How to Build a VMware vSphere 6.x Home Lab
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Introduction

Before virtualization, I had many computers around my house that required maintenance, upgrading, replacement, etc., as well as the power to run all of the equipment. This was very time-consuming and expensive. In 1999, I began using VMware Workstation 2.0 to create virtual machines (VMs) to study NetWare, NT 4.0, Windows 2000, etc. Since that time, I have used it in all of my studies and reduced my lab equipment to two computers, a server in the office, and a laptop I use when traveling. Originally, ESX/ESXi didn't run in a VM, requiring more hardware to study and learn ESX(i).

Beginning with ESX 3.5 and Workstation 6.5.2, it is possible to virtualize ESX(i) in a Workstation VM (or inside a vSphere server, for that matter, but we won’t be discussing that in this white paper), although this is not supported. It is possible to run ESXi 6.x inside of ESXi 6.x, Fusion 7, or VMware Workstation 11 or higher. In fact, VMware and Global Knowledge teach their vSphere 6 courses in this manner: ESXi servers needed for class run as VMs on ESXi hosts, which works well, but requires a dedicated machine. This is often possible in a business setting, but may be difficult for the small business or others where spare hardware is not available. Hence, this white paper will discuss how to use Workstation 14 or Fusion 10 (or higher) to create the hosted environment.

I often get asked by my students how to (relatively) inexpensively set up this kind of lab for study after class, and the result is this white paper. When specific vendors are mentioned, it is not an endorsement, but rather an example of something that meets the recommended specifications.

This white paper is broken down into three major sections; the first and most detailed is about the hardware required, the second is about the VMware Workstation configuration, and the third is about installing vSphere 6.x and vCenter (vC) 6.x. Note that this white paper is not intended to be an in-depth review of how to install and configure vSphere as that is taught in the VMware classes and a VMware class is required for certification.
Lab Hardware

The biggest question is whether to build your lab at a stationary location, such as your home or on a spare server at work, or whether it needs to be portable. In many cases, a stationary configuration is sufficient, so the desktop/server route works well and is usually less expensive. If you need to do demonstrations for customers, study at multiple locations, etc., then a laptop configuration may work better for you, though it will probably cost more.

As far as minimum CPU requirements are concerned, you’ll need at least two cores (or CPUs) to be able to install ESXi and/or VC, but this will be very slow. I suggest a minimum of four cores (or CPUs, preferably hyperthreaded) so there is enough CPU power to run the VMs and the host operating system (OS). Eight or more cores work well. If you’re planning on creating and using I/O-intensive VMs, and/or running many VMs, and/or doing a lot on the host OS while VMs are running, you should consider at least 12 cores. Remember that ESXi 6 (vSphere 6) requires 64-bit-capable CPUs to run, so be sure to purchase 64-bit-capable CPUs with either Intel VT or AMD-V support (both physically on the CPU and enabled in the BIOS).

As far as minimum memory requirements are concerned, you’ll need at least 4 GB of RAM to be able to install ESXi and 8 GB RAM for the vCenter Appliance, but this will be extremely slow. In fact, the VMs will run primarily from the hard disk and will probably be so slow as to be unusable.

The vCenter appliance by itself requires at least 8 GB, not counting the virtualization overhead, the OS that will be running Workstation or Fusion, VMware Workstation or Fusion overhead, or any other apps you wish to run at the same time. For this reason, I suggest 16 to 32 GB of RAM (or even more if possible) to give you enough resources to run all the VMs below (plus additional memory if you want to run other applications and/or VMs on the host). I would suggest you use either the Openfiler or the Active Directory (AD) option from Table 1 below to reduce the hardware requirements and provide the opportunity to practice with shared storage. The actual requirements will vary, depending on what you choose to install (both for the ESXi and vCenter VMs, as well as any VMs you create inside the ESXi VMs), but I base this on the following minimum configuration for running labs (Table 1).

