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Colorado Springs, CO 80919  
August 19, 2015

James Jones  
Chief Executive Officer  
XYZ Software Development  
5450 Tech Center Drive  
Colorado Springs, CO 80919

Dear Mr. Jones,

Good day, sir. Attached is a proposal for the expansion of our customer support data center. Due to the overwhelming success of our web application software lines and the resulting expansion of our client base, the data center has run out of available servers to allow us to immediately begin work on new customers' software solutions. A decision is needed to allow engineering to move forward with a project to virtualize the data center using VMware virtualization tools.

The two options-virtualize the data center or purchase additional servers-presented in the proposal outline the implementation timelines, costs, benefits and shortfalls of each option to allow you to make an informed decision in this matter. Of note is the comparative analysis of the two options on page 11 that allows you to quickly see the differences between the two options. Due to the tremendous difference in costs, both current and future, the option to virtualize the data is strongly recommended.

I ask that you consider the proposal and put it to vote with the board of directors. I would be happy to come and formally present this proposal at your discretion. If you have any questions regarding this proposal, please do not hesitate to call me at 719-555-1234 or you can reach me via email at [jeremy.sample@xyzsoftdev.cm](mailto:jeremy.sample@xyzsoftdev.cm) anytime.

Sincerely,

NAU Student

Proposal to Virtualize the Customer Support Data Center

National American University

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### **Informative Abstract**

XYZ Software Development has expanded its customer base to such an extent that there are no longer any available servers to keep up with the ever-increasing customer requirements. This situation needs an expansion decision to focus engineering efforts as the company moves forward. This paper studies the benefits and downfalls of two infrastructure expansion options: add more physical servers; virtualize the data center. The primary research for this paper involved a targeted audience questionnaire limited to three key respondents, one each from XYZ Software Development and two major competitors. Results showed that the primary reasons for virtualization included gross resource underutilization in physical-build servers, and the comparative cost benefit of virtualization versus physical server expansion. Each external respondent also gave resource utilization statistics for both physical and virtual server builds hosting their proprietary software on hardware and software infrastructures similar to this company's servers. These statistics indicated that a single physical server could viably host eight virtual servers to maximize the utilization of the server's resources. The findings within this paper clearly point to virtualization as the most viable and cost-effective solution to the customer support problem.

## **Introduction**

### **Statement of Purpose**

XYZ Software Development stands above the competition by providing full-featured and robust web application solutions to customers in a timely and professional manner. The company has run out of servers to use for customer-specific software development and customer acceptance testing due to extremely rapid growth in the client base. The situation demonstrates a need to decide a course of action to either repurpose the current server hardware or purchase additional servers to accommodate the new client base. The purpose of this proposal is to gain approval to resolve the customer support dilemma through a virtualization restructure of the data center using VMware products. This will allow the company to flex its automation infrastructure with minimal cost and effort to provide continued quality support to customers as the client base rapidly expands.

### **Background**

Virtualization is defined as "abstracting a computer's physical resources into virtual ones with the help of specialized software. Abstraction layers allow for the creation of multiple VMs [virtual machines] on a single physical machine. Each VM can run its own OS [operating system]" (Lunsford, 2009, para. 5). This abstraction, which allows for easier resource sharing, affects the processors, memory, network, and sometimes even the storage resources of the physical computer. The specialized software used to create these abstraction layers is called a hypervisor; ESXi 5.0 from VMware is such a hypervisor.

[A hypervisor] divides a single physical computer into multiple logical computers, or virtual servers, each running its own guest operating system (GOS). The hypervisor multiplexes and arbitrates access to the resources of the host platform so that they can be

shared among multiple virtual servers, while enforcing a level of isolation that ensures that each virtual server is not affected by the others (Loveland, S., Dow, E., LeFevre, F., Beyer, D., & Chan, P., 2008, para. 7).

Many companies turn to a virtual environment because of the potential for cost reduction, both in new hardware and in eventual data center expansion. As a company's workload increases, the company can either expand their data center or virtualize and run the same workloads on several virtual machines using fewer physical servers without perceptible performance loss (Kotsovinos, 2011). Lee, L. & Sawyer, R. (2009) explained that "each virtual machine can run its own operating system, enabling Windows and Linux applications to co-exist on the same [physical] hardware" (para. 3). Achieving this virtualization goal is viable for many companies due to the overwhelming underutilization of their traditional physical server's resources (both processors and memory). Virtualization provides a means to exceed customer expectations in performance while yielding higher returns on automation infrastructure investments (Opara & Soluade, 2013).

