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**Data Center  
Virtualization  
on vSphere 6.7**

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**JON HALL  
JOSHUA ANDREWS**

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**VMware®**

**Certified Professional Data Center  
Virtualization on vSphere 6.7  
Exam 2V0-21.19**

**Study Guide**





# VMware®

## **Certified Professional Data Center Virtualization on vSphere 6.7 Exam 2V0-21.19**

### **Study Guide**



Jon Hall

Joshua Andrews

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*The authors would like to dedicate this book to their patient and understanding families.*



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—Jon Hall



# About the Authors

**Jon Hall** began his career in IT as a technical educator for companies like SMC Networks, Compaq, and Hewlett-Packard, where he focused on networking, storage area networking, server administration, and datacenter virtualization technologies. Eventually, he became involved in technical certification and has continued to focus on certification for the past 15 years. Jon considers certification to be a critical part of the IT industry, and indeed it has become his passion. As a certification manager at VMware, Jon built an industry-leading program from a single certification to more than a dozen certifications across various technologies and levels of expertise. On the way, he helped over 100,000 IT professionals become virtualization evangelists. During that time he also worked as a technical editor on several VMware Press books and spoke at numerous VMware events across the globe. Today, Jon works as the certification manager for Nutanix, where he continues to create new evangelists in the hybrid and multicloud spaces. This is his first book. He can be reached at [www.linkedin.com/in/halljon](http://www.linkedin.com/in/halljon).

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In his IT career Josh has been a programmer, network engineer, system administrator, storage administrator, technical writer, and consultant, and a freelance instructor for VMware. He worked for VMware for several years as a member of the certification team, focusing on developing and administering the VMware Certified Advanced Professional exams. During that time he acted as technical editor for several books from VMware Press.

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# Introduction

Why should you learn about VMware vSphere? Although the concept of virtualization has been around since the days of mainframe computing, VMware was and is the company that made virtualization a mainstay in the x86/x64 space. Originally, VMware introduced a desktop virtualization product called Workstation followed by the server virtualization products GSX and ESX and a datacenter management product called VirtualCenter. Today, the ESX and VirtualCenter products have converged into the vSphere platform. This platform allows IT administrators to get greater utilization out of existing physical servers and reduce the overall datacenter footprint, sometimes by 50 percent or more. It also provides features to allow for high availability and scaling up with a predictable level of performance. Today, vSphere is used by 100 percent of Fortune 500 companies and distributed by over 75,000 partners.<sup>1</sup> This means that if you intend to get a job in the IT space, whether you are working for a large organization or a big partner, you are likely to be working with vSphere. Because of this, companies look for individuals who are certified. Holding the VMware certification lets companies know that you are qualified to work with vSphere at a guaranteed level of competency.

The purpose of this book is to help you pass the Professional VMware vSphere 6.7 (2V0-21.19) exam, exam number 2V0-21.19. The exam is closely tied to a version of vSphere. This book focuses on vSphere 6.x (6.5, 6.7). The current version of the certification, VMware Certified Professional - Data Center Virtualization 2020 (VCP-DCV 2020), is based on the 6.7 release of vSphere and covers installation, configuration, and administration. VMware's information about the exam is posted at [www.vmware.com/education-services/certification/vcp6-7-dcv-exam.html](http://www.vmware.com/education-services/certification/vcp6-7-dcv-exam.html)

This book covers all of the objectives tested for in the exam and includes topical information, lab work, and review questions. Because this book covers many of the tasks an administrator would perform on a day-to-day basis, this book should remain a useful reference even after you have passed the exam and earned your certification.

## What Is vSphere?

The datacenter virtualization platform known as vSphere consists of multiple components. At its core is ESXi, a bare metal hypervisor that allows an x86 server to be virtualized. This virtualization allows the server's compute resources, as well as attached networking and storage resources, to be utilized by virtual servers (known as virtual machines, or VMs). These VMs can each run individual workloads with defined resource settings, allowing all of the server's resources to be efficiently utilized. vSphere includes VMFS, a filesystem optimized for virtualization, and vCenter Server, a management tool used to

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1. [www.vmware.com/company/why-choose-vmware.html](http://www.vmware.com/company/why-choose-vmware.html)

collectively manage all of the virtualized servers in the datacenter as well as providing advanced features like vMotion (live migration), High Availability (designed to manage unplanned downtime and maximize VM uptime), and a Distributed Resource Scheduler (designed to optimize performance), just to name a few.

## Why Become VCP-DCV Certified?

There are several good reasons to become VMware certified, particularly with the VCP-DCV certification:

**Provides proof of professional achievement** There are basically two types of organizations that work with vSphere. First, there are companies that have a vSphere implementation. Second, there are partners of VMware that distribute and implement vSphere for their customers. In both cases, it is vital that the individuals working with the implementation know what they are doing. It is typical for these organizations to actively look for candidates who are certified so that they can feel confident that the person they are hiring is capable. Gaining the VCP-DCV certification shows organizations that you are one of these people.

**Increases your marketability** Having the VCP-DCV certification establishes your capability to employers and indicates that you can potentially step right into the position with little or no training. This benefit to the employer can often translate into a better salary for you. Furthermore, out of all of VMware's certifications, this is the one that covers the core datacenter virtualization components. As a result, this certification is the one most often looked for by organizations.

**Provides an opportunity for advancement** Most raises and advancements are based on performance. Individuals who become certified have a tendency to work with more of the features of a product and are able to get a more stable, better-performing implementation. Having an implementation that performs well and utilizes all of its desired features is certain to reflect positively on an employee and provide opportunities in their organization.

## How to Become VCP-DCV Certified

The first step in becoming VMware VCP-DCV certified is to attend a VMware authorized training course. VMware requires all of its certification candidates to first complete a training course. There are over a dozen courses or course combinations to choose from, which provides options if you already have a certain level of expertise working with vSphere.

Next, you must take and pass the VMware vSphere 6.7 Foundations exam. This exam, as well as the VCP-DCV exam, is version specific, so you should take the exam that matches up to the version of vSphere you are working with if at all possible (since VMware periodically retires older-version exams).

Finally, you must take and pass the VCP-DCV exam. All of these steps must be completed before you earn the certification, and although the path above is the most logical (and recommended) order in which to complete all of the requirements, you can take the course and exams in whatever order you prefer.

The exam is administered by Pearson VUE and can be taken at any Pearson VUE testing center. To register for the exam, you must go to VMware's website. You will need a myLearn account if you do not already have one. Your results for the exam are presented to you immediately upon completion. If you pass, keep in mind that you will still need to fulfill the other requirements before you can obtain your certification. Shortly after you have completed all requirements, VMware will grant your certification. This is an automatic process, although it may take a few days following the completion of all requirements.

## Who Should Buy This Book

Anybody who wants to become VCP-DCV certified will benefit from this book in multiple ways. The book covers all of the objectives on the exam and includes a large number of practice questions that can help you prepare. In addition, the book contains a collection of hands-on labs that can be performed in a vSphere environment. The labs can be done in your own environment or by using VMware's Hands-On Lab environment.

This book can also help a fledgling vSphere user increase their proficiency, both by learning about new or previously unused features and by practicing with the included labs.

Since this book focuses on the VCP-DCV certification, there is an expectation that you have enough of a background with vSphere to successfully pass the underlying vSphere Foundations exam and therefore have sufficient knowledge of the topics covered by that exam. That being said, we have done as much as possible to make this book usable to candidates who might have minimal exposure to vSphere.



In order to take advantage of all of the hands-on labs and exercises presented in this book, you will need to have a vSphere implementation. If you have an implementation already, we recommend that you perform these labs outside the production environment. If you do not have your own implementation, you can utilize one of VMware's Hands-On Lab environments. In particular, we recommend that you use the VMware Virtualization 101 hands-on lab, since this lab provides both vSphere and vCenter.

# How This Book Is Organized

This book consists of 11 chapters plus supplementary information: a glossary, this introduction, and the assessment test after the introduction. The chapters are organized as follows:

**Chapter 1, “What’s New in vSphere 6.7,”** describes features that are new to vCenter Server, vSphere Operations, security, availability, storage, networking, developer and automation interfaces, and Host Lifecycle Management enhancements.

**Chapter 2, “Configuring and Administering Security in a vSphere Datacenter,”** focuses on access to a vSphere environment and hardening of that environment, including how to configure and administer role-based access control, securing ESXi and vCenter Server, configuring and enabling SSO and identity sources, and securing vSphere virtual machines.

**Chapter 3, “Networking in vSphere,”** focuses on configuring policies and networking features and verifying vSphere networking proper operations. This chapter also shows you how to configure Network I/O Control (NIOC).

**Chapter 4, “Storage in vSphere,”** shows you how to set up storage for a vSphere implementation, including managing vSphere integration with physical storage, configuring software-defined storage, configuring vSphere Storage Multipathing and Failover, performing VMFS and NFS configurations and upgrades, and setting up and configuring Storage I/O Control (SIOC).

**Chapter 5, “Upgrading a vSphere Deployment,”** is all about performing ESXi host and virtual machine upgrades, performing vCenter Server upgrades (Windows), and migrating vCenter Server to the VCSA.

**Chapter 6, “Allocating Resources in a vSphere Datacenter,”** focuses on configuring multilevel resource pools and configuring vSphere DRS and Storage DRS clusters.

**Chapter 7, “Backing Up and Recovering a vSphere Deployment,”** describes the process of backing up vSphere components, including configuring and administering the vCenter Server Appliance backup and restore operations, configuring and administering vCenter Data Protection, and configuring vSphere Replication.

**Chapter 8, “Troubleshooting a vSphere Deployment,”** will show you how to troubleshoot major vSphere components, including vCenter Server and ESXi hosts, vSphere storage and networking, vSphere upgrades and migrations, virtual machines, HA and DRS configurations, and fault tolerance.

**Chapter 9, “Deploying and Customizing ESXi Hosts,”** focuses on configuring Auto Deploy for ESXi hosts and creating and deploying host profiles.

**Chapter 10, “Ensuring High Availability for vSphere Clusters and the VCSA,”** is all about configuring vSphere HA Cluster features and configuring vCenter Server Appliance (VCSA) HA.

**Chapter 11, “Administering and Managing vSphere Virtual Machines,”** will show you how to create and manage vSphere virtual machines and templates, create and manage a Content Library, and consolidate physical workloads using VMware vCenter Converter.

Each chapter begins with a list of the VCP-DCV objectives that are covered in that chapter. The book doesn’t cover the objectives in the order in which they are present in the exam, since the order is subject to change and exam items are randomly placed during the exam itself. At the end of each chapter, you’ll find a couple of elements you can use to prepare for the exam:

**Exam Essentials** This section summarizes important information that was covered in the chapter. You should be able to perform each of the tasks or convey the information requested.

**Review Questions** Each chapter concludes with approximately 20 review questions. You should answer these questions and check your answers against the ones provided after the questions. If you can’t answer at least 80 percent of these questions correctly, go back and review the chapter, or at least those sections that seem to be giving you difficulty.



The review questions, assessment test, and other testing elements included in this book are *not* derived from the official VMware exam questions, so don’t memorize the answers to these questions and assume that doing so will enable you to pass the exam. You should learn the underlying topic, as described in the text of the book. This will let you answer the questions provided with this book *and* pass the exam. Learning the underlying topic is also the approach that will serve you best in the workplace—the ultimate goal of a certification like VMware’s.

To get the most out of this book, you should read each chapter from start to finish and then check your memory and understanding with the chapter-end elements. Even if you’re already familiar with a topic, you should skim the chapter; vSphere is complex enough that there are often multiple ways to accomplish a task, so you may learn something even if you’re already competent in an area.

