EXAM CRAM

220-901
220-902

PEARSON IT
CERTIFICATION

DAVID L. PROWSE

EXAM CRAM

CompTIA® A+

220-901 and 220-902

David L. Prowse

Pearson
800 East 96th Street
Indianapolis, Indiana 46240 USA

CompTIA® A+ 220-901 and 220-902 Exam Cram

ISBN-13: 978-0-7897-5631-2
ISBN-10: 0-7897-5631-5

Library of Congress Control Number: 2015956432

Printed in the United States of America

First Printing: January 2016

Trademarks

All terms mentioned in this book that are known to be trademarks or service marks have been appropriately capitalized. Pearson IT Certification cannot attest to the accuracy of this information. Use of a term in this book should not be regarded as affecting the validity of any trademark or service mark.

Warning and Disclaimer

Every effort has been made to make this book as complete and as accurate as possible, but no warranty or fitness is implied. The information provided is on an "as is" basis. The author and the publisher shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this book or from the use of the DVD or programs accompanying it.

Special Sales

For information about buying this title in bulk quantities, or for special sales opportunities (which may include electronic versions; custom cover designs; and content particular to your business, training goals, marketing focus, or branding interests), please contact our corporate sales department at corpsales@pearsoned.com or (800) 382-3419.

For government sales inquiries, please contact governmentsales@pearsoned.com.

For questions about sales outside the U.S., please contact international@pearsoned.com.

Associate Publisher
Dave Dusthimer

Acquisitions Editor
Betsy Brown

Development Editor
Eleanor C. Bru

Managing Editor
Sandra Schroeder

Senior Project Editor
Tonya Simpson

Copy Editor
Box Twelve Communications

Indexer
Lisa Stumpf

Proofreader
Chuck Hutchinson

Technical Editor
Chris Crayton

Publishing Coordinator
Vanessa Evans

Media Producer
Lisa Matthews

Cover Designer
Alan Clements

Compositor
Studio Galou

Contents at a Glance

Table of Contents

DVD Only:

Appendix B: Additional Reading and Resources
Practice Exam 1 Answers
Practice Exam 2 Answers
Practice Exam 3
Practice Exam 4
Exam Alerts
Cram Quizzes

About the Author

David L. Prowse is the author of more than a dozen computer training books and video products. He has worked in the computer field for 20 years and loves to share his experience through teaching and writing. He runs the website www.davidlprowse.com, where he gladly answers questions from readers and students.

Acknowledgments

Thanks to David Dusthimer, Betsy Brown, Eleanor Bru, and everyone else at Pearson who was involved in this project.

Special thanks to Chris Crayton, the best technical editor a person could ask for!

About the Technical Reviewer

Chris Crayton (MCSE) is an author, technical consultant, and trainer. Formerly, he worked as a computer technology and networking instructor, information security director, network administrator, network engineer, and PC specialist. Chris has authored several print and online books on PC repair, CompTIA A+, CompTIA Security+, and Microsoft Windows. He also has served as technical editor and content contributor on numerous technical titles for several of the leading publishing companies. Chris holds numerous industry certifications, has been recognized with many professional teaching awards, and has served as a state-level SkillsUSA competition judge.

We Want to Hear from You!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we're doing right, what we could do better, what areas you'd like to see us publish in, and any other words of wisdom you're willing to pass our way.

We welcome your comments. You can email or write to let us know what you did or didn't like about this book—as well as what we can do to make our books better.

Please note that we cannot help you with technical problems related to the topic of this book.

When you write, please be sure to include this book's title and author as well as your name and email address. We will carefully review your comments and share them with the author and editors who worked on the book.

Email: feedback@pearsonitcertification.com

Mail: Pearson IT Certification
ATTN: Reader Feedback
800 East 96th Street
Indianapolis, IN 46240 USA

Reader Services

Register your copy of *CompTIA A+ 220-901 and 220-902 Exam Cram* at www.pearsonitcertification.com for convenient access to downloads, updates, and corrections as they become available. To start the registration process, go to www.pearsonitcertification.com/register and log in or create an account*. Enter the product ISBN 9780789756312 and click Submit. Once the process is complete, you will find any available bonus content under Registered Products.

**Be sure to check the box that you would like to hear from us to receive exclusive discounts on future editions of this product.*

CompTIA

CompTIA A+

Becoming a CompTIA Certified IT Professional is Easy

It's also the best way to reach greater professional opportunities and rewards.

Why Get CompTIA Certified?

Growing Demand

Labor estimates predict some technology fields will experience growth of over 20% by the year 2020.* CompTIA certification qualifies the skills required to join this workforce.

Higher Salaries

IT professionals with certifications on their resume command better jobs, earn higher salaries and have more doors open to new multi-industry opportunities.

Verified Strengths

91% of hiring managers indicate CompTIA certifications are valuable in validating IT expertise, making certification the best way to demonstrate your competency and knowledge to employers.**

Universal Skills

CompTIA certifications are vendor neutral—which means that certified professionals can proficiently work with an extensive variety of hardware and software found in most organizations.

Learn

Learn more about what the exam covers by reviewing the following:

- Exam objectives for key study points.
- Sample questions for a general overview of what to expect on the exam and examples of question format.
- Visit online forums, like LinkedIn, to see what other IT professionals say about CompTIA exams.

Certify

Purchase a voucher at a Pearson VUE testing center or at CompTIAstore.com.

- Register for your exam at a Pearson VUE testing center:
- Visit pearsonvue.com/CompTIA to find the closest testing center to you.
- Schedule the exam online. You will be required to enter your voucher number or provide payment information at registration.
- Take your certification exam.

Work

Congratulations on your CompTIA certification!

- Make sure to add your certification to your resume.
- Check out the CompTIA Certification Roadmap to plan your next career move.

Learn more: **Certification.CompTIA.org/aplus**

* Source: CompTIA 9th Annual Information Security Trends study: 500 U.S. IT and Business Executives Responsible for Security
** Source: CompTIA Employer Perceptions of IT Training and Certification

Introduction

Welcome to the *CompTIA A+ Exam Cram*, Seventh Edition. This book prepares you for the CompTIA A+ 220-901 and 220-902 certification exams. Imagine that you are at a testing center and have just been handed the passing scores for these exams. The goal of this book is to make that scenario a reality. My name is David L. Prowse, and I am happy to have the opportunity to serve you in this endeavor. Together, we can accomplish your goal to attain the CompTIA A+ certification.

Target Audience

The CompTIA A+ exams measure the necessary competencies for an entry-level IT professional with the equivalent knowledge of at least 12 months of hands-on experience in the lab or field.

This book is for persons who have experience working with desktop computers and mobile devices and want to cram for the A+ certification exam—*cram* being the key word. This book does not cover everything in the computing world; how could you in such a concise package? However, this guide is fairly thorough and should offer you a lot of insight…and a whole lot of test preparation.

If you do not feel that you have the required experience, have never attempted to troubleshoot a computer, or are new to the field, then I recommend the following:

- Attend a hands-on A+ class with a knowledgeable instructor.
- Consider purchasing the *CompTIA A+ Cert Guide*, which goes into much more depth than this text. On a side note, another great reference book that should be on every computer technician's shelf is the latest edition of *Upgrading and Repairing PCs* by Scott Mueller.

