, another node begins to provide service (a process known as failover). Users experience a minimum of disruptions in service. |
| Hyper-V root server | The computer, or more specifically, the hardware, that runs the Hyper-V role. |
| Hypervisor | The layer of software that exists above the hardware and below the management operating system. It creates partitions to provide isolated execution environments and manages each partition's access to hardware resources. |
| Live migration | The Hyper-V technology in Windows Server 2008 R2 that enables you to transparently move running virtual machines from one node of the failover cluster to another node in the same cluster without a dropped network connection or perceived downtime. |
| Management operating system | The operating system installed on the physical computer when the Hyper-V role is enabled. After enabling the Hyper-V role, the management operating system is moved into a partition known as the *parent partition*. The management operating system automatically starts when the physical computer starts.  The management operating system provides management access to the virtual machines and an execution environment for the Hyper-V services. The management operating system also provides the virtual machines with access to the hardware resources it owns. |
| Parent partition | The partition used to store the management operating system. |
| Pass-through disk | A pass-through disk is a disk that is configured for Hyper-V to “bypass” the host’s file system and access the disk directly. This disk can be a physical hard disk on the host or a logical unit on a storage area network (SAN). Hyper-V requires the disk to be in an offline state on the host to ensure that the host and the guest do not try to use the disk at the same time.  Pass-through disks do not provide certain virtual hard disk (VHD) features, including VHD snapshots, dynamically expanding VHDs, and differencing VHDs. However they are the fastest performing type of VHD. |
| Virtual hard disk (VHD) | The file format for a virtual hard disk, the storage medium for a virtual machine. It can reside on any storage topology that the management operating system can access, including external devices, SANs, and network-attached storage. |
| Virtual machine | A computer that is a software implementation of a computer. Virtual machines are used to run different operating systems at the same time on one physical computer. Each operating system runs in its own isolated execution environment. |
| Virtual network | A virtual version of a physical network switch. A virtual network can be configured to provide access to local or external network resources for one or more virtual machines. |

# **Introduction**

Many organizations today rely on some degree of virtualization. Whether it is a few virtual machines running on a single physical computer or a whole server farm across multiple root servers, virtualization optimizes investment in hardware and network infrastructure by:

* Increasing the utilization of underused hardware.
* Improving server availability.
* Reducing IT costs.

The purpose of this paper is to provide guidance and best practices for deploying Microsoft® Exchange Server 2010 in a virtualized environment with Windows Server® 2008 R2 Hyper‑V™ technology. This paper has been carefully composed to be relevant to organizations of any size.

Windows Server 2008 R2 Hyper-V is a powerful virtualization technology that enables organizations to take advantage of the benefits of virtualization without having to buy third-party software. By deploying Exchange Server 2010 with Windows Server 2008 R2 Hyper‑V technology, an organization can avoid the complications that can arise from dealing with multiple vendors because both Exchange Server and Hyper-V technology come from Microsoft.

One of the most utilized benefits of virtualization technology is server consolidation, which enables one server to take on the workloads of multiple servers. For example, by consolidating an office’s file and print server, Exchange server, and web server on a single root server, organizations can reduce the costs of hardware, maintenance, and IT support. This consolidation also reduces costs associated with managing server heat, electricity usage, physical space, and maintenance.

There are a number of different reasons why an organization might want to virtualize an Exchange environment. The following are major reasons that are common to most organizations:

* When an organization uses virtualization for its server infrastructure, Exchange is virtualized to be in alignment with standard corporate policy.
* To consolidate underused application servers onto one physical server for increased hardware utilization.
* Small and medium-sized organizations, as well as small branch offices for larger organizations, may consolidate Exchange CAS and HUB server roles into a virtualized environment with other application servers on the same physical server.
* To save on space, power, and cooling

Exchange Server can be virtualized on one or more servers. A small organization could have a single server that provides all the required Exchange roles and functionality. A large organization will require a more complex configuration in which the Exchange roles are installed on multiple servers for Client Access server, Hub Transport, Edge, Mailbox, and Unified Messaging. Each of these roles comes with its own unique workload characteristics. Typically a Mailbox server is processor, memory and disk-intensive whereas a Client Access server is processor and memory-intensive. A Hub Transport server is memory and disk-intensive. Careful planning and workload balancing must be performed to determine optimum configurations. These roles can be expanded to additional servers to provide high availability and failover scenarios. This paper describes best practices for balancing these multiple roles across Hyper-V root servers.

The following sections describe the processes that are necessary for determining server requirements in a virtualized environment. These are processes that have been proven to be effective by the Exchange Server and Hyper-V engineering teams. Where appropriate, this paper provides references to information sources.

## Outline

The paper includes five main sections:

### Virtualized Exchange Server Best Practices

This first section describes best practices for configuring the Hyper‑V root server and its Hyper-V guests. It further describes best practices for deploying Exchange Server roles in a Hyper‑V environment and improvements with Hyper‑V in Windows Server 2008 R2 and Service Pack 1 (SP1).

### Server Deployment Best Practices

This section describes the best practices for deploying each of the Exchange Server 2010 roles in a Hyper-V virtualized environment. The high-level descriptions in this section illustrate the concepts involved. Detailed descriptions are in later sections of the document.

### Capacity, Sizing, and Performance of Exchange Server on Hyper-V Best Practices

This section describes the best practices for calculating the storage and processor requirements for each of the Exchange Server roles based on the e-mail requirements of the organization. This section describes realistic figures for a simple small to medium–sized organization that has no high availability requirements.

### Best Practices for Maintaining High Availability of Exchange Server 2010 on Hyper-V

This section expands upon the previous section to describe a larger organization that has high availability requirements. Again the information focuses on best practices for both the design of the Exchange topology and the virtualization of it.

### Running Exchange Alongside Other Workloads in a Virtual Environment

This section describes best practices for deploying Exchange alongside other workloads in a virtual environment.

## Audience

The audience for this paper is IT professionals who are deploying Exchange Server 2010 with Hyper-V technology. It is primarily a technical paper, however a less technical audience will also benefit from many of the recommendations and best practices it describes.

## Background Information About Hyper-V

Hyper-V technology, a key feature of Windows Server 2008 R2, integrates with familiar, Windows-based server management tools. Businesses do not have to purchase additional software to take advantage of its powerful virtualization features such as live backup and live migration. For customers who want a complete server management solution that works with virtual machines and physical servers, Microsoft System Center now includes advanced virtual machine management and monitoring capabilities.

With Hyper-V technology, Microsoft provides a platform with flexible and robust virtualization capabilities. Whether in your data center, with a service provider—and whether in a private cloud or public cloud—Microsoft provides the flexibility and control to consume IT as a service, whichever way best meets your unique business needs.

When planning to reuse existing hardware for the root server, it is important to confirm that the hardware supports hypervisor-based virtualization. Hypervisor software runs directly on the hardware platform and beneath the operating systems running on the computer. The Hyper-V root server runs the hypervisor, which is a thin layer of software or firmware that makes it possible for multiple guest virtual machines to run on the root server at the same time. Most modern servers come with a hypervisor. All guest virtual machines get resources from the root server. It is, therefore, crucial to correctly size the Hyper-V root server to ensure availability and high performance for all resources.

## Server Core Installation Option

As a best practice, the Server Core installation option of the Windows Server 2008 operating system should be installed on the physical root server. Server Core is a minimal server installation of Windows Server 2008, including the Hyper-V role. When you select the Server Core installation option, Setup installs only the files that are required for the supported server roles. For example, the Explorer shell is not installed as part of a Server Core installation. After you have enabled the Hyper-V role, you can manage the Hyper-V role and guest virtual machines remotely using the Hyper-V management tools. Installing the Server Core option helps secure both the server running Hyper-V and all the virtual machines running on it. Other benefits of Server Core include:

* **Reduced maintenance**. Because a Server Core installation installs only what is required for the specified server roles, less servicing is required than on a full installation of Windows Server 2008.
* **Reduced attack surface**. Because Server Core installations are minimal, there are fewer applications running on the server, which decreases the attack surface.
* **Reduced management**. Because fewer applications and services are installed on a server running a Server Core installation, there is less to manage.
* **Less disk space required**. A Server Core installation only requires about 1 gigabyte (GB) of disk space to install, and approximately 2 GB for operations.

For more information about the Server Core installation option, see [Install the Hyper-V Role on a Server Core Installation of Windows Server 2008](http://technet.microsoft.com/en-us/library/cc794852(WS.10).aspx) at http://technet.microsoft.com/en-us/library/cc794852(WS.10).aspx

**Note**   Exchange Server 2010 will not install on a Windows 2008 R2 Server Core installation, therefore a full installation of Windows Server 2008 R2 is required for the Hyper‑V guest virtual machines.

# **Virtualized Exchange Server Best Practices**

This section describes best practices to consider when deploying Exchange Server in a virtualized environment. These include:

* Scale up or scale out?
* Hyper-V root sizing
* Hyper-V guest configuration
* Determining Exchange Server role virtual machine locations
* Deployment recommendations

This section covers the best practices at a high level. Later sections of this paper describe methods for calculating server requirements and workloads.

## Scale Up or Scale Out?

In a virtual environment, just as in a physical environment, the decision to scale up or scale out still has to be made. Scaling up is deploying fewer servers with more resources per server, whereas scaling out is deploying more servers, each consuming less resources.. The correct method to implement largely depends upon the customer’s environment and requirements. In a physical computer environment, decisions regarding server sizing are inflexible after they are implemented, whereas in a virtual environment, it is possible to divide up physical resources among multiple guest servers, which provides design and implementation flexibility.

We generally recommend that an organization scale up their mailbox servers to host more mailboxes, however both scaling up and scaling out are valid solutions that Microsoft supports.

Exchange Server 2010 offers built-in high availability features that allow multiple Exchange Server roles to be distributed across multiple hosts to provide high availability. High availability requirements often determine when to scale out. For more information, see the “Best Practices for Maintaining High Availability of Exchange Server 2010 on Hyper-V” section of this document.

