Chapter 4

Data Center Virtualization and Cloud Computing

This chapter lays the foundation for creating virtual data centers by covering such topics as:

- The need for virtualization in the data center.
- Advantages of type-1 hypervisors such as VMware ESXi and Microsoft Hyper-V
- Advantages file systems designed for virtualization such as VMware VMFS
- Introduction to Network Virtualization components such as switches and adapters.

The concepts described in this chapter are still very relevant to data center virtualization today and to the activities in this booklet. The activities in the booklet are selected to support the building of a virtual VMware data center in chapter 7 of this booklet.

In this chapter you will start building a virtual data center for the hypothetical Universal AeroSpace (UAS) company. In this scenario you will be placed in the position of a consultant for the Computer Technology System firm. Your job will be to help Universal AeroSpace evaluate setting up virtual datacenter using VMware vSphere. To start with they would like to reduce costs by using the free version of VMware vSphere to host virtual Windows Servers on two separate ESXi hosts. Using two hosts will provide better performance along with fault tolerance in the event of a hardware problem or upgrade.

Activity 4-1: Downloading the Free vSphere Hypervisor

Time Required: 15 minutes

Objectives: Download the vSphere 7 hypervisor to a folder on your local computer.

Requirements: MyVMware account.

Description: In this activity you will use your MyVMware account from chapter 1 to download the free copy of the vSphere Hypervisor. You will be using this hypervisor to build a sample data center for the Universal AeroSpace company.
1. If necessary, start your Windows workstation and open a Web Browser to MyVMware.
2. Login using the MyVMware account you created in Chapter 1.
3. Click the **Trial and Free Products** button.
4. Scroll down and click the **VMware vSphere Hypervisor (64 bit)** link to the right of the Download Free Products section.
5. If you have not downloaded the vSphere Hypervisor you will see a Register button. Click the **Register** button to display the Accept End-User License Agreement page. If you have already registered, the Download Packages will be displayed along with your license key.

Record the license key below for use in future activities.
6. Click the **Manually Download** button to the right of the VMware vSphere Hypervisor (ESXi ISO) image and start the download.
7. After the download is complete, if necessary, open the download folder and move the image file to the folder you created for VMware Products previously in Chapter 1.
8. You can return to your MyVMware page and logoff.

Activity 4-3: Setting up a Windows iSCSI Target Server

Time Required: 20 minutes

Objectives: Setup your Windows Server 2019 to be an iSCSI target. You will use this iSCSI target in chapter 7 activities.

Requirements: Windows Server 2019 installation made in Activity 3-9 of Chapter 3.

Description: In the future, Universal AeroSpace is planning to implement a Storage Area Network (SAN) using a dedicated SAN server. Since the company currently has a Windows Server 2019 system, you can use this server to simulate the SAN. In this activity you will setup your Windows Server 2019 system to act as an iSCSI target server that will be used in future activities to test the SAN network with vCenter hosts.

1. Open VMware Workstation Player on your desktop and then click on your Windows Server 2019 virtual machine.
2. Click **Edit virtual machine settings** link and verify that your adapter is set to NAT. Click **OK** to close the Edit virtual machines settings window.
3. Start the Windows Server 2019 VM and logon using your administrator account and password. (Password1!)
4. Open a command prompt window (click the Start button, type CMD and press Enter). Type the command **IPCONFIG** and press Enter to list the current IP address of your Windows Server 2016.

> Note that an IP address consists of four numbers (called octets) separated by periods. In this address, the first three octets from the left represent the subnet and the last octet is your unique server's address on that subnet. You will need to use this subnet address for all devices connected to the NAT switch. For that reason, record the IP address information for future reference.

5. Perform the following procedure to set a fixed IP address of 101 for your Windows Server 2019 virtual machine and then record that address for use in later activities.
   a. Start **File Explorer**, **right-click Network**, and   click **Properties**.
   b. Click the **Change adapter settings** link and then **right-click** your **Ethernet0** adapter and click **Properties**.
   c. Click the **Internet Protocol Version 4(TCP/IPv4)** option and click the **Properties** button to display the Internet Protocol Version 4(TCP/IPv4) window.
   d. Click the **Use the following IP address** option button and then enter the three values of the NAT subnet followed by 101 in the last octet. Enter the Subnet Mask and Default Gateway values you recorded in step 4. (At this time, we will leave the DNS server settings on automatic.)
   e. Click **OK** to save your changes and then close all the network properties windows.