## Bonus Contents

This book is accompanied by an online learning environment that provides several additional elements. The following items are available among these companion files:

**Sample Tests** All of the questions in this book appear in our proprietary digital test engine—including the 30-question assessment test at the end of this introduction and the over 200 questions that make up the review question sections at the end of the chapters. In addition, there are two 55-question practice tests.

**Electronic “Flashcards”** The digital companion files include 68 questions in flashcard format (a question followed by a single correct answer). You can use these to review your knowledge of the VCP-DCV exam objectives.

**Glossary** The key terms from this book, and their definitions, are available as a fully searchable PDF.



To register and gain access to this interactive online learning environment, please visit this URL: [www.wiley.com/go/Sybextestprep](http://www.wiley.com/go/Sybextestprep).

## Conventions Used in This Book

This book uses certain typographic styles in order to help you quickly identify important information and to avoid confusion over the meaning of words such as on-screen prompts. In particular, look for the following styles:

- *Italicized text* indicates key terms that are described at length for the first time in a chapter. (Italics are also used for emphasis.)
- A monospaced font indicates the contents of configuration files, messages displayed at a text-mode Linux shell prompt, filenames, text-mode command names, and Internet URLs.
- *Italicized monospaced text* indicates a variable—information that differs from one system or command run to another, such as the name of a client computer or a process ID number.
- **Bold monospaced text** is information that you’re to type into the computer, usually at a Linux shell prompt. This text can also be italicized to indicate that you should substitute an appropriate value for your system. (When isolated on their own lines, commands are preceded by nonbold monospaced \$ or # command prompts, denoting regular user or system administrator use, respectively.)

In addition to these text conventions, which can apply to individual words or entire paragraphs, a few conventions highlight segments of text:



A note indicates information that's useful or interesting but that's somewhat peripheral to the main text. A note might be relevant to a small number of networks, for instance, or it may refer to an outdated feature.



A tip provides information that can save you time or frustration and that may not be entirely obvious. A tip might describe how to get around a limitation or how to use a feature to perform an unusual task.



Warnings describe potential pitfalls or dangers. If you fail to heed a warning, you may end up spending a lot of time recovering from a bug, or you may even end up restoring your entire system from scratch.

### Sidebars

A sidebar is like a note but longer. The information in a sidebar is useful, but it doesn't fit into the main flow of the text.



### Real World Scenario

#### Real World Scenario

A real world scenario is a type of sidebar that describes a task or example that's particularly grounded in the real world. This may be a situation I or somebody I know has encountered, or it may be advice on how to work around problems that are common in real, working Linux environments.

### Exercises

An exercise is a procedure you should try out on your own computer to help you learn about the material in the chapter. Don't limit yourself to the procedures described in the exercises, though! Try other commands and procedures to really learn about Linux.

# Objective Mapping

Table I.1 contains an objective map to show you at a glance where you can find each VCP-DCV exam objective covered.

**TABLE I.1** 2V0-21.19 Objective Map

<b>Exam Objective</b>	<b>Chapter</b>
<b>Section 1 – VMware vSphere Architectures and Technologies</b>	
Objective 1.1 – Identify the prerequisites and components for vSphere implementation	3, 5, 9
Objective 1.2 – Identify vCenter high availability (HA) requirements	10
Objective 1.3 – Describe storage types for vSphere	4
Objective 1.4 – Differentiate between NIOC and SIOC	4
Objective 1.5 – Manage vCenter inventory efficiently	6
Objective 1.6 – Describe and differentiate among vSphere, HA, DRS, and SDRS functionality	4, 6, 10
Objective 1.7 – Describe and identify resource pools and use cases	6
Objective 1.8 – Differentiate between VDS and VSS	3
Objective 1.9 – Describe the purpose of cluster and the features it provides	2, 6, 10
Objective 1.10 – Describe virtual machine (VM) file structure	4, 11
Objective 1.11 – Describe vMotion and Storage vMotion technology	4, 11
<b>Section 2 – VMware Products and Solutions</b>	
Objective 2.1 – Describe vSphere integration with other VMware products	3
Objective 2.2 – Describe HA solutions for vSphere	10
Objective 2.3 – Describe the options for securing a vSphere environment	1
<b>Section 3 – Planning and Designing</b>	
(There are no testable objectives for this section.)	

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<b>Exam Objective</b>	<b>Chapter</b>
<b>Section 4 – Installing, Configuring, and Setting Up a VMware vSphere Solution</b>	
Objective 4.1 – Understand basic log output from vSphere products	8
Objective 4.2 – Create and configure vSphere objects	1, 2, 3, 4, 6, 10, 11
Objective 4.3 – Set up a content library	1, 11
Objective 4.4 – Set up ESXi hosts	1, 9
Objective 4.5 – Configure virtual networking	3
Objective 4.6 – Deploy and configure VMware vCenter Server Appliance (VCSA)	1, 5, 7
Objective 4.7 – Set up identity sources	1, 2
Objective 4.8 – Configure an SSO domain	1, 2
<b>Section 5 – Performance-tuning and Optimizing a VMware vSphere Solution</b>	
Objective 5.1 – Determine effective snapshot use cases	1, 7, 11
Objective 5.2 – Monitor resources of VCSA in a vSphere environment	5, 6, 8
Objective 5.3 – Identify impacts of VM configurations	8, 11
<b>Section 6 – Troubleshooting and Repairing</b> (There are no testable objectives for this section.)	
<b>Section 7 – Administrative and Operational Tasks in a VMware vSphere Solution</b>	
Objective 7.1 – Manage virtual networking	3
Objective 7.2 – Manage datastores	1, 4
Objective 7.3 – Configure a storage policy	4
Objective 7.4 – Configure host security	1, 2

**TABLE 1.1** 2V0-21.19 Objective Map *(continued)*

<b>Exam Objective</b>	<b>Chapter</b>
Objective 7.5 – Configure role-based user management	2
Objective 7.6 – Configure and use vSphere Compute and Storage cluster options	4, 6
Objective 7.7 – Perform different types of migrations	1, 6, 7, 11
Objective 7.8 – Manage resources of a vSphere environment	1, 3, 4, 6, 9
Objective 7.9 – Create and manage VMs using different methods	1, 7, 11
Objective 7.10 – Create and manage templates	1, 11
Objective 7.11 – Manage different VMware vCenter Server objects	1, 2, 3, 4, 6
Objective 7.12 – Set up permissions on datastores, clusters, vCenter, and hosts	2
Objective 7.13 – Identify and interpret affinity/anti-affinity rules	4, 6, 10
Objective 7.14 – Understand use cases for alarms	8
Objective 7.15 – Utilize VMware vSphere Update Manager (VUM)	1, 5
Objective 7.16 - Configure and manage host profiles	9

# Assessment Test

1. Which component is a requirement for deploying vCenter Enhanced Linked Mode when using a combination of vCenter Server for Windows and vCenter Server Appliances?
  - A. External PSC
  - B. Embedded PSC
  - C. Load Balancers
  - D. vCenter High Availability
2. Which method should a virtual machine running a current version of Windows use to take advantage of PMem?
  - A. vPMemDisk
  - B. vPMem
  - C. NVDIMM
  - D. RDMA
3. What vSAN queue is responsible for managing witness traffic?
  - A. VM I/O Queue
  - B. Namespace Queue
  - C. Resync I/O Queue
  - D. Metadata Queue
4. An organization has an encrypted virtual machine whose Encrypted vSphere vMotion setting is set to Required. If encryption is later disabled for the VM, what happens to the Encrypted vSphere vMotion setting?
  - A. It is set to Disabled.
  - B. It reverts to the default (Opportunistic).
  - C. It remains set to Required.
  - D. Encryption cannot be disabled until the setting is changed to Disabled.
5. Which objects can be added to a Content Library prior to vSphere 6.7 Update 1? (Choose three.)
  - A. VMX files
  - B. OVA files
  - C. ISO images
  - D. VMTX files
  - E. Certificates

6. Where would an administrator configure EVC to support migration of a VM across a hybrid cloud environment?
  - A. On the cluster
  - B. On the datastore
  - C. On the individual VM
  - D. On the PSC
  
7. An administrator wants to configure RDMA over Converged Ethernet (RoCE). Which of these are requirements to support RoCE v1? (Choose two.)
  - A. Lossless layer 2 network
  - B. Lossless layer 3 network
  - C. PFC priority enabled VLAN
  - D. Teamed RoCE NICs
  
8. Which options would enable an administrator to create a distributed virtual switch? (Choose two.)
  - A. 10GbE NICs
  - B. vCenter Server/VCSA
  - C. vSphere Enterprise Plus license
  - D. Network I/O Control
  
9. What protocol can be enabled on vCenter Server to provide information about a vDS to management software?
  - A. MPP
  - B. LLDP
  - C. SNMP
  - D. NMP
  
10. Which two types of traffic, if selected for use by a VMkernel adapter, will cause the default TCP/IP stack to no longer be used for that traffic? (Choose two.)
  - A. Fault-tolerant traffic
  - B. Provisioning traffic
  - C. vSphere Replication traffic
  - D. vMotion traffic
  
11. Which technology cannot be used to prioritize specific types of traffic?
  - A. SIOC
  - B. Traffic shaping
  - C. NIOC
  - D. LACP

12. Which technology can be configured on an ESXi iSCSI adapter to ensure security and data integrity?
  - A. Kerberos
  - B. CHAP
  - C. KVM
  - D. AES-256
13. What provisioning technology should be used on a VM to allow for space reclamation in an all-flash array without needing to use the UNMAP command?
  - A. ZeroedThick
  - B. EagerZeroedThick
  - C. Thin
  - D. 2gbsparse
14. What feature can vSphere use to present a SAN LUN to a virtual machine?
  - A. RDM
  - B. FCoE
  - C. CIFS
  - D. SIOC
15. When using `esxtop`, which value will show you the average total response time for VMkernel operations?
  - A. KAVG
  - B. GAVG
  - C. DAVG
  - D. QAVG
16. Which DRS option is best for architects to establish usage based on predefined SLAs?
  - A. VM Distribution
  - B. Memory Metric for Load Balancing
  - C. CPU Overallocation
  - D. Proactive HA
17. What value is used by network-aware DRS to determine when a host has excessive network utilization?
  - A. 70% utilization
  - B. 75% utilization
  - C. 80% utilization
  - D. 85% utilization

18. What can be done to ensure that virtual machines with anti-affinity rules are restarted during an HA restart event?
- A. Nothing, anti-affinity rules are ignored for a HA restart
  - B. Set the HA Advanced Option `das.respectvmvantiAffinityRules` to *false*
  - C. Configure admission control with sufficient resources
  - D. Configure the Anti-Affinity Rule to **Must**
19. Which types of I/O filters are offered by VMware? (Choose two.)
- A. Replication
  - B. Encryption
  - C. Caching
  - D. Storage I/O Control
20. Which patterns are valid for use with vSphere Auto Deploy? (Choose two.)
- A. Serial
  - B. CPU type
  - C. Domain
  - D. Image profile
21. Where is the data plane located for vSphere Distributed Switches?
- A. On the vCenter server
  - B. On the Platform Services Controller
  - C. On the ESXi host
  - D. On the Service Composer VM
22. What virtual machine hardware component was newly supported beginning with vSphere 6.5 (VM Hardware v13)?
- A. 3D video support
  - B. NVDIMM controllers
  - C. Virtual RDMA
  - D. PCI Passthrough
23. Storage policies are assigned to a VM during which procedures? (Choose two.)
- A. Initial deployment
  - B. Powering on
  - C. Migration
  - D. Placing in Standby mode

- 24.** An administrator has upgraded the vCenter server to version 6.7. The cluster uses an external Platform Services Controller. What is the next component to be upgraded in the vSphere upgrade process?
- A.** ESXi hosts
  - B.** Platform Services Controller
  - C.** Virtual appliances
  - D.** Virtual machines
- 25.** How many additional vSphere Replication servers can be deployed to scale the solution to handle a large number of virtual machines?
- A.** 1
  - B.** 2
  - C.** 5
  - D.** 9
- 26.** What are two advantages to enabling compression for vSphere Replication? (Choose two.)
- A.** It reduces network bandwidth requirements.
  - B.** It reduces CPU utilization.
  - C.** It reduces the amount of buffer memory.
  - D.** It reduces the RPO time.
- 27.** Which three are valid failure events that Proactive HA can respond to? (Choose three.)
- A.** Memory
  - B.** Network
  - C.** CPU
  - D.** Power Supply
  - E.** Shared Storage
- 28.** A High Availability cluster has eight powered-on virtual machines whose total resource requirements add up to 12 GHz and 28 GB. These virtual machines are running on a cluster containing four hosts, whose total resources for running virtual machines equal 38 GHz and 112 GB. Based on this scenario, what is the current memory failover capacity for the cluster?
- A.** 85%
  - B.** 75%
  - C.** 68%
  - D.** 58%
- 29.** What is the advantage of creating a snapshot of a virtual machine that includes the VM's memory?
- A.** The snapshot can restore the VM even if the VMDK file is corrupted.
  - B.** The size of the snapshot is significantly smaller.

