



Best Practices for Running Allscripts Emergency Department on VMware vSphere

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DEPLOYMENT AND TECHNICAL CONSIDERATIONS GUIDE

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Introduction

This document provides direction to those interested in running Allscripts Emergency Department (ED) on VMware vSphere™ 4. It provides basic guidance on the architecture of Allscripts Emergency Department as well as the value of utilizing the VMware platform. The results of recent testing done jointly by VMware and Allscripts are covered, where the performance and functionality of Allscripts ED on VMware virtual infrastructure are characterized. Finally, some best practices for utilizing the two product sets together in your datacenter are outlined.

VMware and Allscripts ED Overview

This section provides a basic description of the capabilities provided both by VMware vSphere and Allscripts Emergency Department.

Allscripts ED

Allscripts ED is the most comprehensive Emergency Department Information System (EDIS) for patient registration, triage, tracking, charting, disposition, charge capture, and reporting. Allscripts ED provides the following:

- Management of a single, seamless patient record in a Microsoft Windows environment.
- Voice, pen, and touch screen technology.
- Interfaces to existing hospital systems and to other Electronic Medical Record solutions from Allscripts.
- Real-time, mobile access to patient information from any location at any time.

Allscripts ED is a complete Emergency Department Information System. However, Allscripts can also install the system in phases as an alternative to full implementation. The following diagram provides a logical representation of the Allscripts Emergency System operation.

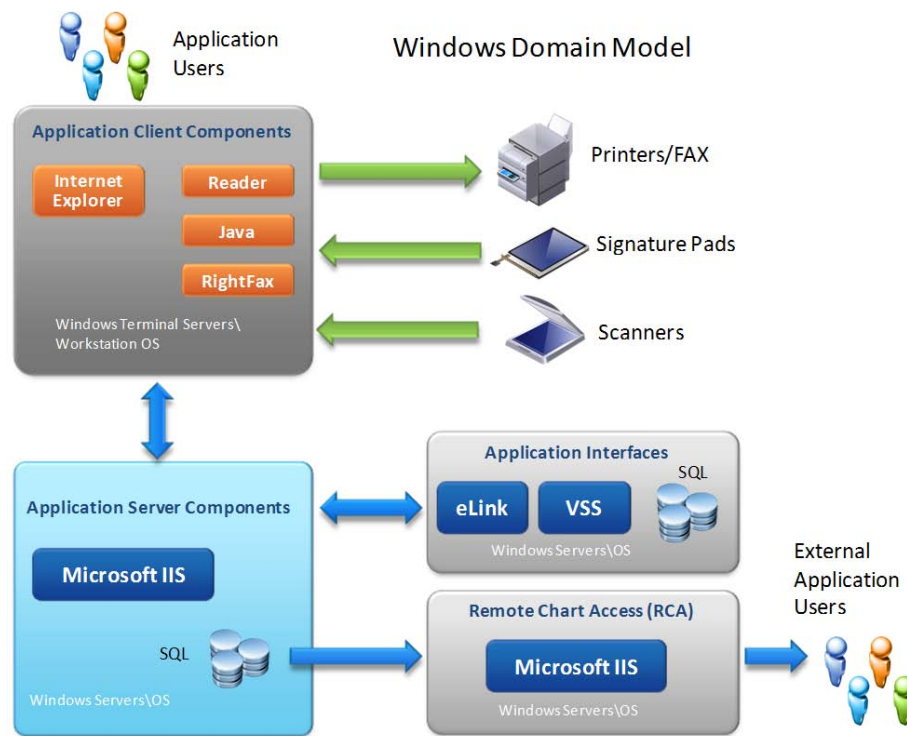


Figure 1. Allscripts ED System Design

VMware vSphere or VMware Virtual Infrastructure

VMware's leading virtualization solutions provide multiple benefits to IT administrators and users. VMware virtualization creates a layer of abstraction between the resources required by an application and operating system, and the underlying hardware that provides those resources. A summary of the value of this abstraction layer includes the following:

- **Consolidation:** VMware technology allows multiple application servers to be consolidated onto one physical server, with little or no decrease in overall performance.
- **Ease of Provisioning:** VMware virtualization encapsulates an application into an image that can be duplicated or moved, greatly reducing the cost of application provisioning and deployment.
- **Manageability:** Virtual machines may be moved from server to server with no downtime using VMware vMotion™, which simplifies common operations like hardware maintenance and reduces planned downtime.
- **Availability:** Unplanned downtime can be reduced and higher service levels can be provided to an application. VMware High Availability (HA) ensures that in the case of an unplanned hardware failure, any affected virtual machines are restarted on another host in a VMware cluster.

