

# **VMware Server Consolidation; Terminal Services Thin Clients**

By

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Submitted to  
the Faculty of the Information Technology Program  
in Partial Fulfillment of the Requirements for  
the Degree of Bachelor of Science  
in Information Technology

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## **Abstract**

*VMware Server Consolidation and Terminal Services Thin Clients* is a consolidation project for Brown County General Hospital, a non-profit organization. The hospital has approximately 30 servers supporting its day to day needs. As new services are requested new servers are purchased and installed. This has created an abundance of servers, most of them running near idle. The VMware portion of this project aims to monitor and log the performance of servers so that an accurate consolidation scenario can be achieved. The second portion of this project is Terminal Services Thin Clients. The client machines in the hospital are all full desktop systems. Many of the client machines only run a telnet program and Internet Explorer, while others run the Microsoft Office Suite. Converting the eligible full desktop systems will provide less time spent on support and less money spent on hardware.

# **VMware Server Consolidation; Terminal Services Thin Clients**

## **1. Statement of the Problem**

Brown County General Hospital, a community-owned not-for-profit hospital, is located in Georgetown, Ohio. It is a 115 bed acute-care facility that offers a wide variety of services such as emergency, cardiopulmonary, maternity, intensive care, inpatient, same-day surgery, therapy, and hospice. The hospital is fully accredited by the Joint Commission on Accreditation of Healthcare Organizations, which means that they voluntarily submit to evaluations of compliance with nationwide hospital standards on a continuing basis. Joint Commission accreditation acts as an assurance that Brown County General Hospital practices continuous quality monitoring to provide patients with quality health care.

The current information system infrastructure at Brown County General Hospital has become antiquated over time. While adding new services to accommodate their patients and stay current with nationwide hospital standards, the hospital has accumulated an excess number of servers that are not being utilized to their full capacity. They currently have approximately 30 physical servers since they separated some services from others or applications were run on different operating systems. The current environment makes it increasingly difficult for administrators to manage and is not cost effective. Adding new services to the current system is impractical under the existing environment because of limits on physical space, inadequate manpower, lack of available hardware, and the amount of time required to configure additional hardware.

An additional problem experienced by Brown County General Hospital is that individual employees are running full desktop computer systems instead of utilizing thin clients. Many of the client machines in the hospital run only a telnet program and Internet Explorer. Running thin clients will result in substantial savings to the hospital since many users will replace their full desktop computer system with a thin client. By downsizing the number of full desktop computer systems, less time will be required for maintenance and thin clients are less likely to fail. If a failure did occur with a thin client, it can quickly be replaced with a spare without any specific configuration for the user.

Solving the identified issues facing Brown County General Hospital will require several steps. First, the hospital needs to consolidate its servers using virtualization. This will lower its total cost of ownership without eliminating availability or resiliency. In fact, virtualization will provide the hospital with a higher level of availability, greater disaster recovery and ease future growth. Secondly, the desktop computer systems will be replaced with thin clients to provide the same quality of service while cutting costs.

## **2. Description of the Solution**

### **2.1 User Profile**

There are two different sets of users for the thin client project, a Server Administrator and the end users, which is comprised of hospital employees. Only the Administrator will be the user of the virtualization project.

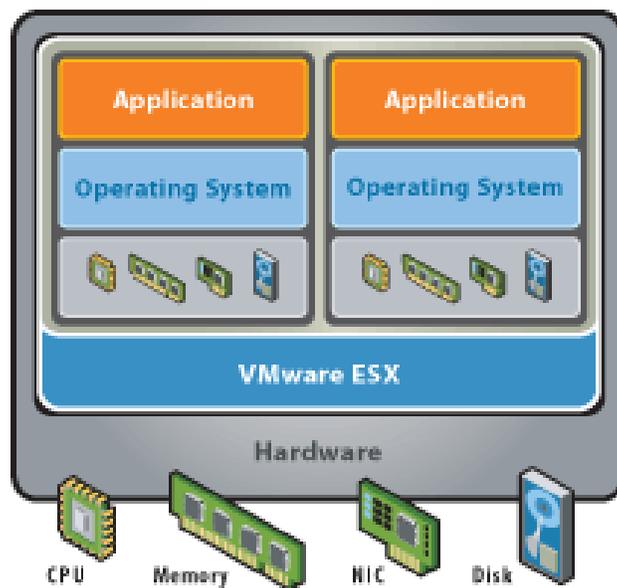
The Server Administrator is the designated person chosen by Brown County Hospital. He is head of the IT department. He is fully versed in back-end maintenance of terminal services for the thin client project (2). The Administrator is responsible for the daily maintenance of the terminal server and ensuring that the end users have access to the appropriate resources (2). This includes such things as folders, printers, and applications. For the virtualization project, the Administrator is responsible for monitoring the resource usage and adjusting accordingly. If another administrator is selected in the future, they should hold a bachelor degree in IT or Computer Science and have a thorough understanding of VMware infrastructure. Their computer literacy level should be high.