- C. The restored snapshot will include any open files.
  - D. Quiescing is automatically performed during the snapshot.
- 30.** Which two options would not be considered if an administrator's use case is to share a GPU across multiple VMs? (Choose two.)
- A. vSphere DirectPath I/O
  - B. NVIDIA vGPU/Grid
  - C. BitFusion FlexDirect
  - D. PCI Passthrough

# Answers to Assessment Test

1. A. While VCSA includes an Embedded PSC that can be used with vCenter Enhanced Linked Mode, it can only be used with VCSA nodes and is not supported for Windows vCenter Server installations.
2. B. A virtual machine with VM hardware 14 or later and a current guest OS is PMem-aware and can use vPMem to take advantage of PMem.
3. D. The Metadata Queue manages objects that comprise a VM, such as witness traffic, cluster monitoring, and membership activities.
4. C. If encryption is disabled on a VM, the setting for Encrypted vSphere vMotion must be explicitly changed to Disabled. Until then, it remains set to Required.
5. B, C, E. A Content Library allows for OVA and OVF files to be used as templates and also allows for the management of support files like ISO images and certificates. vSphere 6.7 Update 1 introduced support for VM template files (.vmtx) in content libraries.
6. C. Configuring EVC at the individual VM level allows for migration support out of an on-premise cluster into an entirely different datacenter.
7. A, C. RoCE v1 requires a Lossless Layer 2 Network and a PFC-enabled VLAN, whereas RoCE v2 requires both Layer 2 and Layer 3 to be Lossless.
8. B, C. To create a vDS, you must have a license that allows it, such as Enterprise Plus. vDS creation and management is performed on the vCenter Server/VCSA.
9. C. SNMP allows for information, alerts, and errors to be sent to a receiver running management software. This includes information related to a vDS.
10. B, D. Once a VMkernel adapter has been linked to the vMotion or the provisioning TCP/IP stack, those traffic types will no longer be carried on the default stack.
11. D. SIOC, NIOC, and traffic shaping are all technologies specifically designed to optimize traffic. LACP (Link Aggregation Control Protocol) is used to combine the bandwidth of multiple network adapter interfaces into a larger, logical bandwidth.
12. B. The Challenge Handshake Authentication Protocol (CHAP) uses a three-way handshake algorithm on ESXi iSCSI adapters to verify the identity of the ESXi host and, if applicable, of the iSCSI target device.
13. B. The use of EagerZeroedThick provisioning zeroes out all storage in advance, saving an administrator from using the VMFS UNMAP procedure manually.
14. A. Raw Device Mapping (RDM) is used to map a SAN LUN on a physical storage device to a virtual machine.

15. A. The total time it takes for a VMkernel command to process is expressed by the ESXi Kernel Average Latency time metric (KAVG).
16. C. CPU Overallocation is a useful feature when establishing multiple SLAs or service tiers.
17. C. DRS observes the Transmit (Tx) and Receive (Rx) rates of a host's connected physical uplinks and avoids placing VMs on hosts whose physical NICs are greater than 80% utilized.
18. B. HA by default will enforce anti-affinity rules unless you set the advanced option `das.respectvmvmtiaffinityrules` to *false*.
19. B, D. I/O filters not offered by VMware are available from third-party partners.
20. A, C. Patterns include host-specific information like vendor or serial number and network information like IP address and domain.
21. C. The data plane for a vSphere Distributed Switch resides on each ESXi host.
22. C. Virtual RDMA support was new for VM Hardware v13. NVDIMM Controllers were not supported until VM Hardware v14, and PCI Passthrough and 3D video were supported prior to the vSphere 6.5 release.
23. A, C. Storage policies are applied when you create, clone, or migrate a virtual machine.
24. A. vSphere 6.7 is a complex set of products and features that include several upgradeable components. Understanding the correct upgrade sequence is vital for ensuring that all needed services are running and available.  
The order of actions during a vSphere upgrade is as follows:
  1. Back up the configuration.
  2. Upgrade Platform Services Controller.
  3. Upgrade vCenter Server.
  4. Upgrade ESXi hosts.
  5. Upgrade virtual machines and virtual appliances.
25. D. vSphere 6.x supports a maximum of 9 additional vSphere Replication servers (for a total of 10).
26. A, C. Using compression can reduce the amount of replication data that is transferred through the network, which helps save network bandwidth and reduces the amount of buffer memory used on the vSphere Replication server. However, compressing and decompressing data requires more CPU resources on both the source site and the server that manages the target datastore.
27. A, B, D. Proactive HA monitors the network, power, memory, local storage, and fan of each host.

28. B. The memory failover capacity for this cluster is 112 GB minus 28 GB divided by 112 GB, which is 75%.
29. C. Creating a snapshot that includes the VM's memory captures the live state of the VM. This includes any files that might be in memory that have not yet been committed to disk.
30. A, D. vSphere DirectPath I/O and the PCI Passthrough option are both used to link a host graphics card directly to a single VM.



# Chapter 1

## What's New in vSphere 6.7

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### 2V0-21.19 EXAM OBJECTIVES COVERED IN THIS CHAPTER:

#### ✓ VMware Products and Solutions

- Describe the options for securing a vSphere environment

#### ✓ Installing, Configuring, and Setting Up a VMware vSphere Solution

- Create and configure vSphere objects
- Set up a content library
- Set up ESXi hosts
- Deploy and configure VMware vCenter Server Appliance (VCSA)
- Set up identity sources
- Configure an SSO domain

#### ✓ Performance-Tuning and Optimizing a VMware vSphere Solution

- Determine effective snapshot use cases

#### ✓ Administrative and Operational Tasks in a VMware vSphere Solution

- Manage datastores
- Configure host security
- Perform different types of migrations
- Manage resources of a vSphere environment
- Create and manage VMs using different methods
- Create and manage templates
- Manage different VMware vCenter Server objects
- Utilize VMware vSphere Update Manager (VUM)



VMware is continually updating all of the different components that make up vSphere. The ESXi hypervisors to vCenter management and all of the various subsystems continually receive bug fixes, enhancements, and new features. Major updates to the ecosystem are released as new versions (the last being 6.0, released in 2015), with “sub” or “point” releases containing important updates and enhancements released more often.

In addition to the version and point releases, VMware also releases “Updates,” which tend to be mostly bug fixes but do often contain an extra or enhanced feature or two.

While keeping your environment up-to-date is important from a security standpoint, more critically for the purpose of this book is to ensure that you are studying the correct version of vSphere. The 2V0-21.19 exam at the time of this writing covers vSphere 6.7 U1. If you are going to download the binaries to install a practice environment, or are researching exam topics in the official documentation, make sure you are referencing the correct version and update number.

In this chapter, we will go over the latest updates and changes in vSphere 6.7 U1.

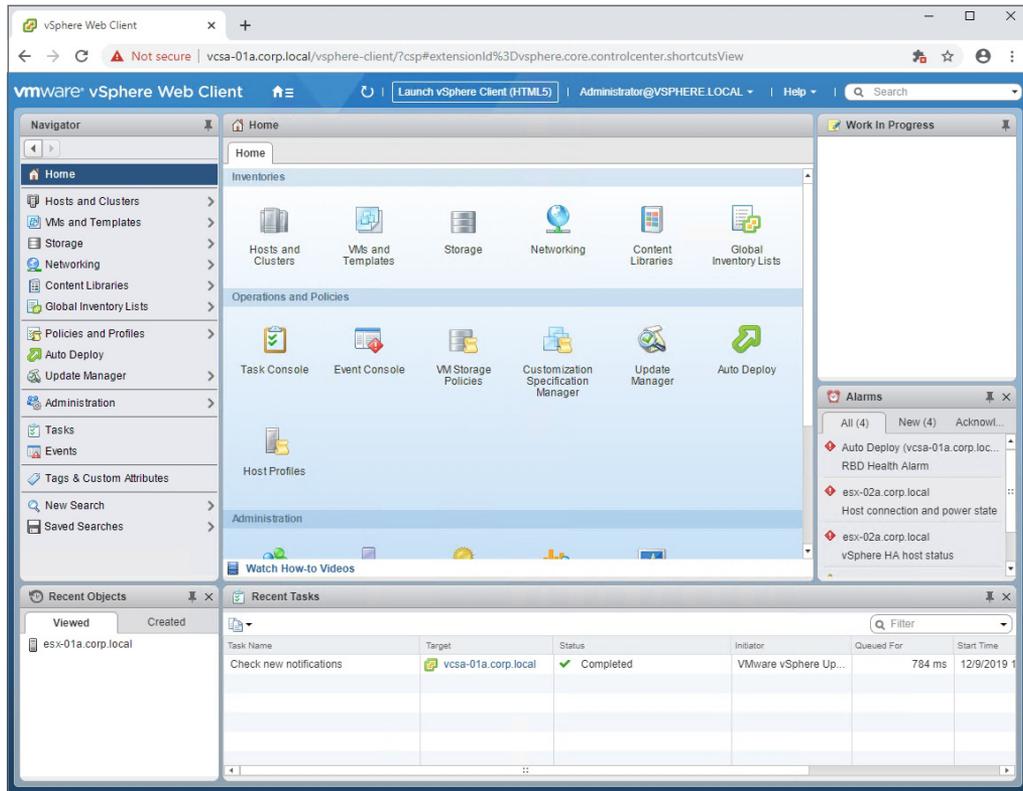
## Accessing vSphere

Environments are primarily managed day to day by graphical tools. While command-line tools and APIs are in widespread use, they are typically for one-off or automated solutions. For VMware vSphere environments, there are several graphical utilities you might use, from the host console (DCUI, or Direct Console User Interface) to the ESXi host’s HTML5 web client.

Prior to vSphere 6.5, primary management of the vSphere environment was managed by a Flash-based Flex client called the VMware vSphere Web Client. However, with the decline and fall of Flash as a development platform, VMware started working on an HTML5 client, using the new Clarity framework. Initially released as a fling (one of VMware’s unsupported free tools) in March 2016, by vSphere 6.7 U1 this new client has almost achieved feature parity with the Flex client—and in fact some of the new features can only be accessed in the HTML5 client.

### VMware vSphere Client

As shown in Figure 1.1 and Figure 1.2, the clients can be easily differentiated, yet the new client doesn’t radically change the user interface. Note that while both clients are included with vSphere 6.7, this will be the last release that includes the Flex client.