<table>
<thead>
<tr>
<th>VM</th>
<th>Number</th>
<th>Purpose</th>
</tr>
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<tbody>
<tr>
<td>ESXi 6.x</td>
<td>2 (3 for vSAN and some other advanced classes)</td>
<td>Two VMs allow for VMotion, HA, DRS, etc., to be used and studied. vSAN requires at least three ESXi hosts. If vSAN is being used, you don't need the Openfiler VM or the iSCSI or NFS options in the Domain Controller.</td>
</tr>
<tr>
<td>vCenter</td>
<td>1</td>
<td>Most businesses use vC for management tasks, and you’ll be tested on using vC. This can either be a VM inside of one of your ESXi VMs (which will therefore require more than the minimum memory to run itself and vC) or installed in a Windows server.</td>
</tr>
<tr>
<td>Openfiler or other iSCSI or NAS VM</td>
<td>1</td>
<td>Allows VMotion, HA, DRS, etc., to be used (shared storage is used frequently by many features). In addition, you’ll want to learn more about iSCSI if you haven’t already, and Openfiler is a free way to do so. This is the preferred option for those with experience in Linux and not using AD.</td>
</tr>
<tr>
<td>AD Domain Controller with the iSCSI Target and File Services for NFS installed</td>
<td>1</td>
<td>AD allows the AD integration components of vSphere at the vC and ESXi levels to be implemented. Setting up NFS and/or iSCSI allows VMotion, HA, DRS, etc., to be used (shared storage is used frequently by many features, and you’ll have the ability to study and use both NFS and iSCSI with this method). This is the preferred option for those with experience in Windows and using AD.</td>
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Table 1. VMs required to study vSphere.

Remember that the host OS will require some resources (typically the better part of a core or two and one to two GB of RAM, depending on what you want to do), not to mention disk space and performance.

**Desktop / Server**

The big question that needs to be addressed here is what kind of performance you require. If it is purely for study and performance doesn’t matter, an inexpensive desktop will be sufficient, assuming the specs below are met. On the other hand, if you will be doing a lot of work and/or performance is a bigger factor, consider getting a high-end workstation or a server so that you can have more disk drives installed for better I/O performance, as well as more expandability.

If disk drive performance is your biggest issue (and that is almost always the case), you could (and really should) use SSD or NVMe drives instead of SATA or SAS drives and any kind of desktop or server that meets the other requirements described here.

A tower server is generally preferred over a rack mount version of the same server as it is more expandable in terms of disks and possibly other areas (such as CPU or memory), as well as supporting PCIe cards for things such as graphics cards. A moderately powerful desktop would work as well in most cases. I am primarily a Windows user, so I created my server with Windows 10.

You could use Windows Server 2016 as well though it costs more to license. I suggest you configure your server as follows (Table 2), or better as your needs and budget allow.
<table>
<thead>
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<th>Component</th>
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<th>Reason</th>
<th>Recommendation</th>
</tr>
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<tbody>
<tr>
<td>8\textsuperscript{th} Generation Core i7 (8700 or better recommended for 12 MB Cache &amp; 6 cores [12 hyperthreads]) or i9 Processor (7960 or better recommended for 22+ MB Cache and 16+ cores [32 hyperthreads]) for desktop or the equivalent or better server CPU</td>
<td>8 cores minimum; 12 or more would be better</td>
<td>I suggest the most CPUs possible so you can run multiple VMs at the same time (at least two ESXi servers and a storage / domain controller, vCenter will require at least two more CPUs either in an ESXi VM or in a Windows VM), which is a total of eight, not counting the host OS or anything else; I also wanted the most L2 cache available to make them as efficient as possible, given that the host OS, many VMs, and often Office applications and web browsers are all often used at the same time.</td>
<td>Buy the latest CPU family with the most cores and L2 cache at the fastest speeds in demanding environments. Windows 10 only supports two physical sockets (in most editions), so more physical CPU sockets will be wasted money in Windows-hosted environments unless you license additional cores in Windows Server.</td>
</tr>
<tr>
<td>RAM</td>
<td>24 GB or more</td>
<td>I suggest you have the ability to run multiple VMs at once with RAM left over for Office, Acrobat, Web Browsers, etc.</td>
<td>Get at least 24 GB; 32+ GB would give you more room for more VMs and/or larger VMs.</td>
</tr>
<tr>
<td>1 Gb Ethernet NICs</td>
<td>1 - 3</td>
<td>Minimum of one, two if you want the VMs to have a separate NIC for their traffic (one for host I/O and one for VM I/O to the outside network).</td>
<td>Get a third if using NAS or iSCSI not in a VM on the same computer. If all the VMs listed in Table 1 are running on the same computer, you can use a host-only network for them to communicate with each other only, or a NAT or Bridged network to provide access to the outside world. In this case, a single NIC would be sufficient.</td>
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<tr>
<td>1 TB SSD or NVMe Drive or larger</td>
<td>2 or more or 2+ TB drive</td>
<td>At least one drive for the host OS and all applications and one for VMs; they could be in a single disk if other storage needs are minimal or the drive is sufficiently large.</td>
<td>SSD or NVMe drives will provide a much better experience than hard drives.</td>
</tr>
<tr>
<td>Monitors</td>
<td>2 or more</td>
<td>You can see multiple VMs at once this way, for example one for the ESXi servers and one for VC or one for the VMs and one for documentation, email, etc.</td>
<td>Two or more monitors will make it much easier to study.</td>
</tr>
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</table>