Essentially, three types of people will read this book: those who want a job in the IT field, those who want to keep their job, and those who simply want a basic knowledge of computers and want to validate that knowledge. For those of you in the first group, the new CompTIA A+ certification can have a positive career impact, increasing the chances of securing a position in the IT world. It also acts as a stepping stone to more advanced certifications. For those in the second group, preparing for the exams serves to keep your skills

sharp and your knowledge up-to-date, helping you to remain a well-sought-after technician. For those of you in the third group, the knowledge within this book can be very beneficial to just about any organization you might work for—as long as that organization uses computers!

Regardless of your situation, one thing to keep in mind is that I write my books to teach you how to be a well-rounded computer technician. While the main goal for this book is to help you become A+ certified, I also want to share my experience with you so that you can grow as an individual.

A person might be tempted to purchase this book solely for the practice exams, but I recommend against studying the practice questions *only*. This book was designed from the ground up to build your knowledge in such a way that when you get to the practice exams, they can act as the final key to passing the real exams. The knowledge in the chapters is the cornerstone, whereas the practice exam questions are the battlements. Complete the entire book and you will have built yourself an impenetrable castle of knowledge.

About the CompTIA A+ 220-901 and 220-902 Exams

This book covers the CompTIA A+ 220-901 and 220-902 exams. There are quite a few changes and additions to these versions of the A+ exams including the following:

- Increased content concerning the troubleshooting of hardware and software.
- Troubleshooting questions are to be found in *both* exams.
- Addition of Windows 8 and 8.1 content.
- Windows XP operating system has been removed.
- OS X and Linux operating system basics have been added.
- Content on mobile devices, such as tablets and smartphones, has been increased.
- Increased performance-based questions where you will be required to answer questions within simulated computer environments, drag-and-drop scenarios, and other performance-related settings.

This book covers all these changes and more within its covers.

For more information about how the A+ certification can help your career, or to download the latest official objectives, access CompTIA's web page at http://certification.comptia.org/.

About This Book

This book is organized into 20 chapters, each pertaining to particular objectives on the exam. Because the official CompTIA objectives can have long names that sometimes deal with multiple subjects, the chapters are divided into more manageable (and memorable) topics. All the questions in this book refer to these topics. Chapter topics and the corresponding CompTIA objectives are listed in the beginning of each chapter.

For the most part, the exam topics in this book are structured to build on one another. Because of this, you should read this entire book in order to best prepare for the CompTIA A+ exams. If you want to review a particular topic, those topics are listed at the end of this introduction. In addition, you can use the index or the table of contents to quickly find the concept you are after.

Chapter Format and Conventions

Every Exam Cram chapter follows a standard structure and contains graphical clues about important information. The structure of each chapter includes the following:

- **Opening topics list:** This defines the topics to be covered in the chapter; it also lists the corresponding CompTIA A+ objective numbers.
- **Topical coverage:** The heart of the chapter, this explains the topics from a hands-on and a theory-based standpoint. This includes in-depth descriptions, tables, and figures geared to build your knowledge so that you can pass the exam. The chapters are broken down into between two and five topics each.
- **Cram Quiz questions:** At the end of each topic is a quiz. The quizzes, and ensuing explanations, are meant to gauge your knowledge of the subjects. If the answers to the questions don't come readily to you, consider reviewing individual topics or the entire chapter. In addition to being in the chapters, you can find the Cram Quiz questions on the disc. The questions are separated into their respective 220-901 and 220-902 categories for easier studying when you approach the exam.

- **Exam Alerts, Sidebars, and Notes:** These are interspersed throughout the book. Watch out for them!

ExamAlert

This is what an Exam Alert looks like. An alert stresses concepts, terms, hardware, software, or activities that are likely to relate to one or more questions on the exam.

Additional Elements

Beyond the chapters, there are a few more elements that I've thrown in for you. They include

- **Practice Exams:** These are located directly after Chapter 20 within the book. There is one for each CompTIA A+ exam. These exams (and additional exams) are available on the disc as well. They are designed to prepare you for the multiple-choice questions that you will find on the real CompTIA A+ exams.
- **Real-World Scenarios:** These are located after the two practice exams. They describe actual situations with questions that you must answer. Their solutions can be found on the disc in the form of videos and computer simulations. They are designed to help prepare you for the performance-based questions within the real CompTIA A+ exams.
- **Cram Sheet:** The tear-out Cram Sheet is located in the beginning of the book. This is designed to jam some of the most important facts you need to know for the exam into one small sheet, allowing for easy memorization. It is also in PDF format on the disc. If you have an e-book version, this might be located at the end of the e-book.

The Hands-On Approach

This book refers to two different computers as the following:

- ***AV Editor*:** I built this desktop computer for this seventh edition in July of 2015. It is an Intel Core i7 system and is designed to act as a powerful audio/video editing workstation.
- ***Media PC*:** I built this desktop computer for the previous edition in January 2012. It is an Intel Core i5 system.

> **Note**
>
> Previous editions of this book included a computer known as *Tower PC*. It was built in 2009 and, as such, is based on older technologies. It has been removed from this edition of the book, but information about it can be found at my website: www.davidlprowse.com.

I built both *A/V editor* and *Media PC* using components that are a good example of what you will see in the field today and for a while to come. These components are representative of the types of technologies that will be covered in the exams. I refer to the components in these systems from Chapter 2, "Motherboards," onward. I like to put things into context whenever possible. By referencing the parts in the computer during each chapter, I hope to infuse some real-world knowledge and to solidify the concepts you need to learn for the exam. This more hands-on approach can help you to visualize concepts better. I recommend that every computer technician build their own PC at some point (if you haven't already). This can help to reinforce the ideas and concepts expressed in the book.

You should also work with multiple systems while going through this book: one with Windows 8, one with Windows 7, and one with Windows Vista. (Not to mention OS X, Linux, Android, and iOS.) Or you might attempt to create a dual-boot or three-way-boot on a single hard drive. Another option is to run one computer with one of the operating systems mentioned and virtual machines running the other operating systems. However, if at all possible, the best way to learn is to run individual computers. This will ensure that you discover as much as possible about the hardware and software of each computer system and how they interact with each other.

This book frequently refers to various ancillary websites, most notably:

- **Microsoft TechNet:** http://technet.microsoft.com
- **Microsoft Support:** http://support.microsoft.com
- **Android OS Help:** https://support.google.com/android
- **Apple Support:** https://www.apple.com/support

As an IT technician, you will be visiting these sites often; they serve to further illustrate and explain concepts covered in this text.

Goals for This Book

I have three main goals in mind while preparing you for the CompTIA A+ exams.

My first goal is to help you understand A+ topics and concepts quickly and efficiently. To do this, I try to get right to the facts necessary for the exam. To drive these facts home, the book incorporates figures, tables, real-world scenarios, and simple, to-the-point explanations. Also, in Chapter 20, you can find test-taking tips and a preparation checklist that gives you an orderly, step-by-step approach to taking the exam. Be sure to complete every item on the checklist! For students of mine who truly complete every item, there is an extremely high pass rate for the exams.

My second goal for this book is to provide you with an abundance of *unique* questions to prepare you for the exam. Between the Cram Quizzes and the practice exams, that goal has been met, and I think it will benefit you greatly. Because CompTIA reserves the right to change test questions at any time, it is difficult to foresee exactly what you will be asked on the exam. However, to become a good technician, you must know the *concept*; you can't just memorize questions. To this effect, each question has an explanation and maps back to the topic (and chapter) covered in the text. I've been using this method for more than a decade with my students (more than 2,000 of them) and with great results.

My final goal is to provide support for this and all my titles, completing the life cycle of learning. I do this through my personal website (www.davidlprowse.com), which has additional resources for you, including an errata page (which you should check as soon as possible), and is set up to take questions from you about this book. I'll try my best to get to your questions ASAP. All personal information is kept strictly confidential.

