Mobile Virtual Classroom

by

Scott Murray

Submitted to
The Faculty of the School of Information Technology
In Partial Fulfillment of the Requirements for
The Degree of Bachelor of Science
In Information Technology

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Scott Murray 04/20/2015
Date

Mark Stockman 04/20/2015
Date

University of Cincinnati
College of
Education, Criminal Justice, and Human Services

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Abstract

ATR Distributing Co, an industrial solutions distributor based in Cincinnati, Ohio, is in need of a solution to perform software training at customer sites. ATR currently only performs training services at their local office in Cincinnati. They now want to accommodate their nationwide customer base by bringing the training courses to them.

The project consists of three main goals: ease of training, server mobility, and company cost savings. For ease of training we tested out two solutions, VMware Horizon and Windows Remote Desktop, to create virtual training labs that are easily accessible by students. The mobility goal consists of a tower server that can be taken on the go and setup at any of their clients’ offices. We will have considerable cost savings from building a mobile server and using virtual machines rather than purchasing all new laptops.
Introduction

The mobile virtual classroom will make it easier for ATR to conduct training on the go, the server mobility allows ATR to train outside of their office, and it also provides ATR and their customers with cost savings. This will help improve customer satisfaction and also provide ATR with more training options in the future.

About the Company

ATR Distributing Company is a local Cincinnati business that sells high-tech industrial automation software and hardware. They also provide technical support and training for their products. The main product they sell and provide training for is called Wonderware System Platform and it acts as a company's “Industrial Operating System” by providing common services including visualization, configuration, deployment, communication, security, data connectivity, data storage and management, people collaboration and many others. These services allow an organization to build a single, unified “Plant Model” that logically represents processes, physical equipment and industrial systems and even legacy systems, making the design and maintenance of these systems more efficient, more flexible and with less risk.
Problem

ATR Distributing holds software training classes at their local office and now they want to be able to take their training on the go to different client locations. The main issue with training on the go is that they currently use older laptops that use remote desktop to access training virtual machines that are located locally in the company’s vSphere Cluster. Training on the go would be more convenient and cheaper for the customers because they wouldn’t need to worry about purchasing flights or hotels. Secondly, ATR doesn’t want to rely on a client’s network structure or broadband to VPN into the local classroom virtual machines. They also don’t want to bog down the client’s network by using their broadband to access the virtual machines located at their Cincinnati office.

Solutions

For this project I have created two possible solutions that allow the students to remotely access the virtual labs via the mobile server. The setup requires the server tower, a wireless router, and a laptop for each student so that they will be able to access the classroom virtual machines without relying on an internet connection. The first solution uses Windows Remote Desktop and allows the students to access their virtual lab directly from the ESXI server. The second solution has VMWare Vcenter and VMware Horizon installed which allows the students to access their virtual machine through the VMware Horizon client that’s already been installed on their laptop. ATR has decided to use the Remote Desktop solution because it is cheaper and they don’t need all of the extra features of VMWare Horizon View.
User Profile

The user only has to work with the Windows Remote Desktop application or the VMware Horizon client software that has been installed on their laptop. They are assigned a specific laptop and virtual lab machine to work with throughout the class. The users can range from being a student, the instructor, or an administrator. The user does not need experience with VMware and there are only a couple of steps to access the virtual classroom lab they have been assigned. The instructor uses the same method as the students but they will use the virtual machine labeled “Instructor”. The administrator has full access and can add and modify existing virtual machines. This server will be used for teaching classes at customer locations.
Network Diagram for Windows Remote Desktop Solution

The windows remote desktop network diagram shows all of the virtual machines that are hosted by the ESXI server and the student’s laptops that can connect to them. The diagram shows how all of the machines are connected to the same router and are on the same network.

Figure 1: Remote Desktop Network Diagram
Network Diagram for VMware Horizon View Connection Solution

The following network diagram for the VMware Horizon View Connection solution shows the physical ESXI host in orange and the physical student laptops. It also shows the virtual lab machines and virtual servers on the ESXI host. The virtual servers run the domain controller, Horizon Connection server, and the Vcenter server.

