Quentin Docter, Emmett Dulaney, and Toby Skandier

CompTIA A+®

COMPLETE STUDY GUIDE

Third Edition

EXAM 220-901
EXAM 220-902

Covers 100% of exam objectives, including motherboard components, types of network cables and connectors, laptop hardware, Windows and other operating systems, security threats, prevention methods, and much more...

Includes interactive online learning environment and study tools with:

+ **4 custom practice exams**
+ **More than 200 Electronic flashcards**
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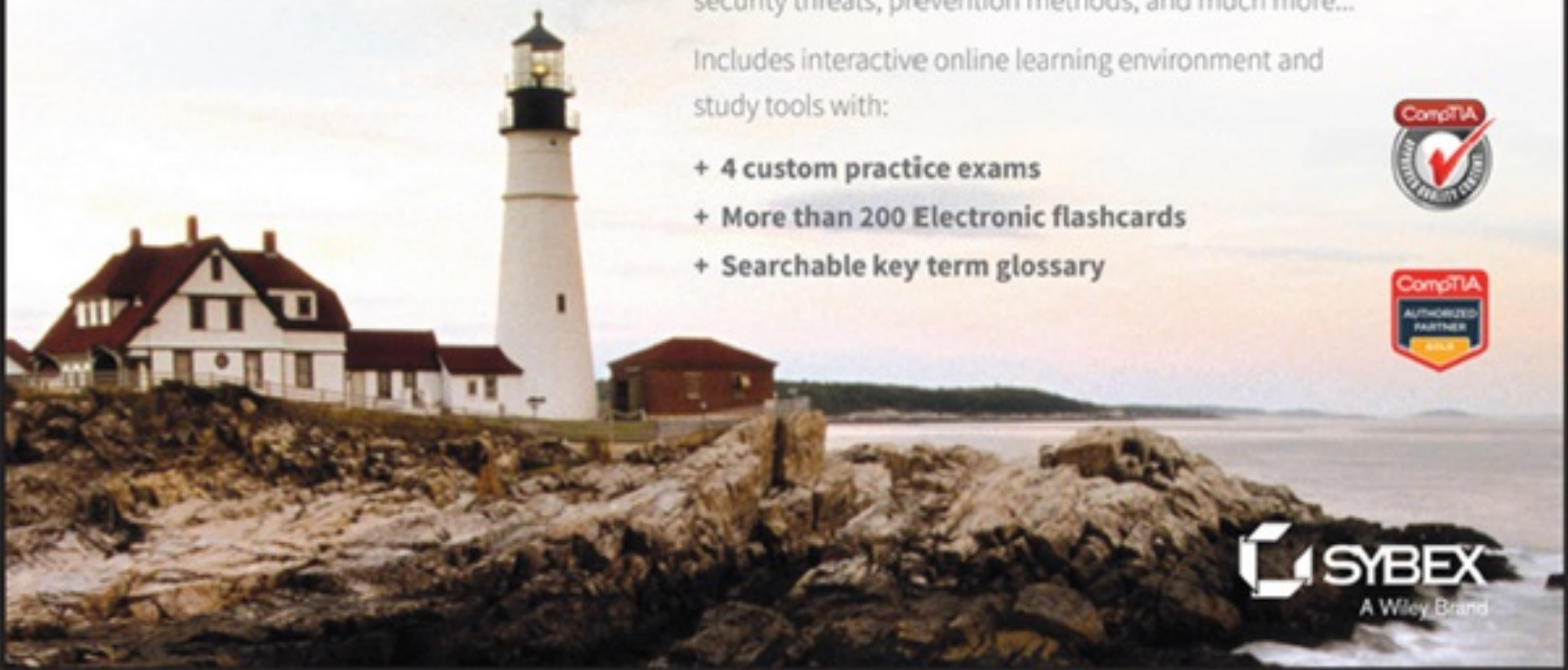

SYBEX
A Wiley Brand

CompTIA® A+® Complete Study Guide

Exam 220-901

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For Kara, Abbie, Lauren, Reina, and Alina
—Quentin Docter

For Carl: Thanks for always looking after the baby.
—Emmett Dulaney

For Charlotte: Welcome to the world, baby.
—Toby Skandier

Acknowledgments

As we were putting this book together, I was reminded of the proverb that begins, “It takes a small village…” That beginning definitely holds true to create a book of this scope and size. From beginning to end, there are scores of dedicated professionals focused on delivering the best book possible to you, the readers.

First, I need to thank my coauthors, Emmett Dulaney and Toby Skandier. Their dedication to producing an excellent book that will best serve the needs of our readers is inspiring. Now, onto the rest of the team.

Kenyon Brown and Gary Schwartz kept us on track and moving forward, which was a challenge at times. Becca Anderson had the fun job of keeping us organized, which is akin to herding cats. Tech editors Robin Abernathy and Ian Seaton provided a great set of expert eyes and made excellent suggestions. Copyeditor Judy Flynn reminded me yet again that I am no master of the English language and saved me from butchering it (too badly). Many thanks also go out to proofreaders Sarah Kaikini and Jen Larsen at Word One, and our indexer Jack Lewis. Without their great contributions, this book would not have made it into your hands.

—Quentin Docter

I would like to thank my coauthors, Quentin Docter and Toby Skandier, without whom this book would have never happened. Thanks are also due to Gary Schwartz for keeping this book on schedule and working tirelessly to turn it into something usable.

—Emmett Dulaney

Yet another stellar project with Quentin and Emmett. While we haven't started finishing each other's sentences, we certainly have found our groove, I would say. That turns work into less thereof. Thank you, guys. Thanks also to our tireless editorial and production team. Keep up the great work!

—Toby Skandier

About the Authors

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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 multiindustry 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
*** Source: 2013 IT Skills and Salary Report by CompTIA Authorized Partner

Introduction

Welcome to the CompTIA A+ Complete Study Guide. This is the third edition of our best-selling study guide for the A+ certification sponsored by CompTIA (Computing Technology Industry Association).

This book is written at an intermediate technical level; we assume that you already know how to *use* a personal computer and its basic peripherals, such as USB devices and printers, but we also recognize that you may be learning how to *service* some of that computer equipment for the first time. The exams cover basic computer service topics as well as some more advanced issues, and they cover some topics that anyone already working as a technician, whether with computers or not, should be familiar with. The exams are designed to test you on these topics in order to certify that you have enough knowledge to fix and upgrade some of the most widely used types of personal computers.

We've included review questions at the end of each chapter to give you a taste of what it's like to take the exams. If you're already working as a technical service or support technician, we recommend that you check out these questions first to gauge your level of knowledge. (You can also take the assessment test at the end of this introduction, which is designed to see how much you already know.)

Don't just study the questions and answers—the questions on the actual exams will be different from the practice ones included with this book. The exams are designed to test your knowledge of a concept or objective, so use this book to learn the objective behind the question.

You can mainly use the book to fill in the gaps in your current computer service knowledge. You may find, as many PC technicians have, that being well versed in all the technical aspects of the equipment is not enough to provide a satisfactory level of support —you must also have customer-relations skills. We include helpful hints to get the customers to help you help them.

What Is A+ Certification?

The A+ certification program was developed by the Computing Technology Industry Association (CompTIA) to provide an industry-wide means of certifying the competency of computer service technicians. The A+ certification is granted to those who have attained the level of knowledge and troubleshooting skills that are needed to provide capable support in the field of personal computers. It is similar to other certifications in the computer industry, such as the Cisco Certified Network Associate (CCNA) program and the Microsoft certification programs. The theory behind these certifications is that if you need to have service performed on any of their products, you would sooner call a technician who has been certified in one of the appropriate certification programs than just call the first "expert" in the phone book.

The A+ certification program was created to offer a wide-ranging certification, in the

sense that it is intended to certify competence with personal computers and mobile devices from many different makers/vendors. You must pass two tests to become A+ certified:

- The A+ 220-901 exam, which covers basic computer concepts, PC hardware, basic networking, soft skills (such as customer service), and safety
- The A+ 220-902 exam, which covers operating systems, security, mobile devices, and troubleshooting

You don't have to take the 220-901 and the 220-902 exams at the same time. However, the A+ certification is not awarded until you've passed both tests.

Why Become A+ Certified?

