

APPLICATION NOTE: AN 10391

Deploying ShoreTel Servers under VMware 5.0/5.1

Version Support

- ShoreTel 11.2, ShoreTel 12.2 or later
- VMware[®] vSphere 5.0/5.1

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Introduction

ShoreTel supports the deployment of ShoreTel servers, both Headquarter (HQ) servers and remote (DVS) servers, in VMware[®] virtual machines (VMs) running on the VMware ESXi 5.0/5.1 platform (part of vSphere 5.0/5.1). Support for ShoreTel servers on VMware 5.0/5.1 requires ShoreTel 11.2, ShoreTel 12.2 or later.

In this document, we provide the following information:

- Supported and non-supported configurations and VMware features
- Considerations when planning a deployment of ShoreTel servers on VMware.
- Details regarding the resources (CPU, memory, network, and disk storage) recommended to support various numbers of users and call loads.
- Steps for configuring VMware ESXi hosts.
- Steps for creating and configuring VMs to run ShoreTel servers.
- Best practices guidelines for configuring VMware.
- A troubleshooting guide for performance issues.
- An appendix containing VMware definitions and terminology.
- An appendix with references to additional information about VMware.

We assume that the reader is familiar with VMware concepts and terminology, and is proficient at managing a VMware ESXi system. In this document, we do not provide tutorial information about VMware.

Note : For ShoreTel deployments using VMware 4.0/4.1 please refer to Application *Note AN-10259*.



Supported Configurations and VMware Features

In ShoreTel 11.2, ShoreTel 12.2 and later we support the following configurations and VMware features:

- ShoreTel HQ and DVS servers with 2 to 8 virtual CPUs (the minimum recommended VM size is 2 virtual CPUs)
- VMware ESXi version 5.0/5.1
- Microsoft Windows 2003
 - SP2 and R2, Standard and Enterprise Editions, 32-bit (only for ShoreTel 11.2 and ShoreTel 12.2)
- Microsoft Windows 2008
 - o SP2, Standard and Enterprise Editions, 32-bit
 - o R2, Standard and Enterprise Editions, 64-bit
- Intel and AMD CPUs that are certified for ESXi 5.0/5.1
- Normal and High Availability (HA) VMware configurations
- vMotion (live migration of virtual machines from one ESXi host to another)
- VMware snapshots during maintenance operations such as backup and upgrade (see the discussion of snapshots in the VMware Terminology Appendix).
- Shoretel also supports ECC deployments under VMware (please refer to ECC documentation for Details)

Non-supported Configurations and VMware Features

In ShoreTel 11.2, ShoreTel 12.2 and later we do not support the following configurations and VMware features:

- VMware Player, VMware Workstation, or VMware Server
- ShoreTel software other than HQ and DVS servers running in virtual machines, such as PCM and CSTA
- Disaster Recovery (DoubleTake); instead, we will leverage VMware failover via HA
- VMware Fault Tolerance (FT) configuration
- VMware ESX 3.5
- VMware snapshots during production operation (see the discussion of snapshots in the VMware Terminology Appendix).



Planning a Deployment of ShoreTel Servers on VMware

In this section, we describe the kinds of information that are required when planning a deployment of ShoreTel servers on VMware, and various constraints that must be taken into consideration.

When planning a deployment of ShoreTel servers on VMware, the following kinds of decisions need to be made:

- How many ShoreTel servers (HQ and DVS) will be installed, and what is the required capacity (users, call load, and so forth) for each server?
- Is VMware High Availability (HA) required, or is it sufficient to have the ShoreTel server running non-redundantly in a single VM? (Note: The VMware Fault Tolerance (FT) mode is not currently supported.)
- Is live migration (vMotion) required, or is it sufficient to keep the ShoreTel servers always on the same host, or to migrate them only when they are powered down?
- Will network storage (NAS or SAN) be used, or will the VM and its files be stored on the ESXi host's local disks?
- Will the ESXi hosts be used only for running ShoreTel VMs, or will other (non-ShoreTel) VMs also run on the same ESXi hosts? What is the relative resource priority of the different VMs?
- Does the ShoreTel server require access to a physical serial port (for example, if interfacing with a third-party voicemail system)?

If VMware HA or live migration via vMotion is needed:

- At least two ESXi hosts, with compatible CPU architectures, are required; three ESXi hosts are preferred (to provide a backup after one ESXi host fails).
- Shared network storage (NAS or SAN) is required.
- The ESXi hosts must be made part of the same ESXi cluster, and high availability must be enabled for the cluster.
- The ESXi hosts must be in the same subnet or VLAN, to allow the IP address of a VM to remain the same when it fails over from one ESXi host to another.
- A dedicated NIC is required to support the HA and vMotion traffic.

If VMware HA is not needed:

- A single ESXi host is sufficient.
- Local storage is sufficient, but network storage (NAS or SAN) is recommended.