Currently the XYZ Software Development customer support data center has six Dell PowerEdge R-820 rack-mounted servers available. Two of the servers are dedicated to customer-specific software development while the other four support customer acceptance testing. When a new customer has defined his or her requirements and the forecasted solution moves into the software development phase, engineers determine if there are any available software development servers available to begin work. If there are, the server is prepared and software development begins within two days. If there are no servers available, there are two choices depending on any contractual obligations to timelines. One choice is that if the customer has very short timelines then progress halts on another customer's software development to free

the server for use by this customer. The other choice is that if the customer does not have short timelines then the customer's solution is put in queue awaiting the next available software development server. The process for the customer acceptance testing phase is managed in much the same way.

Last quarter there were up to two customer solutions waiting for software development at any given time and up to three customer solutions waiting for customer acceptance testing. This situation is worsening this quarter as the client base continues to grow.

### **Statement of Problem**

Due to the recent and ongoing rapid expansion of the client base, the ability to provide timely solutions is severely hampered by the inadequate customer support data center. This data center provides servers to support both customer-specific software development and customer acceptance testing for the solutions this company provides. There are no more available servers in the data center which has resulted in extended periods of inactivity on a given customer's requirements until a server becomes available. These wait periods-sometimes lasting up to two weeks-affect both the customer-specific software development and the customer acceptance testing phases of the customer solution process.

### **Proposed Plan**

There are two clear ways in which to solve this problem. The first option is to repurpose two of the existing servers as hypervisor hosts using VMware virtualization products and convert the customer support data center to a virtual environment. The second option is to purchase additional servers for the customer support data center to handle the increased workload. Either of these options will satisfy the need.



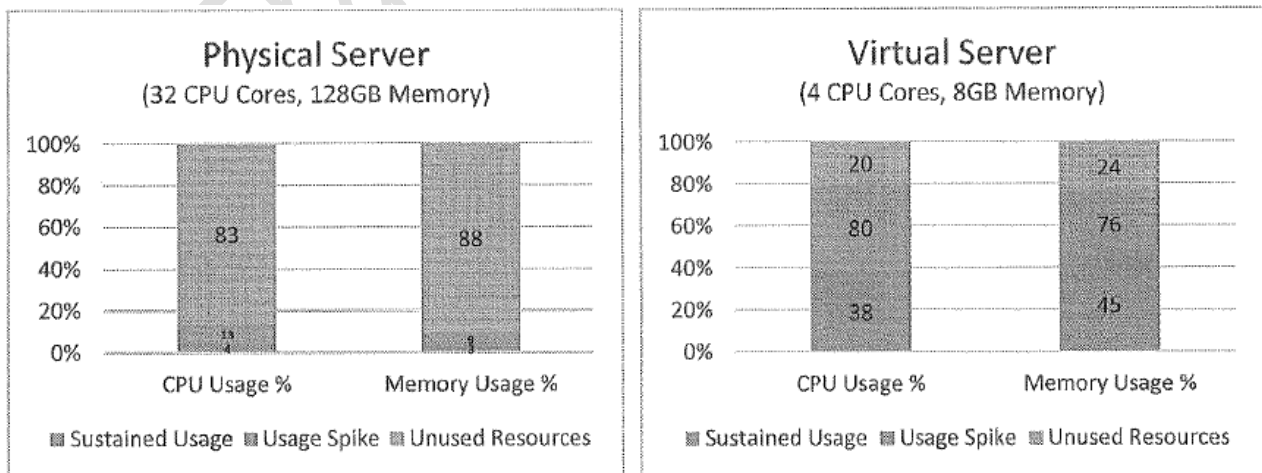
## Research Methods

The primary research consisted of a mix of a questionnaire and follow-up interviews with the respondents for clarification. The questionnaire was distributed to the supervisor of this company's customer support data center and similar supervisors, as IT colleagues, in two competing firms. All firms have similar web application products hosted by similar server hardware. The two outside firms have both recently virtualized a portion of their development and testing automation infrastructure. The questions asked in the survey were:

- What was the primary reason(s) your company switched to a virtual environment?
- Have you experienced any degradation in server performance due to virtualization?
- Describe how virtualization has affected your company's ability to scale your data center.
- Has your company experienced lower operating costs in the data center due to virtualization?
- Describe how server virtualization has impacted your company's ability to satisfy the requirements of your customers.
- What hardware did your company need to purchase to implement virtualization in your data center?
- Server Performance Metrics -Physical Server Build
  - o Available Resources (CPU & Memory)
  - o Resource Utilization
    - CPU (sustained and spike)
    - Memory (sustained and spike)

**Results/Findings**

Both of the surveys sent to the external companies showed that their top reasons for virtualization were resource underutilization in the physical build servers and the extremely high cost of expanding their data center using only physical build servers. None of the respondents have experienced any degradation of server performance due to virtualization. Both external respondents stated that virtualization affected their ability to scale the data center by allowing them to expand very quickly and with only the cost of the required software licenses. None of the respondents reported any marked improvement in operating cost expenditures due to virtualization. Both surmised their data centers were too small to have a noticeable impact. Respondents reported that virtualization has resulted in timely project completion due to there no longer needing to be a waiting queue. All respondents reported that the equipment they need(ed) to purchase to implement virtualization consisted of servers and storage arrays. Everything else was already on-hand as part of their legacy infrastructure. The two external respondents provided resource utilization metrics for both physical-build and virtual-build servers hosting their proprietary software on hardware and software infrastructures similar to that of XYZ Software Development. The graphic below illustrates the average of the statistics provided.



Given the difference in usage percentages between the physical and virtual build servers as shown above, a single physical server could be virtualized to host eight virtual servers and still function quite well.

#### Option One: Virtualize the Data Center

**Implementation Overview.** This option proposes movement toward a virtual environment in phases to prevent stopping work on the customer solutions currently in progress. It is recommended that the next available physical server is rebuilt using the ESXi 5.0 hypervisor and provisioned with eight virtual servers built to a standard specification. Once these virtual servers are built and tested, each server can be fitted with a customer's solution from the customer-specific software development and customer acceptance testing wait queues. At this point, the work for those customers can begin in the appropriate phase. This work on the first set of eight virtual servers is a trial run for the virtualization restructure. If the trial succeeds, two things will occur. First the company will purchase two Dell MD 3620i rack-mountable storage arrays. Then the engineering staff will repeat this process to create another eight virtual servers on an ESXi 5.0 host hypervisor as the next physical server becomes available. When the storage arrays arrive engineers will integrate them into the virtual environment and utilize them for virtual server storage and migration. This will allow for the benefits of archiving completed solutions as a steady-state for future work and further expansion of the virtual data center using the two established hypervisor systems as the client base continues to grow.

#### Costs.

- Two (2) copies of VMware ESXi 5.0 vSphere Hypervisor. Unit Cost: \$5,042.00
- One (1) copy of VMware vCenter (to provide vMotion server migration capability). Unit Cost: \$6,044.00

- Two (2) x Dell PowerVault MD3620i iSCSI Network Array Storage devices.

Each includes 12 x 900GB 10,000 rpm SAS hard drives.

Unit Cost: \$23,032.00

- Licenses for the operating system and third-party software (per server).

Unit Cost: *current market price*

- Total Cost (minus licenses): \$62,192.00

**Timeframe after approval to implement.**

• Create the first ESXi 5.0 hypervisor with eight virtual servers.	1 week
• Trial run of the virtualization solution.	1-2 weeks
• Procure and acquire of network storage arrays. Create the second ESXi 5.0 hypervisor with eight additional virtual servers.	2 weeks
• Create the vCenter virtual environment manager server	1 week
• Integrate the storage arrays into virtual environment.	1 week
<b>Total Time After Approval:</b>	<b>6-7 weeks</b>