## Hyper-V Root Sizing

The largest consideration for sizing the Hyper-V root server is accommodating the guests it will support. However, there are a number of other factors to take into account:

* When calculating the RAM requirements on the Hyper-V root server, plan for an additional 1 GB or more of RAM for management of Windows Server 2008 R2.
* Plan for a dedicated network interface card (NIC) for managing the Hyper‑V root server. This card should not be connected to a local Hyper-V virtual switch.
* For a simple virtual network configuration that establishes connectivity to an external network, we recommend that you have at least two network adapters on the server running Hyper-V: one network adapter dedicated to the management operating system so you can access it remotely, and one or more network adapters dedicated to the virtual machines.
* If using live migration, plan for a dedicated NIC of 1 GB or higher due to the large amount of data moved across network.
* If Internet SCSI (iSCSI) storage is being used, choose dedicated, separate NICs for iSCSI storage.
* Plan for separate LUNs/arrays for the management operating system, guest operating system virtual hard disks (VHDs), and virtual machine storage.
* Management operating system and VHD LUNs should employ a redundant array of independent disks (RAID) to provide data protection and improve performance.
* For blade servers that have two physical disks, use the two physical disks for the host server only. Have the guests on direct-attached storage exposed as pass-through disks, or a separate storage area network (SAN),
* In a Hyper-V environment, a temporary memory storage file (BIN file) is created and maintained for each guest virtual machine. The size of each BIN file is equal to the amount of memory allocated to the guest virtual machine. The BIN file is stored alongside the Hyper‑V guest virtual hard disk and should be taken into account when determining the amount of disk space required on the Hyper‑V root server.
* The hypervisor running on the Hyper‑V root server has to manage each of the running Hyper‑V guests, resulting in extra load on the root server processors. This overhead can vary and a conservative allowance of 10 percent overhead should be allowed when sizing the host processors.

## Hyper­‑V Guest Configuration

Keep in mind that because there are no routines within Exchange Server that test for a virtualized platform, Exchange Server behaves no differently programmatically on a virtualized platform than it does on a physical platform.

### Guest Memory

Memory must be sized for guest virtual machines using the same methods as physical computer deployments.

Some hypervisors can oversubscribe or dynamically adjust the amount of memory available to a specific guest virtual machine based on the perceived utilization of memory in the guest virtual machine as compared to the needs of other guest virtual machines managed by the same hypervisor. This technology makes sense for workloads in which memory is needed for brief periods of time and then can be surrendered for other uses. However, it doesn't make sense for workloads that are designed to use memory on an ongoing basis. Exchange—like many server applications that have optimizations for performance that involve caching of data in memory—is susceptible to poor system performance and an unacceptable client experience if it doesn't have full control over the memory allocated to the physical computer or virtual machine on which it is running.

Many of the performance gains in recent versions of Exchange, especially those related to reduction in input/output (I/O) are based on highly efficient usage of large amounts of memory. When that memory is no longer available, the expected performance of the system can't be achieved. For this reason, memory oversubscription or dynamic adjustment of virtual machine memory must be disabled for production Exchange servers.

### Guest Storage

Each Exchange guest virtual machine must be allocated sufficient storage space on the root virtual machine for the fixed disk that contains the guest's operating system, any temporary memory storage files in use, and related virtual machine files that are hosted on the root machine.

Consider the following best practices when configuring Hyper-V guests.

* Fixed VHDs are recommended for the virtual operating system.
* Allow for a minimum of a 15-GB disk for the operating system, allow additional space for the paging file, management software, and crash recovery (dump) files. Then add Exchange server role space requirements.
* Storage used by Exchange should be hosted in disk spindles that are separate from the storage that hosts the guest virtual machine's operating system.
* For Hub Transport servers, correctly provision the necessary disk space needed for the message queue database, and logging operations.
* For Mailbox servers, correctly provision the necessary disk space for databases, transaction logs, the content index, and other logging operations. .

**Note**The amount of disk space needed and the optimal disk configuration for an environment is described in the next section of this document.

## Determining Exchange Server Role Virtual Machine Locations

When determining Exchange Server Role virtual machine locations, consider the following general best practices:

* Deploy the same Exchange roles across multiple physical server roots (to allow for load balancing and high availability).
* Never deploy Mailbox servers that are members of the same Database Availability Groups (DAGs) on the same root.
* Never deploy all the Client Access Servers on the same root.
* Never deploy all the Hub Transport servers on the same root.
* Determine the workload requirements for each server and balance the workload across the Hyper‑V guest virtual machines.

**Note**For more information about how to determine workload requirements, see the “Capacity, Sizing, and Performance of Exchange on Hyper-V Best Practices” section of this document.

## Deployment Recommendations

When designing an Exchange Server 2010 virtualized environment, the core Exchange design principles apply. The environment must be designed for the correct performance, reliability, and capacity requirements. Design considerations such as examining usage profiles, message profiles, and so on must still be taken into account.

When considering a high availability solution that uses DAGs, we recommend that you review the Mailbox Storage Design Process article on TechNet as a starting point for designing the Exchange storage system For more information, see [Mailbox Storage Design Process](http://technet.microsoft.com/en-us/library/ff367907.aspx) at http://technet.microsoft.com/en-us/library/ff367907.aspx.

Because virtualization provides the flexibility to make changes to the design of the environment later, some organizations might be tempted to spend less time on their design at the outset. As a best practice, spend adequate time designing the environment to avoid pitfalls later.

Group the Exchange Server roles in such a way that balances workloads on the root servers. Mixing both roles on the same Hyper‑V root server can balance the workloads and prevent one physical resource from being unduly stressed, rather than if the same roles were put on the same hosts. The following figure illustrates examples of balanced workloads.



Figure 1. CAS/HUB Mailbox Combined roles

This figure shows a 1:1 ratio of Client Access server/Hub virtual machines to Mailbox virtual machines for an 8 core, 16 core, and 24 core root server. The actual configuration of balanced workloads is described in detail in the “Capacity, Sizing, and Performance of Exchange Server on Hyper-V Best Practices” section of this document. In this illustration, the Mailbox servers hosted on the same Hyper‑V root server must not be members of the DAG.

# **Server Deployment Best Practices**

This topic describes the best practices for deploying each of the Exchange Server 2010 roles in a Hyper-V virtualized environment. Virtual machines should be sized specific to the Exchange role (that is, Edge Transport, Hub Transport, Client Access, Mailbox, Unified Messaging, or multi-role). These best practices include:

* Mailbox server deployment
* Edge Transport server or Hub Transport server deployment
* Client Access server deployment
* Unified Messaging server deployment
* Client Access server/Hub Transport multi-role deployment
* Client Access server/Hub Transport/Mailbox server multi-role deployment
* Exchange Hosting Mode
* Storage options when using Hyper-V

In addition, this section includes the following topics:

* Virtualization scenarios that are not supported
* Hyper-V Best Practices Analyzer
* Improvements with Windows Server 2008 R2 Hyper-V

For more information about capacity planning, sizing, and performance see the “Capacity, Sizing, and Performance of Exchange on Hyper-V Best Practices” section of this paper.

## Mailbox Server Deployment

The Mailbox server role dictates how many Client Access server and Hub Transport roles there should be in an environment and so it is the first role that should be evaluated. From these results it is possible to calculate the required number of Hub Transport and Client Access server roles. For more information about sizing the Mailbox server role, see the “Capacity, Sizing, and Performance of Exchange Server on Hyper-V Best Practices” section of this document.

## Edge Transport or Hub Transport Server Deployment

The following bullets describe the recommendations for a physical and virtual deployment of an Edge Transport or Hub Transport server.

* 1 Hub Transport virtual machine: 5 Mailbox virtual machines with antivirus
* 1 Hub Transport processor core : 7 Mailbox processor cores without antivirus

## Client Access Server Deployment

In Exchange Server 2010, the Client Access server is where all MAPI clients connect and communicate for Mailbox server data, unlike in previous versions of Exchange in which the MAPI clients connected directly to the Information Store. Connecting directly to the Client Access server takes work off the Mailbox role and puts it on the Client Access server, which calls for a reduction in the number of Mailbox roles each Client Access server can support. The recommended ratio is now 3:4 in both physical and virtual environments.

Note that the ratio of Client Access server to Mailbox servers may change in certain environments, such as when there is a high number of Outlook® Web App or Exchange ActiveSync® users to the number of direct MAPI connections. In this case there would be a requirement for increasing the ratio of Client Access servers per Mailbox servers. The actual ratio should be determined in the test environment by using stress-loading tools as described in the ”Capacity, Sizing, and Performance of Exchange Server on Hyper-V Best Practices” section of this document.

## Unified Messaging Server Deployment

The Exchange Server 2010 Unified Messaging (UM) role provides voice mail services and consolidates voice mail and email messages into a user’s inbox. For more information about this role, see [Voicemail with Unified Messaging in Exchange 2010](http://www.microsoft.com/exchange/en-us/unified-messaging.aspx) at www.microsoft.com/exchange/en-us/unified-messaging.aspx

Microsoft Exchange Server 2010 SP1 supports virtualization of the Unified Messaging role when it is installed on the 64-bit edition of Windows Server 2008 R2.

Unified Messaging must be the only Exchange role in the virtual machine. Other Exchange roles (Client Access, Edge Transport, Hub Transport, Mailbox) are not supported on the same virtual machine as Unified Messaging.

The virtualized machine configuration running Unified Messaging must have at least 4 CPU cores. Memory should be sized using published sizing guidance for the Unified Messaging role. For more information see [Understanding Memory Configurations and Exchange Performance](http://technet.microsoft.com/en-us/library/dd346700.aspx) at http://technet.microsoft.com/en-us/library/dd346700.aspx.

## Client Access Server/Hub Transport Multi-role Deployment

The Client Access server/Hub Transport role is a valid deployment and makes the ratio of Client Access server/Hub Transport servers to Mailbox servers one-to-one, which works out very simply for balancing workloads.

Given that Mailbox roles belonging to a DAG should not be deployed on the same physical server, having a Client Access server/Hub Transport 1:1 ratio with Mailbox roles provides a simple method for separating the Mailbox roles onto separate servers.