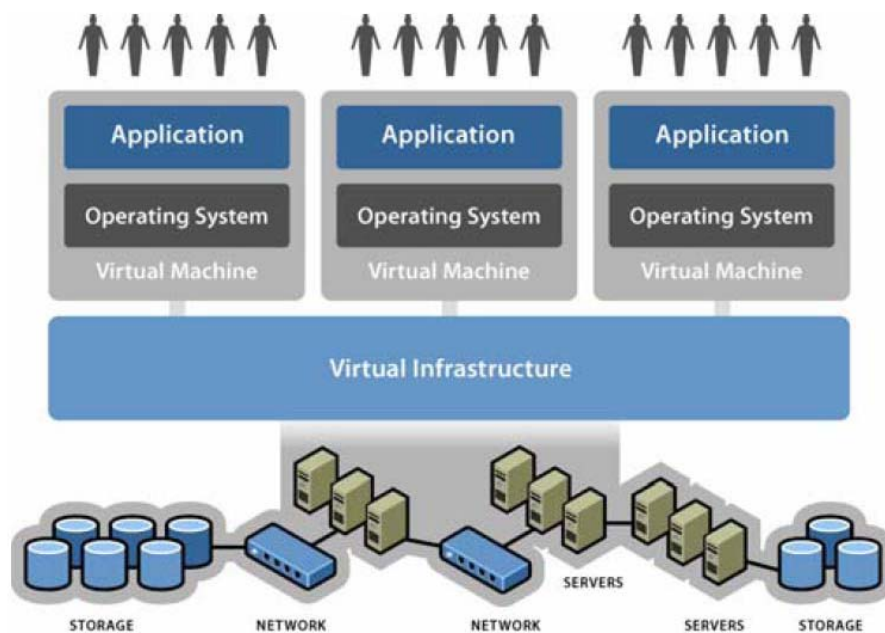


Figure 2. VMware vSphere Virtual Infrastructure

Allscripts ED Architecture and Deployment Strategy

The Allscripts ED system consists of a SQL database, IIS server, interface server, terminal server, thin clients, and thick clients running in a Microsoft Windows environment. The system can also consist of clustered SQL servers, multiple load balanced terminal servers, fax server, test server, report server, and remote chart access server. The following diagram shows a typical, average-sized Allscripts ED deployment.

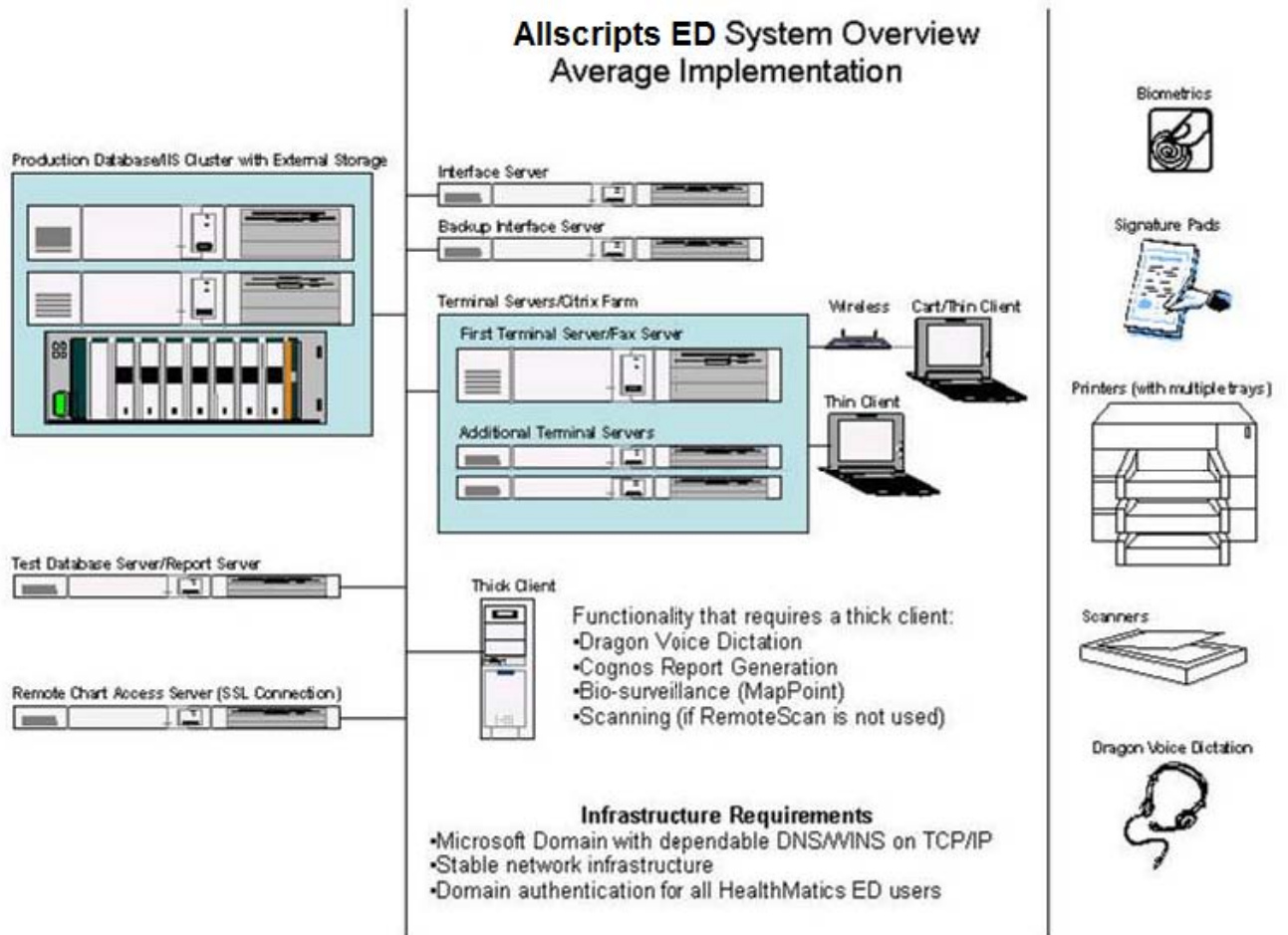


Figure 3. Allscripts ED Architecture Design

Allscripts ED System Deployment – Physical Implementation

The components of the Allscripts ED – system deployment are distributed across multiple servers (physical or virtual). The following table provides a description of each server requiring a physical host when deployed in a non-virtualized environment.