Figure 2: VMware Horizon View Network Diagram
Technical Elements

- Programs – VMware Horizon View v5.5, VMware VSphere client v5.5, VMware Horizon Client v5.5, Windows Remote Desktop

All of the computing and storage is accomplished using the host server running VMware ESXI 5.5 and VMware Horizon View v.5.5. The VMware Horizon View program is run on a virtual 2012R2 Windows server. The students can access the virtual machines on the host server by using the VMware Horizon View Client from their laptops. They can also access their virtual labs through the Windows Remote Desktop application without using any of the extra VMware servers. The host machine was added to ATR’s local Vcenter cluster so that the original lab VMs could be copied and migrated to the mobile host via Vmotion. When the server isn’t in use it will be added to the local Vcenter cluster and used for classes held at ATR.
Budget Analysis

Budget using Windows Remote Desktop:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP Tower Workstation</td>
<td>$4,500</td>
</tr>
<tr>
<td>VMware ESXI</td>
<td>Already own licensing</td>
</tr>
<tr>
<td>Windows Remote Desktop</td>
<td>$0.00</td>
</tr>
<tr>
<td>Cisco Router</td>
<td>$100.00</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$4,600</strong></td>
</tr>
</tbody>
</table>

Budget using VMware Horizon View Connection:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP Tower Workstation</td>
<td>$4,500</td>
</tr>
<tr>
<td>VMware ESXI</td>
<td>Already own licensing</td>
</tr>
<tr>
<td>VMware Horizon View</td>
<td>$3,025</td>
</tr>
<tr>
<td>VMware Vcenter</td>
<td>$6,044.00</td>
</tr>
<tr>
<td>Cisco Router</td>
<td>$100.00</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$13,669</strong></td>
</tr>
</tbody>
</table>

Alternate Budget if purchased new laptops:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP EliteBook 9470m Quantity 14</td>
<td>$20,000</td>
</tr>
<tr>
<td>VMware Fusion 7 Quantity 14</td>
<td>$980</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$20,980</strong></td>
</tr>
</tbody>
</table>

Customer Cost Savings Analysis

This chart shows the average amount of money a customer could save per student by having the training taught at their location. If they have 10 students they could be saving around $14,000 and this helps ATR market their training classes.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Flight (Delta)</td>
<td>$700.00</td>
</tr>
<tr>
<td>Hotel for 5 days (Holiday Inn)</td>
<td>$93.00 x 5 = $465</td>
</tr>
<tr>
<td>Rental Car(Alamo)</td>
<td>$53.27 x 5 = $266.35</td>
</tr>
<tr>
<td><strong>Total Cost Per Employee:</strong></td>
<td><strong>$1,431.35</strong></td>
</tr>
</tbody>
</table>
Server Performance Testing

Performance testing is meant to determine how much stress the server can handle while running all necessary virtual machines. Vcenter has built in logging that allows the administrator to run performance tests on the host server that shows the memory and CPU usage. For testing I ran all 13 virtual machines including all lab virtual machines and the 3 virtual servers. The virtual labs were running the Wonderware InTouch software and the 3 virtual servers were running Vcenter, View Connection, and domain services. They were run like this for about 6 hours and the results showed the highest percentage of the CPU being used hit around 40 percent whereas the memory was hitting between 80 and 83 percent. The graphs below represent a week of the host server’s performance and clearly shows when the stress test was executed.

Figure 3: CPU Performance

Figure 4: Memory Usage
The following figure shows the max capacity and current usage of the server. The server has 49 gigabytes and it has about 40 gigabytes allocated to the virtual machines. It is only using around 40 percent of the CPU when it is stress tested which shows that a couple more virtual machines could be added.

Figure 5: Server Resources
**User Testing**

User testing has been done using ATR employees of whom some are experts in the computer field and others are novices. They were provided with two user testing forms, one for Horizon View Client and one for Remote Desktop Connection, which gave them directions and finished with questions. The directions given to the students had them logging into their physical laptops with the Student account and then opening one of the virtual desktops via Remote Desktop or the Horizon View client. They were then instructed on how to open the Wonderware InTouch application to show that the software was working on the virtual machine. The questions asked how easy the process was and also how quickly they were able to get the virtual machine up and running. The employees all thought the process was very easy and that the virtual machines started up fairly quick. They were also asked if the steps were hard to follow or if they had any feedback on how to improve the project and the responses were no for each question.
Security and Backup Plans

The server and virtual machines are both very secure because they do not require an internet connection and only users who know the password to the secure Wi-Fi router can access them. Every virtual machine on the server is password protected along with the virtual servers. The ESXI host has had the default password changed to a more secure password that only the administrator knows. All of the VMware applications like Vcenter and View Connection have had their default passwords changed as well. If the machine is stolen the software that is installed only uses demo licenses and would be useless for a thief. When the server is sent anywhere it is sent to a specific contact at the customer location or if the instructor drives it can go with him or her.

The VMware ESXi hypervisor has been installed onto an 8 GB flash SD card and has been imaged in case the operating system becomes corrupted or fails. Storage fault tolerance is done by having half the VMs on one SSD, the others on the second SSD, and a copy of all of them on the third SSD. Originally it was planned to have a RAID 5 data array with a Raid controller but the SSDs were failing. Research showed that RAID 5 with SSDs on this particular raid controller wasn’t reliable but RAID 10 could work if a fourth SSD is purchased. Also, the virtual machines have all been copied and backed up on our local servers.