## Exchange Hosting Mode

Exchange Hosting Mode (or Multi-tenant support) provides the core feature-set of Exchange Server in a manner that can be deployed to multiple customers in a single installation, and provides ease of management and flexibility of provided features to end-users.

The multi-tenant solution available for Exchange 2010 SP1 includes most of the features and functionality available in Exchange 2010 SP1 Enterprise deployments, but also includes features and functionality that will allow you to create and manage tenant organizations.

Exchange Hosting Mode servers are supported in a virtualized environment. For more information see [Multi-Tenant Support](http://technet.microsoft.com/en-us/library/ff923272.aspx) at http://technet.microsoft.com/en-us/library/ff923272.aspx.

## Storage Options When Using Hyper-V

Exchange 2010 includes improvements in performance, reliability, and high availability that enable organizations to run Exchange on a wide range of storage options.

When examining the available storage options, being able to balance the performance, capacity, manageability, and cost requirements is essential to achieving a successful storage solution for Exchange.

Hyper-V supports the following types of physical storage:

* Direct-attached storage (DAS), which is storage attached to the management operating system. You can use Serial Advanced Technology Attachment (SATA), external Serial Advanced Technology Attachment (eSATA), Parallel Advanced Technology Attachment (PATA), Serial Attached SCSI (SAS), SCSI, USB, and Firewire.
* Storage area networks (SANs). You can use Internet SCSI (iSCSI), Fibre Channel, and SAS technologies.

Network-attached storage (NAS) is not supported for Hyper-V.

The storage used by the Exchange guest virtual machine for storage of Exchange data (for example, mailbox databases or Hub transport queues) can be virtual storage of a fixed size (for example, fixed VHDs in a Hyper-V environment), SCSI pass-through storage, or Internet SCSI (iSCSI) storage. Pass-through storage is storage that is configured at the host level and dedicated to one guest virtual machine. All storage used by an Exchange guest virtual machine for storage of Exchange data must be block-level storage because Exchange 2010 doesn't support the use of network-attached storage (NAS) volumes. Also, NAS storage that is presented to the guest as block-level storage via the hypervisor is not supported.

The following virtual disk requirements apply for volumes used to store Exchange data:

* Virtual disks that dynamically expand are not supported by Exchange.
* Virtual disks that use differencing or delta mechanisms (such as differencing VHDs or snapshots) are not supported.
* Reverting to virtual machine snapshots of an Exchange guest virtual machine is not supported.
* Configuring iSCSI storage to use an iSCSI initiator inside an Exchange guest virtual machine is supported.

**Note**   In a Hyper-V environment, each fixed VHD must be less than 2,040 GB.

Storage used by Exchange should be hosted in disk spindles that are separate from the storage that is hosting the guest virtual machine's operating system.

### Internal or External Storage

A number of server models on the market today support from 8 through 16 internal disks. These servers are a fit for some Exchange deployments and provide a solid solution at a low price point. Organizations that meet their storage capacity and I/O requirements with internal storage and do not have a specific requirement to use external storage, should consider using server models with an internal disk for Exchange deployments. Organizations that have higher storage and I/O requirements or have an existing investment in SANs, should examine larger external direct-attached storage or SAN solutions.

Fibre Channel has historically been the storage protocol of choice for data centers for a variety of reasons, including performance and low latency. These considerations have offset Fibre Channel’s typically higher costs. In the last several years, Ethernet’s continually advancing performance from 1 Gb/s to 10 Gb/s and eventually beyond have led to great interest in storage protocols leveraging the Ethernet transport such as iSCSI and recently, Fibre Channel over Ethernet (FCoE).

This solution can reduce costs in several ways, such as the elimination of dedicated Fibre Channel switches and a reduction in cabling, which can also be a significant cost in large data center environments.

### Direct-Attached Storage

Storage improvements made to Exchange Server 2010 qualify using low-cost, high-speed direct-attached storage (DAS) solutions, including the use of SATA hard disk drives and configurations that do not use RAID. These improvements include:

* **Disk I/O reductions**. Exchange 2010 delivers up to a 50 percent reduction in disk IO from Exchange 2007 levels. This means that more disks meet the minimum performance required to run Exchange, which drives down storage costs.
* **Optimizations for SATA disks**. I/O patterns are optimized so that disk writes do not come in bursts. This removes a barrier that had previously limited the use of SATA desktop class hard disk drives disks.
* **Automatic page patching**. Exchange Server 2010 is more resilient to storage problems. When Exchange 2010 is deployed with replicated copies of each mailbox database and a corruption is caused by minor disk faults, Exchange automatically repairs the affected database pages using one of the database copies configured for high availability. Automatic detection and repair of data corruptions from minor disk errors means organizations can take advantage of lower-cost storage options while maintaining system reliability.
* **Support for “just a bunch of disks” (JBOD) configurations**. Exchange 2010 can be deployed with up to 16 replicated copies of each mailbox database, and fast database-level failover makes it possible for administrators to swap failed drives with minimal impact to users. This application-level redundancy allows storage configurations that do not use RAID to be used, (which is called “just a bunch of disks”), resulting in dramatic cost savings.

### iSCSI

iSCSi allows clients (called *initiators*) to send SCSI commands to SCSI storage devices (targets) on remote servers or arrays. Unlike Fibre Channel, which requires dedicated cabling and switches, iSCSI leverages the existing network infrastructure, but typically it should be dedicated infrastructure.

iSCSI provides an advantage in that it is the only storage solution that can be utilized by Hyper-V guest virtual machines for guest clustering.

iSCSi allows clients to send SCSI commands to SCSI storage devices on remote servers or arrays. Unlike Fibre Channel, which requires dedicated cabling and switches, iSCSI leverages the existing network infrastructure. The cost of jumbo frame Ethernet switches is also much lower than Fibre Channel switches, and copper cabling is cheaper than fibre.

iSCSI provides an advantage in that it is the only storage solution that can be utilized by Hyper-V for clustered guest virtual machines.

Virtual SCSI controllers have major performance benefits over virtual IDE controllers. We recommend using virtual SCSI to improve disk I/O performance. Virtual SCSI may be configured as pass-through or fixed disk.

Consider the following best practices for iSCSI:

* **Dedicated NIC**. Dedicate a NIC for iSCSI traffic, so that iSCSI traffic does not share the network with LAN traffic.
* **Enable jumbo frames**. One of the bigger sources of overhead with an iSCSI SAN is frame handling. Enabling jumbo frames increases the Ethernet frame size. This larger frame size means fewer frames are required to relay the same amount of information, thereby greatly improving SAN speed. When enabling jumbo frames, it is important to make sure that every point on an iSCSI SAN has jumbo frames enabled.
* **Offload TCP**. Use TCP offloading to offload processing of the TCP/IP stack to the network controller. This frees up the CPU for other processing tasks.
* **Configure the iSCSI initiator on host**. The recommendation is that the iSCSI initiator be configured in the host and not on the guest because it provides increased performance. However, configuring the iSCSI initiator on the guest is a supported configuration if necessary.

Configuring iSCSI storage to use an iSCSI initiator inside an Exchange guest virtual machine is supported. However, there will be reduced performance in this configuration if the network stack inside a virtual machine is not full-featured (for example, not all virtual network stacks support jumbo frames).

### Fibre Channel over Ethernet

Fibre Channel over Ethernet (FCoE) is an emerging technology, now standardized, that brings the benefits of leveraging an Ethernet transport while retaining the advantages of the Fibre Channel protocol and the ability to leverage Fibre Channel storage arrays.

### For More Information

* For more information about planning for disks and storage, see [Planning for Disks and Storage](http://technet.microsoft.com/en-us/library/dd183729(WS.10).aspx) at http://technet.microsoft.com/en-us/library/dd183729(WS.10).aspx.
* For more information about running currently supported versions of Microsoft Exchange Server in a hardware virtualization environment, see the “Hardware Virtualization” topic in [Exchange 2010 System Requirements](http://technet.microsoft.com/en-us/library/aa996719.aspx) at http://technet.microsoft.com/en-us/library/aa996719.aspx.
* For more information about best practices for deploying Exchange Server, see the following:
* [Exchange 2010 Tested Solutions: 500 Mailboxes in a Single Site Running Hyper‑V on Dell Servers](http://technet.microsoft.com/en-us/library/gg436085.aspx) at http://technet.microsoft.com/en-us/library/gg436085.aspx.
* [Exchange 2010 Tested Solutions: 9000 Mailboxes in Two Sites Running Hyper-V on Dell M610 Servers, Dell EqualLogic Storage, and F5 Load Balancing Solutions](http://technet.microsoft.com/en-us/library/gg513522.aspx) at http://technet.microsoft.com/en-us/library/gg513522.aspx.
* [Exchange 2010 Tested Solutions: 16000 Mailboxes in a Single Site Deployed on IBM and Brocade Hardware](http://technet.microsoft.com/en-us/library/gg513523.aspx) at <http://technet.microsoft.com/en-us/library/gg513523.aspx>.

## Virtualization Scenarios That Are Not Supported

The following scenarios are not currently supported in production environments when virtualizing Exchange Server with Hyper‑V:

* Snapshots, differencing/delta disks
* Virtual processor/physical processor core ratios greater than 2:1
* Applications running on the root virtual machine (excluding antivirus, backup, management software, and so on).

## Hyper-V Best Practices Analyzer

To assist in bringing the Hyper‑V server into compliance with best practices, the Hyper‑V Best Practices Analyzer should be used to run a series of Best Practices Analyzer checks.

The Hyper‑V Best Practices Analyzer scans a server that is running the Hyper‑V role, and helps identify configurations that do not comply with best practices for this role. The Hyper V Best Practices Analyzer scans:

* The configuration of the physical computer
* The virtual machines
* Other resources including virtual networking and virtual storage.

Scan results are displayed as a list that can be sorted by severity, and include recommendations for fixing issues and links to instructions. No configuration changes occur automatically by running the scan.