Good luck in your certification endeavors. I hope you benefit from this book. Enjoy!

Sincerely,

David L. Prowse

www.davidlprowse.com

Exam Topics

Table I.1 lists the exam topics covered in each chapter of the book.

TABLE I.1 **Exam Cram CompTIA A+ Exam Topics**

Exam Topic	Chapter
The Six-Step A+ Troubleshooting Process	1
Troubleshooting Examples and PC Tools	
Motherboard Components and Form Factors	2
The BIOS/UEFI	
Installing and Troubleshooting Motherboards	
CPU 101	3
Installing and Troubleshooting CPUs	
RAM Basics and Types of RAM	4
Installing and Troubleshooting DRAM	
Understanding and Testing Power	5
Power Devices	
Power Supplies	
Hard Drives	6
RAID	
Optical Storage Media	
Solid State Storage Media	
Installing, Configuring, and Troubleshooting Visible Laptop Components	7
Installing, Configuring, and Troubleshooting Internal Laptop Components	
Understanding Tablet and Smartphone Hardware	
Installing and Upgrading to Windows 8	8
Installing and Upgrading to Windows 7	
Installing Windows Vista	
Windows User Interfaces	9
System Tools and Utilities	
Files, File Systems, and Drives	
Updating Windows	10
Maintaining Hard Drives	
Repair Environments and Boot Errors	11
Windows Tools and Errors	
Command-Line Tools	

Exam Topic	Chapter
The Video Subsystem	12
The Audio Subsystem	
Input/Output Devices, and Peripherals	13
Custom PC Configurations	
Printer Types and Technologies	14
Installing, Configuring, and Troubleshooting Printers	
Types of Networks, Network Devices, and Cloud Technology	15
Cables, Connectors, and Tools	
TCP/IP	
SOHO and Windows Networking	16
Troubleshooting Networks	
Security Threats and Prevention	17
Desktop Operating System Security	
SOHO Security	
Android and iOS Basics	18
Android/iOS Networking and Synchronization	
Android/iOS Security and Additional Troubleshooting	
OS X and Linux	
Safety	19
Procedures and Environmental Controls	
Professionalism and Communication Skills	
Getting Ready and the Exam Preparation Checklist	20
Tips for Taking the Real Exam	
Beyond the CompTIA A+ Certification	

This page intentionally left blank

CHAPTER 13

Peripherals and Custom Computing

This chapter covers the following A+ exam topics:

- Input/Output, Input Devices, and Peripherals
- Custom PC Configurations

You can find a master list of A+ exam topics in the "Introduction."

This chapter covers the CompTIA A+ 220-901 objectives 1.4, 1.7, 1.9, 1.11, 1.12, 3.1, and 3.2.

The computer is built, the OS is installed, and video is configured. Now let's discuss the devices and peripherals we add on to the computer, the ports they connect to, as well as some custom PC configurations you will undoubtedly encounter in the field.

Input/Output, Input Devices, and Peripherals

To take advantage of a computer, the appropriate input/output devices and peripherals must be connected to the proper input/output (I/O) ports. Keyboards, mice, and multimedia devices can be connected to a variety of ports. This section briefly describes those devices and the ports they connect to.

I/O Ports

I/O ports enable a user to input information by way of keyboard, mouse, or microphone; plus they enable the output of information to printers, monitors, USB devices, and so on. The CompTIA A+ exams require you to describe USB, IEEE 1394 (FireWire), and Thunderbolt ports, as well as Bluetooth technology. The most common of these by far is USB.

USB

USB ports are used by many devices, including keyboards, mice, printers, flash drives, cameras, and much more. The USB port enables data transfer between the device and the computer and usually powers the device as well. The speed of a USB device's data transfer depends on the version of the USB port, as shown in Table 13.1.

TABLE 13.1 **Comparison of USB Versions**

USB Version	Name	Data Transfer Rate
USB 1.0	Low-Speed	1.5 Mb/s
USB 1.1	Full-Speed	12 Mb/s
USB 2.0	High-Speed	480 Mb/s
USB 3.0	SuperSpeed	5.0 Gb/s
USB 3.1	SuperSpeed+	10.0 Gb/s

USB 1.0 and 1.1 are deprecated. If you encounter an older computer that has only these ports, consider installing a USB adapter card that adheres to a higher version of USB.

ExamAlert

Memorize the specifications for USB; focus on USB 2.0 and higher.

A computer can have a maximum of 127 USB devices. However, most computers are limited to a maximum of a dozen ports or so. To add devices beyond this, a USB hub can be used, but no more than five hubs can be in a series of USB devices. All cables connecting USB devices must comply with their standard's maximum length. USB version 1.1 cables are limited to 3 meters in length (a little less than 10 feet), and USB version 2.0 cables can be a maximum length of 5 meters (a little more than 16 feet). Maximum recommended USB 3.0/3.1 length is 3 meters. The standard USB cable has four pins: a +5 V pin for power, a positive data pin, a negative data pin, and a ground pin. Most USB connections are half-duplex, meaning that the device can send or receive data but cannot send and receive data simultaneously.

There are various plugs used for the different types of USB connections. The most common are Type A and Type B, which are 4-pin connectors, but there are also mini- and micro-connectors, which are 5-pin. Type A connectors are the type you see on the back of a computer or on the side of a laptop. Figure 13.1 displays an illustration of these connectors.

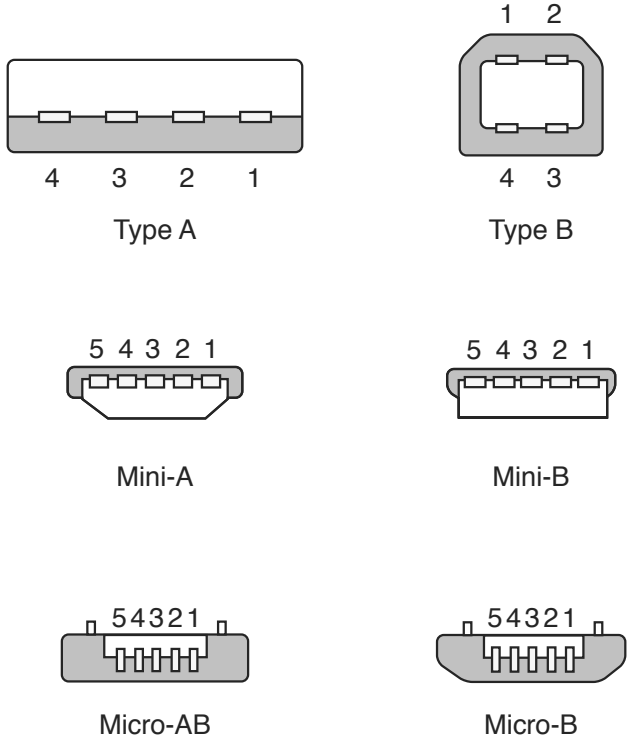

FIGURE 13.1 **USB connectors**

Type A and Type B connectors are commonly used for printers and other larger devices. Mini- and micro-connectors are often used for handheld computers, smartphones, mice, digital cameras, portable music players, and cell phones. However, some companies create proprietary cables and connectors for their devices based off of the USB specifications. These devices will not connect properly to Type A, Type B, and mini- or micro-connectors.

> **Note**
>
> As of the writing of this book, a newer USB plug (Type C) has been developed. It is about a third the size of a Type A plug and works well in conjunction with the USB 3.1 standard.