There are several good reasons to get your A+ certification. The CompTIA Candidate's Information packet lists five major benefits:

- It demonstrates proof of professional achievement.
- It increases your marketability.
- It provides greater opportunity for advancement in your field.
- It is increasingly a requirement for some types of advanced training.
- It raises customer confidence in you and your company's services.

Provides Proof of Professional Achievement

The A+ certification is quickly becoming a status symbol in the computer service industry. Organizations that include members of the computer service industry are recognizing the benefits of A+ certification and are pushing for their members to become certified. And more people every day are putting the "A+ Certified Technician" emblem on their business cards.

Increases Your Marketability

A+ certification makes individuals more marketable to potential employers. A+ certified employees also may receive a higher base salary because employers won't have to spend as much money on vendor-specific training.

What Is an ASC?

More service companies are becoming CompTIA A+ Authorized Service Centers (ASCs). This means that over 50 percent of the technicians employed by such service centers are A+ certified. Customers and vendors alike recognize that ASCs employ the most qualified service technicians. As a result, an ASC gets more business than a nonauthorized service center. And, because more service centers want to reach the

ASC level, they will give preference in hiring to a candidate who is A+ certified over one who is not.

Provides Opportunity for Advancement

Most raises and advancements are based on performance. A+ certified employees work faster and more efficiently and are thus more productive. The more productive employees are, the more money they make for their company. And, of course, the more money they make for the company, the more valuable they are to the company. So if an employee is A+ certified, their chances of being promoted are greater.

Fulfills Training Requirements

Most major computer hardware vendors recognize A+ certification. Some of these vendors apply A+ certification toward prerequisites in their own respective certification programs, which has the side benefit of reducing training costs for employers.

Raises Customer Confidence

As the A+ Certified Technician moniker becomes better known among computer owners, more of them will realize that the A+ technician is more qualified to work on their computer equipment than a noncertified technician.

How to Become A+ Certified

A+ certification is available to anyone who passes the tests. You don't have to work for any particular company. It's not a secret society. It is, however, an elite group. To become A+ certified, you must do two things:

- Pass the A+ 220-901 exam
- Pass the A+ 220-902 exam

The exams can be taken at any Pearson VUE testing center. If you pass both exams, you will get a certificate in the mail from CompTIA saying that you have passed, and you will also receive a lapel pin and business card.

To register for the tests, call Pearson VUE at (877) 551-PLUS (7587) or go to www.pearsonvue.com/comptia. You'll be asked for your name, Social Security number (an optional number may be assigned if you don't wish to provide your Social Security number), mailing address, phone number, employer, when and where you want to take the test, and your credit card number (arrangement for payment must be made at the time of registration).

Although you can save money by arranging to take more than one test at the same

seating, there are no other discounts. If you have to repeat a test to get a passing grade, you must pay for each retake.

Tips for Taking the A+ Exam

Here are some general tips for taking your exam successfully:

- Bring two forms of ID with you. One must be a photo ID, such as a driver's license. The other can be a major credit card or a passport. Both forms must include a signature.
- Arrive early at the exam center so that you can relax and review your study materials, particularly tables and lists of exam-related information. When you enter the testing room, you will need to leave everything outside; you won't be able to bring any materials into the testing area.
- Read the questions carefully. Don't be tempted to jump to an early conclusion. Make sure that you know exactly what each question is asking.
- Don't leave any unanswered questions. Unanswered questions are scored against you. There will be questions with multiple correct responses. When there is more than one correct answer, a message at the bottom of the screen will prompt you to, for example, choose two. Be sure to read the messages displayed to know how many correct answers you must choose.
- When answering multiple-choice questions that you're not sure about, use a process of elimination to get rid of the obviously incorrect answers first. Doing so will improve your odds if you need to make an educated guess.
- On form-based tests (nonadaptive), because the hard questions will take the most time, save them for last. You can move forward and backward through the exam.
- For the latest pricing on the exams and updates to the registration procedures, visit CompTIA's website at www.comptia.org.

Who Should Read This Book?

If you are one of the many people who want to pass the A+ exams, and pass them confidently, then you should buy this book and use it to study for the exams.

This book was written to prepare you for the challenges of the real IT world, not just to pass the A+ exams. This study guide will do that by describing in detail the concepts on which you'll be tested.

What Does This Book Cover?

This book covers everything you need to know to pass the CompTIA A+ exams.

Part I of the book starts at Chapter 1 and concludes after Chapter 12. It will cover all of the topics on which you will be tested for Exam 220-901:

Chapter 1: Motherboards, Processors, and Memory Chapter 1 details the characteristics of motherboards and their slots and built-in components. The CPU, RAM, and BIOS, which are attached to the motherboard, are also presented in Chapter 1.

Chapter 2: Storage Devices and Power Supplies Chapter 2 presents the popular forms of storage devices in use today, including traditional hard drives, solid-state drives, flash drives, and memory cards. Capacities, form factors, and the makeup of these components are also discussed.

Chapter 3: Peripherals and Expansion Chapter 3 covers installation and characteristics of expansion cards, the ports they and the motherboard present to the user, and the peripheral devices connected to these interfaces. Required cabling and its characteristics are also included.

Chapter 4: Display Devices Chapter 4 runs the gamut of display devices and their characteristics. Everything from the familiar LCD and plasma panels to the cutting-edge organic LED is covered in this chapter.

Chapter 5: Custom Configurations Chapter 5 presents information based on a newer objective outlining the specialized systems that we see more and more of in the field today. Examples include gaming PCs, graphic design and audio/video editing workstations, home theater PCs, and home servers.

Chapter 6: Networking Fundamentals Chapter 6 covers characteristics of cable types and connectors, network devices, networking tools, and network topologies.

Chapter 7: Introduction to TCP/IP Chapter 7 details the most common network protocol in use today. It covers TCP/IP structure, addressing (including IPv6), and common protocols in the suite.

Chapter 8: Installing Wireless and SOHO Networks Chapter 8 contains two main sections. The first is on wireless networking standards and security, and the second discusses setting up a small office, home office (SOHO) network and choosing an Internet connection type.

Chapter 9: Understanding Laptops Chapter 9 covers topics such as laptop-specific hardware, components within a laptop display, and laptop features.

Chapter 10: Understanding Mobile Devices Chapter 10 covers topics related to mobile devices such as tablets, smartphones, e-readers, and wearable technology.

Chapter 11: Installing and Configuring Printers Chapter 11 starts by discussing different printing technologies, such as impact, inkjet, and laser printers. It then moves

on to cover installing printers and performing printer maintenance.

Chapter 12: Hardware and Network Troubleshooting Chapter 12 covers the troubleshooting side of hardware and networking, including the need to identify and use the appropriate tools.

Part II of the book, Chapters 13 through 23, covers all of the topics on which you will be tested for Exam 220-902:

Chapter 13: Operating System Basics Chapter 13 starts the examination of Microsoft Windows operating systems. CompTIA expects you to know how to administer three of them—Microsoft Windows 8/8.1, Windows 7, and Windows Vista. In addition, you will need to know about many of the various editions of each version.

Chapter 14: Operating System Administration Chapter 14 continues the discussion begun in Chapter 13, and it looks at utilities and features that exist in each of the three versions of Windows operating systems that you need to know for the exam.

Chapter 15: Working with Windows 8/8.1 Chapter 15 focuses only on Windows 8/8.1. It's newest of the three versions of Windows operating systems tested on the 220-902 exam, and this chapter looks at its unique features.

Chapter 16: Working with Windows 7 Chapter 16 focuses only on Windows 7. This chapter looks at features unique to the Windows 7 Starter, Windows 7 Home Premium, Windows 7 Professional, Windows 7 Ultimate, and Windows 7 Enterprise editions.

Chapter 17: Working with Windows Vista Chapter 17 examines Windows Vista and the features unique to the Windows Vista Home Basic, Windows Vista Home Premium, Windows Vista Business, Windows Vista Ultimate, and Windows Vista Enterprise editions.

Chapter 18: Working with Mac OS and Linux Chapter 18 focuses on operating systems other than Microsoft Windows. It looks at Mac OS and Linux.

Chapter 19: Security Just when you think this book couldn't get any better, we toss in a chapter devoted to security. This chapter looks at all of the security topics on the exam, and it includes information on social engineering, best practices, and securing SOHO networks—both wired and wireless.

Chapter 20: Network Services, Cloud Computing, and Virtualization Chapter 20 focuses on the newest technologies related to networking with an emphasis on cloud computing and virtualization.