To download the Hyper-V Best Practices Analyzer, see the [Microsoft Download Center](http://www.microsoft.com/downloads/en/details.aspx?FamilyId=89d80c15-0082-4fef-a4fc-fefa463bed08&displaylang=en) at www.microsoft.com/downloads/en/details.aspx?FamilyId=89d80c15-0082-4fef-a4fc-fefa463bed08&displaylang=en

## Improvements with Windows Server 2008 R2 Hyper-V

This section briefly summarizes the improvements to existing functionality in Hyper‑V, which include:

* Dynamic virtual machine storage
* Enhanced processor support
* Enhanced networking support
* Live migration
* Dynamic memory
* Microsoft RemoteFX™
* Hyper V Failover Clustering

### Dynamic Virtual Machine Storage

Improvements to virtual machine storage include support for hot plugging and hot removal of the storage on a SCSI controller of the virtual machine. By supporting the addition or removal of VHDs and physical disks while a virtual machine is running, it is possible to quickly reconfigure virtual machines to meet changing requirements. Hot plugging and removal of storage requires the installation of Hyper-V integration services (included in Windows Server 2008 R2) on the guest operating system.

### Enhanced Processor Support

Hyper‑V has increased processor support to up to 64 physical processor cores. When capacity planning for virtualizing Exchange Server, remember that there is still the limit of four virtual processors per virtual machine. The increased processor support makes it possible to run more demanding workloads on a single host. In addition, there is support for Second-Level Address Translation (SLAT) and CPU Core Parking. CPU Core Parking enables Windows Server and Hyper-V to consolidate processing onto the fewest number of possible processor cores, and suspends inactive processor cores. SLAT provides an indirection layer from virtual machine memory access to the physical memory access. In virtualization scenarios, hardware-based SLAT support improves performance. On Itanium-based processors, this is called Extended Page Tables (EPT), and on AMD-based processors, it is called Nested Page Tables (NPT).

### Enhanced Networking Support

Support for jumbo frames, which was previously available in only in physical environments, has been extended to virtual machines. This feature enables virtual machines to use jumbo frames up to 9,014 bytes in size, if the underlying physical network supports it.

### Live Migration

Hyper-V live migration moves running virtual machines from one physical host to another physical host with no impact on availability to users. To achieve this with no impact, Hyper‑V pre-copies the memory of the migrating virtual machine to the destination physical host. As this is occurs, any virtual machine modifications to the virtual machine’s memory pages are tracked and any modified pages are transferred to the destination physical computer. Hyper-V then moves the storage handle for the virtual machine’s VHD files to the destination physical computer and the destination virtual machine is brought online on the destination Hyper-V server.

The guest operating system of the migrating virtual machine is unaware the migration is happening, so no special configuration for the guest operating system is needed.

Live migration requires the failover clustering role to be added and configured on the servers running Hyper-V. In addition, failover clustering requires shared storage for the cluster nodes. This can include an iSCSI or Fibre Channel SAN. All virtual machines are stored in the shared storage area, and the running virtual machine state is managed by one of the nodes.

On a given server running Hyper-V, only one live migration (to or from the server) can be in progress at a given time, which means live migration cannot be used to move multiple virtual machines simultaneously.

We recommend the use of the Cluster Shared Volumes feature of failover clustering in Windows Server 2008 R2 with live migration. Cluster Shared Volumes provides increased reliability when used with live migration and virtual machines, and also provides a single, consistent file namespace so that all servers running Windows Server 2008 R2 see the same storage.

Exchange server virtual machines, including Exchange Mailbox virtual machines that are part of a Database Availability Group (DAG), can be combined with host-based failover clustering and migration technology as long as the virtual machines are configured such that they will not save and restore state on disk when moved or taken offline.

### Dynamic Memory

Although dynamic memory might be appropriate for certain applications, dynamic adjustment of virtual machine memory should be disabled for production Exchange servers.

Dynamic memory allows memory on a host virtual server to be pooled and dynamically distributed to virtual machines as necessary. Memory is dynamically added or removed based on current workloads, and is done so without service interruption. This technology makes sense for workloads in which memory is needed for brief periods of time and then can be surrendered for other uses. However, it doesn't make sense for workloads that are designed to use memory on an ongoing basis. Exchange, like many server applications that have optimizations for performance that involve caching of data in memory, is susceptible to poor system performance and an unacceptable client experience if it doesn't have full control over the memory allocated to the physical or virtual machine on which it is running.

Many of the performance gains in recent versions of Exchange, especially those related to reduction in I/O, are based on highly efficient usage of large amounts of memory. When that memory is no longer available, the expected performance of the system cannot be achieved.

### Microsoft RemoteFX

Although Microsoft Remote FX may be appropriate for certain applications, it must be disabled for production Exchange servers.

Microsoft RemoteFX in Windows Server 2008 R2 SP1, introduces a new set of remote user experience capabilities that enable a media-rich user environment for virtual desktops, session-based desktops and remote applications. RemoteFX can be deployed to a range of thick and thin client devices, enabling cost-effective, local-like access to graphics-intensive applications and a broad array of end user peripherals, improving productivity of remote users.

### Hyper‑V Failover Clustering

The Failover Clustering feature enables you to create and manage failover clusters. A failover cluster is a group of independent computers that work together to increase the availability of applications and services. The clustered servers (called nodes) are connected by physical cables and by software. If one of the cluster nodes fails, another node begins to provide service (a process known as failover). Users experience a minimum of disruptions in service.

A new feature of failover clusters called Cluster Shared Volumes is specifically designed to enhance the availability and manageability of virtual machines. Cluster Shared Volumes are volumes in a failover cluster that multiple nodes can read from and write to at the same time. This feature enables multiple nodes to concurrently access a single shared volume. The Cluster Shared Volumes feature is only supported for use with Hyper-V and other technologies specified by Microsoft.

On a failover cluster that uses Cluster Shared Volumes, multiple clustered virtual machines that are distributed across multiple cluster nodes can all access their virtual hard disk (VHD) files at the same time, even if the VHD files are on a single disk (LUN) in the storage. This means that the clustered virtual machines can fail over independently of one another, even if they use only a single LUN. When Cluster Shared Volumes is not enabled, a single disk (LUN) can only be accessed by a single node at a time. This means that clustered virtual machines can only fail over independently if each virtual machine has its own LUN, which makes the management of LUNs and clustered virtual machines more difficult.

For a two-node failover cluster, the storage should contain at least two separate volumes (LUNs), configured at the hardware level. Do not expose the clustered volumes to servers that are not in the cluster. One volume will function as the witness disk. One volume will contain the files that are being shared between the cluster nodes. This volume serves as the shared storage on which you will create the virtual machine and the virtual hard disk.

# **Capacity, Sizing, and Performance of Exchange on Hyper-V Best Practices**

Performance planning determines the software and hardware configuration required to handle a certain user load. Before planning the hardware for a system, a realistic set of organizational requirements must be determined including but not limited to:

* The expected number of users (at peak and on average).
* The usage profile for the system.
* Desired response time for certain activities.
* Expected future growth.
* High availability and disaster recovery constraints.
* Other factors, such as the maximum CPU usage and disk I/O.

After the general requirements have been determined, use the methods and sizing tools described in this section to define the hardware configuration that should be able to cope with the defined requirements. The capacity of the configuration will require validation using load simulators such as the Exchange Load Generator and Microsoft Exchange Server Jetstress 2010. The Exchange Load Generator is a simulation tool to measure the impact of MAPI, Outlook® Web App, ActiveSync, IMAP, POP, and SMTP clients on Exchange servers. Jetstress simulates disk I/O load on a test server running Exchange to verify the performance and stability of the disk subsystem before putting the server into a production environment. Depending on the results of this validation step, the hardware configuration can be fine-tuned to achieve the desired performance and capacity.

You can download the Exchange Load Generator from the [Microsoft Download Center](http://www.microsoft.com/downloads/en/details.aspx?FamilyID=CF464BE7-7E52-48CD-B852-CCFC915B29EF) at www.microsoft.com/downloads/en/details.aspx?FamilyID=CF464BE7-7E52-48CD-B852-CCFC915B29EF

You can download Exchange Server Jetstress 2010 from the [Microsoft Download Center](http://www.microsoft.com/downloads/en/details.aspx?displaylang=en&FamilyID=13267027-8120-48ed-931b-29eb0aa52aa6) at www.microsoft.com/downloads/en/details.aspx?displaylang=en&FamilyID=13267027-8120-48ed-931b-29eb0aa52aa6

## Hardware Considerations

When considering virtualization, there are a number of factors to take into account, for example, whether to reuse existing hardware. Reusing hardware introduces limitations such as the speed of core processor, or a switched network bandwidth, or a wide area network (WAN) limitation. Regardless of these factors, the approach to follow for capacity planning always starts with calculating the required workloads and then dividing them across multiple platforms while following the high availability requirements and any workload balancing as outlined in the previous section.

## Organization Requirements

For the purposes of this section, consider the following requirements for a small to medium sized organization with no high availability requirements:

* Mailbox storage requirements
* Mailbox size requirements
* Mailbox profile requirements
* Deleted item retention
* Calendar version logging

For an organization that has an existing Exchange 2007 or earlier installation, these requirements may be accurately gathered by using the [Microsoft Exchange Server Profile Analyzer](http://www.microsoft.com/downloads/en/details.aspx?FamilyId=C009C049-9F4C-4519-A389-69C281B2ABDA&displaylang=en), which is available from the Microsoft Download Center at www.microsoft.com/downloads/en/details.aspx?FamilyId=C009C049-9F4C-4519-A389-69C281B2ABDA&displaylang=en.

Organizations that are considering virtualizing an existing Exchange 2010 environment should use the average user message rate profile based on performance counter data during peak average period.

Organizations without an existing Exchange installation must take care to correctly determine the requirements for the organization.

Initially, this section discusses requirements for a single server solution. For more information about mailbox high availability requirements, see the “Best Practices for Maintaining High Availability of Exchange Server 2010 on Hyper‑V” section.