Physical Architecture Details

Table 1. Allscripts ED Physical Server Descriptions

Server	Details
Production Database Server	The production database server (SQL/IIS server) can be a single server or a two-server active/passive Microsoft cluster running on Microsoft Windows Server. For version information, see the Allscripts ED 6.3 documentation.
Test Database Server/Report Server	Test and Report Server running Cognos Impromptu and Microsoft Windows Server. For version information, see the Allscripts ED 6.3 documentation.
Interface Server	The interface server is a translator between the Allscripts ED system and other hospital systems; runs on Microsoft Windows Server. For version information, see the Allscripts ED 6.3 documentation.
Remote Chart Access Server	The Remote Chart Access (RCA) server allows remote Allscripts ED users to view patient charts over the Internet; runs on Microsoft Windows Server. For version information, see the Allscripts ED 6.3 documentation.
Citrix/Terminal Server	Citrix XenApp Servers for application presentation to thin clients; runs on Microsoft Windows Server. For version information, see the Allscripts ED 6.3 documentation.

Production Database Server

The production database server (SQL/IIS server) can be a single server or a two-server active/passive Microsoft cluster. A cluster requires specific procedures for proper administration. See the *Allscripts ED 6.3 Cluster Administration Procedures* documentation for more information.

Due to the amount of data the Allscripts ED system stores, the production database server requires external storage. The external storage can be an external disk array or a SAN. In a clustered environment, external storage is shared between both nodes. External storage contains all patient data for the production, training, and demo databases. External storage consists of multiple drive volumes for non-clustered and clustered environments.

Both the production database server hardware (CPUs, RAM, HD, Networking) and external storage requirements depend on the number of patient visits per year, the maximum number of simultaneous users on the system, the number of scanned documents, and the type of environment (non-clustered or clustered). Contact Allscripts for specific production database server requirements. All production database server and storage requirements must be confirmed with Allscripts prior to installation.

Test Database Server / Report Server

Since Allscripts ED is version-specific, a separate test server is required to support a test environment for new versions. The test server is both a database server and a terminal server. The test environment is similar to the production environment, but built on a smaller scale.

The test server can also be used as a report server. Allscripts ED provides standard and custom reports through Cognos Impromptu. Reports can run on the test server to minimize performance issues in a production environment.

Interface Server

The interface server is a translator between the Allscripts ED system and other hospital systems. The interface server runs the SQL Server database, the interface engine, and C++. Data passes to and from the interface server for translation. Interfaces are configured based on defined specification requirements to process transactions.

Additional interface servers can be installed based on the number of interfaces, or for backup. All interface servers must be identical (hardware and software) and have unique network names and IP addresses. Contact Allscripts for specific interface server requirements. All interface server requirements must be confirmed with Allscripts prior to installation.

Terminal Server / Fax Server

Allscripts recommends using a thin client environment for Allscripts ED; a Windows Terminal Server (WTS) is required. The maximum number of concurrent Allscripts ED users on a terminal server is determined by the amount of RAM on the terminal server. A single Allscripts ED user session averages 200MB. Therefore, a terminal server with 16GB of RAM would support approximately 60 users.

Allscripts recommends an N+1 formula for calculating the number of terminal servers required for a specific environment. This means there should be enough terminal servers to support the maximum number of concurrent Allscripts ED users, plus one additional terminal server. Terminal servers can be configured in either a "broad" or a "deep" implementation arrangement. A broad implementation means more terminal servers with fewer concurrent users per terminal server. This implementation allows fewer users to be impacted if a terminal server fails. A deep implementation means fewer terminal servers are configured with the maximum number of concurrent users per terminal server. This implementation allows more users to be impacted if a terminal server fails. In either implementation, the N+1 formula should be used and an additional terminal server should be available.

Allscripts recommends using Citrix Presentation Server\XenApp for terminal servers. Citrix Presentation Server\XenApp allows multiple terminal servers to be joined together in a server farm. A server farm simplifies administration of users and applications and provides load balancing. Allscripts ED applications can be published and pushed out to each user.

Allscripts ED requires Captaris RightFax 9.3 Business Server and a Brooktrout TR1034 fax board for faxing. RightFax is installed on the first terminal server. However, a dedicated fax server can be used, if desired. The RightFax terminal server must be a 2U server due to the size of the fax board. Other terminal servers can be 1U servers.

Remote Chart Access Server

The Remote Chart Access (RCA) server allows remote Allscripts ED users to view patient charts over the Internet. RCA can send automatic emails to a primary care physician when their patient visits the Emergency Department. Contact Allscripts for specific remote chart access server requirements. All remote chart access server requirements must be confirmed with Allscripts prior to installation.

Thin Clients

A thin client is a device that runs the Allscripts ED application from a terminal server. Thin clients do not have the Allscripts ED application installed and running locally. Thin clients connect to the terminal server through Citrix ICA or Microsoft RDP to run the application. See the *Allscripts ED 6.3 Thin Client Installation* –

Citrix Program Neighborhood Setup and Allscripts ED 6.3 Thin Client Installation – RDP Client Setup documentation for more information.

Wireless devices, signature pads, insurance card scanners, and thumb print scanners require additional setup considerations and additional USB ports, adapters, third party applications, and configuration might be necessary. Contact Allscripts for specific thin client requirements. All thin client requirements must be confirmed with Allscripts prior to installation.