**Benefits.** The primary benefit of virtualization is cost savings. There is a vast difference between the combined costs of the hardware and software required for virtualization when compared to the cost of purchasing five additional physical servers just to accommodate the current customers (\$62,192.00 vs. \$191,851.50). Virtualization with two hypervisors, one VMware vCenter virtual environment manager, and two integrated storage arrays will afford many capabilities that the company will continue to benefit from over the next five to ten years. Engineers will have the ability to greatly increase the virtual server count and subsequently increase the workload considerably with the only additional cost being the licenses for the operating systems and third-party software for each new server implemented. This is due to two

factors: (a) the abundance of resources in the current servers (Dell PER-820), which includes four 8-core processors and 128GB of physical memory and (b) the servers in the development and acceptance testing phases only require four processor cores and 8GB of memory to perform well. The vCenter server combined with the setup of the architecture allows the infrastructure to take advantage of vMotion, vCenter's integrated server migration utility. This capability allows movement of the virtual servers from one hypervisor to the other without needing to shut the virtual server down. This is important because it prevents lost hours when maintenance is required on one of the hypervisors that would require that it is powered off. A virtual environment also provides the benefit of decreased power consumption by replacing the six physical servers with one physical server hosting as many virtual servers as is needed. Because of this, there is the added benefit of less cooling required for the resulting virtual data center (Judge, Pouchet, Ekbote, & Dixit, 2008). Both of these can result in decreased operating costs in the long run. This option only requires three of the six servers currently allocated to customer-specific software development and customer acceptance testing. The other three servers can be reallocated to other sections or departments within the company.

**Shortfalls.** Virtualizing a data center greatly changes how server/network/storage administrators support the servers. Specialized training is required to effectively support a virtual environment. This is because virtualization effectively blends what used to be multiple administration jobs separated by teams (i.e. Windows team, UNIX team, network team, storage operations team, etc.) into one environment, managed by all of these teams collaboratively (Kotsovinos, 2011). Although the teams will still perform their functions as before, the administrators will have to have a basic understanding of all facets of the virtual environment. Tracking software license usage for the operating system and third-party applications for each

new virtual server can easily get out of control. Given the ease in creating a new virtual server, there will very likely be a need to develop a robust and reliable software licensing tracking system to ensure the company is not exposed to potential legal and ethical issues regarding copyright infringement (Andrikopoulos, Binz, Leymann, & Strauch, 2013).

### **Option Two: Purchase Additional Servers**

**Implementation Overview.** This plan can be easily implemented. Procurement will purchase as many new servers as engineering may need to accommodate current workload and try to anticipate future workloads to action purchases of additional servers in time to keep up. In order to maintain likeness in server specifications with current servers, new servers must have at least four 8-core processors and 128GB of physical memory. If this option is approved, the Legal department should research the possibility of selling the customers not only the software solution they requested, but also the server that their software was developed and tested on. This would require that each additional workload includes the purchase of a new server, but would help reduce costs.

#### **Costs.**

- Five (5) x Dell PowerEdge R-820 rack-mounted server. Unit Cost: \$38,370.30
  - o Each includes four 8-core Xenon processors
  - o 128GB physical memory
  - o 16 x 1.2TB 10,000 rpm SAS hard drives
- Licenses for the operating system and third-party software (per server).

Unit Cost: *current market price*

- Total Cost (minus licenses): \$191,851.50

**Timeframe after approval to implement.**

• Procurement and acquisition of new server hardware (five servers).	2 weeks
• Creation of traditional physical server build (per server).	3 days
Total Time After Approval:	5 weeks

**Benefits.** The benefit of this option is that the customers will have the peace of mind knowing that their software solution was developed and tested on a server similar to the intended production server. If Legal can work out selling the customers the servers their solutions were built on then that would have the additional certainty of knowing that it works on that particular server. Another benefit is the ease in tracking software license usage for the operating system and third-party applications for each new server introduced to the data center.

**Shortfalls.** This option has many potential shortfalls. If five new servers were purchased for the existing data center, that will resolve the issue with the existing waiting queues. Those queues are likely to build up again as the client base continues to grow, eventually resulting in a repeat of this problem. Procurement can purchase additional servers to try and keep up, but this may lead to a need to expand the physical space of the data center. This, in turn, will lead to higher operating costs in energy consumption for the new servers and the required cooling.

Contracting with the customers to sell them the servers that their solutions are built upon will help to keep those costs down, but if the customers do not need or want those servers, the company will absorb those costs.