### Mailbox Storage Requirements

The following table describes the mailbox requirements, including the number of users, the percentage growth, and the concurrency of users.

**Table 2. Mailbox Count Requirements**

| **Mailbox Count Requirements** | **Value** |
| --- | --- |
| Total number of mailboxes including resource mailboxes | 2,000 |
| Projected increase in mailbox count over the life of the solution | 10 percent |
| Expected maximum concurrency of active mailboxes at any time | 100 percent |

### Mailbox Size Requirements

Typically, not all users have the same mailbox usage profile. In a real world scenario, it is likely that there would be multiple mailbox size limits. This scenario uses a single mailbox size for simplicity.

**Table 3. Mailbox Size Requirements**

| **Mailbox Size Requirements** | **Value** |
| --- | --- |
| Average mailbox size in MB | 750 MB |
| Average archive mailbox size in MB | 0 (Archive mailbox is not enabled) |
| Projected growth (%) in mailbox size in MB (projected increase in mailbox size over the life of the solution) | Included |

### Mailbox Profile Requirements

Typically, not all users have the same message profile. In a real world scenario, it is likely that there would be multiple message profiles. This scenario uses a single profile for simplicity.

**Table 4. Mailbox Profile Requirements**

| **Mailbox Profile Requirements** | **Value** |
| --- | --- |
| Target message profile (average total number of messages sent plus received per user per day) | 50 messages |
| Average message size in KB | 75 KB |
| % of users in MAPI cached mode | 100 percent |
| % of users in MAPI online mode | 0 |

### Deleted Item Retention

When single item recovery is enabled (it is disabled by default), there is a small additional increase in the size of the mailbox for a 14-day deleted item retention window.

### Calendar Version Logging

Calendar version logging data is enabled by default; there is a small additional increase in the size of the mailbox.

**Table 5. Deleted Item Retention**

| **Item Retention** | **Value** |
| --- | --- |
| Single item recovery | Yes, 14 days |
| Calendar version logging | Yes, 120 days |

## Mailbox Server Capacity Planning

When planning for Mailbox server capacity, the following calculations must be performed:

* Calculate mailbox size on disk
* Calculate database storage capacity requirements
* Calculate transaction log storage capacity requirements
* Review total storage capacity requirements
* Estimate Mailbox CPU Requirements
* Calculate Mailbox server RAM requirements

The [Exchange 2010 Mailbox Server Role Requirements Calculator](http://msexchangeteam.com/archive/2009/11/09/453117.aspx) is a Microsoft Excel® workbook that can perform these calculations. It is highly recommended that all mailbox role calculations are made on the Exchange 2010 Mailbox Server Role Requirements Calculator. The calculator is updated regularly and keeps up-to-date with change in Exchange technology.

### Calculate Mailbox Size on Disk

For the organization described here, the average mailbox size is 750 MB. However, a full mailbox with a 750 MB quota requires more than 750 MB of disk space and the following factors have to be taken into account:

* The prohibit send/receive limit.
* The number of messages the user sends or receives per day.
* The Deleted Items folder retention window (with or without calendar version logging and single item recovery enabled).
* The average database daily variations per mailbox.

These factors determine white space in the database and the dumpster size.

Inputting the values from the previous tables into the Exchange 2010 Mailbox Server Role Requirements Calculator calculates that the Mailbox size on disk = 857 MB

### Calculate Database Storage Capacity Requirements

In this step, the storage capacity required for all mailbox databases is determined. The calculated capacity includes database size, catalog index size, and 20 percent free space.

Inputting the values from the previous tables into the Exchange 2010 Mailbox Server Role Requirements Calculator calculates that the Total database capacity = 3,039 GB

### Calculate Transaction Log Storage Capacity Requirements

To ensure that the Mailbox server does not sustain any outages as a result of space allocation issues, the transaction logs also need to be sized to accommodate all of the logs that will be generated during the backup set.

Inputting the values from the previous tables into the Exchange 2010 Mailbox Server Role Requirements Calculator calculates that the Total log capacity = 24.4 GB

### Review Total Storage Capacity Requirements

The following table summarizes the high-level storage capacity requirements for this single server solution. The next section looks closer at specific storage requirements for high availability.

**Table 6. High Level Storage Capacity Requirements**

| **Disk Space Requirements** | **Value** |
| --- | --- |
| Average mailbox size on disk (MB) | 857 MB |
| Database space required (GB) | 3039 GB |
| Log space required (GB) | 24.4 GB |
| Total space required (GB) | 3063.4 GB |

### Estimate Mailbox CPU Requirements

Estimating Mailbox server CPU requirements is calculated by multiplying the maximum number of mailboxes on a server by the megacycles required per mailbox. Conversely, dividing the megacycles provided by the server by the megacycles required per mailbox can give the number of mailboxes a server may support. Using megacycle requirements to determine the number of mailbox users that an Exchange Mailbox server can support is not an exact science. A number of factors can produce unexpected megacycle results and are discovered in test and production environments.

Megacycle estimates should only be used to approximate the number of mailbox users that an Exchange Mailbox server can support. It is always better to be conservative rather than aggressive during the capacity planning portion of the design process. Estimates can be verified with the Exchange Load Generator stress testing programs in the test and production environments. You can download the [Exchange Load Generator](http://www.microsoft.com/downloads/en/details.aspx?displaylang=en&FamilyID=cf464be7-7e52-48cd-b852-ccfc915b29ef) from the Microsoft Download Center at www.microsoft.com/downloads/en/details.aspx?displaylang=en&FamilyID=cf464be7-7e52-48cd-b852-ccfc915b29ef.

The following table shows the approximate megacycles required per mailbox based upon the number of messages sent and received by that mailbox per day. These figures were determined by performance testing an HP DL380 G5 x5470 3.33 GHz, 8 cores.

**Note**   The words ‘Hertz’ and ‘cycle’ mean the same thing, however typically processors are defined with hertz, and activities with cycles.

**Table 7. Megacycle Estimates Based Upon Mailbox Activity**

| **Messages per mailbox per day** | **Megacycles per mailbox for mailbox database** |
| --- | --- |
| 50 | 1 |
| 100 | 2 |
| 150 | 3 |
| 200 | 4 |

The following step describes how to calculate the megacycle requirements for Mailbox servers.

#### Calculate Mailbox CPU Requirements

In this step, the megacycles required to support the database are calculated, using the following information: 2,000 mailboxes, 50 messages per day

Active mailbox megacycles required = profile specific megacycles × number of mailbox users

= 1 × 2,000

= 2,000 megacycles required

These requirements will be used in a later step to determine the number of Mailbox servers needed to support the workload. Note that the number of Mailbox servers required also depends on the Mailbox server resiliency model and database copy layout.

## Hub Transport Server Capacity Planning

Capacity planning for Hub Transport servers must be done in conjunction with any high availability requirements. Details for capacity planning for a highly available Hub Transport environment are described in the next section of this document.

### Hub Transport Disk Requirements

Hub Transport servers must be designed to meet the capacity and transactional I/O requirements of the organization. It is critical to correctly maintain queue growth and to route email as fast as possible, so that service level agreements (SLAs) are not adversely affected. There are several factors that affect the overall capacity of an Edge Transport server:

* Message tracking logs
* Protocol logs
* Mail database
* Connectivity logs
* Agent logs

For Exchange Server 2010 with SP1, a minimum of 500 MB of free space and free database space must exist on the drive that contains the message queue database (for Exchange 2010, 4 GB must be available), or the transport system will activate back pressure, a system resource monitoring feature of Exchange 2010. If disk space falls below the specified limit, the Exchange server stops accepting new connections and messages, preventing the system resources from being completely overwhelmed and enabling the Exchange Server to deliver the existing messages

Hub Transport servers use an Extensible Storage Engine (ESE) database to store the mail queues. For smaller deployments with lower disk I/O requirements, it may be feasible to place both the transaction logs and the database on the same LUN. Transaction logs do not require much disk capacity because normal log creation is limited by the use of circular logging.

For larger deployments, it is important to separate the log and database files on their own physical disks for best performance. Consider placing the database transaction logs, message tracking logs, activity logs, and protocol logs on same disk as the operating system, and the queue database on another disk.

For more information about sizing, see [Transport Server Storage Design](http://technet.microsoft.com/en-us/library/bb738141(EXCHG.80).aspx) at http://technet.microsoft.com/en-us/library/bb738141(EXCHG.80).aspx.

### Hub Transport Processor Cores

Based upon the best practice recommendation of one core on each Hub Transport for every five cores on Mailbox servers, it is necessary to determine the number of mailbox cores. To make this determination, see the “Calculating the Number of Required Mailbox Cores per Data Center” section of [Mailbox Server Processor Capacity Planning](http://technet.microsoft.com/en-us/library/ee712771.aspx) at <http://technet.microsoft.com/en-us/library/ee712771.aspx>.

For example, if there are 20 mailbox cores within the data center, the minimum number of processor cores that should be deployed for the Hub Transport is equal to:

(number of required mailbox cores per site) ÷ 5

= 20÷ 5

= 4 cores

## Client Access Server Capacity Planning

Client Access server capacity planning is a very important step when planning the virtualization of an Exchange 2010 organization. The Client Access server is the entry point for all users, including MAPI clients. In addition, the Client Access server hosts important services used by the other Exchange server roles.

### Client Access Server Processor Cores

Based on this Mailbox server core processor data, the minimum number of processor cores that should be deployed for the Client Access server is equal to:

(number of required mailbox cores) × 3 ÷ 4

= 20 × 3 ÷ 4

= 60 ÷ 4

= 15 cores

## Client Access and Hub Transport Server Combined Roles Capacity Planning

In a traditional Exchange deployment, Client Access, Hub Transport, and Mailbox server roles can be deployed on different physical servers. However, there are reasons to combine the Client Access server and Hub Transport server roles on the same physical server or virtual machine. There are also scenarios where deploying the Client Access server, Hub Transport server, and Mailbox server roles on the same physical server or virtual machine makes sense.