The end users of the thin clients include many of the hospital employees. Their computer literacy level varies from basic to medium. Most are proficient in data entry, word processing and/or meditech (2). Others have more advanced skills. Their responsibilities and computer needs vary depending on their job description. Receptionists use meditech (2). The administrative staff focuses on word processing, data entry and Microsoft Outlook (2).

Due to budget overruns, the virtualization project has been put on hold. Brown County Regional Hospital intends to complete the project however; the completion date will be after the end of the quarter. All employees will utilize the services provided by the virtualization project although the use will be transparent.

## 2.2 Design Protocol

Virtualization is the best long-term solution to eliminate the abundance of servers. This will reduce the hospital's total cost of ownership without eliminating availability, resiliency, manageability or restricting growth of their infrastructure (4). It will also allow Brown County Hospital to merge physical computers and storage devices to complete a virtual infrastructure (5). VMware has been selected as the best candidate to complete this portion of the project based on reliability, price, performance, and reputation. VMware "...inserts a thin layer of software directly on the computer hardware or on a host operating system. This software layer creates virtual machines and contains a virtual machine monitor or "hypervisor" that allocates hardware resources dynamically and transparently so that multiple operating systems can run concurrently on a single physical computer without even knowing it."(5).

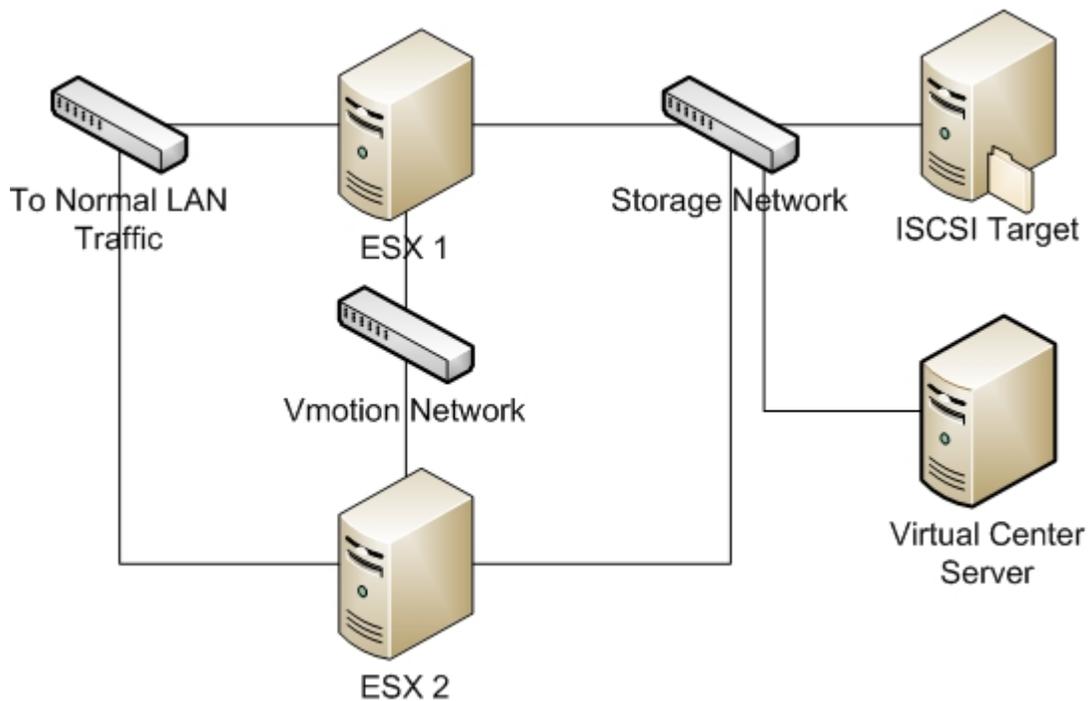


**Figure 1 – VMware ESX Server Diagram**

The purchased VMware Infrastructure will be the Enterprise Edition License that includes one year of support available 24 hours per day, seven day per week via phone or web (5). Additional hardware will be required to run the VMware ESX server. This will be accomplished with two Dell Power Edge 2950's with Dual Quad-Core 3.16ghz processors and 16GB of RAM (1). At this time the virtualization portion of the project has been postponed because another project went over-budget. The funds earmarked for the virtualization project were diverted to other projects. The client fully intends to proceed with the virtualization project when funds become available. Unfortunately, the funds will not be available before the end of the Senior Design project. Since the project could not be completed as scheduled, it was important to verify that the project could be successfully completed within the system at Brown County Hospital as proposed. To accomplish this, a beta system was developed to demonstrate that the virtualization model would function as specified.