If multiple ESXi hosts are used (whether for high availability or not):

- It is useful to have shared storage. Using shared storage simplifies the management of VMs (for example, allowing them to be moved or cloned from one ESXi host to another).
- The ESXi hosts must be interconnected via one or more Gigabit Ethernet connections.



If shared storage (NAS or SAN) is used:

- The storage system must be certified for use with VMware ESXi (see the <u>VMware</u> <u>Systems Compatibility Guide</u>).
- The ESXi hosts must be connected to NAS shared storage via one or more Ethernet connections; you should not share a 1 Gigabit NIC. 10 and 40 Gigabit NICs can be shared with careful resource allocation.
- The ESXi hosts must be connected to SAN shared storage via one or more 1 Gigabit or faster Ethernet or FibreChannel connections.
- The NAS or SAN must have a RAID-5 configuration, for performance and reliability.
- The total disk capacity must be at least 3 times the capacity required for the VMs themselves, to allow storing VM templates and other kinds of information.
- A NAS must have an exported NFS or iSCSI file system (note: iSCSI has not been tested at ShoreTel).
- A SAN must have an exported VMFS file system.

If access to a serial port is required:

- The serial port on an ESXi host will have to be assigned to the VM, limiting the ability
 of the VM to fail over to another ESXi host (*therefore, a serial port cannot be used
 in the HA mode*).
- Alternatively, special hardware devices can be provisioned on the network and provide access to "virtual" serial ports.

If other VMs are running on the same ESXi host:

• If you have a 1 Gigabit NIC, the ShoreTel VM should have a dedicated NIC. You can share 10 and 40 Gigabit NICs.

The sizing requirements for each ESXi host (type and number of CPUs, amount of memory, and so forth) depend on the usage scenarios, and are given in the next section of this document.

The sizing requirements for each NAS or SAN (capacity, network throughput, and disk I/O throughput) depend on the usage scenarios, and are given in the next section of this document.



Recommended Sizing for ShoreTel Virtual Machines

When a VM is created, it is necessary to specify various properties related to size, such as the number of CPUs, the amount of memory, and the size of the disk. The values of these properties for a VM are similar to the values for an equivalent physical machine.

Table 1 provides recommended configuration values for ShoreTel deployments of three system sizes: small (up to 500 users), medium (up to 2500 users), and large (up to 10,000 users). The values are for typical deployments, and make various assumptions about usage patterns, but may not be appropriate for deployments in which the usage patterns are unusual. Different disk sizes are recommended for a ShoreTel HQ server and a ShoreTel remote server (DVS).

System Size	Users	Call Load per System	Call Load per Server (w/o Reports)	Minimum Virtual Sockets/Cores per VM ¹	RAM per VM (GB)	Storage System Throughput (MB/s)	Voice Network Throughput (Mb/s)	Disk Size per HQ VM (GB)	Disk Size per DVS VM (GB)
Small	500	5,000	1,000	2	4	0.17	16	60	40
Medium	2,500	25,000	5,000	4	8	0.83	80	150	80
Large	10,000	50,000	10,000	8	8	3.1	320	260	130

Table 1. Recomme	nded VM sizing	parameters
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The following comments apply to Table 1:

- The call load is the peak number of completed calls per hour. To handle the full call load per system, 5 or more servers are required, with each server handling a fraction of the system call load.
- The throughput to the disk storage system is expressed in MBytes per second, and includes the reading and writing of voicemail message files, and the writing of log files and CDR database records. The occasional reading of CDR database records to generate Director reports is not included.
- The throughput on the voice network is expressed in Mbits per second, and includes the digitized voice traffic for calls, but not other lower-volume traffic such as signalling, monitoring, and management.
- All configurations assume a Xeon 2.5 GHz or faster *Intel* processor. See *examples*

¹ In VMware 5.0/5.1 CPU core allocation is in the form of Virtual Sockets and Cores. As long as the count is correct, it doesn't matter how it's specified. 1 socket and 8 cores is equivalent to 4 sockets and 2 cores



Processor Family	Minumum Cores	Threads	Minimum Clock Speed	Example Models
Legacy	Not Suppoted	Not Suppoted	Not Suppoted	LV 2.16
3000	6	12	3.2	W3690
5000	4	8	2.66	X5550
7000	8	16	2.26	X7560
E3	4	8	3.2	E3-1290
E5	4	8	2.4	E5-2665
E7	10	20	2.4	E7-2870

Examples of Supported CPUs

- All configurations assume 1333 MHz memory or better.
- All configurations assume Gigabit Ethernet (or faster), to support I/O-intensive VMware administrative operations such as the starting and management of VMs, as well as to carry ShoreTel voice and data traffic.
- All configurations assume SAN or NAS disk storage, RAID-5; for small systems, non-RAID-5 local storage may be sufficient but is not recommended.
- The table lists the supported call load without CDR reports. Generating CDR reports reduces the supported call load by 50%.