We recommend deploying the Client Access server and Hub Transport server roles on the same physical server in the following circumstances:

* **Server consolidation**. For deployments where the primary goals are to minimize the number of physical servers, operating system instances, and Exchange servers to manage, a Client Access server and Hub Transport combined role deployment is a recommended solution. Running the Client Access server and Hub Transport server roles on the same physical server provides the necessary role redundancy with a minimum requirement of two physical servers, that is, the combined Hub Transport and Client Access role on different physical servers.
* **Virtualization**. For deployments where virtualization host servers have processor counts that are divisible by 8 (for example, 8, 16, 24, 32, or 48), deploying Client Access and Hub Transport combined role servers in a 1:1 processor core ratio with single role Mailbox servers ensures a well-balanced virtual machine workload regardless of host server size.

## Unified Messaging Server Capacity Planning

Unified Messaging capacity planning is determined by the number of concurrent calls. These calls can be either incoming or outgoing, and can be generated when:

* A user leaves a voice mail message
* An Outlook Voice Access user accesses their Exchange 2010 mailbox
* A user uses the Play on Phone feature to listen to their voice messages.

The more you increase the number of concurrent connections on a single Unified Messaging server, the more resources it requires. It is especially important to decrease this setting on low-end, slower computers on which the Unified Messaging server role is installed. Performance counters are available, and the Get-UMActiveCalls cmdlet can also be used to monitor the number of calls that are currently connected to a Unified Messaging server.

If the number of concurrent calls required by your organization is larger than the number a single Unified Messaging server supports, you can scale horizontally and increase the capacity of concurrent calls by installing the Unified Messaging server role on an additional server and then adding the new Unified Messaging server to the same dial plan.

### Number of Concurrent Calls

Microsoft Exchange 2010 SP1 now supports virtualization of the Unified Messaging (UM) role on the 64-bit edition of Windows Server 2008 R2, running as the guest operating system under Windows Server 2008 R2 Hyper-V. Unified Messaging must be the only Exchange role in the virtualized server.

The virtualized machine configuration running Unified Messaging must have at least four CPU cores. Testing was conducted by the Exchange Server and Hyper-V engineering teams on physical computers with 8 CPU cores and 32 GB of memory. In this configuration, a virtualized Unified Messaging server experiencing a typical mixture of user and caller interactions can handle fewer concurrent calls than a physical Unified Messaging server with the same specifications.

Under sustained load, tests show that a virtualized UM server configured as described can handle 40 concurrent calls if Voice Mail Preview is active for all UM users, and 65 concurrent calls if Voice Mail Preview is not in use.

In typical Unified Messaging deployments, the ratio of Unified Messaging–enabled mailboxes served to concurrent calls is at least 100:1. This is because the amount of time that a Unified Messaging server spends in servicing requests (recording messages, using Outlook Voice Access) for any given user usually amounts to a few minutes per day .

Therefore, a Unified Messaging server role, virtualized as described, will support about 4,000 Unified Messaging–enabled mailboxes if they all have Voice Mail Preview enabled, and about 6,500 mailboxes if Voice Mail Preview is not enabled.

# **Best Practices for Maintaining High Availability of Exchange Server 2010 on Hyper-V**

The previous section described a small organization with no high availability requirements that has 2,000 users in a single site. This section examines an organization that has 15,000 users distributed equally across two different physical locations, called *Data Centre 1* and *Data Centre 2*, which are connected with a wide area network (WAN) link.

The organization requires a high availability solution. There is a service level agreement (SLA) in place that states that:

* All mailboxes and messaging must be available in a user’s local data center within five minutes in the event of a mailbox server failure.
* All mailboxes and messaging must be available within four hours of a data center being completely lost, for example, in the event of a natural disaster.

The organization has a history of difficulty with backup tape management, so they want to minimize requirements for traditional tape backups.

The mail profile of this organization is the same as in the previous example.

**Table 8. Mailbox Requirements**

|  |  |
| --- | --- |
| **Mailbox Count Requirements** | **Value** |
| Total number of mailboxes including resource mailboxes | 15,000 |
| Projected increase in mailbox count over the life of the solution | 10 percent |
| Expected maximum concurrency of active mailboxes at any time | 100 percent |
| **Mailbox Size Requirements** | **Value** |
| Average mailbox size in MB | 750 MB |
| Average archive mailbox size in MB | 0 (Archive mailbox is not enabled) |
| Projected growth (%) in mailbox size in MB (projected increase in mailbox size over the life of the solution) | Included |
| **Mailbox Profile Requirements** | **Value** |
| Target message profile (average total number of messages sent plus received per user per day) | 50 messages |
| Average message size in KB | 75 KB |
| % of users in MAPI cached mode | 100 percent |
| % of users in MAPI online mode | 0 |
| **Item Retention** | **Value** |
| Single item recovery | Yes, 14 days |
| Calendar version logging | Yes, 120 days |

## Determine High Availability Strategy

When designing an Exchange 2010 environment, many design decisions for highly available solutions drive other design components.

### Mailbox Servers

Exchange Server 2010 provides built-in high availability with Exchange native data protection. Database Availability Groups ( DAGs) use a subset of Windows failover clustering technologies, such as the cluster heartbeat, cluster networks, and cluster database (for storing data that changes or can change quickly, such as database state changes from active to passive or the reverse, or from mounted to dismounted or the reverse). Because DAGs rely on Windows failover clustering, they can only be created on Exchange 2010 Mailbox servers running the Windows Server 2008 Enterprise operating system or Windows Server 2008 R2 Enterprise operating system. Data is replicated between DAG members using log shipping. Multiple copies of databases are supported in the same site and across sites. Automatic failover or manual switchovers are supported. Up to 16 copies of a database are supported across multiple servers.

We recommend that the high availability strategy be determined first in the design process. The following information should be reviewed and understood prior to starting this step:

* [Understanding High Availability Factors](http://technet.microsoft.com/en-us/library/ee832790.aspx) at http://technet.microsoft.com/en-us/library/ee832790.aspx
* [Planning for High Availability and Site Resilience](http://technet.microsoft.com/en-us/library/dd638104.aspx) at http://technet.microsoft.com/en-us/library/dd638104.aspx
* [Understanding Backup, Restore and Disaster Recovery](http://technet.microsoft.com/en-us/library/dd876874.aspx) at http://technet.microsoft.com/en-us/library/dd876874.aspx

The following steps should be performed to determine the high availability strategy.

#### Step 1: Determine whether site resiliency is required

Organizations that have more than one data center must decide whether to deploy the Exchange infrastructure in a single data center or distribute it across two or more data centers. The organization's recovery SLAs should define what level of service is required following a primary data center failure. This information should form the basis for this decision.

In this example, there is an SLA requiring the ability to restore the messaging service and all data within four hours in the event of a data center failure. Therefore the customer must deploy the Exchange infrastructure in a secondary data center to meet these requirements.

#### Step 2: Determine relationship between mailbox user locations and data center locations

This step examines the location of the mailbox users. For example, are all mailbox users located primarily in one site or are they distributed across many sites and are those sites are associated with data centers? If they're distributed across many sites and there are data centers associated with those sites, determine if there is a requirement to maintain affinity between mailbox users and the data center in that site.

In this example, all of the active users are distributed equally across the two data centers. Therefore, users’ mailboxes should be located within their own data center.

#### Step 3: Determine database distribution model

Given the decision to deploy mailboxes in both data centers; the next step is to determine which database distribution model best meets the needs of the organization.

**Note**   For more information about different database distribution models, see [Database Availability Group Design Examples](http://technet.microsoft.com/en-us/library/dd979781.aspx) at http://technet.microsoft.com/en-us/library/dd979781.aspx.

In this step, it is necessary to determine the location of the DAG databases and the witness server. The witness server and its directory are used only for quorum purposes where there's an even number of members in the DAG. You don't need to create the witness directory in advance. Exchange will automatically create and secure the directory for you on the witness server. The directory shouldn't be used for any purpose other than for the DAG witness server. We recommend that you use an Exchange 2010 Hub Transport server in the Active Directory® Domain Services (AD DS) site that contains the DAG. This allows the witness server and directory to remain under the control of an Exchange administrator.

The organization in this example needs to deploy highly available Mailbox servers in a multiple data center environment, where each data center actively serves a local user population. We recommend that multiple DAGs be deployed, and multiple witness servers in separate data centers be used to maintain service to each data center's local user population in the event of a WAN outage, as illustrated in the following figure.



Figure 2. Database distribution model for the organization based upon their requirements

**Note**For clarity, this figure shows only the mailbox servers and witness servers. The actual solution would include other servers, such as Client Access, Hub Transport, and global catalog servers in each data center.

Because DAG1 and DAG2 contain an even number of members, they use a witness server. Although multiple DAGs can use the same witness server, multiple witness servers in separate data centers are used to maintain service to each data center's local user population in the event of a WAN outage.

Users located in Data Center1 would have their active mailbox database located on DC1MBX1, with passive database copies on DC1MBX2 and DC2MBX1 and DC2MBX2. Similarly, users located in Data Center2 would have their active mailbox database located on DC2MBX3, with passive database copies on DC2MBX4 and DC1MBX3 and DC1MBX4. If all network connectivity is lost between Data Center1 and Data Center2, the following occurs:

* For DAG1, members DC1MBX1 and DC2MBX2 would be in the majority and would continue to service users in Data Centre1 because they can communicate with the locking node, which is the one DAG member that put an SMB lock on the witness.log file for DAG1.
* For DAG2, members DC2MBX3 and DC2MBX4 would be in the majority and would continue to service users in Data Centre2 because they can communicate with the locking node for DAG2.

For more information, see [Database Availability Group Design Examples](http://technet.microsoft.com/en-us/library/dd979781.aspx) at http://technet.microsoft.com/en-us/library/dd979781.aspx.

#### Step 4: Determine backup and database resiliency strategy

Backups are traditionally used for disaster recovery, recovery of items deleted accidentally, long-term data storage, and point-in-time database recovery. Exchange 2010 includes several new features and core changes that, when deployed and configured correctly, can provide native data protection, thus eliminating the need to make traditional data backups.