The backup for if the server fails at a customer site is to have the students and instructor VPN into ATR’s network and connect to one of the local virtual machines on their network. This backup would only work if the broadband at the customer site can handle enough upload data for 11 virtual machines. Another backup is that the Instructor’s laptop is high powered and could support hosting some of the virtual machines. The virtual machines would need to be scaled back a little and may run slower but would still work.
**Project Timeline**

This Gantt chart shows the second semester details of this project. The first semester consisted of Gathering requirements for the project and creating a prototype in the UC sandbox. This project was split up into multiple phases and each stage had an estimated amount of hours required to be completed as shown in the Gantt chart:

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order and Build Mobile Server</td>
<td>10 days</td>
<td>Mon 1/5/15</td>
<td>Fri 1/16/15</td>
</tr>
<tr>
<td>Configure server with Vmware Software</td>
<td>11.5 days</td>
<td>Thu 1/8/15</td>
<td>Fri 1/23/15</td>
</tr>
<tr>
<td>Submit Gantt Chart and Deliverables</td>
<td>1 day</td>
<td>Mon 1/26/15</td>
<td>Mon 1/26/15</td>
</tr>
<tr>
<td>Install Microsoft server 2012 and Vmware Horizon Components</td>
<td>7.5 days</td>
<td>Wed 1/28/15</td>
<td>Fri 2/6/15</td>
</tr>
<tr>
<td>Submit Testing Plan</td>
<td>1 day</td>
<td>Mon 2/9/15</td>
<td>Mon 2/9/15</td>
</tr>
<tr>
<td>Configure Security settings and User Profiles</td>
<td>5 days</td>
<td>Mon 2/9/15</td>
<td>Fri 2/13/15</td>
</tr>
<tr>
<td>Submit Revised Abstract</td>
<td>1 day</td>
<td>Mon 2/16/15</td>
<td>Mon 2/16/15</td>
</tr>
<tr>
<td>Submit Draft Tech Expo Poster</td>
<td>1 day</td>
<td>Mon 3/9/15</td>
<td>Mon 3/9/15</td>
</tr>
<tr>
<td>Submit Draft Report</td>
<td>1 day</td>
<td>Mon 3/9/15</td>
<td>Mon 3/9/15</td>
</tr>
<tr>
<td>Testing</td>
<td>20 days</td>
<td>Mon 2/16/15</td>
<td>Fri 3/13/15</td>
</tr>
<tr>
<td>Submit Final Poster</td>
<td>1 day</td>
<td>Mon 3/23/15</td>
<td>Mon 3/23/15</td>
</tr>
<tr>
<td>Presentation Preparation</td>
<td>16 days</td>
<td>Mon 3/16/15</td>
<td>Mon 4/6/15</td>
</tr>
<tr>
<td>Submit Final Report</td>
<td>1 day</td>
<td>Mon 4/20/15</td>
<td>Mon 4/20/15</td>
</tr>
<tr>
<td>Submit Library Copy</td>
<td>1 day</td>
<td>Thu 4/30/15</td>
<td>Thu 4/30/15</td>
</tr>
</tbody>
</table>

*Figure 6: Gantt Chart Timeline*
Figure 7 is my Gantt chart that shows the timeline of these phases:
Conclusion

The mobile virtual classroom will make it easier for ATR to conduct training on the go, the server mobility will allow ATR to train outside of their office, and it also provides ATR with cost savings. This will help improve customer satisfaction and also provide ATR with more training options in the future. This project has also allowed ATR to test new VMware products like VMware Horizon view to see if they could implement them into future projects.
Works Cited

Appendix

Below are the forms that were used for user testing. Users were given directions on how to use the system and then asked about how fast and easy it was to use.

Mobile Virtual Classroom

User Testing for Windows Remote Desktop Connection

Directions:

1.) Successfully login to the host laptop using Username: Student, Password: ww
2.) From the desktop open the Remote Desktop Connection named "TRAIN1"
3.) Open the Intouch application which is located in Programs in the Wonderware folder
4.) Select the 'Demo Application 1024x768'
5.) Hit Ignore for the licenses dialog box
6.) Close out of all programs and logoff virtual machine

Questions:

1.) On a Scale of 1-10, with 1 being Very Difficult and 10 being very easy how easy was it to login and open the InTouch application? Circle one of the numbers below.