You can't put a square peg in a round hole (normally). Sometimes you need to make a connection but the devices and/or cables don't match up, so you'll need an adapter—and there are adapters for virtually everything you might want to do. Let's say you need to make a connection to a USB Type B connector from a USB Type A connector, or you need to connect from USB to RJ45, or you need to connect from a USB to the older PS/2 connector—well, there are adapters for all of those situations and more. Most PC technicians will carry a variety of adapters with them just in case the need arises. Something to think about for your PC toolkit.

Historically, a USB device was designed to be a host or a slave. The host is in charge of initiating data transfers (for example, a PC). However, USB version 2.0 introduced on-the-go (OTG), which enables a device to act as both a host and a slave. This is more common in handheld computers and smartphones (devices that connect with either mini- or micro-plugs).

USB devices connect to what is known as a root hub, regardless of whether they are USB version 1.1, 2.0, or 3.0 devices. The USB devices, root hub, and host controllers can be viewed from within Windows in a couple ways:

- **Device Manager:** Within Device Manager, click Universal Serial Bus Controllers to expand it. The root hub and controllers are listed within. Individual devices will be listed under such categories as Human Interface Devices.
- **System Information:** Open System Information by opening the Run prompt and typing **`msinfo32`**. Expand Components, and then select USB.

Windows offers a disk-caching component called ReadyBoost. This uses flash-based memory such as USB flash drives and SD cards to cache information for the OS at high speeds. The cache can be as much as 32 GB in size on one device or 256 GB in size if spread across multiple devices. For USB flash drives, this technology works best at USB 3.0 speeds (or higher).

When troubleshooting USB devices, keep a few things in mind:

- **Verify that USB is enabled in the BIOS/UEFI:** It is possible to enable/disable USB within the BIOS. Keep this in mind when troubleshooting USB devices that are not functioning whatsoever. The user might have inadvertently set this to disabled or perhaps the computer was shipped in that state.
- **Make sure the computer is running the correct version of USB:** For example, if the computer is USB 3.0-compliant from a hardware standpoint, make sure it is running USB 3.0 on the software side. Some versions of Windows need to be updated to communicate at the latest USB speeds. This update makes a huge difference in the speed of data transfer. Sometimes Windows informs the user that an update to USB is available and that the USB devices work faster if this update is completed. In other cases, a USB firmware update for the motherboard is needed.
- **Check the version of the USB port:** For example, if a device can run at USB 3.0, make sure it isn't connected to a USB 2.0 (black port), because that will cause the device to run at USB 2.0 speeds. If it is connected to a slower port, be sure to connect it to a USB 3.0 (blue) port.
- **Verify connectivity:** Make sure the device is plugged in and that it is using the correct cable. Some incompatible USB plugs might look similar to the correct plug and might even connect to a device.

When removing USB devices from a computer, remember to disable them in the Notification Area before disconnecting them. Do this by right-clicking on the Safely Remove Hardware and Eject Media icon and selecting Eject. This will avoid damage to a USB device (for example, corruption to the USB flash drive). If you cannot disable it in the system, power down the computer and then disconnect them. For more information about USB, visit http://www.usb.org.

One of the problems with USB is that it suffers from latency. Due to this fact, users who work with audio and video prefer a zero-latency connection, such as IEEE 1394.

IEEE 1394

The Institute of Electrical and Electronics Engineers (IEEE) is a nonprofit organization that creates standards regarding cables and connectors and other technology related to electricity. One common standard is IEEE 1394, also referred to as FireWire (a deprecated Apple standard replaced by Thunderbolt). It is a port used for devices that demand the low-latency transfer of data in real time, such as music or video devices. Up to 63 devices can be powered by a computer, with no more than 16 devices per chain. Table 13.2 describes some of the IEEE 1394/FireWire versions.

TABLE 13.2 **Comparison of IEEE 1394/FireWire Versions**

IEEE 1394 Version	Data Transfer Rate	Connector Type	Cable Length Between Devices
IEEE 1394a	400 Mb/s	4-conductor and 6-conductor	4.5 meters (15 feet)
IEEE 1394b	800 Mb/s	9-conductor	10 meters (100 meters with Category 5e cable)

ExamAlert

Know the specifications for IEEE 1394a (FireWire 400) and 1394b (FireWire 800).

Thunderbolt

Thunderbolt is a high-speed hardware interface developed by Intel. As of the writing of this book, this is used primarily by Apple computers. It combines elements of PCI Express and DisplayPort technologies. Versions 1 and 2 use the Mini DisplayPort connector and version 3 uses the USB Type-C connector. Cables used with Thunderbolt should be no more than 3 meters (copper) and 60 meters (optical).

Thunderbolt 2 gives you access to the latest 4K monitors. In fact, with the Mac Pro, you can connect up to three 4K displays at once. And because Thunderbolt is based on DisplayPort technology, it provides native support for the Apple Thunderbolt Display and Mini DisplayPort displays. DVI, HDMI, and VGA displays connect through the use of adapters.

Thunderbolt can be used to transfer data at high rates to external storage devices or to displays (or both; up to six devices can be daisychained, meaning wired together in sequence). If you look at the ports of the computer and see the thunderbolt icon next to the Mini DisplayPort port, then it is meant to be used for data transfer to peripherals. If you see a display icon, then it

can be used with a monitor. While you can physically connect a Thunderbolt device to a Mac with DisplayPort, the device will not work, but if you connect a DisplayPort device to a Mac with Thunderbolt, the device will work. Table 13.3 describes the different versions of Thunderbolt.

TABLE 13.3 **Comparison of Thunderbolt Versions**

Thunderbolt Version	Data Transfer Rate	Connector Type	PCI Express Version Required
Version 1	10 Gb/s	DisplayPort	Version 2.0
Version 2	20 Gb/s	DisplayPort	Version 2.0
Version 3	40 Gb/s	USB Type-C	Version 3.0

ExamAlert

Know the Thunderbolt versions, speeds, and connection types.

If a desktop computer doesn't come with a Thunderbolt connector, you can add a Thunderbolt adapter card, which can facilitate the use of high-speed, large-capacity storage devices and other technologies. There are also adapters that connect Thunderbolt to USB 3.0 and eSATA. On the video side, there are adapters that allow Thunderbolt to be changed over to DVI or to HDMI. As mentioned before, there are adapters for everything. If you can dream it up, it probably already exists.

PS/2

The PS/2 connector is used for connecting keyboards and mice to a desktop computer or laptop. The PS/2 port was originally introduced in the late 1980s as part of IBM's Personal System/2 computer. Keyboards and mice connect via a 6-pin Mini-DIN connector. In the PC 99 color scheme, PS/2 keyboard ports are purple and PS/2 mouse ports are green.

Although PS/2 had almost a 20-year run, these connectors are less common on new computers; they were the standard until USB became popular. However, like the older DB15 VGA port, you might see them for backward compatibility. For example, the *AV Editor* computer's motherboard has a single PS/2 port.

Bluetooth

Moving on to a wireless option for peripherals: Bluetooth is a short-range, low-speed wireless network primarily designed to operate in peer-to-peer

mode (known as ad hoc) between PCs and devices such as printers, projectors, smartphones, mice, keyboards, and so on. It can be used with gaming consoles and by connecting a smartphone to a car's technology system or to a smart TV.

Bluetooth runs in virtually the same 2.4 GHz frequency used by IEEE 802.11b, g, and n wireless networks, but it uses a spread-spectrum frequency-hopping signaling method to help minimize interference. Bluetooth devices connect to each other to form a personal area network (PAN).