In estimating the network throughput to the storage system for data storage and retrieval, and the network throughput for voice traffic, we make the following assumptions:

- At any given time, 50% of the users are participating in a call; each user is generating network traffic at a rate of 64 Kbits/s. Therefore, the voice traffic throughput for 500 users is 16 Mbits/s.
- Each user generates 1 voicemail message per hour, of length 1 minute and size 500 KB, requiring an average throughput to the storage system of 500 KB/hr or 0.14 KB/s. Therefore, the storage throughput from writing voicemail messages for 500 users is 70 KB/s (0.07 MB/s), and the storage throughput from reading the same messages is an additional 0.07 MB/s, for a total of 0.14 MB/s.
- Each call generates 2 KB of CDR data and 20 KB of log records, so for a call load of 1 call per hour, the average network throughput to the disk is 22 KB/hr or 0.006 KB/s. Therefore, the storage traffic throughput from writing CDR and log data for 5000 calls per hour is 30 KB/s (or 0.03 MB/s).



In estimating the disk sizes, we make the following assumptions:

- The recommended disk sizes include space both for software (operating system software plus ShoreTel software) and for ShoreTel data (databases, voicemail files, and logs).
- For the ShoreTel software, we allow 3 times the minimum space to provide temporary storage for upgrades.
- We assume 15 one-minute voicemail messages per user, or 7.5 MB per user (assuming voicemail requires 30 MB/hour).
- We assume that each call generates 2KB of CDR data, and that CDRs are generated at the peak rate for 10 hours/day, 5 days/week, and 4 weeks/month, and are saved for 3 months.
- We assume that each call generates 20KB of log records (representing a "medium" level of log verbosity), and that log records are generated for 10 hours/day and are saved for 7 days.
- We want the disk to get only 50% full, so we double our estimates.

The table lists the combined disk size for the operating system software, ShoreTel software, and ShoreTel data. The operating system software and ShoreTel software together require approximately 19 GB for an HQ server and 13 GB for a DVS server; the remaining disk space is used for ShoreTel data.

Configuring the VMware ESXi Infrastructure

In this section, we outline the steps are required to configure the VMware ESXi intrastructure (hosts, network, and storage). We do not describe the steps in detail; they are provided here as a reference checklist. The steps for configuring VMware HA for ShoreTel can be found in the next section.

The steps in configuring the VMware ESXi Infrastructure for ShoreTel servers are:

- 1. Do capacity planning (CPU, memory, network, and storage) for the system as a whole, for each ESXi host, and for each VM on an ESXi host. Recommended VM sizing parameters are listed in Table 1 of this document.
- 2. Set up the IP network infrastructure (routers, services, etc.).
- 3. Set up the SAN and/or NAS storage infrastructure. Make sure the storage system is certified for use with VMware.
- 4. Acquire hardware for the VMware ESXi hosts and the VMware vCenter server. Make sure the hardware is certified for use with VMware ESXi. If VMware HA is going to be used, make sure all the ESX hosts have compatible CPUs.
- 5. On each ESXi host, install the ESXi software and enter the appropriate software license information. The ESXi software can be installed from a CD (if the ESXi host has a CD reader) or from an ISO image.



- 6. On the vCenter server, install the vCenter software. The vCenter software can be installed from a CD or downloaded from the ESXi host via a web browser.
- 7. On a Windows client machine, install VMware vSphere Client software. The client software can be downloaded from the VMware web site, or from an ESXi host via a web browser.
- 8. Via the vSphere Client, connect to the vCenter server and do initial high-level configuration:
 - a. Add a datacenter (a logical collection of ESXi hosts).
 - b. Add the ESXi hosts to the datacenter.
- 9. Via the vSphere Client, connect to the vCenter server (or alternatively to each ESXi host separately) and set up virtual networking and datastores (VMFS or NFS volumes):
 - a. Create one or more virtual switches on each ESXi host (one may already be there by default), and connect the virtual switches to the physical NICs (uplink adapters). Choose the virtual-switch configuration (e.g., load-balancing or failover) based on needs.
 - b. If the HA mode will be used, enable VMKernel networking on each ESX host (in Configuration -> Networking -> Virtual Switch Properties).
 - c. Set up datastores on local disks, SAN storage, or NAS storage (NFSmounted). Choose the number, location, and size of the datastores, depending on your needs.
- 10. Via the vSphere Client, connect to the vCenter server and configure clusters (clusters are required for VMware HA, and are convenient for system management):
 - a. Optionally, create one or more clusters and configure the default properties of the cluster (for example, whether VMware HA is enabled); the steps for configuring VMware HA can be found in the next section.
 - b. Add the appropriate ESXi hosts to each cluster.
- 11. Optionally, create users and roles, if it is necessary to grant privileges on specific VMs to specific users:
 - a. Use existing users and roles on the vCenter Server (Windows) or ESXi host (Unix).

After the steps above are completed, the ESXi system is ready for the VMs to be created, and ShoreTel software to be installed in the VMs, as described in a later section.



Configuring VMware High Availability (HA)

In this section, we describe the steps required to configure a cluster for VMware HA (part of step 10 in the previous section). The configuration is done via the "New Cluster..." menu item for a datacenter (if creating a new cluster), or via the "Edit Settings..." menu item for a cluster (if editing an existing cluster).