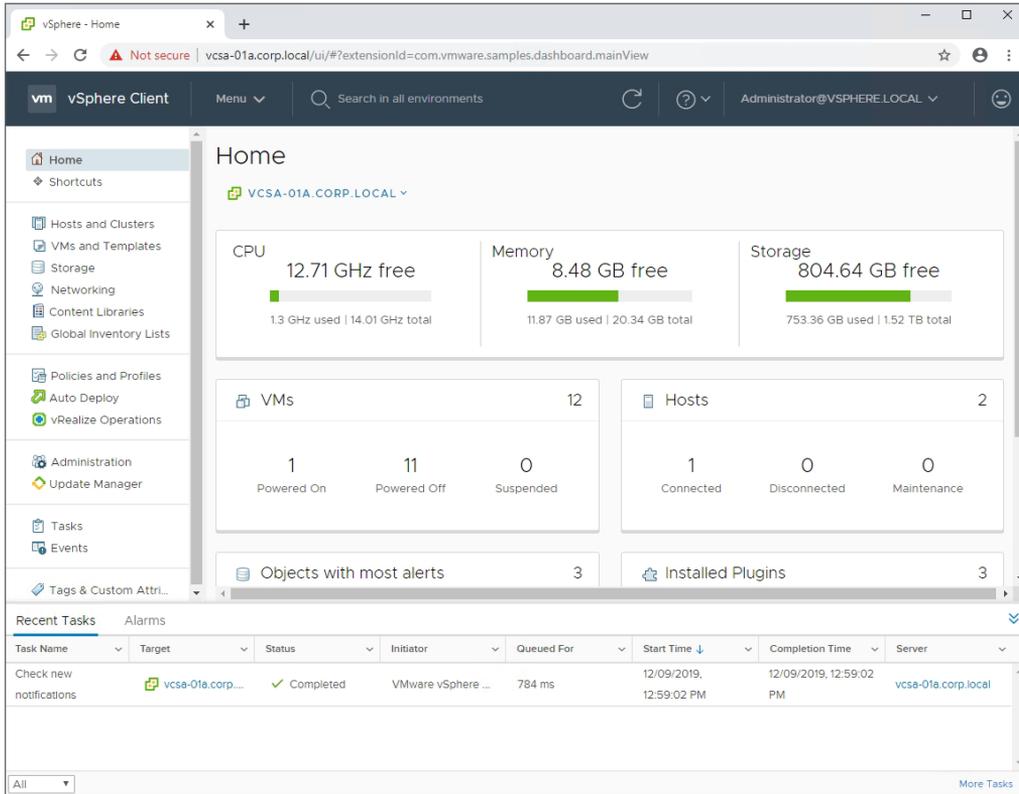
**FIGURE 1.1** The home page of the Flex vSphere web client

While traditionally the VMware certification exams have tried to avoid “where is this setting in the GUI?” -type questions, with a new client being transitioned, it is possible some will show up. For starters, the new client is accessed by a different URL. Where the Flex client is still at <https://<vcenter FQDN or IP address>/vsphere-client/ui/>, the new HTML5 client can be found at <https://<vcenter FQDN or IP address>/ui/>.

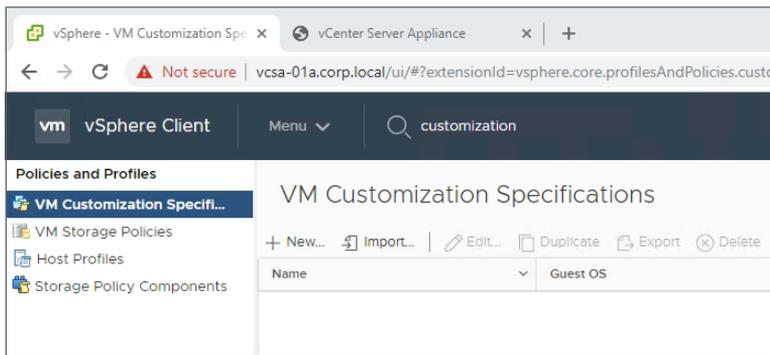
You might have noticed in Figure 1.1 and Figure 1.2 that the home screen for the HTML5 client has performance information instead of icons for possible tasks (such as VM Storage Policies). Most of the tasks can be found under the same Navigator section. For instance, VM Customization Manager can be found under Policies and Profiles, although it has been renamed VM Customization Specifications as shown in Figure 1.3.

However, System Configuration has changed. While it is still under the Administration section and shows all available vCenter servers (as shown in Figure 1.4), it no longer displays the full list of vCenter services as shown in Figure 1.5.

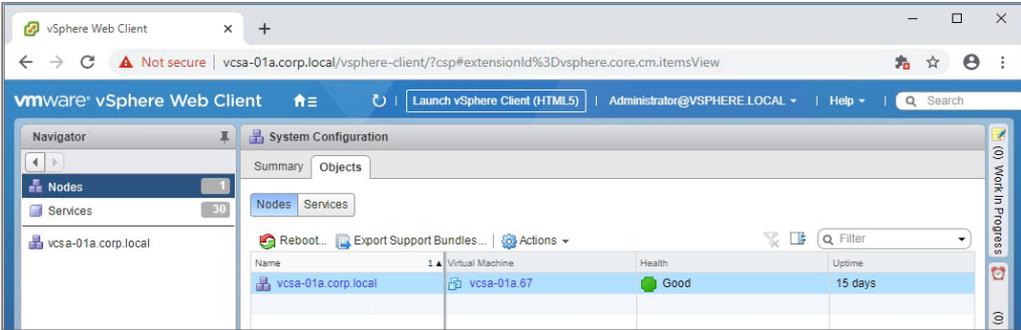
**FIGURE 1.2** The home page of the HTML5 vSphere client



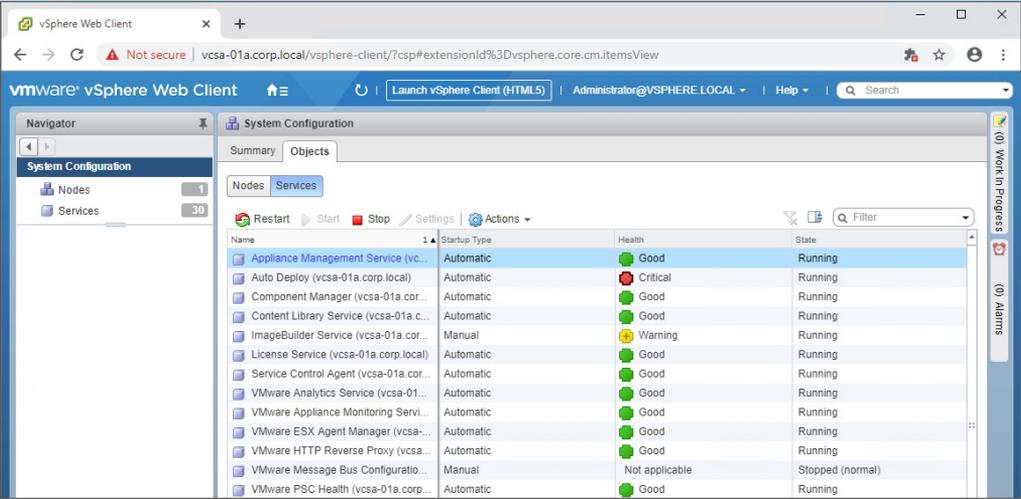
**FIGURE 1.3** Policies and Profiles contains the renamed customizations tool.



**FIGURE 1.4** The Nodes section of the Flex client shows all the connected vCenter appliances.

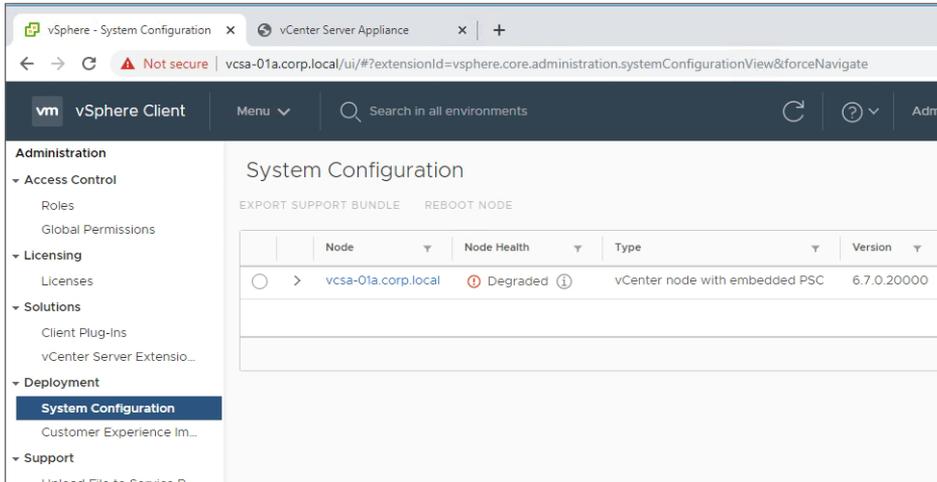
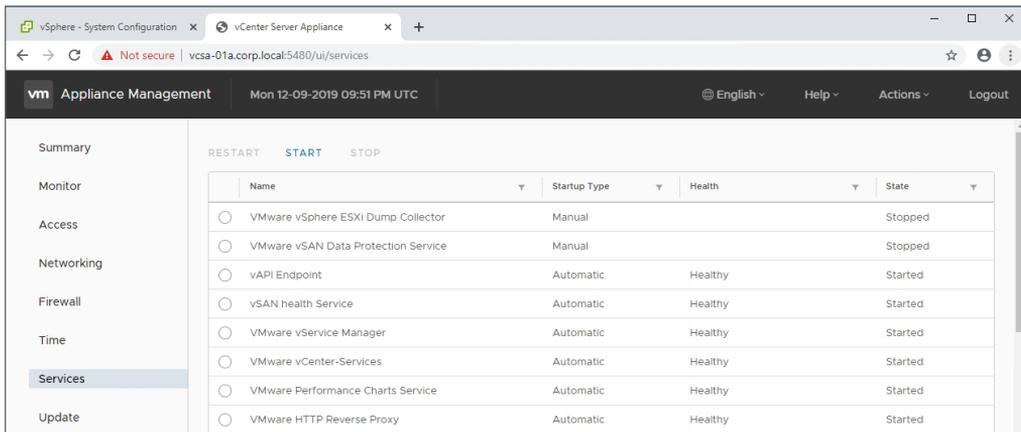


**FIGURE 1.5** The Flex client System Configuration section shows vCenter services.



The list of services has been moved to the VAMI console, which can be accessed by clicking the hyperlinked name of the vCenter server as shown in Figure 1.6.

By clicking on the vCenter server, you can log into the updated VCSA management console, which has the list of services as shown in Figure 1.7.

**FIGURE 1.6** The node list of the HTML5 client**FIGURE 1.7** The VCSA console shows the available services that can be started.