Some systems and devices include integrated Bluetooth adapters, and others need a Bluetooth module connected to the USB port to enable Bluetooth networking. Bluetooth devices must first be paired before they can be used together.

Bluetooth version 1.2 offers a data transfer rate of 1 Mb/s. Version 2 is rated at 3 Mb/s. Version 3 has theoretical speeds of up to 24 Mb/s, but it does so by combining with 802.11 technology. Bluetooth is divided into classes, each of which has a different range. Table 13.4 shows these classes, their ranges, and the amount of power their corresponding antennae use to generate signal.

TABLE 13.4 **Bluetooth Classes**

Class	mW	Range
Class 1	100 mW	100 meters (328 ft.)
Class 2	2.5 mW	10 meters (33 ft.)
Class 3	1 mW	1 meter (3 ft.)

As you can see, Class 1 generates the most powerful signal and has the largest range. The most common Bluetooth devices are Class 2 devices, with a range of 10 meters. Examples of this include portable printers, headsets, and computer dongles that connect to USB ports and allow the PC to communicate with other Bluetooth-enabled devices.

Input, Output, and Hybrid Devices

I/O devices (also called peripherals) can be used solely to input information, to output information, or to act as a hybrid of the two. Let's start with the types of devices used to input information and the various peripherals a technician might see in the field.

The usual suspects include the keyboard, for typing information in Windows or other OS, and the mouse, for manipulating the GUI. These two are

known as human interface devices (HID). Some other devices that you might not have worked with yet include touchpads, digital cameras, web cameras, microphones, biometric devices, bar code readers, and MIDI devices. Table 13.5 describes these devices.

TABLE 13.5 **Description of Various Input Devices and Peripherals**

Device	Description	Types and Connections
Keyboard	Used to type text and numbers into a word processor or other application.	101-key keyboard is standard, USB, PS/2, and wireless connections.
Mouse	Used to control the GUI; works in two dimensions. Might have two or more buttons and a scroll wheel to manipulate the OS. The Buttons tab in Mouse Properties is used to change which buttons act as the primary and alternative click buttons.	Optical mouse, USB, PS/2, and wireless connections.
Touchpad	Device used on a laptop to control the cursor on the screen.	These are often integrated to the laptop but can also be connected externally via USB or Wi-Fi.
Motion sensor	Device used with PCs, Macs, and gaming consoles to allow a user to control the computer by swiping, grabbing, pinching, and so on in mid-air.	Often connected via USB or Wi-Fi, these are controlled with infrared technology. Some devices can also be controlled with voice activation.
Digital cameras/ Camcorders	Takes still photographs and/or video using an electronic image sensor. Images are displayed on-screen and can be saved to solid-state media such as SD cards and CompactFlash.	Can be a single device or integrated into smartphones/tablets. Can connect to the PC via USB or Wi-Fi.
Web cameras (webcam)	Enables a user to monitor other areas of a home or building, communicate via video telephony, and take still images.	Can connect to a PC via USB, to a LAN via RJ45, or via Wi-Fi.
Scanner	Used to optically scan images and other objects and convert them into digital images to be stored on the computer.	Can connect via USB, and IEEE 1394, or via Wi-Fi.
Microphones	Enables users to record their voices or other sounds to the computer. Common usages are webcasts, podcasts, for voice-overs while screen capturing, and for gaming.	Can connect to a PC via 1/8-inch (3.5 mm) mini-jack (sound card) or via USB.

Device	Description	Types and Connections
Biometric devices	Provides access to systems based on a particular physical characteristic of a user. Used for authentication purposes (for example, a fingerprint reader).	Can be integrated to the PC or can be connected via USB, Wi-Fi, or connected to the network.
Barcode readers	Reads barcodes (for example, linear barcodes, 2D barcodes, Post Office barcodes, and such). After physical installation, they need to be programmed to understand these codes.	Connects to the PC via USB, Wi-Fi, PS/2, or might be integrated into handheld computers and smartphones.
Smart card reader	Device that accepts smart cards used for authentication and data storage.	Can be integrated as a slot (for, example to a laptop). Also available in USB versions.
Musical Instrument Digital Interface (MIDI) devices	Enables computers, music keyboards, synthesizers, digital recorders, samplers, and so on to control each other and exchange data.	Uses a 5-pin DIN Connector.
Gamepads and joysticks	Gamepads are game controllers made famous by Nintendo, PlayStation, and Xbox; there are also gamepads for PCs. Joysticks are often used for flight simulator games.	Connects via USB Type A connections. Older versions used the 15-pin gaming port on a sound card.

Troubleshooting any of the devices in Table 13.5 is usually quite easy. Make sure that the device is connected properly to the computer (or has a working wireless connection) and verify within the Device Manager that the latest drivers are installed for the device. Then find out if any additional software is necessary for the device to function. Portions of the software might have to be installed to the device and to the OS.

Keyboards and mice can be especially troublesome. Keyboard errors are commonly caused by jammed keys and defective cables or cable connectors. A common mouse issue is when the cursor jumps around the screen. This could be due to an incorrect mouse driver or perhaps the mouse is on an uneven or nonreflective surface. Also, you might encounter a mouse that stops working after a computer comes out of sleep mode. Make sure that Windows is updated and that the correct and latest driver is being used for the mouse. Use the associated Control Panel apps to troubleshoot the device. Calibrate the device and/or synchronize the device to the system as necessary.

The main output devices you should know for the exams are display devices and speakers (covered in Chapter 12) and printers (to be discussed in Chapter 14). Because they are covered in those chapters, we will not discuss them here.

A few of the hybrid devices you will encounter are touchscreens, KVMs, smart TVs, and set-top boxes. Table 13.6 describes those in brief.

TABLE 13.6 **Description of Hybrid I/O Devices**

Device	Description	Types and Connections
Touchscreen	A video display that detects the presence of either a finger, stylus, or light pen that enables interaction with the OS. It incorporates a digitizer (the input portion of the device) that converts the tapping on the screen into digital functions.	Used in tablet PCs, AIO PCs, smartphones, and drawing tablets.
KVM switch	Enables a user to control two or more computers from one Keyboard, Video display, and Mouse (KVM).	Passive: works off computer's USB power Active: plugs into an AC outlet.
Smart TV	Combines the functionality of a television with Internet features and streaming of media.	Users can interact with the TV by inputting information via keyboard, gamepad, or remote control.
Set-top box (STB)	Device used by cable TV and satellite-based TV providers to allow access to digital (and possibly encrypted) television stations. Also used as a hybrid device that combines conventional TV with Internet technologies.	These often manifest themselves as small computers offering two-way communications over TCP/IP networks.

Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

220-901 Questions

1. What is the data transfer rate (speed) of USB 3.0?

- ❍ **A.** 12 Mb/s
- ❍ **B.** 400 Mb/s
- ❍ **C.** 480 Mb/s
- ❍ **D.** 5 Gb/s

2. What is the maximum number of USB devices a computer can support?

- ❍ **A.** 4
- ❍ **B.** 63
- ❍ **C.** 127
- ❍ **D.** 255

3. Which type of USB connector is normally found on a desktop PC or laptop?

- ❍ **A.** Type A
- ❍ **B.** Type B
- ❍ **C.** Type C
- ❍ **D.** Type D

4. What is the maximum data transfer rate of IEEE 1394a?

- ❍ **A.** 400 Mb/s
- ❍ **B.** 800 Mb/s
- ❍ **C.** 5 Gb/s
- ❍ **D.** 24 Mb/s

5. You just installed a barcode reader to a laptop. What should you do next?

- ❍ **A.** Adjust the light wavelength.
- ❍ **B.** Test the reader by reading barcodes.
- ❍ **C.** Program the reader to recognize codes.
- ❍ **D.** Point the barcode reader at someone.