The steps in the initial configuration of a cluster for HA are as follows:

- If the cluster does not yet exist, create the cluster and give it a name; the HA
 prerequisites must be met (two or more compatible ESXi hosts, shared NAS or SAN
 storage, etc.).
- 2. On the "Cluster Features" page, check the "Turn On VMware HA" box.
- 3. On the "VMware HA" page, check the "Enable Host Monitoring" box. The other settings can generally be left at their default values, unless the customer has special requirements.
- 4. On the "Virtual Machine Options" page, use the default values ("VM restart priority" is "Medium", and "Host Isolation response" is "Shut down"). These values can later be modified per VM if necessary.
- 5. On the "VM Monitoring" page, use the default values (VM monitoring" box disabled). These values can later be modified per VM if necessary. It is generally not necessary to enable VM monitoring for the ShoreTel server virtual machine.
- 6. On the "VMware EVC" page, use the default values (EVC disabled).
- 7. On the "Virtual Machine Swapfile Location" page, use the default values (store the swapfile in the same directory as the virtual machine).

After the hosts and virtual machines (including the ShoreTel server virtual machine) have been added to the cluster, the HA settings for individual virtual machines can be modified if the default values are not appropriate, as described near the end of the next section.

Configuring ShoreTel Virtual Machines

In this section, we describe the steps required to configure ShoreTel VMs. We assume that the ESXi hosts, datastores, clusters, and so forth have already been set up, as outlined in the previous sections.

We assume that the user is already familiar with creating and configuring VMware VMs, and we focus here mainly on the aspects that are specific to ShoreTel servers.

The following steps are required for creating, configuring, and installing ShoreTel VMs. *Except for step 1, or otherwise indicated, the configuring is done via vSphere Client.*

- 1. Plan the configuration of the ShoreTel VM:
 - a. Where will the VM be located (on which ESXi host and in which datastore)? Considerations include:
 - i. There must be sufficient CPU and memory on the ESXi host to support the VM.



- ii. There must be sufficient space in the datastore to the VM plus other files that may be created such as snapshots.
- iii. The VM files must be accessible from any ESXi host on which the VM will run, so preferably will be kept in shared storage; putting the VM on the local storage of an ESXi host prevents the VM from running on a different ESXi host.
- iv. The VM files that are used by normal VMs require high-performance storage, but the files used by templates can be kept on lower-performance storage.
- b. Will the VM use HA mode? Considerations include:
 - i. The HA mode requires two, or preferably three, compatible ESXi hosts, each of which has sufficient resources for the VM to execute.
 - ii. The HA mode requires that the VM files be maintained on shared storage (SAN or NAS) rather than local storage.
- c. What operating system will the VM use? Considerations include:
 - i. Executing in a VM may require a different operating system license than executing on a physical host.
- d. How large will the VM be (number of virtual CPUs, amount of memory, amount of disk space, and so forth)?
 - i. Sizing guidelines are provided in Table 1 of this document.
 - ii. Changing the number of virtual CPUs after a VM has been created is possible but is not recommended.
 - iii. Changing the amount of memory after a VM has been created is straightforward, but requires restarting the VM.
 - iv. Changing the amount of disk space is difficult, possibly requiring reformatting of the virtual disk.
 - v. To save storage spaceonly for templates, it is possible to allocate and commit disk space on demand (thin provisioning).
- e. Will it be created from an existing physical server, from an existing VM or template, or from scratch?
 - i. If the VM is created from an existing physical server, it is best to remove all unnecessary files (for example, logs) from the physical server, to avoid having to copy them and possibly to reduce the size of the VM files. Also, it may be useful to put the data files on a different drive from the software (for example, the D: drive), to reduce the size of the VM.
 - ii. If the VM is created from an existing physical server, it may be necessary to add a Windows license, depending on the type of license was on the physical machine; it will be necessary to add a new ShoreTel license, because the MAC address will change.