## Real World Scenario

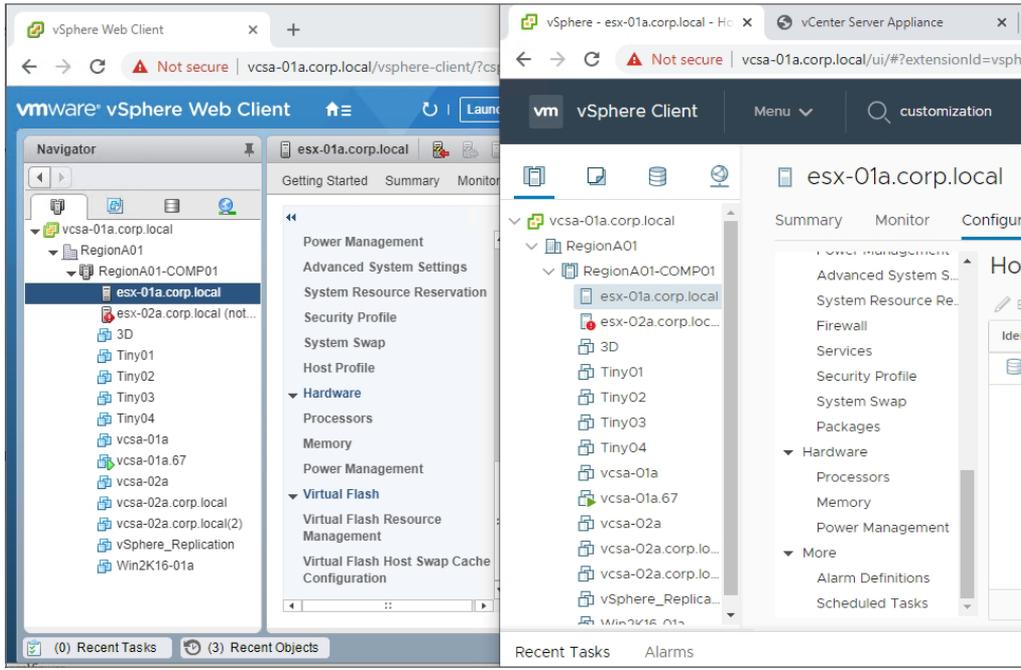
### Right-Sizing a Practice Environment

A more subtle tweak of the HTML5 interface is the health display. While Figure 1.4 shows that my vcsa-01a appliance has a “Good” status, the new client in Figure 1.6 shows that it’s “Degraded.” What gives? Turns out the HTML5 client noticed I dialed back the RAM provisioned to the VCSA appliance.

If you are creating a nested environment for practice, you might want to manipulate the available RAM or CPUs to minimize the impact to your host system. This sometimes results in issues like upgrades failing when their checks show reduced RAM or random flags like this one. While perfectly fine in a demo environment, you will want to stick to the documented settings for a production environment, which for VCSA means only use the GUI to make changes to CPU/RAM.

One of the features not yet moved into the HTML5 client is the Virtual Flash configuration, as seen in Figure 1.8. If you wish to configure or manage Virtual Flash you'll need to use the Flex client.

**FIGURE 1.8** The Virtual Flash settings are not yet ported to the HTML5 client (note the lack of a Virtual Flash section in the HTML5 client on the right).



In the Update Manager section of this chapter, we'll talk about the limited Update Manager features available in the HTML5 client.

## Application Programming Interface

For automation or access through other tools, VMware provides software development kits (SDKs), command-line tools (such as PowerCLI), and application programming interfaces (APIs). While there are some changes to the PowerCLI for 6.7, they are beyond the requirements of the VCP-level exams. However, VMware has referred to the new SDKs and APIs in blog posts and release notes and those could be considered fair game for the exam.

For in-depth documentation, visit [www.vmware.com/support/pubs/sdk\\_pubs.html](http://www.vmware.com/support/pubs/sdk_pubs.html). To download the SDKs and explore the APIs, head over to [code.vmware.com/sdks](http://code.vmware.com/sdks).

These updated SDKs were listed in the vSphere 6.7 release blog:

**vSphere Management SDK** Bundle containing several vSphere SDKs: vSphere Web Services SDK, vSphere Storage Management SDK, vSphere ESX Agent Manager SDK, SSO Client SDK, and vSphere Storage Policy SDK.

**vSphere Automation SDK** This is a family of SDKs for programmatic access from different programming languages—Java, Python, .NET, Perl—plus a REST SDK. Note that vSphere 6.5 included an Automation SDK for Ruby, but that has not been updated for 6.7 at the time of writing.

**vSphere Client SDK** The Client SDK is intended to help the creation of extensions for the vSphere client.

**vSAN Management SDK** This is a family of SDKs intended to help developers create solutions around vSAN. Languages available are Java, Python, .NET, Perl, and Ruby. There is also a REST SDK.

## Topology and UI Updates for VCSA

The management platform for vSphere—VMware's vCenter server—has received some important changes for 6.7 and received further changes for U1. The topologies allowed for vCenter have undergone several changes with each release, along with different methods for changing topologies, and this is a prime topic for exam questions.

### External Platform Services Controller

The Platform Services Controller (PSC) component of vSphere manages the Single Sign-On (SSO) domain for the environment. It can be installed embedded on the same Windows server or VCSA appliance as vCenter, or externally on a separate appliance or Windows sever.

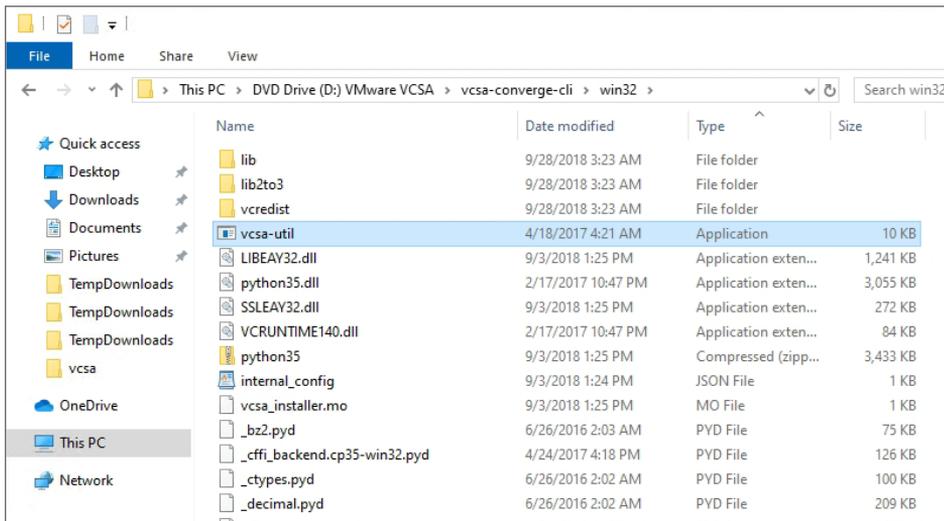
In previous versions, the external deployment version was required for Enhanced Linked Mode, where multiple vCenter servers can be managed from the same client UI.

However, the embedded version now works with Enhanced Linked Mode and the external deployment is no longer recommended. VMware has stated that in a future release, the external PSC will no longer be supported, and new tools have been released to modify existing vCenter topologies to the recommended, embedded deployment.

First, VMware offers a vSphere Topology and Upgrade Planning Tool, which can be found at [vspherecentral.vmware.com](http://vspherecentral.vmware.com); it will ask a series of questions before recommending a deployment topology with documentation links.

For existing deployments, you can migrate (VMware calls it “converge”) from an external to an embedded PSC by using the new convergence tool, *vcsa-util*, available on the VCSA 6.7 U1 ISO as shown in Figure 1.9. There are Windows, Linux, and MacOS versions of the tool, and note that it is not available on the Windows-based vCenter Server ISO.

**FIGURE 1.9** The convergence tool allows for migrating a PSC from external to embedded.

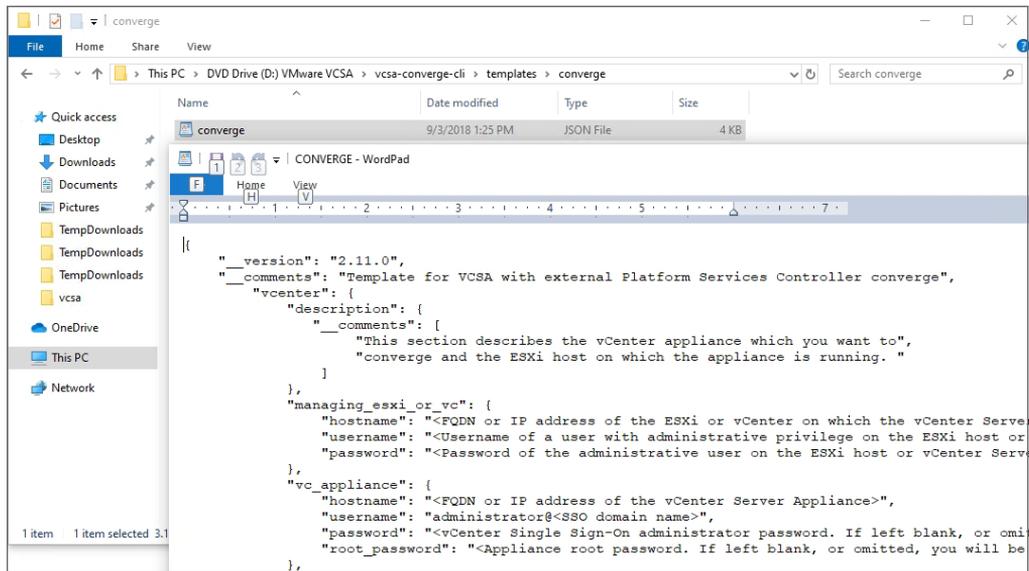


In addition to migrating a PSC from external to embedded, the tool can also decommission an external PSC. Either method requires a JSON template as shown in Figure 1.10. You should modify the sample JSON template for your environment, then submit that template when you run the *vcsa-util* tool.

Another tool included on the ISO is *cmsso-util*, which allows you to manipulate vCenter/PSC relationships, including consolidating or splitting vSphere domains. Using the tool you can complete the following tasks:

- Move a vCenter server to a different vSphere domain.
- Move all vCenter servers in a domain to a different domain.
- Point a vCenter server with an embedded PSC to an external PSC, including in a different domain.

**FIGURE 1.10** A JSON file is required to pass the environment information to the conversion tool.



The *cmsso-util* tool can be run from VCSA or from `C:\Program Files\VMware\ vCenter Server\bin\` on a Windows-based vCenter server.

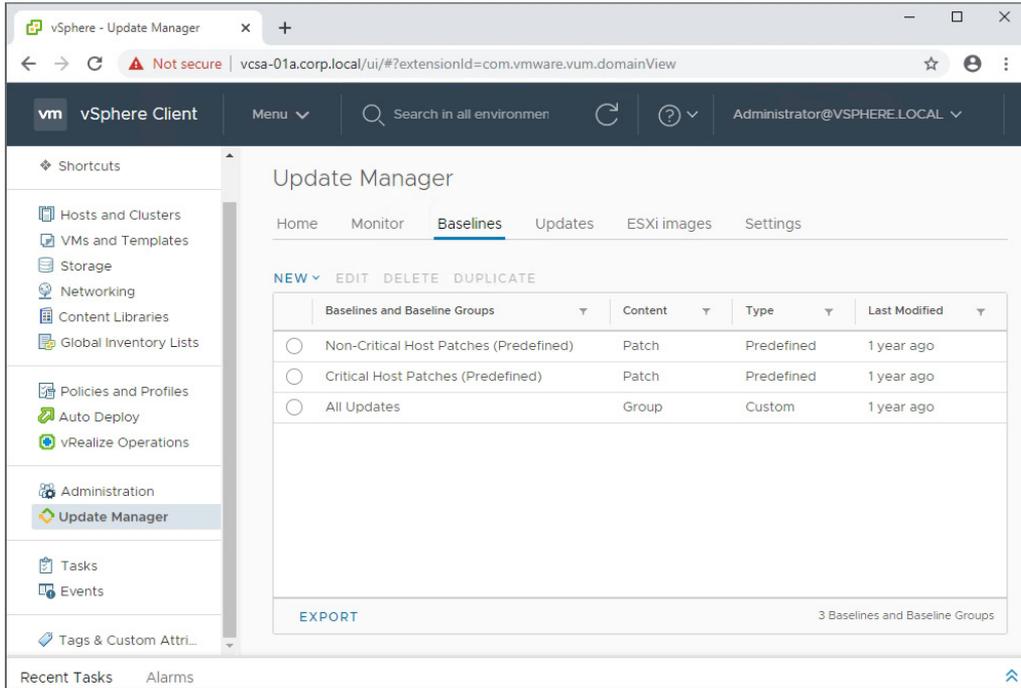
## Update Manager

With vSphere 6.7 U1, Update Manager gets a new look in the vSphere Client; however, the VM update functionality has not been ported, so updating VM hardware and VMware Tools still requires the Flex client.