> Record the IP address information you entered for your Windows Server 2019 system below.

6. Perform the following procedure to add the iSCSI Target role to your Windows Server 2019 VM.
   a. Start Server Manager and click the **Add roles and features** link.
   b. Click **Next** to begin.
   c. Verify that the **Role-based or feature-based** option button is selected and then click **Next**.
   d. Verify that your Server 2019 is selected and click **Next**.
   e. Expand both the **File and Storage Services** and **File and iSCSI Services** options.

f. Click to select the **iSCSI Target Server** option and click **Next**.

g. Verify that the .**NET Framework 4.7 Features** is selected and then click **Next** to display the confirmation screen.

h. Click **Install** to start the installation process.

i. After the installation process has successfully completed, click **Close** to return to the Server Manager Dashboard.

7. Restart your server, log back in as administrator, and start Server Manager.

8. Perform the following procedure to add a storage area to your iSCSI target service.

a. On the left-hand pane, click to expand **File and Storage Services.**

b. From the left pane, click the **iSCSI** link and then click the "**To create an iSCSI virtual disk, start the New iSCSI Virtual Disk Wizard**" link.

c. Click the **Type a custom path** option, type **c:\iscsi\vdisk01**, and click **Next**.

d. In the Specify iSCSI virtual disk name page, type **iSCSI vDisk 01** and click **Next** to display the Specify iSCSI virtual disk size page.

e. Verify that the **Dynamically expanding** option is selected, then type **100** (or the largest value you can given your virtual disk size) in the Size field and click **Next**.

9. Verify that the **New iSCSI target** option is selected and then click **Next**.

10. Type **iSCSI-FileCluster** in the Name field and click **Next** (no spaces are allowed in the Name field).

11. In the Specify access servers page, click **Add** to display the Select a method to identify the initiator page. This page is important as it allows you to select which computers can use this iSCSI target.

12. Click the **Enter a value for the selected type** option, pull down Type menu and select **IP Address**. Enter your NAT subnet (from step 4) followed by 141 in the last octet of the Value field (for example, enter 192.168.###.141 where ### is your NAT network address) and click **OK**.

Record the Initiator 1 IP address for future use.

13. Repeat step 29 to add another machine with an IP address of **142** into the Value field.

14. Click **Next** to display the Enable Authentication page.

15. Click the **Enable CHAP** check box and then enter the username "root" and 12-character password (for example: Password123!) you want to use for this iTarget.

Record the username and password for future reference.

16. Click **Next** to display the "Confirm selections"window. After verifying the selections, click **Create** to create the virtual disk.

17. Click **Close** to return to the Server Manager.

You can edit the iSCSI Target by clicking the iSCSI option to display the iSCSI targets on your server. **Right-click the iSCSI cluster** and click **Properties** to display the Properties window. Verify your settings and then close the window.

18. Close Server manager and power down the Windows Server 2019.

You have now completed this activity. You will work more with this iSCSI target in chapter 7.

Activity 4-4: Installing a vSphere Hypervisor (ESXi)

Time Required: 15 minutes

Objectives: Install the free ESXi Hypervisor within VMware Player 12.

Requirements: Completion of Activity 4-1**.**

Description: Now that the server is running in a test environment, your next task will be to host the virtual server in a production network using vSphere. In this activity you will install the free vSphere ESXi Hypervisor that you downloaded in Activity 4-1.

1. If necessary, start your Windows workstation and start a new instance of VMware Workstation Player.
2. Click **Create a New Virtual Machine**.
3. Click the **Installer disk image file (iso)** option and click the **Browse** button.
4. Navigate to the folder where you stored the vSphere Hypervisor file downloaded in Activity 4-1 and select the VMware-VMvisor-Installer-7#.iso file and click **Open** to return to the New Virtual Machine Wizard screen.
5. Click Next to display the Name the Virtual Machine screen and type **UAS-Host1** virtual machine name.
6. Click the **Browse** button and navigate to your virtual machines folder. Click the **Make New Folder** button and create a folder name UAS-Host1 and click **OK.** Verify your entries and click **Next**.
7. In the Specify Disk Capacity window, record the default disk size and then click to select the **Store virtual disk as a single file** option, and click **Next**.
8. Click **Finish** to boot from the iso image and start the ESXi installation.