Chapter 21: Mobile Operating Systems and Connectivity Chapter 21 details the similarities and differences between Apple- and Android-based mobile devices. This chapter provides extensive hands-on steps for configuring a variety of features and services on these devices.

Chapter 22: Troubleshooting Theory, OSs, and Security If you collected a nickel every time someone requested a chapter on troubleshooting theory, you'd have enough to

buy a decent pair of socks. Since CompTIA has an uncompromising view on the topic, you need to know the topic from the perspective of the objectives, and that is what you will find in Chapter 22.

Chapter 23: Understanding Operational Procedures The last chapter in the book covers the "softer" side of working with computers. Topics include following safety procedures, understanding environmental impacts, practicing proper communication, and professionalism.

What's Included in the Book

We've included several learning tools throughout the book:

Assessment test We have provided an assessment test that you can use to check your readiness for the exam at the end of this introduction. Take this test before you start reading the book; it will help you determine the areas on which you might need to brush up. The answers to the assessment test questions appear on a separate page after the last question of the test. Each answer includes an explanation and a note telling you the chapter in which the material appears.

Objective map and opening list of objectives At the beginning of the book, we have included a detailed exam objective map showing you where each of the exam objectives is covered. In addition, each chapter opens with a list of the exam objectives it covers. Use these resources to see exactly where each of the exam topics is covered.

Exam essentials Each chapter, just before the summary, includes a number of exam essentials. These are the key topics that you should take from the chapter in terms of areas on which you should focus when preparing for the exam.

Chapter review questions To test your knowledge as you progress through the book, there are review questions at the end of each chapter. As you finish each chapter, answer the review questions and then check your answers—the correct answers and explanations are in Appendix A. You can go back to reread the section that deals with each question you got wrong to ensure that you answer correctly the next time that you're tested on the material.

Interactive Online Learning Environment and Test Bank

The interactive online learning environment that accompanies *CompTIA A+ Complete Study Guide Exam 220-901 and Exam 220-902* provides a test bank with study tools to help you prepare for the certification exams and increase your chances of passing them the first time! The test bank includes the following elements:

Sample tests All of the questions in this book are provided, including the assessment test, which you'll find at the end of this introduction, and the chapter tests that include the review questions at the end of each chapter. In addition, there are four practice exams. Use these questions to test your knowledge of the study guide material. The online test bank runs on multiple devices.

Flashcards Two sets of questions are provided in digital flashcard format (a question followed by a single correct answer). You can use the flashcards to reinforce your learning and provide last-minute test prep before the exam.

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

Go to http://sybextestbanks.wiley.com to register and gain access to this interactive online learning environment and test bank with study tools.

How to Use This Book

If you want a solid foundation for preparing for the A+ exams, this is the book for you. We've spent countless hours putting together this book with the sole intention of helping you prepare for the exams.

This book is loaded with valuable information, and you will get the most out of your study time if you understand how we put the book together. Here's a list that describes how to approach studying:

1. Take the assessment test immediately following this introduction. It's okay if you don't know any of the answers—that's what this book is for. Carefully read over the explanations for any question you get wrong, and make note of the chapters where that material is covered.
2. Study each chapter carefully, making sure you fully understand the information and the exam objectives listed at the beginning of each one. Again, pay extra-close attention to any chapter that includes material covered in questions you missed on the assessment test.
3. Read over the summary and exam essentials. These will highlight the sections from the chapter with which you need to be familiar before sitting for the exam.
4. Answer all of the review questions at the end of each chapter. Specifically note any questions that confuse you, and study the corresponding sections of the book again. Don't just skim these questions! Make sure that you understand each answer completely.
5. Go over the electronic flashcards. These help you prepare for the latest A+ exams, and they're really great study tools.
6. Take the practice exams.

Performance-Based Questions

CompTIA includes performance-based questions on the A+ exams. These are not the traditional multiple-choice questions with which you're probably familiar. These questions require the candidate to know how to perform a specific task or series of tasks. The candidate will be presented with a scenario and will be asked to complete a task. They will be taken to a simulated environment where they will have to perform a series of steps and will be graded on how well they complete the task.

The Sybex test engine does not include performance-based questions. However, at the end of most chapters we have included a section called "Performance-Based Questions," which is designed to measure how well you understood the chapter topics. Some simply ask you to complete a task for which there is only one correct response. Others are more subjective, with multiple ways to complete the task. We will provide the most logical or practical solution in Appendix B at the back of the book. Note that these may cover topic areas not covered in the actual A+ performance-based questions. However, we feel that being able to think logically is a great way to learn.

The CompTIA A+ Exam Objectives

The A+ exams consist of the 220-901 exam and the 220-902 exam. Following are the detailed exam objectives for each test.

Exam objectives are subject to change at any time without prior notice and at CompTIA's sole discretion. Please visit the A+ Certification page of CompTIA's website (http://certification.comptia.org/getCertified/certifications/a.aspx) for the most current listing of exam objectives.

A+ Certification Exam Objectives: 220-901

The following table lists the domains measured by this examination and the extent to which they are represented on the exam:

Domain	Percentage of Exam
1.0 Hardware	34%
2.0 Networking	21%
3.0 Mobile Devices	17%
4.0 Hardware & Network Troubleshooting	28%

Objective	Chapter
1.0 Hardware	
1.1. Given a scenario, configure settings and use BIOS/UEFI tools on a PC	1
- Firmware upgrades - flash BIOS	

▪ Firmware upgrades—flash BIOS ▪ BIOS component information: RAM; hard drive; optical drive; CPU ▪ BIOS configurations: Boot sequence; enabling and disabling devices; date/time; clock speeds; virtualization support; BIOS security (passwords, drive encryption: TPM, lo-jack, secure boot) ▪ Built-in diagnostics ▪ Monitoring: Temperature monitoring; fan speeds; intrusion detection/notification; voltage; clock; bus speed	1
1.2. Explain the importance of motherboard components, their purpose, and properties	1
▪ Sizes: ATX; Micro-ATX; Mini-ITX; ITX ▪ Expansion slots: PCI; PCI-X; PCIe; miniPCI ▪ RAM slots ▪ CPU sockets ▪ Chipsets: North Bridge; South Bridge ▪ CMOS battery ▪ Power connections and types ▪ Fan connectors ▪ Front/Top panel connectors: USB; audio; power button; power light; drive activity lights; reset button ▪ Bus speeds	1
1.3. Compare and contrast RAM types and their features	1
▪ Types: DDR; DDR2; DDR3; SODIMM; DIMM; parity vs. non-parity; ECC vs. non-ECC; RAM configurations (single channel vs. dual channel vs. triple channel); single sided vs. double sided; buffered vs. unbuffered; RAM compatibility	1
1.4. Install and configure PC expansion cards	3
▪ Sound cards ▪ Video cards ▪ Network cards ▪ USB cards ▪ FireWire cards ▪ Thunderbolt cards	3

▪ Storage cards ▪ Modem cards ▪ Wireless/cellular cards ▪ TV tuner cards ▪ Video capture cards ▪ Riser cards	
1.5. Install and configure storage devices and use appropriate media	2
▪ Optical drives: CD-ROM/CD-RW; DVD-ROM/DVD-RW/DVD-RW DL; Blu-Ray; BD-R; BD-RE ▪ Magnetic hard disk drives: 5400 rpm; 7200 rpm; 10,000 rpm ▪ Hot swappable drives ▪ Solid state/flash drives: CompactFlash; SD; Micro-SD; Mini-SD; xD; SSD; hybrid; eMMC ▪ RAID types: 0; 1; 5; 10 ▪ Tape drive ▪ Media capacity: CD; CD-RW; DVD-RW; DVD; Blu-Ray; tape; DVD DL	2
1.6. Install various types of CPUs and apply the appropriate cooling methods	1
▪ Socket types Intel: 775, 1155, 1156, 1366, 1150, 2011 AMD: AM3, AM3+, FM1, FM2, FM2+ ▪ Characteristics: speeds; cores; cache size/type; hyperthreading; virtualization support; architecture (32-bit vs. 64-bit); integrated GPU; disable execute bit ▪ Cooling: heat sink; fans; thermal paste; liquid-based; ▪ fanless/passive	1
1.7. Compare and contrast various PC connection interfaces, their characteristics and purpose	3
▪ Physical connections ▪ USB 1.1 vs. 2.0 vs. 3.0:Connector types: A, B, mini, micro ▪ FireWire 400 vs. FireWire 800 ▪ SATA1 vs. SATA2 vs. SATA3, eSATA ▪ Other connector types: VGA; HDMI; DVI; Audio (analog, digital (optical	3