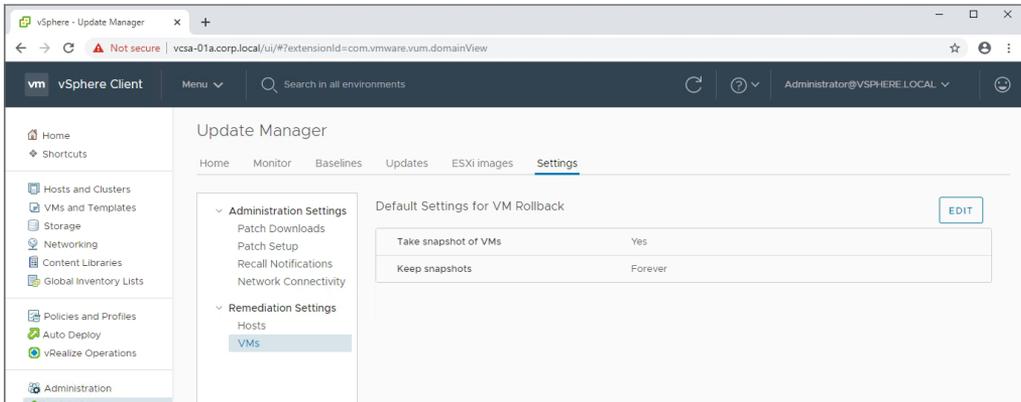
As shown in Figure 1.11, Update Manager ships with two baselines (*Non-Critical Host Patches* and *Critical Host Patches*) and one group that combines those two baselines (*All Updates*).

While the HTML5 client doesn't yet include the functionality to manage baselines for VMs, you can still view and edit the VM remediation settings as seen in Figure 1.12.

**FIGURE 1.11** Listing the baselines and baseline groups in Update Manager



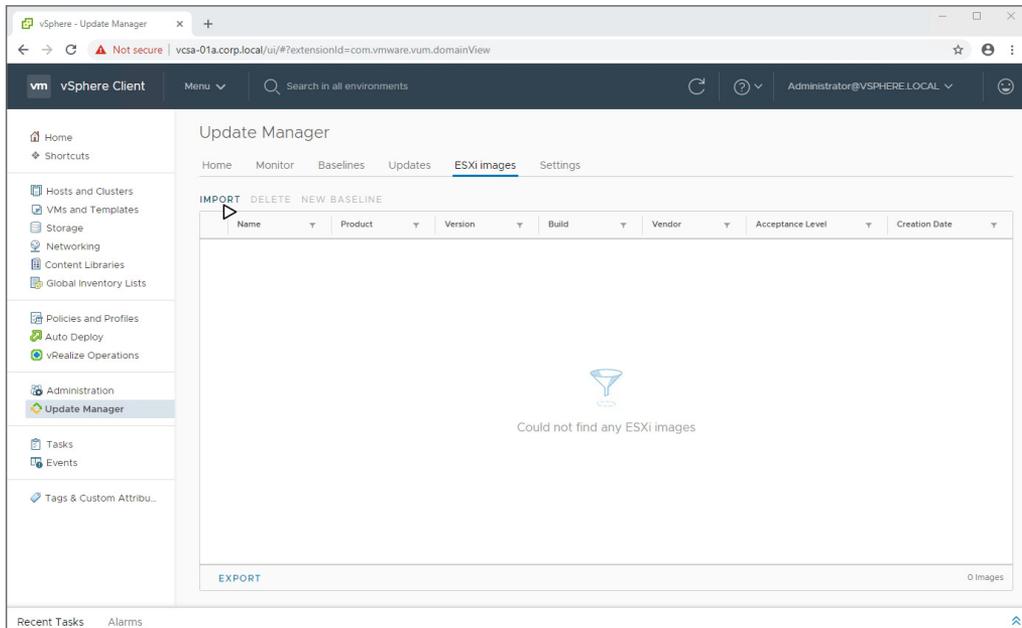
**FIGURE 1.12** Changing the settings for VM remediation



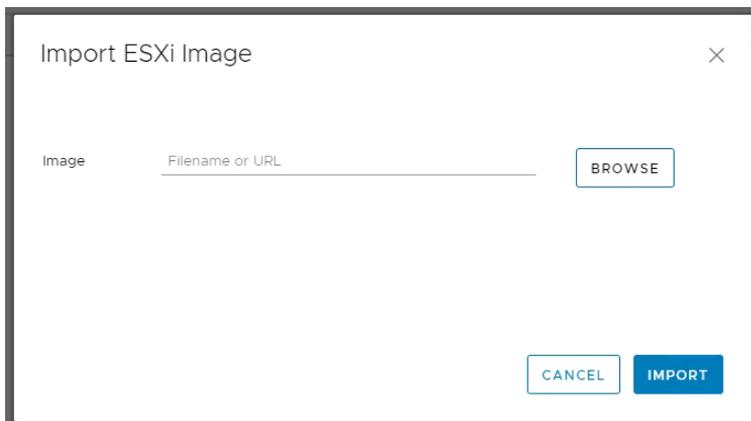
**EXERCISE 1.1****Create a baseline and scan a host for compliance.**

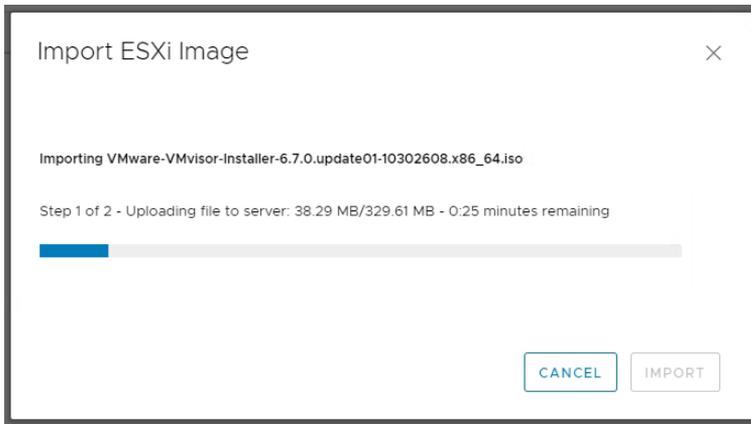
Requires a vCenter server with a datacenter created, one ESXi host, and the ISO for ESXi 6.7 U1.

1. In Update Manager, Click Import to launch the import dialog.

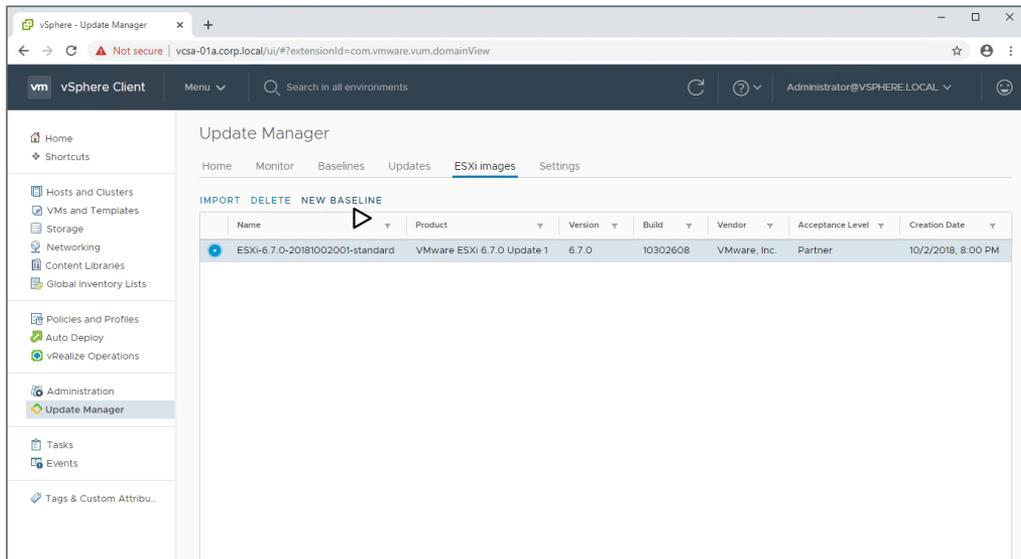


2. Locate the ISO to begin uploading.



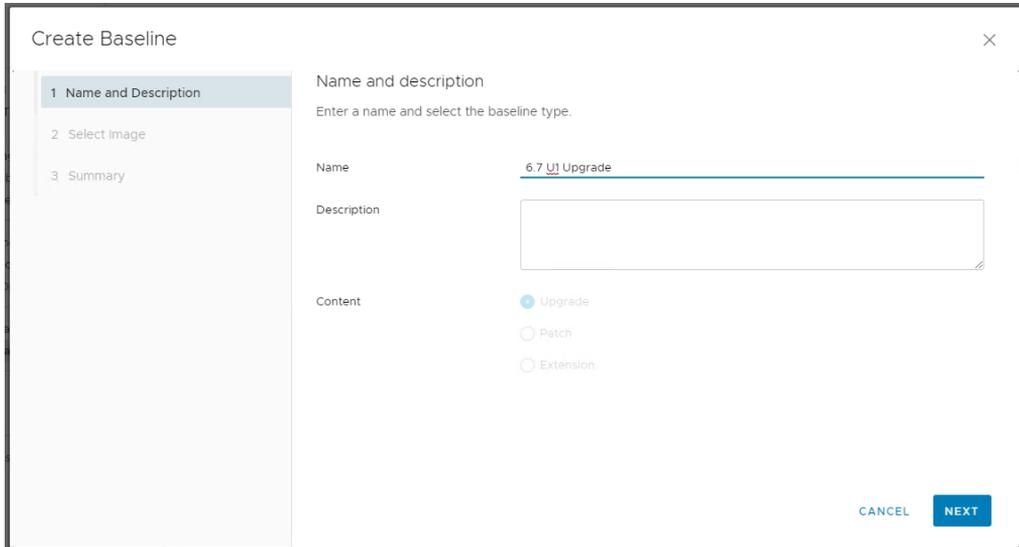


3. Click New Baseline to launch the wizard.

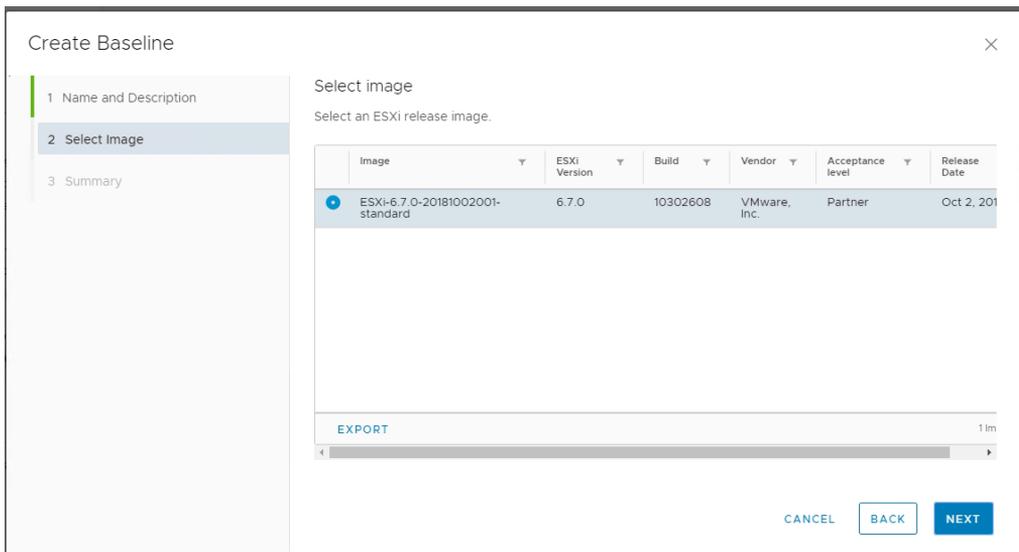


**EXERCISE 1.1 (continued)**

4. Enter a name for the baseline.



5. Select the ISO you uploaded.



## 6. Verify the settings and click Finish.

### Create Baseline

- 1 Name and Description
- 2 Select Image
- 3 Summary

#### Summary

Review your setting selections before finishing the wizard.