Thick Clients

A thick client is a device that has the Allscripts ED application installed and running locally. Thick clients require Windows XP Professional or Windows Vista Business, Internet Explorer 7.0, and Microsoft Word 2003 or 2007. A thick client is required to install the Recovery Room. Dragon Voice Dictation must be installed on an adequately configured user device; however, Allscripts ED can still run through a thin client connection. Thick clients should only be used when necessary. Please consult Allscripts before using thick clients. All thick client requirements must be confirmed with Allscripts prior to installation.

Printing

Allscripts ED can send print jobs to a designated printer. The printer must be a Windows 2008 Server certified printer with the latest printer drivers installed and configured in Windows and in the Administration Console. Allscripts ED can also send prescriptions to a designated prescription printer. The prescription printer must also be configured in Windows and in the Administration Console. Each user must also have rights within Allscripts ED to print prescriptions.

Figure 4 shows a sample layout of a physical implementation of an Allscripts ED Physical Server deployment.

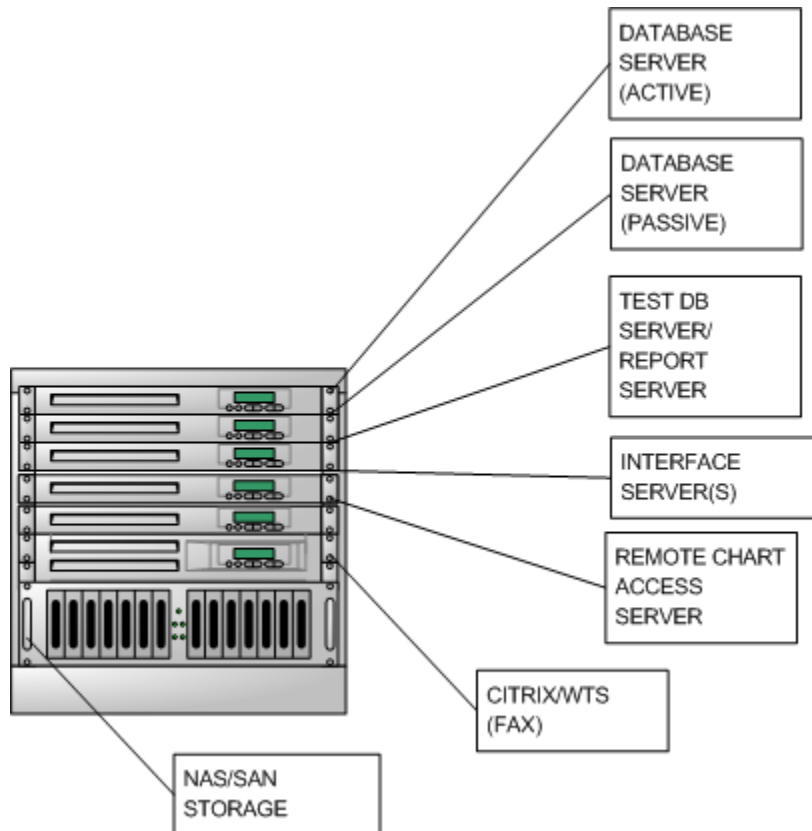


Figure 4. Example Allscripts ED Server Layout (Physical Implementation)

Deployment in a physical, non-virtualized environment requires at least six host machines to run all the applications listed in the previous table. Additional interface servers and Citrix servers will need additional hosts.

Allscripts ED System Deployment – Virtual Implementation

By virtualizing and consolidating Allscripts ED servers and applications on a smaller number of host machines, the virtual deployment of the Allscripts ED Application with VMware vSphere reduces complexity and the overall number of servers required to support a specific environment.

An example of the virtual deployment architecture is shown in Figure 5. This architecture assumes consolidation of the primary database server, and the Test/Report server as VMs on the same physical host. The secondary database server and the Remote Chart Access Server are consolidated as virtual machines on the second physical host. The Citrix server is virtualized on its own host. Additional Citrix servers can be virtualized as needed to scale up for the number of users accessing the application. The Interface Server and the Fax Server run on physical hosts. The Fax Server runs on a physical host as a Brooktrout fax card is recommended for the Allscripts ED solution and fax cards cannot be virtualized.