connector)); RJ-45; RJ-11; Thunderbolt ▪ Wireless connections: Bluetooth; RF; IR; NFC ▪ Characteristics: analog; digital; distance limitations; data transfer speeds; quality; DRM; frequencies	
1.8.Install a power supply based on given specifications	2
▪ Connector types and their voltages: SATA; Molex; 4/8-pin 12v; PCIe 6/8-pin; 20-pin; 24-pin ▪ Specifications: wattage; dual rail; size; number of connectors; ATX; Micro-ATX; dual-voltage options	2
1.9.Given a scenario, select the appropriate components for a custom PC configuration, to meet customer specifications or needs	5
▪ Graphic/CAD/CAM design workstation: multicore processor, high-end video, maximum RAM ▪ Audio/video editing workstation: specialized audio and video card, large fast hard drive, dual monitors ▪ Virtualization workstation: maximum RAM and CPU cores ▪ Gaming PC: multicore processor, high-end video/specialized GPU, high definition sound card, high-end cooling ▪ Home Theater PC: surround sound audio, HDMI output, HTPC compact form factor, TV tuner ▪ Standard thick client: desktop applications, meets recommended requirements for selected OS ▪ Thin client: basic applications, meets minimum requirements for selected OS; network connectivity ▪ Home server PC: media streaming, file sharing, print sharing, Gigabit NIC, RAID array	5
1.10.Compare and contrast types of display devices and their features	4
▪ Types: LCD (TN vs. IPS; fluorescent vs. LED backlighting); Plasma; Projector; OLED ▪ Refresh/frame rates ▪ Resolution ▪ Native resolution ▪ Brightness/lumens ▪ Analog vs. digital	4

▪ Privacy/antiglare filters ▪ Multiple displays ▪ Aspect ratios: 16:9; 16:10; 4:3	
1.11.Identify common PC connector types and associated cables	3
▪ Display connector types: DVI-D; DVI-I; DVI-A; DisplayPort; RCA; HD15 (i.e. DE15 or DB15); BNC; miniHDMI; miniDin-6	
▪ Display cable types: HDMI; DVI; VGA; component; composite; coaxial ▪ Device cables and connectors: SATA; eSATA; USB; Firewire (IEEE1394); PS/2; audio ▪ Adapters and convertors: DVI to HDMI; USB A to USB B; USB to Ethernet; DVI to VGA; Thunderbolt to DVI; PS/2 to USB; HDMI to VGA	3
1.12.Install and configure common peripheral devices	3
▪ Input devices: mouse; keyboard; scanner; barcode reader; biometric devices; game pads; joysticks; digitizer; motion sensor; touch pads; smart card readers; digital cameras; microphone; webcam; camcorder ▪ Output devices: printers; speakers; display devices ▪ Input & output devices: touch screen; KVM; smart TV; set-top box; MIDI-enabled devices	3
1.13.Install SOHO multifunction device / printers and configure appropriate settings	11
▪ Use appropriate drivers for a given operating system: Configuration settings (duplex; collate; orientation; quality) ▪ Device sharing: wired (USB; serial; Ethernet); Wireless (Bluetooth; 802.11(a, b, g, n, ac); Infrastructure vs. ad hoc); integrated print server (hardware); cloud printing/remote printing ▪ Public/shared devices: sharing local/networked device via operating system settings (TCP/Bonjour/AirPrint); Data privacy (user authentication on the device; hard drive caching)	11
1.14.Compare and contrast differences between the various print technologies and the associated imaging process	11
▪ Laser: imaging drum, fuser assembly, transfer belt, transfer roller, pickup rollers, separate pads, duplexing assembly. Imaging process: processing, charging, exposing, developing, transferring, fusing and cleaning. ▪ Inkjet: ink cartridge, print head, roller, feeder, duplexing assembly, carriage and belt; calibration.	11

▪ Thermal: Feed assembly, heating element; special thermal paper ▪ Impact: Print head, ribbon, tractor feed; impact paper ▪ Virtual: print to file; print to PDF; print to XPS; print to image	
1.15 Given a scenario, perform appropriate printer maintenance	11
▪ Laser: replacing toner, applying maintenance kit, calibration, cleaning ▪ Thermal: replace paper, clean heating element, remove debris ▪ Impact: replace ribbon, replace print head, replace paper ▪ Inkjet: clean heads, replace cartridges, calibration, clear jams	11
2.0 Networking	
2.1.Identify the various types of network cables and connectors	6
▪ Fiber: Connectors: SC, ST, and LC ▪ Twisted Pair: Connectors: RJ-11, RJ-45; wiring standards: T568A, T568B ▪ Coaxial: Connectors: BNC, F-connector	6
2.2.Compare and contrast the characteristics of connectors and cabling	6
▪ Fiber: Types (single-mode vs. multi-mode); speed and transmission limitations ▪ Twisted pair: Types: STP, UTP, CAT3, CAT5, CAT5e, CAT6, CAT6e, CAT7, plenum, PVC; speed and transmission limitations; splitters and effects on signal quality ▪ Coaxial: Types: RG-6, RG-59; speed and transmission limitations; splitters and effects on signal quality	6
2.3.Explain the properties and characteristics of TCP/IP	7
▪ IPv4 vs. IPv6 ▪ Public vs. private vs. APIPA/link local ▪ Static vs. dynamic ▪ Client-side DNS settings ▪ Client-side DHCP ▪ Subnet mask vs. CIDR ▪ Gateway	7
2.4.Explain common TCP and UDP ports, protocols, and their purpose	7
▪ Ports: 21 – FTP; 22 – SSH; 23 – TELNET; 25 – SMTP; 53 – DNS; 80 –	7

HTTP; 110 – POP3; 143 – IMAP; 443 – HTTPS; 3389 – RDP; 137–139, 445 – SMB; 548 or 427 – AFP ▪ Protocols: DHCP; DNS; LDAP; SNMP; SMB; CIFS; SSH; AFP ▪ TCP vs. UDP	
2.5.Compare and contrast various WiFi networking standards and encryption types	8
▪ Standards: 802.11 a/b/g/n/ac; speeds; distances; and frequencies ▪ Encryption types: WEP; WPA; WPA2; TKIP; AES	8
2.6.Given a scenario, install and configure SOHO wireless/wired router and apply appropriate settings	8
▪ Channels ▪ Port forwarding, port triggering ▪ DHCP (on/off) ▪ DMZ ▪ NAT/DNAT ▪ Basic QoS ▪ Firmware ▪ UPnP	8
2.7.Compare and contrast Internet connection types, network types, and their features	8
▪ Internet connection types: cable; DSL; dial-up; fiber; satellite; ISDN; cellular (tethering; mobile hotspot); line of sight wireless Internet service ▪ Network types: LAN; WAN; PAN; MAN	8
2.8.Compare and contrast network architecture devices, their functions, and features	6
▪ Hub ▪ Switch ▪ Router ▪ Access point ▪ Bridge ▪ Modem	6