Baseline name	6.7 UI Upgrade
Baseline description	
Baseline type	Upgrade

#### ESXi Image

Name	ESXi-6.7.0-20181002001-standard
Product	VMware ESXi 6.7.0 Update 1
Version	6.7.0
Vendor	VMware, Inc.
Acceptance level	Partner

[CANCEL](#) [BACK](#) [FINISH](#)

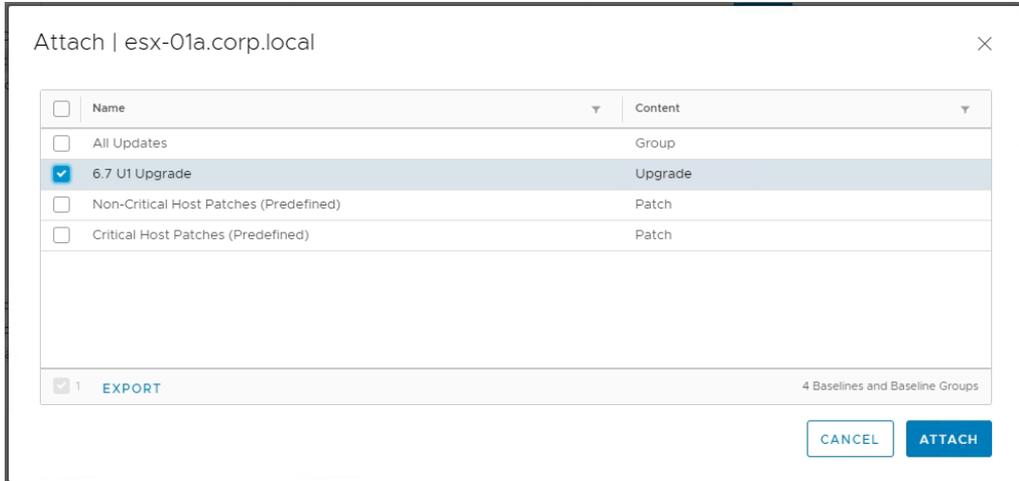
## 7. Open the Updates tab for your host and click Attach.

The screenshot shows the vSphere Client interface for a host named 'esx-01a.corp.local'. The 'Updates' tab is selected, displaying the 'Attached Baselines' section. The interface includes a navigation pane on the left, a top navigation bar, and a main content area with a table for attached baselines. The table is currently empty, and the 'ATTACH' button is visible.

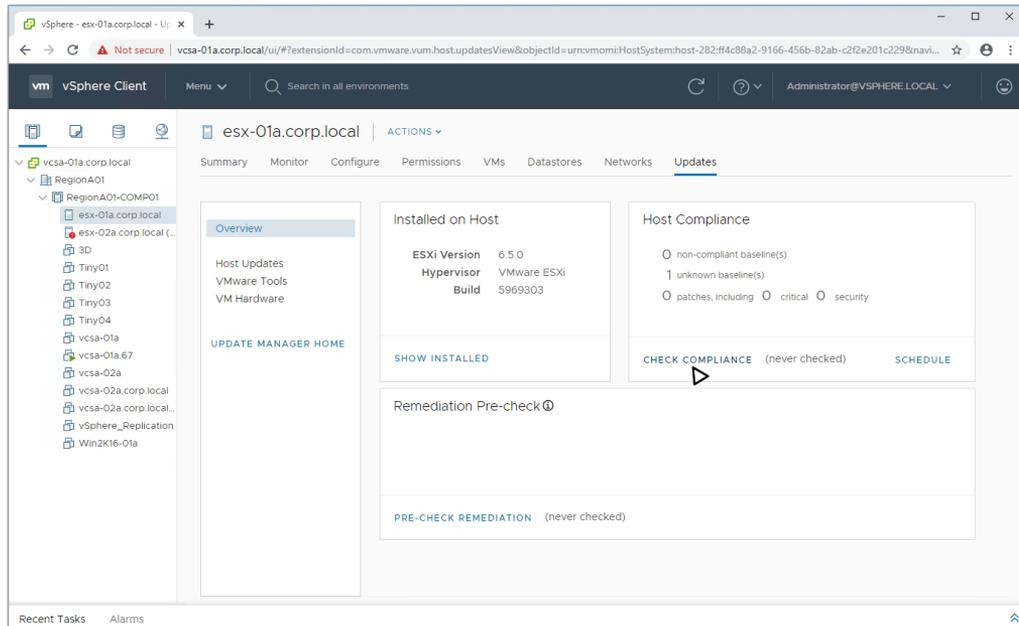
Recent Tasks    Alarms

**EXERCISE 1.1 (continued)**

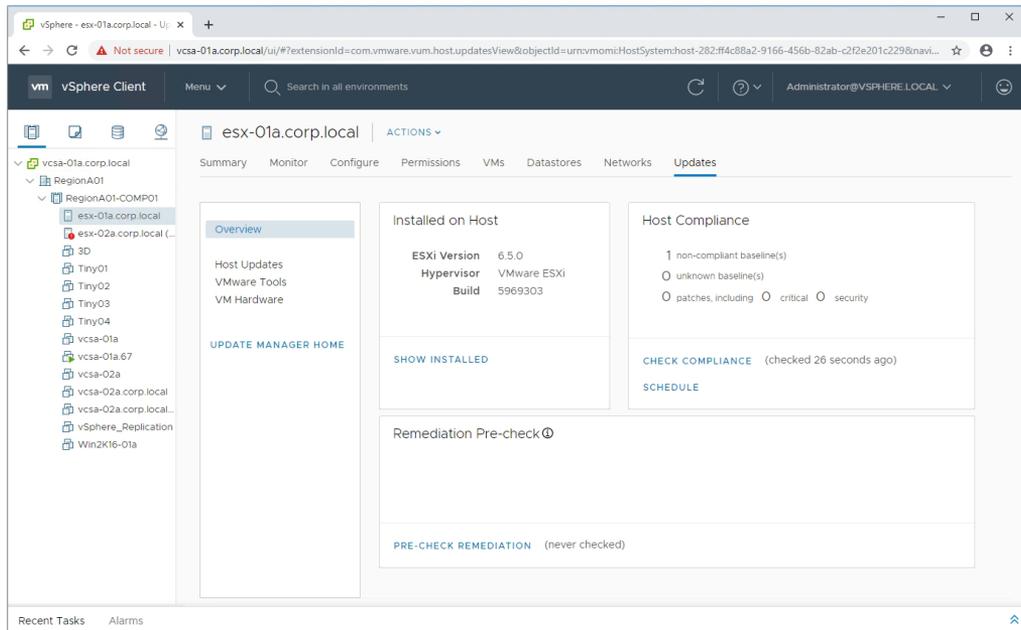
8. Select the new baseline you created and click Attach.



9. From the Overview section, click Check Compliance.



10. Note that it might take a few minutes for the Host Compliance to update. Assuming your host is not 6.7 U1, the host should report a noncompliant baseline.



The new-to-6.7 Quick Boot feature of ESXi ties into Update Manager. With Quick Boot, only the ESXi kernel is restarted when patches and updates are installed. Since the hardware, BIOS, and subsequent hardware checks are bypassed, rebooting ESXi is much faster.

You can see if your 6.7 hosts are compatible with Quick Boot in the Overview section of the Update Manager tab for the host, as shown in Figure 1.13.

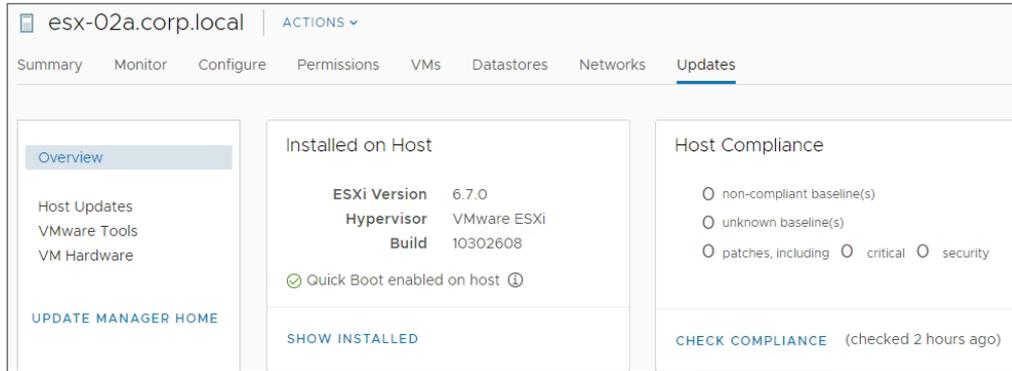
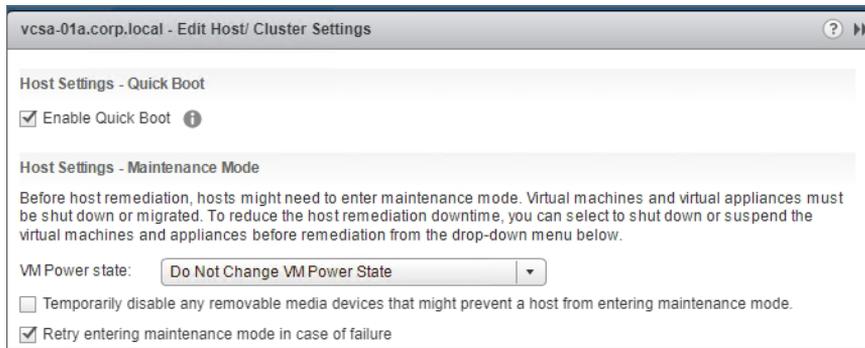
You can disable Quick Boot, but only in the Update Manager UI of the Flex client, as shown in Figure 1.14.

There is also a command-line script available on 6.7 hosts to check Quick Boot compatibility. The script will also list any incompatibilities if Quick Boot cannot be enabled.

```
[root@esx-02a:~] /usr/lib/vmware/loadesx/bin/loadESXCheckCompat.py
Congratulation - your system is compatible with loadESX
```

Per VMware KB article 52477, the following issues are among those that could prevent Quick Boot from being enabled:

- The host platform is not supported.
- The host is configured to use a TPM.
- A pass-through device is configured for VMs on your host.

**FIGURE 1.13** Viewing Quick Boot status of a 6.7 host**FIGURE 1.14** Disabling Quick Boot requires the Flex client.

- There are vmklinux drivers loaded on your host.
- There are other noncertified drivers loaded on your host.

Quick Boot is disabled in the Update Manager UI.

## Storage Updates

Several different storage components are either updated or brand-new for vSphere 6.7 and 6.7 U1. There is support for new hardware, a new way to see extremely high I/O, and several vSAN updates. While studying vSAN outside this book, make sure you are reading only up to U1 as VMware is continually adding new features and enhancements for vSAN.