**Comparative Analysis**

The table below shows key differences between the two options proposed above.

	<b>Physical Build Option</b>	<b>Virtualization Option</b>
<b>Timeframe to implement</b>	5 weeks	6-7 weeks
<b>Cost to implement (to satisfy current customers)</b>	\$191,851.50	\$62,192.00 plus specialized training
<b>Cost to accommodate future customers</b>	\$38,370.30 plus software licensing per additional customer	Cost of software licensing
<b>Software license management</b>	Use current method	Tighter control required

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### **Conclusion**

The situation XYZ Software Development finds itself in requires a decision to continue to provide quality and timely service to satisfy the customers' needs. Given current and future costs involved in expanding the customer support data center, the option to convert to a virtualized data center is the most effective. Engineering requests a decision to allow them to move forward with a project to virtualize the data center using VMware virtualization tools. This will afford them the ability to flex the scale of the data center at a minimal cost as our client base continues to grow.

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**Appendix A**  
**Virtualization Questionnaire**

**Instructions**

Please complete this questionnaire answering each question completely and thoughtfully. When completing the resource utilization metrics portion (question 11), please provide feedback in the form of percentage utilized of total available resources. For best results, gather the data from your archived performance logs over a month period and provide the average of those metrics. Most importantly, DO NOT provide any proprietary information or trade secrets about your company or its business practices in the answers you provide. Please return the completed questionnaire via email to [irem.v.sample@xyzsoftdev.com](mailto:irem.v.sample@xyzsoftdev.com) by July 29, 2015.

1. Has your company implemented virtualization in your data center for servers supporting software development and acceptance testing?

YES      NO

2. If yes, what was the primary reason(s) you made the switch from physical to virtual?

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3. Have you experienced any degradation of performance in your servers due to virtualization?

YES      NO

4. If yes, please explain the performance degradation you experienced.

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5. Please describe how virtualization has affected your company's ability to scale your data center?

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6. Has your company experienced lower operating costs in the data center due to virtualization?

YES      NO

7. If yes, please explain how the operating costs were lowered.

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8. Please describe how server virtualization has impacted your company's ability to satisfy the requirements of your customers?

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9. What hardware did you need to purchase to implement virtualization in your data center? (general hardware-make and model specifics are not necessary-Le. server, switch, storage array, etc.)

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10. Please describe the application infrastructure your web application software requires (general software – such as database management system, web application server, web host software, etc.).

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11. Please fill in the Resource Utilization Metrics chart below with the requested performance information for the servers supporting your company's development and acceptance testing processes. If you evaluate multiple servers of each type, please provide the average of the results for each type. Note that the first line is for the performance metrics of a physical build server, the second line is for the metrics of a virtual build server (the virtual server itself, not the hypervisor host).

Resource Utilization Metrics (Physical Build Server vs. Virtual Build Server)						
	Available Resources		Memory Usage		CPU Usage	
Build Type	Memory (GB)	CPU Cores	Sustained Usage %	Peak Usage Spike %	Sustained Usage %	Peak Usage Spike %
Physical						
Virtual						

## **Appendix B**

### **Create a Virtual Machine Using VMware Workstation 11**

#### **Introduction**

We need a common understanding of what a virtual machine is, and a process we will follow to create our virtual machines, as our company moves forward with the plan to restructure our data center. A virtual machine is a software file-based emulated guest computer-server or workstation that replicates the host physical computer's resources (processors, memory, and network) as virtual resources and functions as if it were a real computer in and of itself. ESXi 5.0 is the VMware host server operating system (hypervisor) that we will install on our existing Dell PowerEdge server hardware to host several guest virtual servers. The ESXi 5.0 hypervisor manages how the guest virtual servers access and utilize the host physical server's processors, memory, and network resources.

#### **Overview**

These instructions describe the process for creating a virtual machine as a Windows Server 2008 R2 server. The resulting virtual server is the baseline for the majority of our server requirements in the customer support data center. Become intimately familiar with this instruction set as this is how we will create the virtual environment for future customer-specific software development and customer acceptance testing.