6. What does a KVM do?

   ❍ **A.** Connects a computer to Bluetooth-enabled devices

   ❍ **B.** Allows multiple users to share a single computer

   ❍ **C.** Networks multiple computers together

   ❍ **D.** Connects multiple computers to save resources

7. You are installing a wireless keyboard to a PC. What does the PC require?

   ❍ **A.** Bluetooth dongle

   ❍ **B.** Thunderbolt connection

   ❍ **C.** Ethernet connection

   ❍ **D.** IEEE 1394

8. A user calls you with a complaint that none of his USB devices are working. What is the most probable cause?

   ❍ **A.** The USB 3.0 controller has failed.

   ❍ **B.** The root hub is not configured.

   ❍ **C.** The USB is disabled in the BIOS.

   ❍ **D.** The USB is disabled in Windows.

9. You plug a USB device into the front panel port of a PC but nothing happens. What is the most likely cause?

   ❍ **A.** The front panel connectors are not plugged into the motherboard.

   ❍ **B.** You plugged a USB 3.0 device into a USB 2.0 port.

   ❍ **C.** You need to reboot the computer.

   ❍ **D.** You plugged a USB 2.0 device into a USB 3.0 port.

10. Which of the following has a data transfer rate of 40 Gb/s and uses a USB Type-C connector?

    ❍ **A.** USB 3.1

    ❍ **B.** Thunderbolt version 3

    ❍ **C.** Bluetooth version 3

    ❍ **D.** Thunderbolt version 2

11. Which of the following are considered both input and output devices?

    ❍ **A.** Keyboard, mouse, touchpad

    ❍ **B.** Smart card reader, motion sensor, biometric device

    ❍ **C.** Printer, speakers

    ❍ **D.** Smart TV, touchscreen, KVM, STB

Cram Quiz Answers

220-901 Answers

1. **D.** 5 Gb/s is the data rate for USB 3.0; 12 Mb/s is the data rate for USB version 1.1; and 400 Mb/s is the data rate of IEEE 1394a (FireWire 400). USB 2.0 has a maximum data transfer rate of 480 Mb/s.
2. **C.** USB can support up to 127 devices on one computer. However, USB hubs will be necessary to go beyond the number of USB ports (usually 4 or 6) commonly found on a system. FireWire supports up to 63 devices.
3. **A.** Type A connectors are almost always included on desktop PCs and laptops.
4. **A.** IEEE 1394a (FireWire 400) specifies a maximum data transfer rate of 400 Mb/s. IEEE 1394b (FireWire 800) specifies 800 Mb/s. USB 3.0 runs at 5 Gb/s. Bluetooth version 3 runs at 24 Mb/s.
5. **C.** After installing the device as well as the driver for the device, program the reader to recognize the codes.
6. **D.** A KVM connects multiple computers to a single keyboard, mouse, and monitor. This way, fewer resources in the way of peripherals (input/output devices) are necessary to use the computers.
7. **A.** Wireless keyboards and mice often use Bluetooth to transmit to a PC or laptop. The computer must either have a built-in Bluetooth antenna or a Bluetooth dongle connected to a USB port for the keyboard to function. These types of devices do not connect to Thunderbolt, Ethernet, or IEEE 1394 ports.
8. **C.** If none of the USB devices are working, chances are that USB has been disabled in the BIOS. This might be company policy so that users can't access USB drives or boot the computer to a USB drive. If the USB 3.0 controller fails, the USB 2.0 controller should still be functioning for other ports. The USB root hub requires no configuring; it is auto-configured by Windows. Although it might be possible to disable one USB device at a time in Windows, it will be uncommon. Disabling all the devices in Windows is rare.
9. **A.** Most likely, the front panel connectors are not plugged into the motherboard. A USB 3.0 device will work fine in a USB 2.0 port but at the lower speed. A USB 2.0 device will work at USB 2.0 speed when plugged into a USB 3.0 port. Rebooting is usually not necessary when installing USB devices.
10. **B.** Thunderbolt version 3 has a data transfer rate of 40 Gb/s and uses a USB Type-C connector. Although SuperSpeed+ USB 3.1 can use the newer USB Type-C connector, it has a data transfer rate of 10 Gb/s. Bluetooth version 3 has theoretical speeds up to 24 Mb/s. Thunderbolt version 2 transfers data at 20 Gb/s and uses a DisplayPort (or Mini DisplayPort) connector.
11. **D.** Smart TVs, touchscreens, KVMs, and STBs are considered both input and output devices. Keyboards, mice, touchpads, smart card readers, motion sensors, and biometric devices are considered input devices. Printers and speakers are considered output devices.

Custom PC Configurations

There are several custom configurations that you might encounter in the IT field. You should be able to describe what each type of computer is and the hardware that is required for these custom computers to function properly.

Audio/Video Editing Workstation

Multimedia editing, processing, and rendering require a fast computer with high-capacity storage and big displays (usually more than one). Examples of audio/video workstations include

- **Video recording/editing PCs:** These run software such as Adobe Premiere Pro, Final Cut, or Sony Vegas.
- **Music recording PCs:** These run software such as Logic Pro or Pro Tools.

Note

Identify the software programs listed above and understand exactly what they are used for.

Adobe Premiere Pro: http://www.adobe.com/products/premiere.html

Apple Final Cut: http://www.apple.com/final-cut-pro/

Apple Logic Pro: http://www.apple.com/logic-pro/

Avid ProTools: http://www.avid.com/us/products/family/pro-tools

This just scratches the surface, but you get the idea. These computers need to be designed to easily manipulate video files and music files. So from a hardware standpoint, they need a specialized video or audio card, the fastest hard drive available with a lot of storage space (definitely SSD and perhaps SATA Express or PCI Express-based), and multiple monitors (to view all of the editing windows). Keep in mind that the video cards and specialized storage drives are going to be expensive devices; be sure to employ all antistatic measures before working with those cards.

ExamAlert

Remember that audio/video workstations need specialized A/V cards; large, fast hard drives; and multiple monitors.

CAD/CAM Workstation

Computer-aided design (CAD) and computer-aided manufacturing (CAM) workstations are common in electrical engineering, architecture, drafting, and many other engineering arenas. They run software such as AutoCAD. This software is CPU-intensive and images require a lot of space on the screen. Hardware-wise, a CAD/CAM workstation needs a powerful, multicore CPU (or more than one if you are using advanced CAD software or if you are performing 3-D design/rendering), a high-end video card (perhaps a workstation-class video card—much more expensive), and as much RAM as possible. If a program has a minimum RAM requirement of 2 GB of RAM, you should consider quadrupling that amount; plus, the faster the RAM, the better—just make sure your motherboard (and CPU) can support it.

ExamAlert

Don't forget, CAD/CAM computers need powerful, multicore CPUs, high-end video cards, and as much RAM as possible.