- iii. If the VM is created from an existing VM that has previously executed, it is best to remove all unnecessary files (for example, logs) from the VM, to avoid having to copy them. Removing unused files is especially useful if thin provisioning (allocating disk space on demand) is being used.
- iv. If the VM is created from an existing VM, it will be necessary to add a new ShoreTel license, because the MAC address will change.
- v. If the VM replaces an existing ShoreTel server, you may wish to maintain the IP address to avoid having to reconfigure switches and phones. Maintaining the IP address may require changes to your DHCP server, network or VLAN configuration, and so forth.
- 2. Create a ShoreTel VM, using one of the following approaches:
 - a. Use the VMware Converter Standalone utility (available for free download on the VMware website) to create a VM or template from a physical Windows machine on which the ShoreTel server is already installed. The physical machine must be running and accessible to the ESXi host, but the ShoreTel services should be shut down. After the conversion is complete, add licenses for the Windows and ShoreTel software, if necessary.
 - b. Alternatively, use vSphere Client to clone an existing Windows VM or template. Then install ShoreTel software in the new VM, using the normal ShoreTel installation or upgrade procedures. After the cloning is complete, add licenses for the Windows and ShoreTel software, if necessary.
 - c. Alternatively, use vSphere Client to create an empty VM for the appropriate Windows operating system. Then install the appropriate version of the Windows operating system in the VM using the normal Windows installation procedures, and install the ShoreTel server software in the VM using the normal ShoreTel server installation procedures. As part of the installation process, add licenses for the Windows and ShoreTel software.
- 3. While creating the ShoreTel VM, specify the following properties (some of these properties will not be modifiable if an existing physical machine is being converted, or an existing VM is being cloned):
 - a. Name of the VM.
 - b. The cluster (if any) and ESXi host.
 - c. The datastore on which to store the VM files (must be a shared datastore that is accessible to the failover ESXi hosts if the HA mode is required).
 - d. The guest operating system (to allow VMware to set the appropriate defaults for installation).
 - e. The virtual disk size use the size recommended in the appropriate "Disk Size" column of Table 1 of this document.
 - f. Whether to allocate disk space on demand (thin provisioning) or allocate it all at once for a normal VM, it is generally best to eallocate the space as thick provisioned with eager zero, Using a thin provisioning is NOT



recommended, Thin provisioning may be used for a template (which never runs, and therefore never needs to allocate additional disk space).

- g. Whether to edit the VM settings before creating the VM optionally, edit the settings here; however, in this document, we wail until after creating the VM to edit the settings (as described in the next step).
- 4. After creating the ShoreTel VM, specify the following properties (via the "Edit Settings..." menu item for the VM); other properties can keep their default values:
 - a. Hardware:
 - i. CPUs use the values recommended elsewhere in this document ("Cores per VM" in Table 1). VMware 5.0's CPU core allocation is in the form of Virtual Sockets and Cores. As long as the count is correct, it doesn't matter how it's specified. 1 socket and 8 cores is equivalent to 4 sockets and 2 cores.
 - ii. Memory use the values recommended elsewhere in this document ("RAM per VM" in Table 1).
 - iii. CD/DVD Drive 1 if you need to install the Windows operating system or ShoreTel software from a CD or DVD on the client or the ESXi host, or from an ISO image, select the appropriate host device or datastore ISO image.
 - b. Options:
 - i. Boot Options if you need to have the VM enter into the BIOS setup screen the next time it boots (for example, to allow the boot device to be set), set the "Force BIOS Setup" option.
 - c. Resources
 - i. CPU set Limit to "Unlimited"; see the note below regarding Shares and Reservation.
 - ii. Memory -- set Limit to "Unlimited"; see the note below regarding Shares and Reservation.
 - iii. Disk keep the default values for Shares ("Normal") and Limit–IOPs (blank [unlimited]); see the note below regarding Disk Shares and Limits-IOPs.
 - iv. Advanced CPU keep the default values for Hyperthreaded Core Sharing ("Any") and Scheduling Affinity (none). If you decide to set CPU Affinity on a Hyperthreaded processor, make sure you always include both Hyperthreads. The numbering convention is core, thread. Cpu 0,1 is both Hyperthreads of the first core of the first CPU. Avoid Affinitys such as 1-2 and 0-2.
- 5. If the VM does not yet contain a Windows operating system, do the following:
 - a. Power on the VM and open the console.



- b. If necessary, connect the CD/DVD drive or ISO image using the appropriate toolbar icon at the top of the console.
- c. Install the Windows operating system software from the CD, DVD, or ISO file specified earlier.
- d. Use the pulldown menu on the console (VM -> Guest -> Install/Upgrade VMware Tools) to install or upgrade VMware Tools.
- 6. If the VM does not yet contain the ShoreTel server software, install the software using the normal ShoreTel installation procedures.
- 7. Start the VM, and do the standard configuration of the ShoreTel server.
- 8. Set the HA properties for the new VM, as follows:
 - a. Select the "Edit Settings..." menu item for the cluster in which the VM is located.
 - b. Under "Virtual Machine Options", find the new VM; set the VM Restart Priority to "Medium" and the Host Isolation Response to "Leave powered on". You may prefer to set the VM Restart Priority to "Low" or "High" to change the order in which VMs are restarted after a failure.

The following comments apply to CPU Shares and Reservation:

- In an system in which the CPU utilizations of the ESXi host and the individual VMs (including the ShoreTel VM) are low (25% or less on the average, with peaks no more than 75%), it is generally not necessary to reserve CPU bandwidth for the ShoreTel VM.
- If it becomes necessary to reserve CPU bandwidth, the Reservation value should be at least the typical amount of CPU bandwidth that the VM will use, which may be less than the total bandwidth of the number of CPUs allocated to the VM when it was created. However, if other high-priority VMs will be running on the ESXi host, it is preferable not to starve the other VMs by reserving CPU bandwidth that is seldom used.
- In general, the Shares value should be "Normal". However, if you are reserving less
 that the maximum amount of CPU bandwidth that the VM could use (based on the
 number of CPUs it was allocated when it was created), and if you wish to give higher
 priority to the ShoreTel VM than to other VMs on the ESXi host, you may wish to
 change the Shares value to "High".