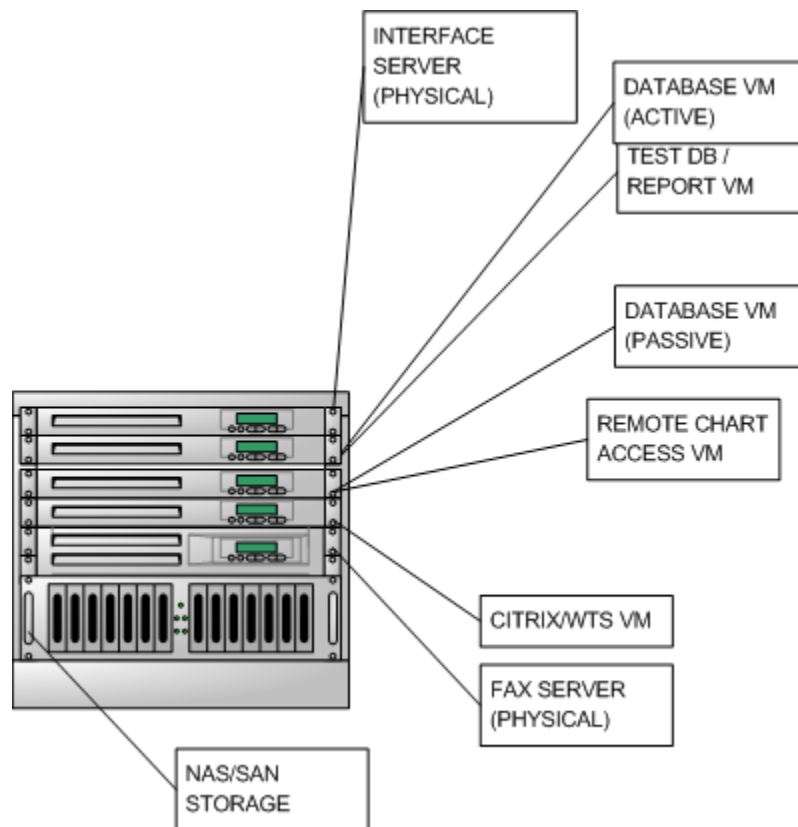


Figure 5. Allscripts ED Deployment using VMware vSphere (Example of Virtual Implementation)

Allscripts ED Test Setup and Results

Testing Methodology and Overview

To characterize the performance of Allscripts ED on VMware vSphere, performance tests were carried out jointly by VMware and Allscripts. This section describes the configuration tested and provides test results.

The primary objective of testing described in this document was to validate that an Allscripts ED environment virtualized with VMware vSphere could reasonably handle a workload of 300 concurrent users with acceptable end user performance. For tests described in this document, the Citrix XenApp terminal servers, the production database server, and the IIS servers were virtualized and run on the VMware vSphere platform. With this virtualized configuration, tests were run for different workloads of 60, 110, 185 and 300 concurrent users respectively. Other servers (Test and RCA) were not tested, but are assumed to also run well when virtualized on VMware vSphere.

Hardware and System Host Configuration

The virtual test environment used four identical host machines to virtualize the Allscripts ED production database server, the IIS Web Server, and the Citrix XenApp Windows terminal server (WTS). For workloads of 60 and 110 users, a single host machine was used to run Citrix XenApp; two host machines were used to horizontally scale and test performance of the Citrix XenApp application for workloads of 185 and 300 concurrent users respectively.

The following table describes the configuration of ESX host hardware servers used for virtualizing Allscripts ED components.

Table 2. ESX Host Hardware

HARDWARE	CONFIGURATION
Servers	Four HP Proliant BL 460c G6 servers. Each server is equipped with: <ul style="list-style-type: none"> • 2.8 GHz dual quad-core Intel Xeon E5560 • 48 GB RAM
Storage	NetApp FAS 3020: <ul style="list-style-type: none"> • Aggregate of 21 disks • RAID DP • 4 Gbps fibre connectivity • 10K RPM disks • FC protocol

Workload Used

Hewlett Packard's Load Runner 8.x software was used with eight custom scripts written to simulate the actions performed by Allscripts ED end users during a "normal" shift in a hospital's emergency room.

Results Observed

The following sections describe configuration and performance test measurements for 60, 110, 185, and 300 concurrent user workloads. These tests translate to hospital scenarios with 60,000, 110,000, 185,000 and 300,000 patient visits per year, respectively.

Testing with 60-User Workload (60,000 patient visits per year)

For testing with a workload of 60 concurrent users, the following configurations of virtual machines were used:

Table 3. Virtual Machine Configuration for 60-User Test

VIRTUAL MACHINE	VCPU'S	MEMORY (MB)	NETWORK ADAPTER
IIS Server	2	4096	vmxnet3
WTS (Citrix/XenApp)	8	16384	vmxnet3
SQL Server	2	4096	vmxnet3

Table 4 provides a summary of performance measurements for a workload of 60 concurrent users.

Table 4. Performance Measurements for 60 Concurrent User Workloads

Virtual Machine	CPU			Memory		Network		Disk			
	(%)			(mb)		Packets/sec		I/O sec		Latency(ms)	
	Avg	Max	Ready (Avg/Max)	Avg	Max	Rec	Tx	Avg	Max	Avg	Max
WTS	46.5	62.5	0.5/3	13065	14090.24	1147	476	13	38.59	2	21.09
IIS	47	91	2.5/8	310	409.6	4166	2085	1	9.84	1	10.85
SQL Server	20	40	0/0.13	758	901.12	2178	2139	23	225.24	1	6.6

For this first test, IIS and WTS virtual machines were configured to run on the same host, and SQL Server ran on a second host. For the host running IIS and WTS virtual machines, host utilization ranged between a low of 54 and a high of 74 percent. For the host running the SQL Server virtual machine, host utilization was a low of 5 and a high of 17 percent.

Testing with 110-User Workload (110,000 patient visits per year)

For testing with a workload of 110 concurrent users, the following configurations of virtual machines were used:

Table 5. Virtual Machine Configuration for 110-User Test

VIRTUAL MACHINE	VCPU'S	MEMORY (MB)	NETWORK ADAPTER
WTS (Citrix/XenApp)	8	24576	vmxnet3
IIS Server	4	4096	vmxnet3
SQL Server	2	4096	vmxnet3

Table 6 provides a summary of performance measurements for a workload of 110 concurrent users.