▪ Firewall ▪ Patch panel ▪ Repeaters/extenders ▪ Ethernet over power ▪ Power over Ethernet injector	
2.9.Given a scenario, use appropriate networking tools	12
▪ Crimper ▪ Cable stripper ▪ Multimeter ▪ Toner generator & probe ▪ Cable tester ▪ Loopback plug ▪ Punchdown tool ▪ WiFi analyzer	12
3.0 Mobile Devices	
3.1.Install and configure laptop hardware and components	9
▪ Expansion options: express card /34; express card /54;SODIMM; Flash; ports/adapters (Thunderbolt; DisplayPort; USB to RJ-45 dongle; USB to WiFi dongle; USB to Bluetooth; USB optical drive) ▪ Hardware/device replacement: keyboard; hard drive (SSD vs. hybrid vs. magnetic disk; 1.8in vs. 2.5in); memory; smart card reader; optical drive; wireless card; Mini-PCIe; screen; DC jack; battery; touchpad; plastics/frames; speaker; system board; CPU	9
3.2.Explain the functions of components within the display of a laptop	9
▪ Types: LCD (TTL vs. IPS; fluorescent vs. LED backlighting); OLED ▪ Wi-Fi antenna connector/placement ▪ Webcam ▪ Microphone ▪ Inverter ▪ Digitizer	9
3.3.Given a scenario, use appropriate laptop features	9
▪ Special function keys: dual displays; wireless (on/off); cellular (on/off);	9

volume settings; screen brightness; Bluetooth (on/off); keyboard backlight; touch pad (on/off); screen orientation; media options (fast forward/rewind); GPS (on/off); airplane mode ▪ Docking station ▪ Physical laptop lock and cable lock ▪ Rotating/removable screens	
3.4.Explain the characteristics of various types of other mobile devices	10
▪ Tablets ▪ Smart phones ▪ Wearable technology devices: smart watches; fitness monitors; glasses and headsets ▪ Phablets ▪ e-Readers ▪ Smart camera ▪ GPS	10
3.5.Compare and contrast accessories & ports of other mobile devices	10
▪ Connection types: NFC; proprietary vendor specific ports (communication/power); microUSB/miniUSB; Lightning; Bluetooth; IR; hotspot/tethering ▪ Accessories: headsets; speakers; game pads; docking stations; extra battery packs/battery chargers; protective covers/water proofing; credit card readers; memory/MicroSD	10
4.0 Hardware and Network Troubleshooting	
4.1.Given a scenario, troubleshoot common problems related to motherboards, RAM, CPU and power with appropriate tools	12
▪ Common symptoms: unexpected shutdowns; system lockups; POST code beeps; blank screen on bootup; BIOS time and settings resets; attempts to boot to incorrect device; continuous reboots; no power; overheating; loud noise; intermittent device failure; fans spin—no power to other devices; indicator lights; smoke; burning smell; proprietary crash screens (BSOD/pin wheel); distended capacitors ▪ Tools: multimeter; power supply tester; loopback plugs; POST card/ USB	12
4.2.Given a scenario, troubleshoot hard drives and RAID arrays with appropriate tools	12

▪ Common symptoms: read/write failure; slow performance; loud clicking noise; failure to boot; drive not recognized; OS not found; RAID not found; RAID stops working; proprietary crash screens (BSOD/pin wheel); S.M.A.R.T. errors ▪ Tools: screwdriver; external enclosures; CHKDSK; FORMAT; file recovery software; bootrec; diskpart; defragmentation tool	12
4.3.Given a scenario, troubleshoot common video, projector and display issues	12
▪ Common symptoms: VGA mode; no image on screen; overheat shutdown; dead pixels; artifacts; color patterns incorrect; dim image; flickering image; distorted image; distorted geometry; burn-in; oversized images and icons	12
4.4.Given a scenario, troubleshoot wired and wireless networks with appropriate tools	12
▪ Common symptoms: no connectivity; APIPA/link local address; limited connectivity; local connectivity; intermittent connectivity; IP conflict; slow transfer speeds; low RF signal; SSID not found ▪ tools: cable tester; loopback plug; punch down tools; tone generator and probe; wire strippers; crimper; wireless locator ▪ Command line tools: PING; IPCONFIG/IFCONFIG; TRACERT; NETSTAT; NBTSTAT; NET; NETDOM; NSLOOKUP	12
4.5.Given a scenario, troubleshoot, and repair common mobile device issues while adhering to the appropriate procedures	12
▪ Common symptoms: no display; dim display; flickering display; sticking keys; intermittent wireless; battery not charging; ghost cursor/pointer drift; no power; num lock indicator lights; no wireless connectivity; no Bluetooth connectivity; cannot display to external monitor; touchscreen non-responsive; apps not loading; slow performance; unable to decrypt email; extremely short battery life; overheating; frozen system; no sound from speakers; GPS not functioning; swollen battery ▪ Disassembling processes for proper re-assembly: document and label cable and screw locations; organize parts; refer to manufacturer resources; use appropriate hand tools	12
4.6.Given a scenario, troubleshoot printers with appropriate tools	12
▪ Common symptoms: streaks; faded prints; ghost images; toner not fused to the paper; creased paper; paper not feeding; paper jam; no connectivity; garbled characters on paper; vertical lines on page; backed up print queue; low memory errors; access denied; printer will not print; color prints in wrong print color; unable to install printer; error codes; printing blank pages; no image on printer display	12

- Tools: maintenance kit; toner vacuum; compressed air; printer spooler

A+ Certification Exam Objectives: 220-902

The following table lists the domains measured by this examination and the extent to which they are represented on the exam.

Domain	Percentage of Exam
1.0 Windows Operating Systems	29%
2.0 Other Operating Systems & Technologies	12%
3.0 Security	22%
4.0 Software Troubleshooting	24%
5.0 Operational Procedures	13%
Total	100%

Objective	Chapter
1.0 Windows Operating Systems	
1.1.Compare and contrast various features and requirements of Microsoft Operating Systems (Windows Vista, Windows 7, Windows 8, Windows 8.1).	15, 16, 17
▪ Features: 32-bit vs. 64-bit; Aero; gadgets; user account control; bit-locker; shadow copy; system restore; ready boost; sidebar; compatibility mode; virtual XP mode; easy transfer; administrative tools; defender; Windows firewall; security center; event viewer; file structure and paths; category view vs. classic view; Side by side apps; Metro UI; pinning; One Drive; Windows store; multimonitor task bars; charms; start screen; power shell; Live sign in; action center ▪ Upgrade paths—differences between in place upgrades; compatibility tools; Windows upgrade OS advisor	15, 16, 17
1.2.Given a scenario, install Windows PC operating systems using appropriate method	15, 16, 17
▪ Boot methods: USB; CD-ROM; DVD; PXE; solid state/flash drives; netboot; external/hot swappable drive; internal hard drive (partition) ▪ Type of installations: unattended installation; upgrade; clean install; repair installation; multiboot; remote network installation; image deployment; recovery partition; refresh/restore ▪ Partitioning: dynamic; basic; primary; extended; logical; GPT ▪ File system types/formatting: ExFAT; FAT32; NTFS; CDFS; NFS; ext3, ext4; quick format vs. full format	15, 16, 17

▪ Load alternate third party drivers when necessary ▪ Workgroup vs. Domain setup ▪ Time/date/region/language settings ▪ Driver installation, software and windows updates ▪ Factory recovery partition ▪ Properly formatted boot drive with the correct partition/format	
1.3.Given a scenario, apply appropriate Microsoft command line tools	14
▪ TASKKILL; BOOTREC; SHUTDOWN; TASKLIST; MD; RD; CD; DEL; FORMAT; COPY; XCOPY; ROBOCOPY; DISKPART; SFC; CHKDSK; GPUPDATE; GPRESULT; DIR; EXIT; HELP; EXPAND; [command name] /?; commands available with standard privileges vs. administrative privileges	14
1.4.Given a scenario, use appropriate Microsoft operating system features and tools.	14
▪ Administrative: computer management; device manager; local users and groups; local security policy; performance monitor; services; system configuration; task scheduler; component services; data sources; print management; Windows memory diagnostics; Windows firewall; advanced security ▪ MSCONFIG: general; boot; services; startup; tools ▪ Task Manager: applications; processes; performance; networking; users ▪ Disk management: drive status; mounting; initializing; extending partitions; splitting partitions; shrink partitions; assigning/changing drive letters; adding drives; adding arrays; storage spaces ▪ Other: User State Migration tool (USMT); Windows Easy Transfer; Windows Upgrade Advisor ▪ System utilities: REGEDIT; COMMAND; SERVICES.MSC; MMC; MSTSC; NOTEPAD; EXPLORER; MSINFO32; DXDIAG; DEFRAG; System restore; Windows Update	14
1.5.Given a scenario, use Windows Control Panel utilities	14
▪ Internet options: Connections; Security; General; Privacy; Programs; Advanced ▪ Display/Display Settings: Resolution; Color depth; refresh rate ▪ User accounts	14