The following comments apply to Memory Shares and Reservation:

- In an system in which the memory utilizations of the ESXi host and the individual VMs (including the ShoreTel VM) are low (50% or less on the average, with peaks no more than 80%), it is generally not necessary to reserve memory for the ShoreTel VM.
- If it becomes necessary to reserve memory, the Reservation value should be at least the typical amount of memory that the VM will use, which may be less than the total memory allocated to the VM when it was created. However, if other high-priority VMs will be running on the ESXi host, it is preferable not to starve the other VMs by reserving memory that is seldom used.



 In general, the Shares value should be "Normal". However, if you are reserving less that the maximum amount of memory that the VM could use (based on the memory it was allocated when it was created), and if you wish to give higher priority to the ShoreTel VM than to other VMs on the ESXi host, you may wish to change the Shares value to "High".

The following comments apply to Disk Shares and Limits-IOPs:

- We have not yet tested the effect of changing these settings, and recommend that they be left at their default values in most cases.
- In general, the Shares value should be "Normal". If other VMs that share the same datastore generate high volumes of storage traffic, and if these other VMs are less sensitive to storage latency than the ShoreTel VM is, then it may be useful to raise the Shares value for the ShoreTel VM to "High".
- In general, the Limits-IOPs value should be unlimited (an empty field) for the ShoreTel VM. If other VMs that share the same datastore have periodic high demands for storage throughput (for example, if other VMs periodically run I/Ointensive database reports), then it may be useful to limit the IOPs on the other (non-ShoreTel) VMs to prevent them from using the entire throughput capacity of the datastore and starving the ShoreTel VM. The appropriate value for IOPs depends on the throughput of the datastore, and will be different for every configuration.

Configuration Best Practices

VMware has published several documents regarding best practices for ESXi system configuration. Links to the following documents are included in the "Appendix: References" section:

- "Performance Best Practices for VMware vSphere5.0"
- "Best Practices for Running VMware vSphere on Network Attached Storage"

The following is a summary of best practices for the ShoreTel server software running in a virtual machine:

- 1. Use ESXi host and storage systems that are listed in the <u>VMware Systems</u> <u>Compatibility Guide</u>.
- 2. Do not use snapshots during the normal execution of a production ShoreTel server. Snapshots should be used with a ShoreTel server only during maintenance operations such as upgrade or backup, and the snapshots should be removed when the maintenance operations are finished. Snapshots can cause additional disk I/O and can introduce latency from locking disk blocks. Latency can lead to degraded voice quality.
- 3. Disconnect unused devices such as COM ports and USB adapters on the host and VM, to avoid possible IRQ sharing conflicts.
- 4. Run the latest version of VMware Tools in the VM.



- 5. Use a dedicated NIC and switches for NAS storage, to prevent disk I/O traffic from impacting other traffic.
- 6. Use a dedicated NIC for vMotion and vCenter, to prevent VMware management traffic from impacting other traffic.
- 7. If your NIC is 1 Gigabit, try to use a dedicated NIC for the ShoreTel VM. You can share ShoreTel VM traffic on a 10 or 40 Gigabit NIC.
- 8. If you're ShoreTel VM traffic is on a shared NIC, create a high share value user defined network resource pool for all the ShoreTel VM traffic.
- 9. Never use 100 Mbit Ethernet.
- 10. Use shared datastores (SAN or NAS) if HA or vMotion are needed.
- 11. Use RAID-5 disk arrays to improve disk I/O performance and reliability.
- 12. Provide sufficient CPU resources so the average CPU utilization of the ESXi hosts and the ShoreTel VM is less than 50%.
- 13. Provide sufficient memory resources so the maximum memory utilization of the ESXi hosts and ShoreTel VM is less than 80%.
- 14. Pre-allocate the disk space used by the ShoreTel VM (use "thick provisioning eager zero").
- 15. Use default values for most VMware configuration settings, unless there is a good reason to do otherwise, or unless different values are specified in this document.
- 16. If the ESXi host is lightly loaded and there is little competition between VMs for resources, it is not necessary to reserve CPU and memory resources for the ShoreTel VM. However, if the ShoreTel VM is occasionally starved for resources because of competition with other VMs, it will be necessary to reserve CPU or memory resources for the ShoreTel VM or to increase the "Share" values.
- 17. In the ShoreTel VM, consider putting the operating system and ShoreTel data files on different virtual drives (e.g., C: and D:), and using a separate SCSI controller for each drive.
- 18. Use the VMware Paravirtual SCSI Adapter
- 19. Install VMware Tools and use the VMXNET 3 network adapter.
- 20. In the ShoreTel VM, use the highest-performance virtual SCSI controller and virtual network adapter that are appropriate for your system. We have tested with the LSI Logic SAS SCSI controller and E1000 network adapter.
- 21. Perform backup or other resource-intensive maintenance operations during times of low ShoreTel server usage, if possible.
- 22. When upgrading the ShoreTel HQ server, login into Director using a browser on a machine other than the HQ server.
- 23. For better performance during ShoreTel server upgrade, use VM clones or volumelevel snapshots for backups instead of using VMware snapshots.