Choose a video card that supports the type of connection your monitors will use (HDMI, DVI, or VGA) as well as the number of monitors you want to use. You can also use USB-based video devices, especially on laptops where you have little to no choice on video card or ports.

Table 2. Server configuration recommendations.

A quick online search for this paper returned desktops with 2 TB of SSD storage, 32 GB of RAM, and a quad core or better processor for $2,500 to $10,000, depending on configuration. Remember that lower spec machines can still be used but performance will be poorer, so keep your patience level in mind when you make a purchase.

**Laptop**

If portability is important to you, consider a laptop instead. The laptop should support at least a quad-core CPU, at least two 1 TB SSD drives (or one 2 TB+ SSD drive), and a minimum of 16 GB of RAM (32 GB is better). A laptop that meets these specifications is the HP ZBook X2 (which supports two drives and up to 32 GB of RAM) with a Core i7 processor. As with the desktops and servers described above, you’ll need a substantial system to run well. A laptop with these specifications will typically cost more than $3,000.

Be sure to get either a solid-state drive or an NVMe drive (the ZBook X2 supports a 2 TB NVMe drive and a 512 GB SSD).
Plugging in an external monitor may make it much easier to study, as mentioned above, so consider a laptop with at least one external VGA or HDMI port, or a docking station that supports one or more such ports. I found a great USB 3 docking station by Anker that supports gigabit Ethernet, audio, and two external monitors (and a few extra USB ports). I’ve used this for several years with great success.

**VMware Workstation or Fusion Installation**

You can get an evaluation copy of the software from VMware that is good for 30 days. Workstation is available at [https://www.vmware.com/products/workstation-pro.html](https://www.vmware.com/products/workstation-pro.html), while Fusion is available at [https://www.vmware.com/products/fusion.html](https://www.vmware.com/products/fusion.html) or you can purchase the software for less than $250 (or upgrade for less than $100). Pricing varies depending on whether you choose Fusion or Fusion Pro (for Macs), or Workstation Player or Workstation Pro. Students and educators can get it even cheaper if they qualify for the academic discount.

*Note: Workstation Player does not support running multiple VMs at once, so while it is cheaper, it is not well suited to the workloads described in this white paper.*

Workstation is available in versions for both Windows (2008, 2012, 2016, 7, 8, and 10, 64-bit only) and Linux (including CentOS, Red Hat, SUSE, Oracle Linux, and Ubuntu, 64-bit only). Fusion requires OS X 10.11 (“El Capitan”) or later. Read the requirements of your specific product for OS versions, minimum CPU technologies supported, etc.

VMware Workstation version 14 and Fusion 10 support up to 64 GB of RAM per VM with the total RAM for all VMs limited only by available host memory. It specifically supports ESXi as a VM.

The application itself installs like most other Windows, Mac, or Linux applications so the specifics won’t be described here. Online versions of the manual are available on VMware’s web site.