A prototype of the virtual environment was setup to verify that it would fulfill the required deliverables. This was accomplished using mainly donated hardware and trial versions of VMware. The donated hardware included three mid-to-low end pc's, one gigabit switch, three gigabit network cards for each VMware ESX server, one gigabit network card for an iscsi server, and one spare laptop to run VMware virtual center. Although this hardware did not match the project hardware available for the Brown County project, it still demonstrated a working prototype. However, it limited the number of virtual machines that could be run. Two of the donated machines were setup running VMware ESX used to represent the two ESX servers that are in the project plan. One iscsi server was setup to mimic the one already in place at Brown County Regional

Hospital, although at a lower performance level. It was a lower performance level since the prototype is a standard pc with scsi and ide drives and the equipment at the hospital is an enterprise EMC solution. By demonstrating that the prototype could run on lower end hardware, it is safe to conclude that it will be successful on the existing iscsi server located at Brown County Hospital. The prototype demonstrated that all deliverables were met for this portion of the project and will be successful when Brown County Hospital is ready to resume the project.



**Figure 2 – ESX Prototype Setup**

The second phase of the Brown County project involved replacing the full desktop systems with thin clients and was to be conducted simultaneously with the first phase. This required the purchase of thin clients to replace the existing computers. Hewlett Packard T5135's with 400 MHz processors were selected as the appropriate thin

clients (3). They connect to a Dell PowerEdge 2950 server with Dual Quad-Core 3.0ghz processors and 4GB RAM (1).



**Figure 3 – HPT5135 Thin Client**

Additional training on the usage of thin clients for Brown County Regional Hospital staff and employees was not required if they had previous experience with full desktop systems. Training, if necessary, will be the same for thin clients as full desktop computers. If problems arise for thin client users, assistance will be provided using the hospital's IT support. This portion of the project has been completed and all deliverables met.

### **3. Objective of the Project (“Deliverables”)**

#### **3.1 Thin Clients:**

- 1) Configuration of terminal services

- 2) Deployment of a minimum of twenty thin clients

### 3.2 VMware:

- 1) Set-up performance monitoring on the virtualization candidates
- 2) Analysis of the performance monitoring to determine virtual machine placement
- 3) Installation and configuration of VMware ESX server

## 4. Design and Development

### 4.1 Budget

#### Virtualization Project: VMware

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>Each</u>	<u>COST</u>
Dell PowerEdge 2950	Dual Quad-Core 3.16ghz 16GB of RAM	2	\$9,000	\$18,000
VMware Infrastructure	Enterprise Edition License 1 Year 24x7 support (Phone/Web Support)	2	N/A	\$14,376
		Total		\$32,376

**Figure 4 – Virtualization Project Budget**

#### Thin Client Project

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>EACH</u>	<u>COST</u>
HP T5135	400MHz CPU 128MB DDR SDRAM	100	\$200	\$20,000
Dell PowerEdge 2950	Dual Quad-Core 3.0ghz 4GB RAM	1	\$5,000	\$5,000
		Total		\$25,000

**Figure 5 – Thin Client Project Budget**

The resources for this project were paid for by Brown County General Hospital. The project required numerous trips to the hospital although much of the work could be accomplished off-site using VPN. If problems arose, there was support from the vendors and the current hospital information system administrators.

#### 4.2. Timeline (Tasks and Schedule)

The timeline for completion of the project is detailed below; however the timeline was not completely met due to the aforementioned delay in the virtualization project. The thin client project was tested and implemented by the end of Winter Quarter 2008. The following tasks on the virtualization project began in Fall Quarter 2007 and were completed in Spring Quarter 2008: research, selection of virtualization technology, identification of the virtualization candidates, performance monitoring and analysis, and hardware selection. The virtualization project prototype testing was completed by the end of April, 2008. The remainder of the project has been postponed.