▪ Folder options: View hidden files; Hide extensions; general options; view options ▪ System: Performance (virtual memory); Remote settings; System protection ▪ Windows firewall ▪ Power options: Hibernate; power plans; Sleep/suspend; Standby ▪ Programs and features ▪ HomeGroup ▪ Devices and Printers ▪ Sound ▪ Troubleshooting ▪ Network and Sharing Center ▪ Device Manager	
1.6.Given a scenario, install and configure Windows networking on a client/desktop.	15, 16, 17
▪ HomeGroup vs. Workgroup ▪ Domain setup ▪ Network shares/administrative shares/mapping drives ▪ Printer sharing vs. network printer mapping ▪ Establish networking connections: VPN; dialups; wireless; wired; WWAN (cellular) ▪ Proxy settings ▪ Remote desktop connection ▪ Remote assistance ▪ Home vs. Work vs. Public network settings ▪ Firewall settings: exceptions; configuration; enabling/disabling Windows firewall ▪ Configuring an alternative IP address in Windows: IP addressing; subnet mask; DNS; gateway ▪ Network card properties: half duplex/full duplex/auto; speed; Wake-on-LAN; QoS; BIOS (on-board NIC)	15, 16, 17
1.7.Perform common preventive maintenance procedures using the appropriate Windows OS tools	14

▪ Best practices: scheduled backups; scheduled disk maintenance; Windows updates; patch management; driver/firmware updates; antivirus/antimalware updates ▪ Tools: Backup; System Restore; recovery image; disk maintenance utilities	14
2.0 Other Operating Systems and Technologies	
2.1.Identify common features and functionality of the Mac OS and Linux operating systems	18
▪ Best practices: Scheduled backups; scheduled disk maintenance; system updates/App store; patch management; driver/firmware updates; antivirus/antimalware updates ▪ Tools: Backup/Time Machine; Restore/snapshot; image recovery; disk maintenance utilities; shell/terminal; screen sharing; force quit ▪ Features: Multiple desktops/Mission Control; Key Chain; Spot Light; iCloud; gestures; Finder; Remote Disc; Dock; Boot Camp ▪ Basic Linux commands: ls; grep; cd; shutdown; pwd vs. passwd; mv; cp; rm; chmod; chown; iwconfig/ifconfig; ps; q; su/sudo; apt-get; vi; dd	18
2.2.Given a scenario, setup and use client-side virtualization	20
▪ Purpose of virtual machines ▪ Resource requirements ▪ Emulator requirements ▪ Security requirements ▪ Network requirements ▪ Hypervisor	20
2.3.Identify basic cloud concepts	20
▪ SaaS ▪ IaaS ▪ PaaS ▪ Public vs. Private vs. Hybrid vs. Community ▪ Rapid elasticity ▪ On-demand ▪ Resource pooling ▪ Measured service	20

2.4.Summarize the properties and purpose of services provided by networked hosts	20
▪ Server roles: Web server, file server; print server; DHCP server; DNS server; proxy server; mail server; authentication server ▪ Internet appliance: UTM; IDS; IPS ▪ Legacy / embedded systems	20
2.5.Identify basic features of mobile operating systems	21
▪ Android vs. iOS vs. Windows ▪ Open source vs. closed source/vendor specific ▪ App source (play store, app store and store) ▪ Screen orientation (accelerometer/gyroscope) ▪ Screen calibration ▪ GPS and geotracking ▪ WiFi calling ▪ Launcher/GUI ▪ Virtual assistant ▪ SDK/APK ▪ Emergency notification ▪ Mobile payment service	21
2.6.Install and configure basic mobile device network connectivity and email	21
▪ Wireless / cellular data network (enable/disable): hotspot; tethering; airplane mode ▪ Bluetooth: enable Bluetooth; enable pairing; find device for pairing; enter appropriate pin code; test connectivity ▪ Corporate and ISP email configuration: POP3; IMAP; port and SSL settings; Exchange, S/MIME ▪ Integrated commercial provider email configuration: Google/Inbox; Yahoo; Outlook.com; iCloud ▪ PRI updates/PRL updates/baseband updates ▪ Radio firmware ▪ IMEI vs. IMSI ▪ VPN	21

2.7.Summarize methods and data related to mobile device synchronization	21
▪ Types of data to synchronize: contacts; programs; email; pictures; music; videos; calendar; bookmarks; documents; location data; social media data; eBooks ▪ Synchronization methods: synchronize to the cloud; synchronize to the desktop ▪ Mutual authentication for multiple services ▪ Software requirements to install the application on the PC ▪ Connection types to enable synchronization	21
3.0 Security	
3.1.Identify common security threats and vulnerability	19
▪ Malware: spyware; viruses; worms; Trojans; rootkits; ransomware ▪ Phishing ▪ Spear phishing ▪ Spoofing ▪ Social engineering ▪ Shoulder surfing ▪ Zero day attack ▪ Zombie/botnet ▪ Brute forcing ▪ Dictionary attacks ▪ Non-compliant systems ▪ Violations of security best practices ▪ Tailgating ▪ Man-in-the-middle	19
3.2.Compare and contrast common prevention methods	19
▪ Physical security: lock doors; mantrap; cable locks; securing physical documents/passwords/shredding; biometrics; ID badges; key fobs; RFID badge; smart card; tokens; privacy filters; entry control roster ▪ Digital security: antivirus/antimalware; firewalls; user authentication/strong passwords; multifactor authentication; directory permissions; VPN; DLP; Disabling ports; Access control lists; smart card; email filtering; trusted/untrusted software sources	19

▪ User education/AUP ▪ Principle of least privilege	
3.3.Compare and contrast differences of basic Windows OS security settings	19
▪ User and groups: administrator; power user; guest; standard user ▪ NTFS vs. share permissions: allow vs. deny; moving vs. copying folders and files; file attributes ▪ Shared files and folders: administrative shares vs. local shares; permission propagation; inheritance ▪ System files and folders ▪ User authentication: single sign-on ▪ Run as administrator vs. standard user ▪ Bitlocker ▪ Bitlocker-to-Go ▪ EFS	19
3.4.Given a scenario, deploy and enforce security best practices to secure a workstation	19
▪ Password best practices: Setting strong passwords; Password expiration; Changing default user names/passwords; Screensaver required password; BIOS/UEFI passwords; Requiring passwords ▪ Account management: Restricting user permissions; Login time restrictions; Disabling guest account; Failed attempts lockout; Timeout/screen lock ▪ Disable autorun ▪ Data encryption ▪ Patch/update management	19
3.5.Compare and contrast various methods for securing mobile devices	17
▪ Screen locks: fingerprint lock; face lock; swipe lock; passcode lock ▪ Remote wipes ▪ Locator applications ▪ Remote backup applications ▪ Failed login attempts restrictions ▪ Antivirus/antimalware	17

▪ Patching/OS updates ▪ Biometric authentication ▪ Full device encryption ▪ Multifactor authentication ▪ Authenticator applications ▪ Trusted sources vs. untrusted sources ▪ Firewalls ▪ Policies and procedures: BYOD vs. corporate owned; profile security requirements	
3.6.Given a scenario, use appropriate data destruction and disposal methods	17
▪ Physical destruction: shredder; drill/hammer; electromagnetic (degaussing); incineration; certificate of destruction ▪ Recycling or repurposing best practices: Low level format vs. standard format; overwrite; drive wipe	17
3.7.Given a scenario; secure SOHO wired and wireless networks	17
▪ Wireless specific: Changing default SSID; Setting encryption; Disabling SSID broadcast; Antenna and access point placement; Radio power levels; WPS ▪ Change default usernames and passwords ▪ Enable MAC filtering	17
▪ Assign static IP addresses ▪ Firewall settings ▪ Port forwarding/mapping ▪ Disabling ports ▪ Content filtering/parental controls ▪ Update firmware ▪ Physical security	17
4.0 Software Troubleshooting	
4.1.Given a scenario, troubleshoot PC operating system problems with appropriate tools	22
▪ Common symptoms: Proprietary crash screens (BSOD/pin wheel); failure to boot; improper shutdown; spontaneous shutdown/restart; device fails to	22