Note: After installing the hypervisor files, you will see the Welcome to VMware ESXi 7.0 Installation message box. To reduce overhead and provide maximum performance, the ESXi hypervisor does not have a GUI interface, but instead works with what is called the DCUI command line interface. You will now use this interface to complete the installation process.

9. Perform the following procedure to install ESXi Hypervisor on your UAS-Host1 virtual machine.
   a. If necessary, click anywhere in the ESXi VM window to transfer the keyboard control to the ESXi VM. (You can return to the Windows desktop by pressing Ctrl+Alt.
   b. Press **Enter** to continue and display the license agreement.
   c. Press **F11** to accept the license agreement and start the scanning process to find a local disk drive. The virtual disk you created for this VM should be displayed.
   d. Press **Enter** to accept the local disk drive selected by the scanning process and continue.
   e. Choose your keyboard layout, or press Enter to accept the US Default keyboard and continue.
   f. In the Enter a root password window, enter a password you want to use for the "root" user and record the password you use. (For test environments, I suggest using the same password as you used for your Windows Server 2019 Administrator account.)
   g. After entering the password twice, press **Enter** to continue.
   h. If necessary, record any CPU warning and press **Enter** again to acknowledge and display the Confirm Install message box.
   i. Press **F11** to continue the installation process. This process may take a few minutes, so you may wish to take a quick stretch break. (Note any warning messages.)

j. When the installation process finishes, the Installation Complete message box will be displayed. Next you will disconnect the installation ISO file.

10. Press **Ctrl+Alt** key combination to return control of the keyboard to the Windows desktop.
11. Click the **Player** menu, point to **Manage**, and click the **Virtual Machine Settings…** option.
12. Click **CD/DVD** setting and then change the connection to the **Use physical drive** option and click **OK**.
13. Return mouse and keyboard control to the ESXi virtual machine by clicking in the virtual machine window and then press **Enter** to reboot the ESXi host. You now have an ESXi host running as a VM on your desktop.
14. When the ESXi Host restarts, press the Ctrl+Alt key combination and then click the "**I Finished Installing**" button.
15. Click in the guest window to return control to the ESXi Host and then press F2 to display the Authorization Required dialog box.
16. Leave the Login Name as "root," press the Tab key, type the password you recorded during installation, and press **Enter** to log on and display the System Customization menu window. You will use this menu to configure the management network in the next activity.

17. To shut down an ESXi hypervisor, press the **Esc** key, press **F12**, and then confirm you are the root user by entering your password.

18. Press the **F2** key to properly shut down the host and then click **OK** to shutdown the ESXi host and exit VMware Workstation Player completing this activity.

Activity 4-7: Configuring the ESXi Management Network

Time Required: 10 minutes

Objectives: Configure your ESXi hypervisor to use the management network.

Requirements: Completion of Activity 4-4.

Description: Now that you have installed ESXi Hypervisor, your next task will be to set up and test the management network. You will then use this network in Activity 4-8 to access your ESXi host from the vSphere Client software.

1. Start an instance of VMware Workstation Player.
2. Perform the following procedure to add a second virtual network adapter to your UAS-Host1 virtual machine. This adapter will be used for the management network. Using a separate management increases security and performance.
   a. Click to select your **UAS-vHost1** virtual machine and click the **Edit virtual machine settings** link.
   b. Click the **Add** button, select **Network Adapter**, and click **Finish**.
   c. Verify that the **NAT** option is selected and click **OK** to close the Virtual Machine Settings window.
3. Start your UAS-vHost1 virtual machine and perform the following procedure to select the newly added network adapter for the ESXi management network.
   a. After the ESXi host is running, click in the guest window, press **F2**, and log on using your "root" user account and password. The System Customization menu you saw in Activity 4-4 will be displayed.
   b. Use the down arrow key to select the **Configure Management Network** option and press **Enter**.
   c. With Network Adapters selected, press **Enter** a second time to display the available network adapters.