Table 6. Performance Measurements for 110 Concurrent User Workloads

Virtual Machine	CPU			Memory		Network		Disk			
	(%)			(mb)		Packets/sec		I/O sec		Latency(ms)	
	Avg	Max	Ready (Avg/Max)	Avg	Max	Rec	Tx	Avg	Max	Avg	Max
WTS	82.5	100	0.4/1.2	15938	17448.96	2164	1088	16	106.22	3	8.86
SQL Server	35	58	0/0.12	1372	1515.52	4251	4067	42	260.88	1	4.97
IIS	46.5	86	0/0.3	586	696.32	8124	4091	3	19.69	1	18.41

Based on host utilization numbers from 60-user testing, for 110-user testing, the WTS virtual machine was moved to run on its own machine and IIS and SQL Server virtual machines were configured to run on the same host. Utilization of the host running IIS and SQL Server virtual machines was a low of 30 percent and a high of 57 percent. For the host running the WTS virtual machine, host utilization was a low of 77 percent and a high of 96 percent.

Testing with 185-User Workload (185,000 patient visits per year)

For testing with a workload of 185 concurrent users, the following configurations of virtual machines were used:

Table 7. Virtual Machine Configuration for 185-User Test

VIRTUAL MACHINE	VCPU'S	MEMORY (MB)	NETWORK ADAPTER
IIS	4	4096	vmxnet3
SQL	4	4096	vmxnet3
WTS 1	8	24 GB	vmxnet3
WTS 2	8	24 GB	vmxnet3

NOTE: For 185-user workloads, two WTS virtual machines were run on different hosts in a cluster.

Table 8 provides a summary of performance measurements for workloads of 185 concurrent users.

Table 8. Performance Measurements for 185 Concurrent User Workloads

Virtual Machine	CPU			Memory		Network		Disk			
	%			(mb)		Packets/sec		I/O sec		Latency(ms)	
	Avg	Max	Ready (Avg/Max)	Avg	Max	Rec	Tx	Avg	Max	Avg	Max
IIS	80	100	1/4.95	807	1024	14434	6662	4	25.43	1	6.51
SQL	59	95	0/1.03	1377	1720.32	6931	7111	60	272.7	1	4.27
WTS 1	62	84.75	1/4.53	17936	21381.12	1867	931	19	317.7	3	23.97
WTS 2	62	93	2/5.89	16261	17448.96	1917	1178	15	86.86	3	7.73

As with 110-user testing, IIS and SQL Server virtual machines were configured to run on the same host. To scale horizontally and increase the capability to handle larger workloads, two WTS virtual machines were installed on separate hosts in a cluster.

Note that the %Ready time observed during testing (amount of time the virtual machine is ready to execute but is waiting for CPU) was always under 5%, on average. %Ready values below 8% typically provide acceptable performance. As workload levels increase, host CPU processing times become increasingly important benchmarks to monitor performance. For 185-user workload testing, CPU processor time statistics recorded for each host were the following:

Table 9. Host Processor Statistics

HOST	CPU (%)		
TOTAL % PROCESSOR TIME	MIN	MAX	AVG
IIS/SQL Host	13.98	37.97	28
WTS 1 Host	22.1	42.8	31
WTS 2 Host	22.38	46.55	31

Testing with 300-User Workload (300,000 patient visits per year)

For testing with a workload of 300 concurrent users, the following configurations of virtual machines were used:

Table 10. Virtual Machine Configuration for 300-User Test

VIRTUAL MACHINE	VCPU'S	MEMORY (MB)	NETWORK ADAPTER
IIS	8	4096	vmxnet3
SQL	4	4096	vmxnet3
WTS 1	8	24 GB	vmxnet3
WTS 2	8	24 GB	vmxnet3

NOTE: Except for the number of vCPUs allocated to the IIS server, the virtual machine configurations are the same as those used with 185-user testing. As with 185-user workloads, two WTS virtual machines were run on different hosts in a cluster.

Table 11 provides a summary of performance measurements for workloads of 300 concurrent users.

Table 11. Performance Measurements for 300 Concurrent User Workloads

Virtual Machine	CPU			Memory		Network		Disk			
	%			(mb)		Packets/sec		I/O sec		Latency(ms)	
	Avg	Max	Ready (Avg/Max)	Avg	Max	Rec	Tx	Avg	Max	Avg	Max
SQL Server	40	53	2.25/9	1537	1720.32	10794	10358	82	339.8	1	4.53
IIS	63	79	4, 7	1092	1187.84	20714	10405	5	22.89	2	8.6
WTS 1	57	84.5	1/2.58	20267	20643.84	1808	881	13	38.15	5	15.04
WTS 2	57	75	1/3.34	15736	16711.68	1755	860	13	29.34	4	14.54

For 300-user workload testing, CPU processor time statistics recorded for each host were the following:

Table 12. Host Processor Statistics

HOST	CPU (%)		
TOTAL % PROCESSOR TIME	MIN	MAX	AVG
IIS/SQL Host	28.5	49.92	42
WTS 1 Host	20.5	42.14	29
WTS 2 Host	19.11	37.94	29

As noted earlier, for best performance, you can monitor CPU utilization of hosts and other key indicators of host performance such as vCPU Ready to ensure that applications running in virtual machines have all the resources necessary to handle required loads.

Test Conclusions and Support

All of the tests carried out for different user loads resulted in satisfactory performance of the Allscripts ED application when virtualized on VMware vSphere. As a result of this testing, VMware is now a supported platform for the Allscripts ED application. The following table summarizes the support of different components of the Allscripts ED application system architecture.