Virtualization Workstation

A virtualization workstation is a computer that runs one or more virtual operating systems (also known as virtual machines or VMs). Did you ever wish that you had another two or three extra computers lying around so that you could test multiple versions of Windows, Linux, and possibly a Windows Server OS all at the same time? Well, with virtual software, you can do this by creating virtual machines for each OS. But if you run those at the same time on your main computer, you are probably going to bring that PC to a standstill. However, if you build a workstation specializing in virtualization, you can run whatever operating systems on it that you need. The virtualization workstation uses what is known as a hypervisor, which allows multiple virtual operating systems (guests) to run at the same time on a single computer. It is also known as a virtual machine manager (VMM). But there are two different kinds:

- **Type 1: Native:** This means that the hypervisor runs directly on the host computer's hardware. Because of this, it is also known as *bare metal*. Examples of this include VMware vSphere and Microsoft Hyper-V.
- **Type 2: Hosted:** This means that the hypervisor runs within (or "on top of") the operating system. Guest operating systems run within the hypervisor. Compared to Type 1, guests are one level removed from

the hardware and therefore run less efficiently. Examples of this include Microsoft Virtual PC and Oracle VirtualBox. Figure 13.2 shows an example of VirtualBox. You will note that it has a variety of virtual machines inside, such as Windows 7, Windows Server, and Linux Ubuntu.

FIGURE 13.2 **VirtualBox Manager window**

Generally, Type 1 is a much faster and efficient solution than Type 2. Because of this, Type 1 hypervisors are the kind used for virtual servers by web-hosting companies and by companies that offer cloud-computing solutions. It makes sense, too. If you have ever run a powerful operating system such as Windows Server within a Type 2 hypervisor such as Virtual PC, you know that a ton of resources are used and those resources are taken from the hosting operating system. It is not nearly as efficient as running the hosted OS within a Type 1 environment. However, keep in mind that the hardware/software requirements for a Type 1 hypervisor are more stringent and more costly. In addition, you need to make sure your CPU supports virtualization. For example, some CPUs do not support Intel Virtualization Technology (VT). To check whether your CPU can support VT, http://ark.intel.com/Products/VirtualizationTechnology.

Intel CPUs that support x86 virtualization use the VT-x virtualization extension. Intel chipsets use the VT-d and VT-c extensions for input-output memory management and network virtualization, respectively. AMD CPUs that support x86 virtualization use the AMD-V extension. AMD chipsets use the AMD-Vi extension.

Any computer designed to run a hypervisor often has a powerful CPU (or multiple CPUs) with four cores or more and as much RAM as can fit in the system. This means a powerful, compatible motherboard as well. So in essence, the guts—the core of the system—need to be robust. Keep in mind that the motherboard BIOS/UEFI and the CPU should have virtualization support.

ExamAlert

Remember that virtualization systems depend on the CPU and RAM heavily. These systems require maximum RAM and CPU cores.

Note

For more information on how to create virtual machines with programs such as Hyper-V and VirtualBox, visit https://technet.microsoft.com/en-us/library/hh846766.aspx and https://www.virtualbox.org/manual/ch01.html.

In general, the security of a virtual machine operating system is the equivalent to that of a physical machine OS. The VM should have the latest updates, the newest AV definitions, perhaps a personal firewall, strong passwords, and so on. However, there are several things to watch out for that, if not addressed, could cause all your work compartmentalizing operating systems to go down the drain. This includes considerations for the virtual machine OS as well as the controlling virtual machine software. Keep an eye out for network shares and other connections between the virtual machine and the physical machine or connections between two VMs.

Consider disabling any unnecessary hardware from within the virtual machine, such as optical drives, USB ports, and so on. One last comment: A VM should be as secure as possible, but, in general, because the hosting computer is in a controlling position, it is likely more easily exploited. A compromise to the hosting computer probably means a compromise to any guest operating systems. Therefore, if possible, the host should be even more secure than the VMs it controls.

Thin Client

A *thin client* (also known as a slim, lean, or cloud client) is a computer that has few resources compared to a typical PC. Usually, it depends heavily on a server. It is often a small device integrated directly into the display or could

be a stand-alone device using an ultra-small form factor (about the size of a cable modem or gaming console). Some thin clients are also known as diskless workstations because they have no hard drive or optical discs. They do have a CPU, RAM, and ports for the display, keyboard, mouse, and network; they can connect wirelessly as well. They are also known simply as computer terminals which might provide only a basic GUI and possibly a web browser. There is a bit of a gray area when it comes to thin clients due to the different models and types over the years, but the following gives a somewhat mainstream scenario.

Other examples of thin clients include point-of-sale (POS) systems such as the self-checkout systems used at stores or touchscreen menus used at restaurants. They serve a single purpose and require minimum hardware resources and minimum OS requirements.

When a typical thin client is turned on, it loads the OS and applications from an image stored (embedded) on flash memory or from a server. The OS and apps are loaded into RAM; when the thin client is turned off, all memory is cleared.

ExamAlert

Viruses have a hard time sticking around a thin client because the RAM is completely cleared every time it is turned off.

So, the thin client is dependent on the server for a lot of resources. Thin clients can connect to an in-house server that runs specially configured software or they can connect to a cloud infrastructure to obtain their applications (and possibly their entire operating system).

Note

Back in the day, this was how a mainframe system worked; however, back then, the terminal did virtually *no* processing, had no CPU, and was therefore referred to as a "dumb" terminal. This is an example of *centralized computing*, where the server does the bulk of the processing. Today, we still have mainframes (super-computers), but the terminal (thin client) incorporates a CPU.

The whole idea behind thin clients is to transfer a lot of the responsibilities and resources to the server. With thin-client computing, an organization purchases more powerful and expensive servers but possibly saves money overall

by spending less on each thin client (for example, Lenovo thin clients) while benefitting from a secure design. The typical thin client might have one of several operating systems embedded into the flash memory, depending on the model purchased. This method of centralizing resources, data, and user profiles is considered to be a more organized and secure solution than the typical PC-based, client/server network, but it isn't nearly as common.

ExamAlert

A thin client runs basic, single-purpose applications, meets the minimum manufacturer's requirements for the selected operating system, and requires network connectivity to reach a server or host system where some, or even the majority, of processing takes place.

Standard Thick Client

A standard *thick client*, or fat client, is effectively a PC. Unlike a thin client, a thick client performs the bulk of data processing operations by itself and uses a drive to store the OS, files, user profile, and so on. In comparison to thin clients and the somewhat centralized computing, with a thick client, a typical local area network of PCs would be known as *distributed computing*, where the processing load is dispersed more evenly among all the computers. There are still servers, of course, but the thick client has more power and capabilities compared to the thin client. Distributed computing is by far the more common method today. When using a thick client, it's important to verify that the thick client meets the recommended requirements for the selected OS.

An example of a standard thick client is a desktop computer running Windows 8 and Microsoft Office, and offers web browsing and the ability to easily install software. This standard thick client should meet (or exceed) the recommended requirements for Window 8, including a 1 GHz 64-bit CPU, 2 GB of RAM, and 20 GB of free hard drive space.

ExamAlert

A standard thick client runs desktop applications such as Microsoft Office and meets the manufacturer's recommended requirements for the selected operating system. The majority of processing takes place on the thick client itself.

Home Server PC

A real server runs software such as Windows Server or Red Hat Enterprise Linux. But this software is expensive and requires a lot of know-how. For the average home user, a server OS is not usually necessary. It requires too much money and hardware resources and takes too much time to configure. However, if you want to have a home server PC, you can do so with any Windows OS that can start a HomeGroup, a Mac with OS X, or with most desktop variants of Linux. Once that computer is configured properly, information can be stored centrally on that system. Files and printers can be shared to the rest of the devices on the network, and media can be streamed to the other systems as well. To configure media streaming in Windows, go to Control Panel > HomeGroup, and then click the Change advanced sharing settings link. Open the appropriate network type and then click the Choose media streaming options link. Turn on media streaming and then click Customize for any particular device. From these last two locations, you can choose what is to be streamed, and you can select parental ratings if you want.