## Persistent Memory

As costs come down and performance improves, the line between long-term storage, what used to be a spinning hard drive, and short-term storage (RAM) becomes closer. For the highest computing speeds, the closer you are to the CPU, the faster the storage should be; however, the faster the storage, the more expensive it is. The sticks of RAM in your server might cost 10 times more per GB than the solid-state drives that are holding the virtual machines.

While solid-state drives (SDDs) and the NVM Express (NVMe) interface have made long-term storage blazing fast, there is a new hardware family known as Persistent Memory (PMem) that takes the dynamic random access memory (DRAM) technology used for the system memory and adds battery backup and capacitors to ensure data is not lost during power cycles.



PMem is also called Non-Volatile Memory (NVM), or NVDIMM, and is the same technology as Intel's Optane, if you have seen references to that on desktop and laptop computers.

A 6.7 ESXi host will automatically create a PMem datastore if it detects compatible PMem hardware. VMs can use PMem either as Virtual Persistent Memory (vPEM) or as a Virtual Persistent Memory Disk (vPMemDisk).

Newer operating systems that are PMem-aware and built on VMs with hardware version 14 and above can be configured with vPEM. With vPEM, applications can reference the storage in byte addressable random mode, which allows more granular use of the PMem storage.

Any operating systems can leverage vPMemDisk, which will show up in the guest as a virtual SCSI device.

PMem does have some drawbacks. For starters, a VM leveraging vPEM can only be migrated to a host with PMem (you can migrate a VM with vPMemDisk to a host without PMem, but you'll lose the performance benefits). If you want to shut down a host with PMem, you'll need to migrate off all VMs utilizing PMem, even if they are powered off. You also lose snapshot and HA support for VMs with PMem configured.

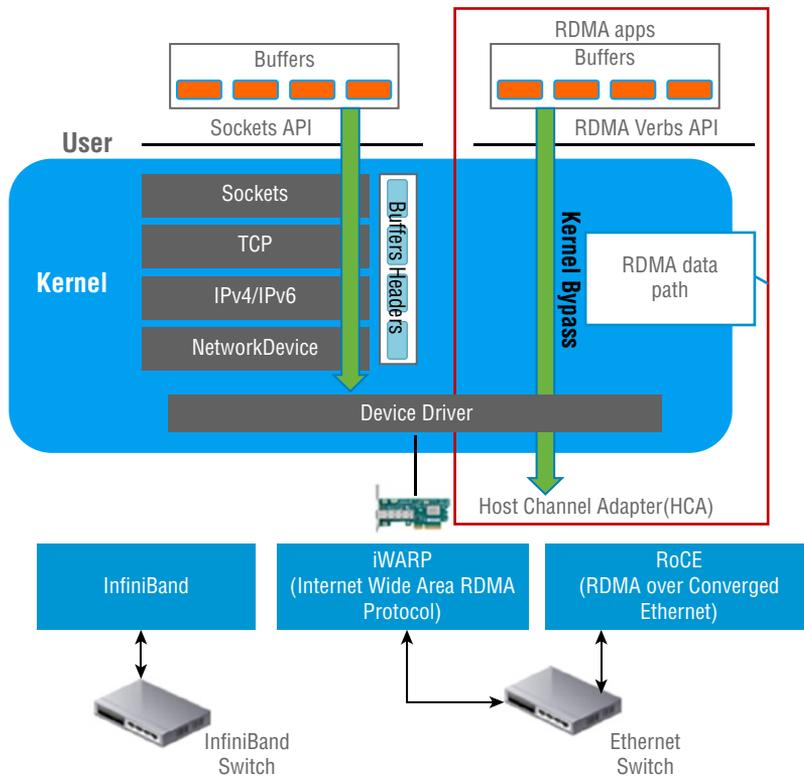
## Remote Direct Memory Access

Another technology released with 6.5 and updated with 6.7 is Remote Direct Memory Access, or RDMA. RDMA improves network performance between hosts (for SMP-FT, NFS, and iSCSI traffic) or between virtual machines for use cases such as high-performance computing or big data applications.

RDMA improves I/O for virtual machines through the use of paravirtualized network adapters (PVRDMAs). With a PVRDMA configured, the ESXi kernel's network stack is bypassed and the VM can talk directly to another VM configured with PVRDMA on the same host or directly to the hardware of the host if the remote VM is on a different host. See Figure 1.15.

While RDMA supports network technologies such as iWARP, Infiniband, and RoCE, VMware only supports RoCE (RDMA over Converged Ethernet). There are three transport nodes: memcopy (when two VMs are on the same host), TCP (between hosts without host channel adapters), and RDMA for hosts with host channel adapters.

**FIGURE 1.15** This graphic from VMware's white paper on RDMA shows the kernel bypass data path.



To take advantage of RDMA for your host's iSCSI connectivity, you will need to configure an iSCSI Extensions for RDMA (iSER) adapter. With an iSER adapter and RDMA-compatible NICs, you can see a significant performance boost for host storage traffic. You can enable iSER from the host's command line with the `esxcli` command:

```
esxcli rdma iser add
```

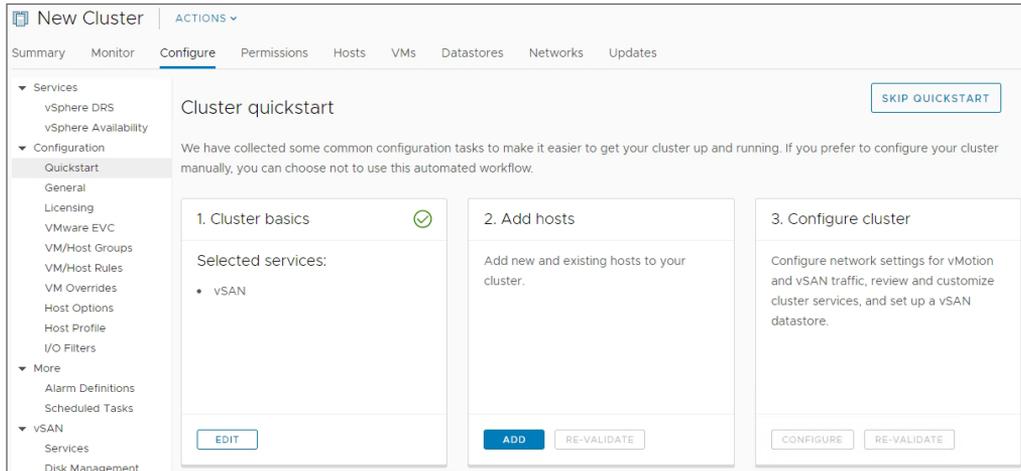
Once the adapter has been enabled, you configure and manage it just like a normal iSCSI adapter.

## vSAN

While many of the vSAN updates for 6.7 and 6.7 U1 are more “optimizations” and enhancements, there are a couple of features that could show up on the VCP exam, including new Microsoft cluster support, new device and security features, plus some new network features.

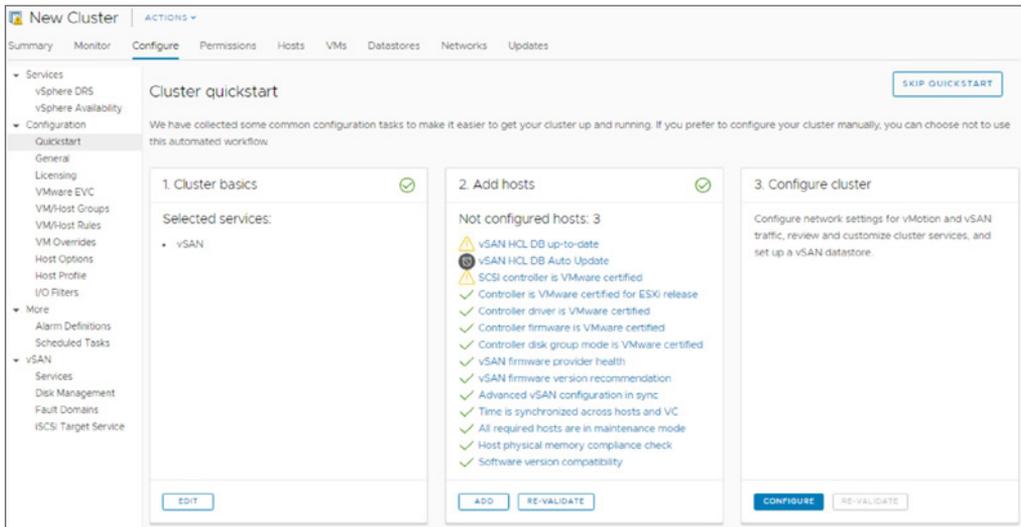
Setting up vSAN is easier now as there is a quickstart wizard for cluster creation, as seen in Figure 1.16.

**FIGURE 1.16** The quickstart guide will walk you through setting up a cluster.



Once you add hosts to a cluster, the quickstart guide will validate them for the services you have chosen for the cluster (HA, DRS, vSAN), as shown in Figure 1.17.

**FIGURE 1.17** This cluster shows a couple of warnings about its environment but is otherwise ready to go.



You can also use quickstart to add hosts to an existing cluster.

Another optimization with 6.7 is Adaptive Resync. This mechanism will balance the I/O requests between the four vSAN I/O queues (VM, Namespace, Resync, and Metadata). As the name implies, it's primarily to balance Resync I/O. During times of heavy VM I/O, when the hosts experience congestion, Adaptive Resync will prioritize VM traffic to ensure that resources perform optimally. When VM I/O is low, it will ensure that Resync traffic performs optimally.

Adaptive Resync looks at bandwidth congestion (a constant stream of data regarding each I/O's bandwidth) and backpressure congestion, which involves the queue length of each I/O class. With these inputs, the scheduler will balance the load, allowing maximum usage for each I/O class when there is no contention and limiting Resync I/O requests when there is contention.

To help storage efficiency, vSAN now fully supports TRIM/UNMAP commands sent by a guest OS. These commands (TRIM for ATA drives and UNMAP for SCSI) are used by the guest OS to indicate blocks of storage no longer in use. When vSAN receives the command, it can free up the underlying storage referenced by the guest. This can greatly improve the available storage in your vSAN cluster, especially for guests that have considerable disk usage.

With 6.7, vSAN now supports Microsoft's Windows Server Failover Clustering (WSFC). WSFC is available in Windows Server 2016 and 2019 and uses network connectivity to cluster multiple Windows servers together to improve availability and scalability. This is supported under vSAN by creating iSCSI targets and pointing the Windows guest software iSCSI adapter to those targets.

The final updates to mention for vSAN is the support for 4K Native Devices and FIPS 140-2 Level 1 Validation. 4K (or 4Kn) drives have a sector size of 4096 bytes, much larger than the 512-byte sector size of traditional drives (called 512n drives). Between sectors on a drive is a sector gap, and each sector needs room for an error correction code (ECC). With a larger sector size, the number of gaps is reduced, saving space for data.

Previously vSphere and vSAN supported 4K drives in emulated mode (512e), which helps with the space issue but comes with a performance hit compared to native 4K devices.

With vSphere 6.7, the VM Kernel Cryptographic Module used by vSAN's encryption setting has passed FIPS 140-2 validation. This is mostly important in the government datacenters that require solutions to carry this certification level. With the new validation, partners can build vSAN-based solutions that are FIPS certified to ensure that the highest standards of encryption are met.

## Security Updates

The FIPS validation mentioned in the last section makes a good segue into VM encryption, as the same VM Kernel Cryptographic Module that is used by vSAN is also leveraged by the virtual machine encryption feature. In addition to the new FIPS certification for VMs at