Table 13. Virtualization Support for Allscripts ED System Components

Server	Details
Production Database Server	Supported on VMware vSphere when implemented as a part of Microsoft Cluster, for continuous availability. Customers should implement the two nodes of the Microsoft cluster as virtual machines residing on two separate physical hosts. Please refer to VMware's guide on how to setup Microsoft Cluster Services on vSphere for further information. http://www.vmware.com/pdf/vsphere4/r41/vsp_41_mscs.pdf
Test Database Server/Report Server	Supported on VMware vSphere
Interface Server	Not supported on VMware vSphere at this time; requires physical server. Please contact Allscripts for further details.
Remote Chart Access Server	Supported on VMware vSphere
Citrix/Terminal Server	Supported on VMware vSphere. Terminal server workloads can be resource-intensive and so were tested comprehensively on the VMware vSphere platform. The vCPU specification requirements provided in this document for terminal servers are based on resource utilization observed during the tests, so these requirements need to be enforced for best performance.
Fax Server	Not supported on VMware vSphere due to fax card requirement. This server can also host a Citrix Server.

Note on virtual machine sizing: The vCPU configurations specified in this white paper are based on testing that was done and the acceptable application performance/response time observed during testing. During testing, it was observed that CPU utilization for 8-CPU WTS virtual machines was an average of 50-60%, with a peak above 90%. When using the configurations described in this paper, there is a possibility that performance may be affected, as there might not be much headroom at peak loads for the hypervisor (vmkernel) to efficiently do its work. This may be more likely to occur if the host has additional virtual machines running on it, if the virtual machine is migrated with vMotion, or if any other CPU-consuming tasks need to be run on the same host. A scale-out approach using smaller virtual machines (for example, using two 4-vCPU virtual machines instead of one 8-vCPU virtual machine) has shown better performance in some scenarios. But even in the case of smaller virtual machines, the number of physical cores on the host should be larger than the number of vCPUs assigned to virtual machines, if the virtual machines might utilize all of the CPU resources on the host.

All implementations of Allscripts ED on VMware vSphere should be discussed with an Allscripts ED Systems Engineer prior to implementation. This ensures that customers are aware of latest best practices for deployment in a VMware vSphere virtualized environment and care is taken that adequate virtual resources are available to meet workload demands of each virtualized application.

Clients need to use the recommended hardware and software for each virtual server as specified by Allscripts. If a client does not use the recommended hardware and software, it becomes their responsibility to monitor and adjust these resources to meet user needs. If Allscripts feels additional resources are required to meet user needs, additional support may be dependent upon the client meeting those requirements. The client assumes full responsibility for the installation, configuration, and support of the virtual environment including all hardware, software, and fault recovery solutions for the virtual servers. Allscripts requires at least one member of the full-time/permanent IS staff to attend certification training for VMware technologies.

Allscripts supports the Allscripts ED application in a virtual environment the same as it does on standalone servers. When issues are confirmed to be unrelated to the virtual environment, Allscripts supports the virtual environment in a manner that is consistent with support provided when Allscripts ED is running on standalone servers. However, when issues are confirmed to be related to the virtual environment, it becomes the client's responsibility to troubleshoot the issue further. Allscripts is committed to the success of the Allscripts ED application in all environments and will work with clients to the best of their ability during this process.

Deployment considerations for Allscripts ED on VMware vSphere

Microsoft Cluster Services

Operating system level clustering, such as that provided by Microsoft Cluster Service (MSCS), can provide an additional layer of availability protection in VMware environments for mission-critical healthcare systems. VMware HA provides hardware level failure monitoring and recovery of virtual machines. Using operating system level clustering protects your virtual machines against guest operating system failures, as well as application failures. MSCS can also be implemented to protect against data loss occurring during system failure. For mission-critical environments, leveraging operating system clustering in a vSphere environment ensures the highest availability and flexibility for the virtualized application environment.

Allscripts recommends the use of MSCS to protect the production SQL Server database from data loss, in case of server failure. In a physical environment, this is implemented as a cluster across two physical nodes. In a virtual environment, MSCS can be implemented across two virtual nodes (virtual machines) running on different hosts, thereby offering protection from host failure. VMware HA can be used in conjunction with Microsoft Cluster Services and offers an additional level of recovery when a host fails. See *the VMware Clustering Guide for MSCS* for further details:

http://www.vmware.com/pdf/vsphere4/r41/vsp_41_mscs.pdf

SQL Best Practices

When running SQL Server with VMware vSphere, it is recommended that customers follow VMware best practices for virtualizing Microsoft SQL Server. See the *VMware SQL Server Best Practices Guide* for further information:

http://www.vmware.com/files/pdf/sql_server_best_practices_guide.pdf

VMware HA/vMotion

VMware HA provides uniform, cost-effective failover protection against hardware and operating system failures within your virtualized IT environment.

- Monitors virtual machines to detect operating system and hardware failures.
- Restarts virtual machines on other physical servers in the resource pool without manual intervention when server failure is detected.
- Protects applications from operating system failures by automatically restarting virtual machines when an operating system failure is detected.

VMware vMotion allows you to:

- Perform live VM migrations with zero downtime, undetectable to the user.
- Continuously and automatically optimize virtual machines within resource pools.
- Perform hardware maintenance without scheduling downtime and disrupting business operations.
- Proactively move virtual machines away from failing or underperforming servers.

Customers can leverage both VMware HA and VMware vMotion with Allscripts ED. See the VMware documentation on how to set up and use VMware HA and vMotion:

http://www.vmware.com/pdf/vsphere4/r41/vsp_41_esxi_server_config.pdf

Backup/Data Recovery

VMware supports several mechanisms for virtual machine and file-level backup and recovery.