Note

Linux is another great option for powerful home server PCs, but it is unlikely that you will encounter a question about Linux media streaming on the A+ exams.

To make this server function quickly and recover from faults, we would equip it with a gigabit network adapter minimum (wired, for best results) and set up a RAID array. The RAID array could be RAID 0 (striping), but to incorporate fault tolerance, we would want RAID 1 (mirroring, 2 drives) or RAID 5 (striping with parity, 3 drives or more). To do this on a Windows system, we might need a RAID controller either embedded on the motherboard or installed as a separate adapter card. Or an external RAID array could be connected to the computer or connected to the network directly (NAS box) and controlled by the computer. Then we would need to configure file sharing and possibly print sharing, discussed in Chapters 16 and 14, respectively.

ExamAlert

Remember that a home server PC should have a fast network adapter and a RAID array, and needs to be part of a network (such as a HomeGroup) so that file and print sharing and media streaming can be configured.

Home Theater PC (HTPC)

A home theater PC (HTPC) can take the place of a Blu-ray player, DVD player, CD player, and various audio equipment. In some cases, it can also take the place of a set-top box (STB) as well. However, this depends on the area you live in. It has become more difficult (but not impossible) to use the HTPC for television reception due to cablecards and encryption techniques.

The requirements for an HTPC include a small form factor (micro-ATX or mini-ITX), a quiet desktop case with a silent video card, and an HDMI output for connectivity to big-screen televisions or projectors. To keep the rest of the computer quiet, a liquid-cooled CPU (instead of fan-based) and solid-state hard drive would complete the equation. Surround sound audio is desired as well, whether it comes from a sound card on the computer or from an external source. Finally, if you want to get TV reception, you would need a TV tuner and possibly an antenna.

ExamAlert

Know that an HTPC needs a small form factor, quiet equipment, surround sound audio, HDMI output, and possibly a TV tuner.

Note

Media PC, which I built for this book, would work well as an HTPC. However, I built another computer called *HTPC1* for exactly this purpose. You can learn more about it at http://www.davidlprowse.com/articles/?p=639.

Home entertainment enthusiasts often have computers hooked up to their home theaters. If this is the case, they might install TV tuner cards. These cards can accept the signal from a cable or satellite provider or an over-the-air (OTA) antenna and then send it back out to the TV or other devices in the home theater. Some TV tuners also act as capture cards, meaning that they can capture the signal and record TV programs. Many come with a remote control (and IR blaster) so that the computer can be controlled in the same manner as a TV.

The purpose of all this is to record shows onto the computer and basically use the computer as a digital video recorder (DVR), among other things. By using programs such as Windows Media Center (WMC) and Kodi, users can control their TV experience. However, according to Microsoft, Windows 8.1 is the last OS that will support WMC.

TV tuner cards are available with PCI Express, PCI, ExpressCard and Mini PCIe (for laptops), and USB interfaces. TV tuners often have RG-6 connectors for cable in and antenna. Make sure you connect to the right one!

An HTPC is often also used as a home server PC because most of the requirements are the same.

Gaming PC

Now we get to the core of it: Custom computing is taken to extremes when it comes to gaming. Gaming PCs require almost all the resources mentioned previously: a powerful, multicore CPU; lots of fast RAM; one or more SSDs (SATA Express or PCI Express); advanced cooling methods (liquid cooling if you want to be serious); a high-end video card and specialized GPU; an above average, high-definition sound card; a big monitor that supports high resolutions and refresh rates; plus a fast network adapter and strong Internet connection (and mad skills). This all creates a computer that is expensive and requires care and maintenance to keep it running in perfect form. For the person who is not satisfied with gaming consoles, this is the path to take.

ExamAlert

A gaming PC requires a multicore CPU, high-end video with specialized GPU, a high-definition sound card, and high-end cooling.

Games are some of the most powerful applications available. If even just one of these elements is missing from a gaming system, it could easily ruin the experience. The video card is a huge component of this equation. Gamers are always looking to push the envelope for video performance by increasing the number of frames per second (frames/s or fps) that the video card sends to the monitor. One of the ways to improve the video subsystem is to employ multiple video cards. It's possible to take video to the next level by incorporating Nvidia's Scalable Link Interface, known simply as SLI (previously Scan Line Interleave) or AMD's CrossFire. A computer that uses one of these technologies has two (or more) identical video cards that work together for greater performance and higher resolution. The compatible cards are bridged together to essentially work as one unit. It is important to have a compatible motherboard and ample cooling when attempting this type of configuration. Currently, this is done with two or more PCI Express video cards (x16/version 3) and is most commonly found in gaming rigs, but you might find it in other PCs as well (such as video editing or CAD/CAM workstations). Because

some motherboards come with only one PCIe x16 slot for video, a gaming system needs a more advanced motherboard: one with at least two PCIe x16 slots to accomplish SLI.

Cram Quiz

Answer these questions. The answers follow the last question. If you cannot answer these questions correctly, consider reading this section again until you can.

220-901 Questions

1. Which of the following is the best type of custom computer for use with Pro Tools?

   - ❍ **A.** CAD/CAM workstation
   - ❍ **B.** Audio/Video Workstation
   - ❍ **C.** Gaming PC
   - ❍ **D.** HTPC

2. What do CAD/CAM workstations require most?

   - ❍ **A.** Liquid cooling and RAM
   - ❍ **B.** TV tuner and silent hard drive
   - ❍ **C.** Surround sound card and specialized GPU
   - ❍ **D.** Powerful CPU and RAM

3. Your organization needs to run Windows in a virtual environment. The OS is expected to require a huge amount of resources for a powerful application it will run. What should you install Windows to?

   - ❍ **A.** Type 2 hypervisor
   - ❍ **B.** Gaming PC
   - ❍ **C.** Type 1 hypervisor
   - ❍ **D.** Thin client

4. What are some of the elements of a home server PC? (Select the two best answers.)

   - ❍ **A.** Liquid cooling
   - ❍ **B.** Fast network adapter
   - ❍ **C.** The best CPU
   - ❍ **D.** RAID array
   - ❍ **E.** Gamepad

5. You just set up an HTPC. However, the Windows Media Center live TV option is not working. All connections are plugged in and all the other portions of Windows Media Center work. What is the most likely cause of the problem?
   - ❍ **A.** The coax cable is plugged into the antenna port.
   - ❍ **B.** Media Center needs to be reinstalled.
   - ❍ **C.** Windows libraries are malfunctioning.
   - ❍ **D.** The computer overheated.

Cram Quiz Answers

220-901 Answers

1. **B.** The audio/video workstation is the type of custom computer that would use Pro Tools, Logic Pro, and other music and video editing programs.
2. **D.** A CAD/CAM workstation most requires a powerful CPU and RAM. Liquid cooling, a surround sound card, and a specialized GPU are required by gaming PCs. TV tuners and silent hard drives are needed by HTPCs.
3. **C.** If the virtual operating system needs a lot of resources, the best bet is a "bare metal" type 1 hypervisor. Type 2 hypervisors run on top of an operating system and therefore are not as efficient with resources. Gaming PCs have lots of resources but are not meant to run virtual environments. Thin clients have the least amount of resources.
4. **B and D.** Home server PCs require a fast network adapter for the quick transfer of files over the network and a RAID array to offer fast and reliable access to data.
5. **A.** If everything is working except for the live TV option, then the coax cable is probably plugged into the antenna port instead of the cable in port of the TV tuner card. This is also a common mistake on set-top boxes.

Index

Symbols

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Z

This page intentionally left blank