Troubleshooting VM Performance Issues

In this section, we discuss how to troubleshoot various performance issues in a VM that is running the ShoreTel server software.

Performance problems in a ShoreTel VM produce the following kinds of symptoms:

- Delays in operations such as completing calls, retrieving call information, and so forth.
- Freezing or hanging.
- Poor quality of voice playback.

Performance problems in a ShoreTel VM are likely to have one of the following causes:

- Inadequate or poorly-allocated CPU, memory, disk, or network resources, for the ESX system as a whole or for the ShoreTel VM.
- Suboptimal or incorrect configuration of the ESXi system or the VM, for example:
 - Using the wrong versions of drivers or other software.
 - Enabling unnecessary VMware features that consume resources.
 - Doing maintenance (e.g., backups) at inappropriate times.
 - Using VMware snapshots during production operation.

Inadequate or poorly-allocated system resources can generally be identified by using the performance monitoring tools available in the vSphere Client or by running the *esxtop* command on the ESXi host.

- High values for CPU utilization, memory utilization, disk I/O bandwidth, disk I/O latency, or network I/O bandwidth can indicate resource problems. For example, average CPU utilization for a VM or for an ESXi host that is consistently above 50% may indicate inadequate CPU resources, and average memory utilization that is consistently above 80% may indicate inadequate memory resources.
- If a VM does not have sufficient resources, allocate additional resources from the ESXi host, if they are available.
- If an ESXi host does not have sufficient resources, move some VMs from that host to a different host, or obtain additional ESXi host resources.

Suboptimal or incorrect configurations can be identified as follows:

- Carefully go through the VMware configuration settings for the ESXi host, the storage subsystem, the network and its adapters, and the ShoreTel VM.
- If the performance problems occur only at certain times, monitor the system to see if anything different is happening during the times of the performance problems, such as backups, report generation, and so forth.
- If the source of the configuration problems cannot be found by examination, collect logs from the ESXi host to send to VMware for analysis; VMware support can provide details regarding how to collect the logs.



• Once the cause of the problems is determined, fix the problems by correcting the configuration or the operating procedures.

If the performance of your ShoreTel server VM is less than expected, the following steps are recommended:

- Attempt to characterize the problem. Does it happen only at certain times? What other processing is happening on the ShoreTel VM, the ESXi host, the datastore, or the network during the times when performance is poor? Has the performance problem always existed, or did it appear suddenly? Is the performance different for this system than for another similar system that is installed elsewhere? Is the performance less than the performance of a physical system with similar resources? The answer to these questions may help focus the search for the cause of the problem.
- 2. Confirm that the ShoreTel VM sizing recommendations (Table 1 and the accompanying comments) are being followed.
- 3. Confirm that the Best Practices guidelines, found elsewhere in this document, are being followed.
- 4. Using the vSphere Client performance monitor, check the amount of CPU, memory, disk I/O, and network I/O resources the ESXi host and the ShoreTel VM are using, to determine if there is a shortage of resources.
- 5. Check that VMware Tools is installed on the ShoreTel VM and that the version is correct.
- 6. Ensure that the ESXi host antivirus software excludes the virtual machine files from active scanning.
- 7. Verify that the ShoreTel VM does not have any snapshots; if any snapshots exist, delete them. Snapshots can have a negative impact on performance, especially on the playback of voice prompts.
- 8. Verify that the disk space for the ShoreTel VM is pre-allocated rather than allocated on demand.
- Check that the storage subsystem is configured for optimal performance. See the VMware knowledge base article, "<u>Troubleshooting hosted disk I/O performance</u> problems (1008885)", for details.
- 10. Perform additional steps that are described in the VMware knowledge base article, <u>"Troubleshooting virtual machine performance issues (1008360)</u>".
- Look in VMware community forums for additional information about troubleshooting VM performance issues, for example, "<u>Performance Troubleshooting for VMware</u> <u>vSphere</u>".

If the cause of the performance problem cannot be determined, submit a support request to VMware, as described in the VMware support article "<u>Submitting a Support Request</u>". You may be asked to submit a log, using the VMware *vm-support* command on the ESXi host.