**Installing vSphere Servers and vCenter**

To install ESXi, simply create a VM in Workstation or Fusion by selecting **File > New** and then pointing to the location of the ESXi .iso image with at least 4 GB of RAM, a SCSI virtual hard disk of at least 10 to 15 GB; more disks or a larger disk if you plan on installing many and/or large VMs inside the ESXi VM and are not using shared storage (such as the Openfiler iSCSI appliance or a Domain Controller with NFS and/or iSCSI Target support as previously described).

If you are deploying the vSAN option, you will need a small boot disk (10 GB should be sufficient) and a second disk for use with vSAN that must be a SSD drive (or at least must be told is a SSD drive) and a third disk (and possibly more) for capacity drives, each of which should probably be at least 50 GB. Be sure that all VMs that you want to talk to each other share a common network. Typically, all will be set either to **Use bridged networking** if you want to see the VMs from other PCs on the
network, or Host-only networking (Private to my Mac in Fusion) if you want to restrict access to the vSphere VMs (and any VMs inside them) to the host that vSphere and the other VMs run on. In addition, the floppy, USB controller, and sound cards can be removed as they will not be used by ESXi. Alternatively, you can create a custom VM in the New VM dialog box by selecting Custom and then choosing the specific configuration you desire.

Once the VM for vSphere is created (if you chose custom) or installed as previously noted, simply attach the ESXi 6.0 or 6.5 CD/DVD as an .iso image to the virtual CD/DVD drive and install it as you would with a physical server. Once ESXi is installed, you can run it as you would on a physical server and create VMs inside it as desired.

You can then create a VM for vCenter per the standard vC requirements and install it as you would in any other physical or virtual environment. This can be in Workstation or Fusion directly (which will generally perform better, but run inside a Windows VM inside of Workstation) or as a VM inside one of the ESXi VMs (usually done with the vCenter Appliance).

If you wish to use the Openfiler appliance, refer to the document How to install and configure OpenFiler at [http://tekblog.com/2017/01/10/how-to-install-and-configure-openfiler/](http://tekblog.com/2017/01/10/how-to-install-and-configure-openfiler/). On the other hand, if you wish to use a Windows server, install Windows 2008 (or higher), and add the iSCSI Target (not Initiator) software and/or the File Services (to get NFS support) feature. Again, if you are deploying vSAN, you can skip these VMs.

**Tip:** At labguides.com, an automated solution for creating all the required VMs on Workstation 10 (it may also work with later versions) or ESXi is available for free. You will need access to the installation software (Windows and ESXi and vCenter), but it makes it much easier and faster to set up your environment. See [http://www.labguides.com/autolab/](http://www.labguides.com/autolab/) for details and to download the tool. This tool may or may not support the latest versions of VMware products, depending on when the author updates the tool.

**Summary**

Carefully select hardware powerful enough to run ESXi as a VM. Remember that you'll probably want more than four cores (or at least hyperthreading on the four cores), 16 to 32 GB of RAM or more, and x64 CPUs with Intel-VT or AMD-V support and enabled in the BIOS. The cost of such a system will be far lower than purchasing several systems and recreating the environment with physical systems, networking equipment, etc.

Done properly, you should be able to reproduce the training environment and run the labs from the courses you take. It is even possible to do advanced configurations, such as VMware Horizon or SRM inside VMs hosted on a single host.
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About the Author
John Hales, VCP, VCP-DT, VCAP-DCA, VCI, is a VMware instructor at Global Knowledge, teaching many of the vSphere classes that Global Knowledge offers. John is also the author of many books, from involved technical books from Sybex to exam preparation books, to many quick reference guides from BarCharts, in addition to custom courseware for individual customers. His latest book on vSphere is entitled *Administering vSphere 5: Planning, Implementing and Troubleshooting*. John has various certifications, including the VMware VCP, VCP-DT, VCAP-DCA, and VCI, the Microsoft MCSE, MCDBA, and MOUS, the EMC EMCSA (Storage Administrator for EMC Clariion SANs), the CompTIA A+, Network+, and CTT+, the Amazon Certified Solutions Architect - Associate and Certified SysOps Administrator - Associate, and the Google Certified Professional – Cloud Architect. John lives with his wife and children in Sunrise, Florida.