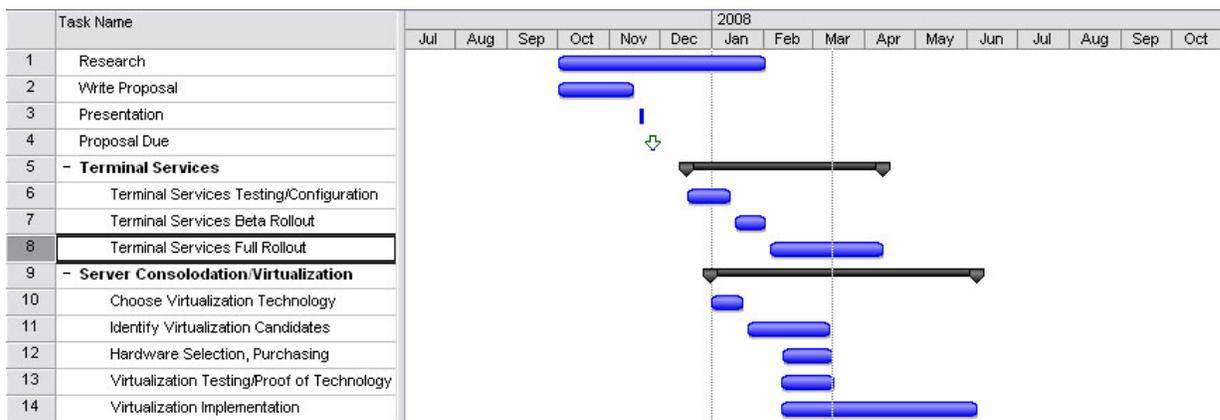


Figure 6: Project Timeline

### **4.3. Software**

The virtualization project software included VMware Infrastructure, Enterprise Edition. A one year license includes 24 hours, 7 days a week support by phone and/or web (5). There are no additional software purchases for the thin client project.

### **4.4. Hardware**

Hardware selected for the virtualization project included: 2 Dell Power Edge 2950, Dual Quad-Core 3.16 GHz CPU with 16GB of RAM (1). The thin client project included 100 HP T5135 thin clients with 400 MHz CPU, 128 MB DDR SDRAM and 1 Dell Power Edge 2950 Dual Quad-Core 3.0ghz 4GB RAM (3) (1).

## **5. Conclusions and Recommendations**

### **5.1 Conclusions**

The information system at Brown County General Hospital was out-of-date, unmanageable and unresponsive to the needs of the users. To enable the hospital to run effectively and efficiently, and most importantly, to allow the hospital to provide quality health care, the mentioned changes were required. The first suggestion was to implement virtual servers to replace the multiple low utilized servers currently in use. This can be accomplished with little interruption of services and will result in a reliable, resilient system with high availability. It is recommended that the Server Administrator regularly test and monitor resource usage to ensure the stability and performance of the systems. As soon as funds are available, this project should resume.

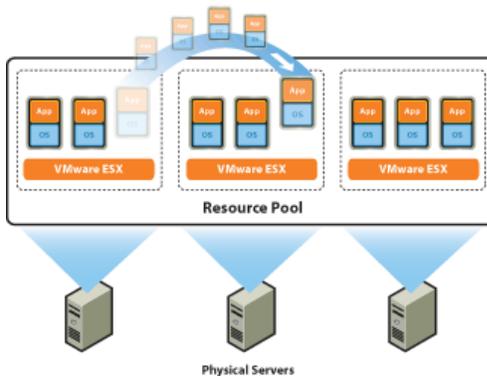
The second phase of this project involved replacing the full desktop computers with thin clients. This solution is enabling the hospital to save space, time, and money all

while being more responsive to the needs of the users and accomplishing their mission of providing quality health care.

## 5.2 Recommendations

Future recommendations include researching the feasibility of several other products to ease and better the management of the hospital. The first recommendation is the implementation of a central management for the thin clients. This would allow changes to be made in one location and eliminate the need to change settings on individual thin clients.

The next set of recommendations is for the virtualization portion of the project. The first recommendation is the addition of VMware Distributed Resource Scheduling (DRS) (5). DRS will allow VMware to move virtual machines between available ESX servers automatically which will keep them balanced and prevent overloading (5).



**Figure 7 – Distributed Resource Scheduling**

The second recommendation is to create appropriate server templates to decrease the amount of time that it takes to deploy new servers. After templates are created, the administrators can simply command VMware to create a new server based on the

template chosen (5). The new server will be available in minutes. The final recommendation is to implement VMware consolidated backup. Consolidated backup from VMware takes the load of backups off of the production servers and the production network (5). It accomplished this by using a separate dedicated server to handle backups.

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