   Notice that you can select multiple adapters. Having multiple adapters provides fault tolerance and load balancing.

   d. Press the **Spacebar** to remove the check from vmnic0.
   e. Use the "down-arrow" to select the vmnic1 adapter you added in step 2 and then press the **Spacebar** to toggle the NIC as selected.
   f. Press **Enter** to save your changes and return to the Configure Management Network menu.
4. In this step you are to follow the procedure shown below to configure the Management network IP address information.
   a. From the Configure Management menu, use the "down-arrow" to select **IPv4 Configuration** and press **Enter** to display an IPv4 Configuration dialog box wit the "Use dynamic IPv4 address" option selected.
   b. Use the down arrow to select the **Set static IPv4 address and network configuration** option and then press the Space bar.
   c. Use the down arrow to select the **IPv4 address**, press the right-arrow key, press backspace key to delete the last octet of the address and enter **141**.
   d. Record the IPv4 address information for future reference.
   d. Press **Enter** to save your settings and return to the Configure Management Network menu. Notice that the new IP address is displayed in the right-hand pane.
   e. Press **Esc** to close the Configure Management Network menu and display the Confirm dialog box.
   f. Press the **Y** key to apply the changes and return to the System Customization menu.
5. Select the **Restart Management Network** option and press **Enter**. When you see the Confirm message box, press **F11** to restart the management network.
6. Press **Esc** key to close the System Customization menu.

7. Press **Ctrl+Alt** key combination to return control to your Windows 10 workstation.
8. Open a command prompt window and enter the command: **Ping ip_address** (where ip_address is the address you recorded in step 4). You should get a Reply message showing that your desktop can now communicate with your ESXi host.
9. You can leave your UAS-Host1 virtual machine running for the next activity.

You are now ready to proceed to then next activity and test your ESXi host using the VMware Host Client.

Activity 4-8: Testing the VMware ESXi Host Client

Time Required: 5 minutes

Objectives: Test the VMware Host Client from your desktop computer.

Requirements: Completion of Activity 4-7.

Description: Now that you have your ESXi host configured on the management network, in this activity you will use the VMware Host client to view your host configuration settings.

1. If necessary, open an instance of VMware Workstation Player and start your ESXi host.
2. Open a browser on your desktop computer (I seem to have the best luck with Chrome).
3. Enter the IP address you recorded in step 12 of Activity 4-7 as the URL to display the VMware ESXi login page. Your browser may show a message such as "Connection is not private". If so use the Advanced feature to proceed to the Web site. This message occurs because we are not using an encrypted secure "https" connection. The browser will default to a standard "http" unencrypted connection.
4. Enter "root" with the username and password recorded in step in activity 4-4 and click the **Login** button to display the ESXi Host opening page as shown in Figure 4-2. (If you see the "Help us improve …" dialog box, you can remove the check from the Join option and click **OK** to continue.)

FIGURE 4-2

5. Click the Networking link in the left-hand pane.

Notice that the management network and the VM network are currently both using the same switch. This can create a single point of failure and cause performance degradation. The management network is using a VMKernel port while the VM Network is using a standard port group. To improve performance and reliability, the management network should be moved to a separate virtual switch, or another adapter port added to VSwitch0. You will learn how to perform these and other vSphere networking configuration options in Chapters 7 and 8.

6. Click the **Storage link** and record the name and capacity of datastore1. Note that **Thin Provisioning** is supported.
7. Click the **Virtual Machines** link from the left-had pane. Currently there are no virtual machines assigned to this host. In chapter 7 you will learn how to use the VMware Host Client to create and run a virtual machine.
8. Click the **Manage** link and then click the **Security and users t**ab.
9. Click **Users** and notice that only the "root" user is listed. Click the **Add user** link and then enter a username and password for yourself and click **Add.** Notice that your username is added to the user list as System Operator. You will learn more about System Operator privileges in later activities.

10. Click the root@192.16x.x.y in the heading line and then click the **Log out** option to exit the ESXi Host Client and return to the Login page.

11. Close your Web browser.

This ends the activities for chapter 4. In chapter 7 you will learn how to use the ESXi Host Client to create virtual machines and perform other management tasks needed to develop a simple 2 host data center for Universal AeroSpace organization.