Appendix: VMware Terminology

The following terms related to VMware are used in this document:

- VMware vSphere VMware's virtualized computing intrastructure, consisting of ESXi hosts, a vCenter server, vSphere clients, and related components.
- VMware ESXi Host A virtualization platform used to create VMs as a set of configuration and disk files that together perform all the functions of a physical machine. Runs as a thin layer on top of physical hardwareVMware Virtual Center (vCenter) server – A server running VMware software that provides coordinated management for the ESXi Server hosts.
- VMware vSphere Client (also called VMware Intrastructure Client) A Windows client application that provides network access to an ESXi Server or VMware cluster.
- VMware ESXi Cluster A collection of ESXi servers with shared resources and a shared management interface.
- Virtual machine (VM) A virtualized x86 computer environment in which a guest operating system and associated application software can run.
- Virtual machine template A VM that cannot be run, but can be used as a pattern to create new VMs. A template can be converted to a regular VM, and vice versa.
- Virtual CPU (vCPU) A virtualized x86 processor core.
- CPU affinity Binding a VM to a particular set of logical CPUs (processor cores).
- **CPU shares, reservations, and limits** Parameters for allocating CPU and memory resources among multiple VMs:
 - Shares Priority of this VM compared to other VMs on the ESXi server, expressed as Low, Normal, and High.
 - Reservation Guaranteed resource allocation for a VM.
 - Limit Upper limit for a VM's resource allocation.
- Hyperthreading Allows a single physical processor to behave like two logical processors.
- VMware High Availability (HA) A feature that provides high availability in a cluster of ESXi servers. If a server goes down, all VMs that were running on the host are restarted on different hosts in the same cluster, after a recovery period.
- VMware Fault Tolerance (FT) A feature that provides continuous availability for a VM by running a live shadow instance that can take over immediately in the event of hardware failure, with no loss of service.
- VMware Datastore A logical container that holds VM files and other files necessary for VM operation. A datastore can be VMFS-based or NFS-based, and can exist on different kinds of physical storage, including local storage, iSCSI, Fibre Channel Storage Area Network (SAN), or Network Attached Storage (NAS). (VMFS = Virtual Machine File System, VMware's cluster file system).



• VMware Snapshot – A set of files that contain the changes that have occurred to a VM since the time the snapshot was taken. A VMware Snapshot with Memory also includes an image of the VM's memory at the time the snapshot was taken. When a snapshot is taken, the original VM on the disk is made read-only, and all further changes to the VM are written to the snapshot. At a later time, the VM can be reverted to its original state by discarding the snapshot, or the snapshot can be merged with the original VM files and the snapshot can then be deleted. A VMware snapshot is useful for freezing the state of a VM in order to do a backup of an unchanging system, or for preserving the state of the VM during an upgrade to allow rolliing back in case of an error. A snapshot is not intended to be kept for an extended period of time (more than a few hours). Because of the additional disk I/O and locking required to update a snapshot is present.



Appendix: References

The following references provide useful information about VMware:

- VMware Resources page (white papers and podcasts)
 - o <u>http://www.vmware.com/resources/</u>
- VMware Systems Compatibility Guide (supported ESXi host hardware)
 - o <u>http://www.vmware.com/resources/compatibility</u>
- VMware Support page (documentation, knowledge base, and videos)
 - o <u>http://www.vmware.com/support/</u>
- VMware document on submitting a support request
 - "Submitting a Support Request" http://www.vmware.com/support/policies/howto.html
- VMware Partners Access (training and marketing materials)
 - o <u>http://www.vmware.com/partners/partners.html</u>
- VMware Education Portal (training materials)
 - o <u>http://mylearn.vmware.com</u>
- VMware Knowledge Base
 - o <u>http://kb.vmware.com</u>
- VMware 5 Features
 - <u>http://www.vmware.com/files/pdf/products/vsphere/vmware-what-is-new-vsphere5.pdf</u>
 - <u>http://www.vmware.com/files/pdf/techpaper/Whats-New-VMware-vSphere-50-</u> <u>Performance-Technical-Whitepaper.pdf</u>
 - http://www.vmware.com/files/pdf/techpaper/Whats-New-VMware-vSphere-50-Storage-Technical-Whitepaper.pdf
- VMware Knowledge Base documents related to performance
 - "Troubleshooting hosted disk I/O performance problems (1008885)" <u>http://kb.vmware.com/kb/1008885</u>
 - "Troubleshooting virtual machine performance issues (1008360)" http://kb.vmware.com/kb/1008360
- VMware Best Practices documents related to performance
 - "Performance Best Practices for VMware vSphere5.0" <u>http://www.vmware.com/pdf/Perf_Best_Practices_vSphere5.0.pdf</u>
 - "Vsphere Resource Management" http://pubs.vmware.com/vsphere-50/topic/com.vmware.ICbase/PDF/vsphereesxi-vcenter-server-50-resource-management-guide.pdf



- "Best Practices for Running VMware vSphere on Network Attached Storage"
 http://vmware.com/files/pdf/VMware_NFS_BestPractices_WP_EN.pdf
- VMware Community Forums
 - o http://communities.vmware.com
- VMware Community Forums articles related to performance
 - "Performance Troubleshooting for VMware vSphere" <u>http://communities.vmware.com/docs/DOC-10352</u>
- EMC (storage products)
 - o <u>http://www.emc.com</u>

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1.3	Steve Wood	Updated 5.0 to reflect 5.0/5.1	May 7, 2013