   1   2   3   4   5   6   7   8   9   10

2.) On a Scale of 1-10, with 1 being very slow and 10 being very fast how long did this process take you to complete? Circle one of the numbers below.

   1   2   3   4   5   6   7   8   9   10

3.) Were there any steps that were difficult to follow?

   Yes, it was a very simple process

4.) Do you have any ideas that could make this project better?

   Nope
Mobile Virtual Classroom

User Testing for VMware Horizon View

Directions:

1.) Successfully login to the host laptop using Username: Student, Password: wvw
2.) From the Desktop open the VMware Horizon Client application
3.) Click ‘Continue’
4.) Now login as “Train1” using password: wonderware
5.) Open the Intouch application which is located in Programs in the Wonderware folder
6.) Select the “Demo Application 1024x768”
7.) Hit Ignore for the licenses dialog box
8.) Close out of all programs and logoff virtual machine

Questions:

1.) On a Scale of 1-10, with 1 being very difficult and 10 being very easy how easy was it to login and open the InTouch application? Circle one of the numbers below.
   
   1  2  3  4  5  6  7  8  9  10

2.) On a Scale of 1-10, with 1 being very slow and 10 being very fast how long did this process take you to complete? Circle one of the numbers below.
   
   1  2  3  4  5  6  7  8  9  10

3.) Were there any steps that were difficult to follow?
   
   Yes

4.) Do you have any ideas that could make this project better?
   
   Additional instructions for more difficult tasks
Here is the screenshot of the Vcenter management screen that shows all of the virtual machines that are on the ESXI host. It includes the virtual labs and the virtual servers. The Vcenter server also provided important logging data about the performance of the host machine and how much of the resources each VM was using.
Below is a screenshot of all of the services running on the Windows 2012 server. The services are AD Domain Services, DNS, and file and storage services.
Here is the screenshot of the View Connection administrative page. It shows the virtual labs and what users are allowed to access them. It also shows which host they are located on and the status of each VM.
The screenshot below shows the Horizon View Client that the student would use to login to a VM.
Here is a screenshot of what the actual server looks like and the type of classroom it would be used in.
Power Point Presentation

Mobile Virtual Classroom
By Scott Murray

AGENDA

- Introduction
- Problem Need
- Solutions
- Network Diagrams
- Technical Requirements
- Testing
- Budget
- Conclusion
- Questions
The Problem Need

- Provide training on the go
- No internet connection required
- Cheaper for our Customers
- Cost savings for ATR

What is a Mobile Virtual Classroom?

- The mobile virtual classroom is a standalone tower server for ATR Distributing that allows them to do training sessions on the go at our Customer’s location
- It allows the students to access our virtual desktops that have our “Wonderware” training software already installed and configured
- The instructor takes the server with them along with a wireless router and the students can connect to the wireless LAN without needing an internet connection
Two Solutions: Windows Remote Desktop and VMware Horizon View Connection

- Both solutions use a VMware ESXi server to host the virtual machines.
- The Remote Desktop Solution would have the students remote into the Windows labs on the ESXi Server.
- The VMware Horizon virtual desktop implementation allows for more configuration but requires more services to work:
  - Domain Controller, DNS Server, Horizon View Connection
  - This would be useful for a larger company with 50-100 virtual machines
- ATR will be using the Windows Remote Desktop solution because it is cheaper and less power consuming.

Network Diagram for Windows Remote Desktop
Network Diagram for VMware Horizon View Connection

Technical Requirements

- Host Server - HP Tower Workstation, 48GBs RAM, 900GBs SSD Storage

- Operating Systems - VMware ESXi v5.5, VMware Vcenter 5.5, Windows Server 2012 R2, Windows 7

- Programs - VMware Horizon View Connection v5.5, VMware VSphere client v5.5, VMware Horizon Client v5.5, Windows Remote Desktop

- Cisco Linksys Wireless Router
User Testing

- Users were given a set of directions to follow.
- They were given a form to fill out about how their experience was when using these solutions.
- Users responded with the process being quick and easy.

Performance Testing

- Stress Tested with all VMs running Wonderware software.
- Max CPU usage was at around 40 percent.
- Max Memory usage was at around 40GBs which is around 83 percent memory.
Budget: Windows Remote Desktop

- HP Tower Workstation: $4,500
- VMware ESXi: Already own licensing
- Cisco Router: $100.00
- Total: $4,600

Budget: VMware Horizon

- HP Tower Workstation: $4,500
- VMware ESXi: Already own licensing
- VMware Vcenter: $6,044.00
- VMware Horizon View: $3,025
- Cisco Router: $100.00
- Total: $13,669
Conclusion

- This solution will provide on the go training
- Convenience for our customers
- Cost savings for both ATR and our customers