Exchange 2010 can address the following scenarios without the need for traditional backups:

* **Disaster recovery**. In the event of a hardware or software failure, multiple database copies in a DAG enable high availability with fast failover and minimal risk of data loss. DAGs can be extended to multiple sites and can provide resilience against data center failures.
* **Recovery of items deleted accidentally**. The Recoverable Items folder in Exchange 2010 and an associated “hold” policy makes it possible to retain all deleted and modified data for a specified period of time.
* **Long-term data storage**. Archiving, multiple-mailbox search, and message retention features in Exchange 2010 provide a mechanism to efficiently preserve data in a manner that is accessible to end-users for extended periods of time.
* **Point-in-time database snapshot**. If a point-in-time copy of mailbox data is a requirement, Exchange provides the ability to create a lagged copy (for up to 14 days) in a DAG environment. This can be useful in the rare event that there is a logical corruption that replicates across the databases in the DAG, resulting in the need to return to a previous point in time. It may also be useful if an administrator accidentally deletes mailboxes or user data.

**Note**There are technical reasons and several issues to consider before using the features that are built into Exchange 2010 as a replacement for traditional backups. Prior to making this decision, see [Understanding Backup, Restore and Disaster Recovery](http://technet.microsoft.com/en-us/library/dd876874.aspx) at http://technet.microsoft.com/en-us/library/dd876874.aspx.

Given the requirement that the organization wants to minimize reliance on traditional tape backups, and that testing and validating restore procedures has not occurred on a regular basis, using Exchange native data protection in place of traditional backups as the database resiliency strategy is preferred.

#### Step 5: Determine number of database copies required

There are a number of factors to consider when determining the number of database copies to deploy. The first is whether a third-party backup solution is being used. We recommend deploying a minimum of three copies of a mailbox database before eliminating traditional forms of protection for the database, such as redundant array of independent disks (RAID) or traditional Volume Shadow Copy Service (VSS)‑based backups.

In the previous step, the organization decided not to deploy a third-party backup solution. As a result, the design should have a minimum of three copies of each database. In this example the organization decides to have four copies of each database to ensure that the service level agreement requirements are met.

#### Step 6: Determine Mailbox server resiliency strategy

Exchange 2010 provides automatic failover protection at the mailbox database level. Determining how many database copies are activated on a per-server basis is a key aspect to Exchange 2010 capacity planning. There are different database distribution models that can be deployed. To meet the requirements of this organization, the most appropriate model is to design for all database copies to be activated. In this model, the Mailbox server role is sized to accommodate the activation of all database copies on the server. For example, if a Mailbox server hosts four database copies, during normal operating conditions, the server has two active database copies and two passive database copies. During a failure or maintenance event, all four database copies would become active on the Mailbox server.

This solution is usually deployed in pairs. In this example, the first pair is servers DC1MBX1 and DC1MBX2, and the second pair is servers DC2MBX3 and DC2MBX4. In this site-resilient deployment that has four database copies and eight servers, this model can be deployed in sets of four servers, with the other two servers residing in the secondary data center. This model provides a four-server building block for solutions using an active/passive site-resiliency model.

This model can be used in the following scenarios:

* Active/passive multi-site configuration in which failure domains (for example, racks, blade enclosures, and storage arrays) require easy isolation of database copies in the primary data center.
* Active/passive multi-site configuration in which anticipated growth may warrant easy addition of logical units of scale.
* Configurations that are required to survive the simultaneous loss of up to three Mailbox servers in the DAG.

In the following figure the green copy of the database is the active copy, the orange copy is the passive copy, and the blue copies are passive copies, but with activation blocked to prevent automatic failover.

The following figure illustrates a sample database layout for this model. (The actual number of databases per server depends upon many factors and should be determined using the [Exchange 2010 Mailbox Server Role Requirements Calculator](http://msexchangeteam.com/archive/2009/11/09/453117.aspx)).



Figure 3. Sample database layout

In the following figure each member of DAG1 is hosted on a separate Hyper‑V server and each member of DAG2 is hosted on a separate Hyper‑V server. This provides both server high availability and site resilience.



Figure 4. Guest virtual machine locations

### Hyper‑V Failover Clustering

Exchange server virtual machines, including Exchange Mailbox virtual machines that are part of a Database Availability Group (DAG), can be combined with host-based failover clustering and migration technology as long as the virtual machines are configured such that they will not save and restore state on disk when moved or taken offline. All failover activity must result in a cold start when the virtual machine is activated on the target node. All planned migration must either result in shut down and a cold start or an online migration that utilizes a technology such as Hyper-V live migration.

When performing live migration of DAG members the following key points should be followed:

* Exchange 2010 SP1, or later, is required.
* To minimize offline time, use cluster shared volumes instead of pass-through drives where possible. In testing, performed by Exchange Server and Hyper-V engineering teams, offline time associated with moving storage resources was cut in half by using cluster shared volumes.
* If the server offline time exceeds five seconds, the DAG node will be evicted from the cluster. It is preferable to ensure that hypervisor and host-based clustering technology is able to migrate resources in less than five seconds. If this is not feasible, the cluster heartbeat timeout can be raised, although we don’t recommend raising it to more than 10 seconds.

To set the [cluster heartbeat timeout](http://technet.microsoft.com/library/dd197562(WS.10).aspx) to 10 seconds, follow these instructions. Note: this only applies to communication between DAG nodes that are on the same subnet.

1. Open PowerShell on one of the Mailbox servers that is a member of the DAG. Note: this only needs to be done on one of the DAG members as the setting will affect the entire DAG.
2. Type the following commands:

Import-module FailoverClusters

(Get-Cluster).SameSubnetThreshold=10

(Get-Cluster).SameSubnetDelay=1000

1. Close PowerShell.

To revert to the default settings, follow these instructions:

1. Open PowerShell on one of the Mailbox servers that is a member of the DAG. Note: this only needs to be done on one of the DAG members as the setting will affect the entire DAG.
2. Type the following commands:

Import-module FailoverClusters

(Get-Cluster).SameSubnetThreshold=5

(Get-Cluster).SameSubnetDelay=1000

1. Close PowerShell.

* If raising the heartbeat timeout threshold, testing should be performed to ensure that migration succeeds within the configured timeout.
* Ensure that the latest patches for the hypervisor are deployed to ensure optimal performance. In testing, the following patches were deployed:
* **KB 2517329**. Performance decreases in Windows Server 2008 R2 when the Hyper-V role is installed on a computer that uses Intel Westmere or Sandy Bridge processors
* **KB 2000977**. Hyper-V: Performance decrease in VMs on Intel Xeon 5500 (Nehalem) systems
* On the live migration network, enable jumbo frames on the network interface for each host and ensure that the switch handling the network traffic was configured to support jumbo frames.
* On the live migration network, change receive buffers to 8192 (default for the network interfaces in test was 896) on each host.
* Deploy as much bandwidth as possible for the live migration network. In testing, Microsoft used 5 Gb (a portion of a Flex-10 interface on HP hardware).

**Note**   Microsoft performed the testing on the following configurations:

* **Hyper-V Host Servers**: HP BL460c G7 blades in c7000 blade enclosure, each 2x4 core (intel E5620) with 96GB RAM
* **Storage**: HP P4500 iSCSI SAN

### Determine Placement of Exchange Server Roles

In a traditional Exchange deployment, the Client Access, Hub Transport, and Mailbox server roles can be installed on different physical servers. However, there are reasons (for example, underutilized servers) to combine the Client Access server and Hub Transport server roles on the same physical server or virtual machine. There are also scenarios in which deploying the Client Access server, Hub Transport, and Mailbox server roles on the same physical server or virtual machine makes sense.

When deciding which virtual machines to host on which root server, your main goal should be to eliminate single points of failure. Best practices include:

* Never deploy Mailbox servers that are members of the same DAGs on the same root.
* Never deploy all the Client Access Servers on the same root.
* Never deploy all the Hub Transport servers on the same root.
* Determine the workload requirements for each server and balance the workload across the Hyper‑V guest virtual machines.

When considering combining the Client Access server, Hub Transport, and Mailbox server roles on the same virtual machine, if the Mailbox servers are members of a DAG and there is a requirement to load balance the Client Access server, additional planning is required. The clustering component added to Mailbox servers that are members of a DAG prevents Network Load Balancing (NLB) from being installed on the server. However, there's still a requirement to load balance inbound traffic to the Client Access servers. In this case, there are two main options:

* Purchase a hardware load balancing appliance. This option can be costly, especially for smaller environments.
* Virtualize the Exchange server roles and isolate the Mailbox server role onto a separate virtual machine running on the same physical server as the virtual Client Access server. With this isolation, you can run NLB for Client Access servers and Mailbox servers that are members of a DAG on the same physical server.

### Hub Transport Servers

When designing a highly available solution for Hub Transport servers, certain factors should be considered.

#### Shadow Redundancy

If the Hub Transport server only receives email from other Exchange 2010 Edge Transport, Hub Transport servers and Mailbox servers, shadow redundancy is fully functional. Therefore the transaction logs and database can be stored on the same disk as the operating system and the Exchange binaries. In this scenario, you can consider not using RAID.

In the case of where the Mailbox server and Hub Transport server are collocated in a DAG, the Mailbox server will always choose another Hub Transport server therefore that Hub Transport should not be on the same host. If the Mailbox server and Hub transport server are not collocated, it is important to separate the Mailbox server and Hub transport server on different hosts.

#### Shadow Redundancy Promotion

If the Hub Transport server receives email from a non-shadow redundancy server, it delays sending an acknowledgement to the sending mail server until it has confirmed that the message has been successfully delivered to its destination. This process is known as *delayed acknowledgement*.

Exchange Server 2010 SP1 uses a new feature called *shadow redundancy promotion* to improve the protection. In Exchange Server 2010 SP1, instead of skipping the delayed acknowledgement, the Hub Transport server can be configured to relay the message to any other Hub Transport server in the site. This process effectively inserts the message into the shadow redundancy pipeline, thereby protecting the message. This approach minimizes the number of unprotected messages in the organization compared to skipping the delayed acknowledgement method altogether.