start/detected; missing dll message; services fails to start; compatibility error; slow system performance; boots to safe mode; file fails to open; missing BOOTMGR; missing Boot Configuration Data; missing operating system; missing graphical interface; missing GRUB/LILO; kernel panic; graphical interface fails to load; multiple monitor misalignment/ orientation	
▪ Tools: BIOS/UEFI; SFC; logs; system recovery options; repair disks; pre-installation environments; MSCONFIG; DEFRAG; REGSRV32; REGEDIT; event viewer; safe mode; command prompt; uninstall/reinstall/repair	22
4.2.Given a scenario, troubleshoot common PC security issues with appropriate tools and best practices	22
▪ Common symptoms: pop-ups; browser redirection; security alerts; slow performance; internet connectivity issues; PC/OS lock up; application crash; OS update failures; rogue antivirus; spam; renamed system files; files disappearing; file permission changes; hijacked email (responses from users regarding email; automated replies from unknown sent mail); access denied; invalid certificate (trusted root CA) ▪ Tools: anti-virus software; anti-malware software; system recovery options; terminal; system restore/snapshot; pre-installation environments; event viewer; refresh/restore; MSCONFIG/safe boot ▪ Best practices for malware removal: Identify malware symptoms; Quarantine infected system; Disable system restore (in Windows); Remediate infected systems (Update antimalware software; Scan and removal techniques (safe mode; pre-installation environment)); Schedule scans and run updates; Enable system restore and create restore point (in Windows); Educate end user	22
4.3.Given a scenario, troubleshoot common mobile OS and application issues with appropriate tools	22
▪ Common symptoms: dim display; intermittent wireless; no wireless connectivity; no Bluetooth connectivity; cannot broadcast to external monitor; touchscreen non-responsive; apps not loading; slow performance; unable to decrypt email; extremely short battery life; overheating; frozen system; no sound from speakers; inaccurate touch screen response; system lockout ▪ Tools: hard reset; soft reset; close running applications; reset to factory default; adjust configurations/settings; uninstall/reinstall apps; force stop	22
4.4.Given a scenario, troubleshoot common mobile OS and application security issues with appropriate tools	22

▪ Common symptoms: signal drop/weak signal; power drain; slow data speeds; unintended WiFi connection; unintended Bluetooth pairing; leaked personal files/data; data transmission overlimit; unauthorized account access; unauthorized root access; unauthorized location tracking; unauthorized camera/microphone activation; high resource utilization ▪ Tools: antimalware; app scanner; factory reset/clean install; uninstall/reinstall apps; WiFi analyzer; force stop; cell tower analyzer; backup/restore (iTunes/iCloud/Apple Configurator; Google sync; One Drive)	22
5.0 Operational Procedures	
5.1.Given a scenario, use appropriate safety procedures	23
▪ Equipment grounding ▪ Proper component handling and storage: antistatic bags; ESD straps; ESD mats; Self-grounding ▪ Toxic waste handling: batteries; toner; CRT ▪ Personal safety: disconnect power before repairing PC; remove jewelry; lifting techniques; weight limitations; electrical fire safety, cable management; safety goggles; air filter mask ▪ Compliance with local government regulations	23
5.2.Given a scenario with potential environmental impacts, apply the appropriate controls	23
▪ MSDS documentation for handling and disposal ▪ Temperature, humidity level awareness and proper ventilation ▪ Power surges, brownouts, blackouts: battery backup; surge suppressor ▪ Protection from airborne particles: enclosures; air filters/mask ▪ Dust and debris: compressed air; vacuums ▪ Compliance to local government regulations	23
5.3.Summarize the process of addressing prohibited content/activity, and explain privacy, licensing, and policy concepts	23
▪ Incident response: First response (identify; report through proper channels; data/device preservation); Use of documentation/documentation changes; Chain of custody (tracking of evidence/documenting process) ▪ Licensing/DRM/EULA: open source vs. commercial license; personal license vs. enterprise licenses ▪ Personally Identifiable Information	23

▪ Follow corporate end-user policies and security best practices	
5.4.Demonstrate proper communication techniques and professionalism	23
▪ Use proper language – avoid jargon, acronyms, slang when applicable ▪ Maintain a positive attitude / Project confidence ▪ Actively listen (taking notes) and avoid interrupting the customer ▪ Be culturally sensitive: use appropriate professional titles, when applicable ▪ Be on time (if late contact the customer) ▪ Avoid distractions: personal calls; texting/social media sites; talking to co-workers while interacting with customers; personal interruptions ▪ Dealing with difficult customer or situation: do not argue with customers and/or be defensive; avoid dismissing customer problems; avoid being judgmental; clarify customer statements (ask open ended questions to narrow the scope of the problem, restate the issue or question to verify understanding); do not disclose experiences via social media ▪ Set and meet expectations/timeline and communicate status with the customer: offer different repair/replacement options if available; provide proper documentation on the services provided; follow up with customer/user at a later date to verify satisfaction ▪ Deal appropriately with customers confidential and private materials: located on a computer, desktop, printer, etc.	23
5.5.Given a scenario, explain the troubleshooting theory.	23
▪ Always consider corporate policies, procedures and impacts before implementing changes. ▪ Identify the problem: Question the user and identify user changes to computer and perform backups before making changes ▪ Establish a theory of probable cause (question the obvious): If necessary, conduct external or internal research based on symptoms ▪ Test the theory to determine cause: Once theory is confirmed determine next steps to resolve problem; If theory is not confirmed re-establish new theory or escalate ▪ Establish a plan of action to resolve the problem and implement the solution ▪ Verify full system functionality and if applicable implement preventive measures ▪ Document findings, actions and outcomes	23

Exam objectives are subject to change at any time without prior notice at CompTIA's sole discretion. Please visit CompTIA's website (www.comptia.org) for the most current listing of exam objectives.

Assessment Test

1. Which of the following is *not* considered a system component that can be found inside a computer?
   A. CPU
   B. RAM
   C. PCIe graphics adapter
   D. Motherboard
2. Which of the following is a physical memory format installed directly in today's desktop computer systems?
   A. DIMM
   B. HDD
   C. SSD
   D. eMMC
3. Which of the following are components that can commonly be found on a motherboard? (Choose all that apply.)
   A. Slots
   B. Fan connectors
   C. Gyroscope
   D. Scanner
   E. HDD
4. What suffix indicates that the capacity of an optical disc is roughly twice that of its standard counterpart?
   A. DL
   B. R
   C. RW
   D. RE
5. What is the name of the standard power connector that has been used with larger drives since the first IBM personal computers were introduced?
   A. AT system connector
   B. Berg
   C. Molex

D. ATX system connector

6. Except in the case of RAID 0, which two things do all types of RAID offer?
   A. Faster read speeds
   B. Faster write speeds
   C. Redundancy
   D. Fault tolerance
   E. Ability to restore automatically from tape after a drive failure
7. You are installing a new graphics adapter in a Windows 7 system. Which of the following expansion slots is designed for high-speed, 3D graphics adapters?
   A. USB
   B. FireWire
   C. PCI
   D. PCIe
8. A user complains that changing from a VGA graphics card to one that supports the latest HDMI revision has resulted in not being able to play back certain content from the computer. Some content does play back, however. What could be the problem?
   A. Digital signal required
   B. Resolution too low
   C. DRM
   D. VGA cable not compatible
9. Which of the following are modular ports used in data communications? (Choose two.)
   A. RG-6
   B. RJ-45
   C. RJ-11
   D. Thunderbolt
   E. RG-11
10. The _____is the measurement of the number of pixels an LCD monitor can display without the image appearing distorted.
   A. Native resolution
   B. Contrast ratio
   C. Pixelation

D. Base frequency

11. Which of the following is *not* a common monitor technology?

A. LCD

B. Plasma

C. OLED

D. Super PMOLED

12. What can be used at the check-in desk of a doctor's office to prevent patients from viewing confidential information?

A. An antiglare filter

B. A privacy filter

C. An LED-backlit display

D. A thin client

13. Which of the following is a standard computer that can access resources locally as well as from servers but requires no specialized enhancements?

A. Gaming PC

B. Home server

C. Thin client

D. Thick client

14. Which of the following is a requirement for virtualization workstations?

A. Enhanced video

B. Enhanced audio

C. Maximum RAM and CPU cores

D. RAID array

15. Which of the following is *not* a requirement for a home server PC?

A. TV tuner

B. Print and file sharing services

C. Gigabit NIC

D. RAID array

16. Which network connectivity device stops broadcasts from being sent to computers on a different network segment?

A. Hub

B. Switch
C. Router
D. Firewall

17. Which layer of the OSI model has the important role of providing error checking?
A. Session layer
B. Presentation layer
C. Application layer
D. Transport layer

18. On which port does FTP run by default?
A. 21
B. 25
C. 63
D. 89

19. Which of the following protocols can be used by a client to access email on a server?
A. DNS
B. FTP
C. SMTP
D. IMAP

20. Which of the following is a company that provides direct access to the Internet for home and business computer users?
A. ASP
B. ISP
C. DNS
D. DNP

21. What is the data throughput provided by one ISDN bearer channel?
A. 16Kbps
B. 56Kbps
C. 64Kbps
D. 128Kbps

22. Which LCD component in a laptop is responsible for providing brightness?
A. Backlight

B. Inverter

C. Screen

D. Backdrop

23. Your laptop has 2GB of installed memory and uses shared video memory. If the video card is using 512MB, how much is left for the rest of the system?