#### **Equipment and Material Needed**

- Computer with VMware Workstation 11 installed and approximately 100GB of free hard drive space
- Windows Server 2008 R2 (SPI) installation DVD
- Windows Server 2008 R2 product key
- Approximately one hour of available time to commit to this process

#### **Instructions**

##### **Preparation.**

1. Read these instructions from beginning to end and pay close attention to the notes and warnings before you begin any step.
2. Insert your Windows Server 2008 R2 (SP1) installation DVD in your DVD drive. Close the AutoPlay options window that will likely appear when the DVD is recognized by the computer.
3. Launch VMware Workstation 11.
4. Click on the Create a New Virtual Machine button on the Home Tab. This will launch the New Virtual Machine Wizard which will guide you through the setup process.
5. Select the Custom (Advanced) option and click the Next button.

**Define the Virtual Machine.**

NOTE: The Workstation 8.0 setting in the following step provides the most advanced virtual machine options while ensuring the appropriate compatibility. Your virtual machine must be compatible with ESXi 5.0 to be usable in our virtual environment.

6. Click on the Hardware drop-down in the Virtual Machine Hardware Compatibility section of this screen and select the Workstation 8.0 option. Click the Next button.
7. Select the Installer Disc option on the Guest Operating System Installation screen to use the disc in your DVD drive. Click the Next button.
8. Enter your Windows product key (distributed with your Windows Server 2008 R2 installation DVD) in the space provided.

NOTE: You must select the enterprise edition in the next step to keep your virtual machine similarly configured to the other virtual machines in our data center.

9. Click on the Version of Windows to Install drop-down and select the Windows Server 2008 R2 Enterprise option.

10. Enter your desired user name, a password, and the password again to confirm in the appropriate blocks of the Personalize Windows section of the screen. Leave the Log on Automatically check box unchecked. Click the Next button.

11. Enter a name for the virtual machine. Choose a name that indicates the server's role or function; something like "Web App Server" would work well. Leave the Location setting as the default. Click the Next button.

**Define the Virtual Machine's Virtual Hardware.**

12. Select the BIOS option on the Firmware Type screen. Click the Next button.

13. Click the Number of Cores per Processor drop-down and select the 2 option on the Processor Configuration screen. This will provide the virtual machine with two virtual processors. Click the Next button.

14. Enter 4096 (representing 4GB memory) in the block next to the Memory for this virtual machine label on the Memory for the Virtual Machine screen. Click the Next button.

15. Select the Use Bridged Networking option on the Network Type screen and click the Next button.

16. Leave the default selection (LSI Logic SAS) on the Select 1/0 Controller Types screen and click the Next button.

17. Leave the default selection (SCSI) on the Select a Disk Type screen and click the Next button.

18. Select the Create a New Virtual Disk option on the Select a Disk screen and click the Next button.

WARNING: If you accidentally put a check in the Allocate all disk space now check box in the following step and complete the installation process, VMware will fully allocate and commit the user-defined 75 GB of your hard drive to this virtual machine and your only recovery is to delete the virtual machine and start over.

19 Change the maximum disk size from the default (40.0) to 75 on the Specify Disk Capacity screen.

Leave the Allocate all disk space now check box unchecked. Select the Store Virtual Disk as a Single File option and click the Next button.

20 Leave the default disk file name on the Specify Disk File screen and click the Next button.

21 Review the settings summary on the Ready to Create Virtual Machine screen to ensure you have configured everything in accordance with these instructions. Place a check mark in the Power on This Virtual Machine after Creation check box. Click the Finish button.

### **Completion.**

VMware workstation will now create the virtual machine to your specifications and start it for you. The Windows Server 2008 R2 installation will automatically begin. As Windows is installed, the virtual machine may automatically restart several times. Leave your computer turned on during this process. The process is complete when the virtual machine restarts for the final time and displays the Windows login screen.

### **Conclusion**

You now have a working Windows Server 2008 R2 virtual server that functions exactly like a traditional physical server. At this point you must run Windows Update on the virtual server to ensure the server has the most recent patches, drivers, and security updates from Microsoft. See the instructional guide titled "How to Migrate Virtual Servers to ESXi 5.0" for follow-on steps describing the processes of exporting the virtual machine from your computer and importing it to the ESXi 5.0 hypervisor server.

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