Third Party Agent-based Backup and Recovery

Agent-based backup in virtual machines works the same as it does in non-virtualized data centers. A backup agent is installed in each virtual machine. A central backup server triggers the agent according to a defined schedule and a copy is made of the virtual machine, which is then stored on the central backup server. This process is resource-intensive and requires management overhead to maintain the agent in each virtual machine.

VMware Data Recovery – Disk-based Agent-less Backup and Recovery

VMware Data Recovery is a disk-based backup and recovery solution that enables quick, simple, and complete data protection for virtual machines. VMware Data Recovery is fully integrated with VMware vCenter™ Server to enable centralized and efficient management of backup jobs. It incorporates capabilities such as block-based data deduplication and performs only incremental backups after the first full backup is completed to maximize storage efficiency. See VMware's *Reference Guide for Data Recovery* for additional information:

<http://vmware.com/files/pdf/data-recovery-evaluators-guide.pdf>

VMware vStorage APIs for Data Protection

Customers with existing backup products from vendors such as Symantec, IBM, and CA can leverage vStorage APIs for Data Protection to perform centralized virtual machine backups without the disruption and overhead of running backup tasks from inside each virtual machine. Vendors have built integrations with VMware leveraging the VMware vStorage APIs for Data Protection to perform backups without burdening vSphere hosts with the processing of backup tasks. Backup tools from these vendors use these APIs to back up and restore virtual machine data from a central backup server or virtual machine without requiring that backup agents and backup processing be done inside of each virtual machine on the vSphere host. This allows you to offload backup processing from ESX servers, and reduce costs by allowing each vSphere host to run more virtual machines.

Configuration Best Practices for Allscripts ED on VMware vSphere

Testing provided the following recommendations and best practices when virtualizing servers as part of an Allscripts ED solution:

Table 14. Allscripts Best Practice Recommendations for Virtualization with VMware vSphere

BEST PRACTICES INCORPORATED FROM RESULTS OF ALL TESTING	
BIOS Settings	Enable Virtualization Technology to run the 64 bit guest OS.
	Enable Turbo Mode for balanced workload over unused cores.
	VT-x set for hardware based virtualization support.
	Enable High Performance mode instead of power saving mode for best performance.
	Power Regulator set to Static High.
	Memory Interleave set to Full interleave.
	Minimum processor idle power; no C-states.
	Enable the first two options for cache prefetching.
	Memory speed with two DIMMs per channel was set to 1333 MHz.
	Enable Hyper-Threading, as it is always recommended for new Intel core i7 Nehalem Processors, i.e., Xeon 5500 series.
CPU Considerations	Enable Intel VT-x technology to ensure hardware virtualization support instead of software Binary Translation (BT).
	NOTE: Using Over-Commit is fine, but ensure that the host is not over-utilized as the host itself required a minimum of two cores for service console, vmkernel, and other components.
	Disable IRQ's like Floppy/CD/DVD ROM, USB Controllers, and other video/audio programs.
	Enable Hyper-Threading.
Memory Considerations	Extended Page Support (EPT) support for MMU overheads.
Network Considerations	Use VMXNET 3 Paravirtualized Network Adapters.
	Ensure that the virtual machine, Service Console and vmkernel are on separate physical adapters to avoid any contention.
	Ensure that all the virtual machines are on the same virtual switch; having virtual machines on separate switches leads to transmission of traffic over different wires, resulting in extra CPU and network overhead.
Storage Considerations	Separate Datastores for GOS and AED Server components on separate VMFS volumes.
	RAID DP was incorporated for optimal performance across 21 disks.
	Ensure Disk Alignment to the boundary value of 64k.
	4 GB FC HBA.
	Multipathing was set to Fixed.
Miscellaneous	Create a golden image of virtual machines to save time and make deployment easier.

Technical Support

All initial support calls must go through Allscripts ED Support. The Allscripts ED Support phone number is 888-672-2433. Allscripts ED Support is available 24x7 and utilizes all necessary resources to resolve issues quickly and completely. On-site hospital contacts are important in situations when additional information or hands-on server interaction is necessary.

In the event it is determined that VMware needs to investigate a technical issue regarding an Allscripts ED deployment, the customer who owns the VMware licenses is authorized to open a support ticket with VMware, provided they have a valid support contract with VMware. Customers can open a support ticket online, or by phone, and request addition of Allscripts contacts to the support ticket. For step by step instructions please review VMware support instructions available at:

<http://www.vmware.com/support/policies/howto.html>

Resources

Customers can find more information about VMware and Allscripts products via the links listed below.

VMware Resources

- VMware official website:
<http://www.vmware.com/>
- VMware Infrastructure 3 and vSphere 4 product Web site:
http://www.vmware.com/products/data_center.html
- VMware download Web site:
<https://www.vmware.com/download/>
- VMware support Web site:
<http://www.vmware.com/vmtrn/>
- VMware Performance Tuning Paper:
http://www.vmware.com/pdf/vi_performance_tuning.pdf
- System Compatibility Guide for a complete list of compatible hardware:
http://www.vmware.com/pdf/vi35_systems_guide.pdf
- Storage/SAN Compatibility Guide for a complete list of compatible storage devices:
http://www.vmware.com/pdf/vi35_san_guide.pdf
- I/O Compatibility Guide for a complete list of compatible networking devices:
http://www.vmware.com/pdf/vi35_io_guide.pdf

Allscripts Resources

- Allscripts Web site:
<http://www.allscripts.com>
- Allscripts ED Overview:
<http://www.allscripts.com/products/edis/default.asp>
- Allscripts ED Client Login:
<http://www.allscripts.com/en/client-login.html#ed>