If Exchange Server 2010 SP1 is installed on the Hub Transport server and there is another Exchange Server 2010 SP1 Hub Transport server in the site, the presence of shadow redundancy promotion means that there is less of a chance that losing a server will result in mail loss when using delayed acknowledgement. If this is the case, these two Hub Transport servers are the same as the Hub Transport servers that are intra-org Hub Transport servers. If not, these Hub Transport servers should use RAID for data protection and separate disks for Database and Transaction logs because it may be necessary to recover the mail queue in the event of losing a Hub Transport server.

### Determining How Many Available Megacycles a Server Can Support

When determining the placement of guest virtual machines on physical servers, it is important that the Hyper‑V root server is sized correctly. An important part of the calculations is knowing the available megacycles the physical server and each processor can support. The following steps describe how to determine how many available megacycles the server model and processor can support.

#### Step 1: Determine benchmark value for server and processor

This step should be performed during a manual calculation or when using the Mailbox Storage Calculator workbook because it is recommended that a megacycle adjustment be calculated and entered into the calculator.

Because the megacycle requirements are based on a baseline server and processor model, it is necessary to adjust the available megacycles for the server against the baseline. To do this, independent performance benchmarks maintained by [Standard Performance Evaluation Corporation](http://www.spec.org) (SPEC) are used. SPEC is a non-profit corporation formed to establish, maintain, and endorse a standardized set of relevant benchmarks that can be applied to the newest generation of high-performance computers.

To obtain the benchmark value for a server and processor, go to the Standard Performance Evaluation Corporation website, search for the processor, under SPECint\_rate2006, select the required server, and record the result. For specific step-by-step instructions, see [Mailbox Server Processor Capacity Planning](http://technet.microsoft.com/en-us/library/ee712771.aspx) on TechNet at http://technet.microsoft.com/en-us/library/ee712771.aspx

#### Step 2: Calculate adjusted megacycles

The previous step calculated the required megacycles for the entire environment based on megacycle per mailbox estimates. Those estimates, taken from the table, were measured on a baseline system (HP DL380 G5 x5470 3.33 GHz, 8 cores) that has a SPECint\_rate2006 value of 150 (for an 8 core server), or 18.75 per core.

It is now necessary to adjust the available megacycles against the baseline for the server being implemented. For example, consider a Dell PowerEdge M710 8-core server with Intel x5550 2.67GHz processors (2,670 megacycles [MHz)) is being deployed. For this configuration, the SPECint\_rate2006 results value is 240, with a value of 30 per core (known in the formula as new platform per core value).

To determine the megacycles of the M710 platform example, use the following formula:

([New platform per core value] × [cycles per core of baseline platform]) ÷ (Baseline per core value) = Adjusted megacycles per core

Adjusted megacycles per core = 30 × 3,333 ÷ 18.75

= 5,333 megacycles per core

Adjusted megacycles per server = adjusted megacycles per core × number of cores

= 5,333 × 8 = 42,662 megacycles per server

#### Step 3: Calculate available megacycles per server

Now that the adjusted megacycles per server are known, adjust for the target maximum processor utilization. For example, if the requirement was not to exceed 80 percent processor utilization during peak workloads or failure scenarios, the following calculation would be used:

Adjusted available megacycles = available megacycles × target max processor utilization

= 42,662 × 0.80

= 34,129

Each server has a usable capacity of 34,129 megacycles.

#### Step 4: Adjust available megacycles for virtualization overhead

When deploying virtual machines on the root server, megacycles required to support the hypervisor and virtualization stack must be accounted for. This overhead varies from server to server and under different workloads. A conservative estimate of 10 percent of available megacycles will be used. Use the following calculation:

Adjusted available megacycles = usable megacycles × 0.90

= 34,129 × 0.90

= 30,716

So this server has a usable capacity for virtual machines of 30,716 megacycles.

The usable capacity per logical processor is 3,839 megacycles.

# **Running Exchange Alongside Other Workloads in a Virtual Environment**

When virtualizing an Exchange environment, it is important to consider any other server workloads that may be installed on the Hyper‑V host server.

## Virtualizing Domain Controllers

Every Exchange Server AD DS site requires a domain controller configured as a global catalog server. In a virtual environment, this server can be virtualized. The following topic describes the workload requirements of domain controllers.

### Domain Controller Disk Space Requirements

For each domain controller, plan to allocate at a minimum the following amount of space:

* 500 MB for AD DS transaction logs.
* 500 MB for the drive that contains the SYSVOL share.
* 1.5 GB to 2 GB for the Windows Server 2008 operating system files.
* 0.4 GB of storage for every 1,000 users in the directory for the NTDS.dit drive.

For example, for a forest that has two domains (domain A, domain B), with 10,000 and 5,000 users respectively, provide a minimum of 4 GB of disk space for each domain controller that hosts domain A and a minimum of 2 GB of disk space for each domain controller that hosts domain B.

In a typical an Exchange environment, the domain controllers run as global catalog servers. Global catalog servers will need additional disk space allocated if the forest contains more than one domain. For a given global catalog server, the additional space requirement is 50 percent of the recommended disk space for each additional domain outside of the global catalog server’s own domain. In this example, domain A requires 4 GB of disk space and domain B requires 2 GB of disk space. A global catalog server in domain A needs an additional 1 GB of disk space, (that is, 50 percent of the 2 GB of disk space for domain B), for a total of 5 GB of storage. A global catalog server in domain B needs an additional 2 GB of disk space, (50 percent of the 4 GB of disk space for domain A), for a total of 4 GB of disk space.

### Domain Controller Memory Requirements

The following table gives a conservative estimate of the minimum required memory allocation for a domain controller. The table assumes that the domain controllers are hosting only AD DS and DNS.

Table 9. Minimum Required Memory Allocation

| **User per domain in a site** | **Minimum memory requirements per domain controller** |
| --- | --- |
| 1–499 | 512 MB |
| 500–999 | 1 GB |
| > 1,000 | 2 GB |

Although this table lists the minimum, additional memory can improve the performance of the directory. AD DS will attempt to cache the database in memory, which reduces disk access and improves performance. This cache is limited by the virtual address space and the amount of physical RAM on the server.

If there is an existing infrastructure, measure the performance of the domain controllers to determine if the existing memory is sufficient for the environment. If this is a new deployment, begin with 2 GB of RAM. Test the configuration with the expected loads and add memory as required.

For virtualized AD DS servers, we recommend that you disable the time sync integration component, and then set the time to a reliable external time provider before you install the Hub Transport role. This recommendation is especially important if your host is joined to the domain the virtual machine is hosting.

For more information about domain controller memory requirements, see the [Active Directory Domain Services Guide](http://technet.microsoft.com/en-us/library/cc268216.aspx) in the Infrastructure Planning and Design Guide Series at http://technet.microsoft.com/en-us/library/cc268216.aspx

For more information about hosting virtualized domain controllers, see [Things to consider when you host Active Directory domain controllers in virtual hosting environments](http://support.microsoft.com/kb/888794) at http://support.microsoft.com/kb/888794.

# **Summary**

This paper describes best practices for deploying Exchange Server 2010 in a virtualized environment with Windows Server 2008 R2 Hyper‑V. The paper is essentially written for IT professionals, although a less technical audience will benefit from reviewing the best practices it describes.

Exchange Server 2010 provides organizations flexible deployment options, on-premises or in the cloud, virtualized or non-virtualized. As demand for virtualization technology grows, Microsoft has continued to make it easier for organizations to choose whether or not to virtualize. Virtualizing Exchange provides many benefits to organizations of all sizes, from a single server installation with a few hundred users, to a large organization with many servers and many thousands of users distributed worldwide. Virtualizing Exchange Server 2010 delivers significant benefits including reduced server hardware costs, power and space savings, improved server utilization and rapid server provisioning.

With Hyper-V technology, Microsoft provides a platform with flexible and robust virtualization capabilities. Whether in your data center, with a service provider or in a private cloud—Microsoft provides the flexibility and control to consume IT as a service, whichever way best meets your unique business needs.

With Exchange Server 2010 SP1 all Exchange Server roles are supported for virtualization. This includes the Unified Messaging role, Exchange Hosted Mode, Combining Exchange Mailbox servers that are part of a Database Availability Group (DAG) with host-based failover clustering and migration technology is also now supported.

As a best practice, spend adequate time designing the virtualized environment to avoid consequences later. For organizations that have high availability or site resilience requirements, it is important to determine these requirements as a first step. After these requirements are determined, standard Exchange design procedures should be used to establish how many Mailbox servers are required and establish the number of databases required on each server along with the number of passive copies required.

When determining what type of storage to use, remember that Hyper‑V supports both direct-attached storage (DAS) and storage area networks (SANs). However, with the native built-in data protection that Exchange Server 2010 offers, which includes DAGs and storage improvements your organization could use low-cost, high-speed DAS solutions, including the use of Serial Advanced Technology Attachment (SATA) hard disk drives and so called “just a bunch of disks” (JBOD) solutions as an alternative to redundant array of inexpensive disks (RAID) configurations. Considerable cost savings can be made by using DAS storage for the virtual machines when the high availability design is performed correctly.

To ensure high availability, it is necessary to deploy the same Exchange roles, for example, Hub Transport server, across multiple physical server roots to allow for load balancing and high availability. Therefore, never deploy Mailbox servers that are members of the same DAGs, or all the Client Access servers, or all the Hub Transport servers, on the same Hyper‑V root server.

The Exchange Server roles must be grouped in such a way that balances workloads on the root servers. Correctly mixing roles on the same Hyper V root server balances the workloads and prevents one physical resource from being unduly stressed.

It is important to correctly size the Hyper‑V root server. This is achieved by using tools such as the Exchange 2010 Mailbox Server Role Requirements Calculator, and load simulators such as the Exchange Load Generator and Jetstress.

In conclusion, Exchange Server 2010 SP1 along with Microsoft Hyper-V technology provides the most flexible, cost saving, highly available solution in the history of the Exchange product line.