A. 2GB

B. 1.5GB

C. 512MB

D. Cannot determine

24. Which of the following standards supports both PCIe and USB 3.0?

A. PC Card

B. PlugCard

C. ExpandCard

D. ExpressCard

25. When using a capacitive touchscreen on a mobile device, what is the most common tool used to input data?

A. Keyboard

B. Trackball

C. Stylus

D. Finger

26. Which technology used by e-Readers gives them longer battery life than tablets?

A. Lithium-polymer battery

B. Low-power backlight

C. Electrophoretic ink

D. Capacitive touchscreen

27. What is the name of the mode that allows two NFC-enabled devices to transmit data to each other?

A. Emulation mode

B. Peer-to-peer mode

C. Reader/writer mode

D. Ad hoc mode

28. What is the function of the laser in a laser printer?

    A. It heats up the toner so that it adheres to the page.

    B. It charges the paper so that it will attract toner.

    C. It creates an image of the page on the drum.

    D. It cleans the drum before a page is printed.

29. What is the component called that stores the material that ends up printed to the page in a laser printer?

    A. Toner cartridge

    B. Ink cartridge

    C. Laser module

    D. Laser cartridge

30. What service was created by Apple to allow iPhones and iPads to print without installing printer drivers?

    A. TCP printing

    B. Bonjour

    C. AirPrint

    D. iPrint

31. Your laser printer has recently starting printing vertical white lines on the documents that it prints. What is the most likely cause of the problem?

    A. The print driver is faulty.

    B. The fuser is not heating properly.

    C. There is toner on the transfer corona wire.

    D. There is a scratch on the EP drum.

32. You are working with a Windows 7 computer that is assigned IP configuration information from a central server. You wish to refresh the IP information on the system manually. Which of the following commands would you use?

    A. `IPCONFIG /refresh`

    B. `IPCONFIG /all`

    C. `IPCONFIG /renew`

    D. `WINIPCFG /all`

33. One laser printer in your office experiences frequent paper jams. What is the most likely cause of the problem?

A. Worn paper feed rollers.

B. Faulty stepper motor.

C. Faulty fuser assembly.

D. The EP drum isn't advancing properly.

34. One of your network users was recently caught browsing pornographic websites at work. Which of the following servers could be installed to prohibit this activity?

A. Web

B. Security

C. Proxy

D. DNS

35. Google Docs is an example of what type of cloud service?

A. SaaS

B. IaaS

C. PaaS

D. GaaS

36. Which type of software is required to run client-side virtualization on your home network?

A. Terminal emulation

B. Process replication

C. Hyperthreading

D. Hypervisor

37. Which of the following are popular mobile-device operating systems? (Choose all that apply.)

A. Android

B. Windows 7

C. Ubuntu

D. iOS

38. Which of the following protocols can be used in close range to transfer data between a mobile device and a computer system or to allow media to stream from the mobile device to an audio system?

A. SMTP

B. Bluetooth

C. NFC

D. Pegasus

39. What term refers to copying data between a mobile device and a computer system to mirror such things as contacts, programs, pictures, and music?

A. Calibration

B. Remote wipe

C. Pairing

D. Synchronization

40. Which of the following computer components can retain a lethal electrical charge even after the device is unplugged? (Choose two.)

A. Monitor

B. Processor

C. Power supply

D. RAM

41. Roughly how much time spent communicating should be devoted to listening?

A. 23 percent

B. 40 percent

C. 50 percent

D. 80 percent

42. You have found prohibited content on a user's machine and need to follow proper procedures. What is the term used to describe the handling of evidence from discovery to delivery to the proper authorities?

A. First response

B. Chain of custody

C. Data preservation

D. Documentation flow changes

43. Which of the following is a security mechanism used by HTTPS to encrypt web traffic between a web client and server?

A. IPSec

B. SSL

C. L2TP

D. PPPoE

14. Which of the following are 4G technologies? (Choose all that apply.)
    A. LTE
    B. GSM
    C. CDMA
    D. WiMax
15. Which of the following standards is also known as CardBus?
    A. PCMCIA 1.0
    B. PCMCIA 2.0
    C. PCMCIA 5.0
    D. ExpressCard
16. When lifting heavy equipment, what is the proper technique?
    A. Get the heaviest part closest to your body and lift with your legs.
    B. Get the heaviest part closest to your body and lift with your back.
    C. Get the lightest part closest to your body and lift with your legs.
    D. Get the lightest part closest to your body and lift with your back.
17. Which of the following is a chip that is integrated into PATA drives, as opposed to being mounted on a daughter card?
    A. Controller
    B. CPU
    C. Host adapter
    D. IDE
18. After SATA was introduced, what was the retroactive term used for the original ATA specification?
    A. EIDE
    B. IDE
    C. PATA
    D. SCSI
19. Which of the following is a virtual machine manager—the software that allows the virtual machines to exist?
    A. Comptroller
    B. Shell

C. Kernel

D. Hypervisor

50. Which of the following would *not* be considered a standard permission in Windows using NTFS?

A. Full Control

B. Modify

C. Allow

D. Write

51. Which feature is designed to keep Windows current by automatically downloading updates such as patches and security fixes and installing these fixes automatically?

A. Security Center

B. Action Center

C. Windows Update

D. Windows Anytime

52. With dynamic storage, which of the following partition types are possible?

A. Complex, bridged, or mirrored

B. Simple, spanned, or striped

C. Simple, complex, or interleaved

D. Spanned, interleaved, or striped

53. You have been told to use Task Manager to change the priority of a process to Below Normal. This equates to a base priority of what?

A. 2

B. 4

C. 6

D. 8

54. Encrypting File System (EFS) is available in which editions of Windows 7? (Choose all that apply.)

A. Professional

B. Home Premium

C. Enterprise

D. Ultimate

E. Business

55. Which of the following can provide electrical power over Ethernet cabling?

    A. PoE

    B. QoS

    C. DoS

    D. WoL

56. With which type of duplexing do communications travel in both directions but in only one direction at any given time?

    A. Full

    B. Half

    C. Auto

    D. Mechanical

57. Which applet in Windows Vista is the primary interface for configuring synchronization of offline files?

    A. Synchronization Wizard

    B. Action Center

    C. Merge

    D. Sync Center

58. Which Control Panel applet allows you to administer, as well as deploy, component services and configure behavior like security?

    A. SFC

    B. Data Sources

    C. Component Services

    D. DDR

59. In Windows, the Account Lockout Counter in an Account Lockout policy keeps track of the number of invalid attempts before lockout occurs. The default is 0 (meaning the feature is turned off), but it can be set from 1 to what?

    A. 9999

    B. 999

    C. 99

    D. 24

60. What Windows operating system tool can be used to block access from the network (be it internal or the Internet)?

A. Windows Firewall

B. Windows Defender

C. Advanced Security

D. Device Manager

51. Which of the following are programs that enter a system or network under the guise of another program? (Choose the best answer.)

A. Worms

B. Trojans

C. Rootkits

D. Spyware

52. Which of the following involves applying a strong magnetic field to initialize the media before tossing it away?

A. Fraying

B. Fracking

C. Degaussing

D. Spreading

53. Which term is synonymous with *MAC filtering*?

A. Disabling Autorun

B. Shredding

C. Port disabling

D. Network Lock

54. Which of the following is a copy of your system configuration at a given point in time?

A. Restore point

B. MBR

C. Registry

D. `BOOT.INI`

55. Which of the following could be described as a small, deviously ingenious program that replicates itself to other computers, generally causing those computers to behave abnormally? (Choose the best answer.)

A. Rogue

B. Redirector

C. Virus

D. Pop-up

Answers to Assessment Test

1. C. System components are essential for the basic functionality of a computer system. Many of the landmarks found on the motherboard can be considered system components, even expansion slots to a degree. What you plug into those slots, however, must be considered peripheral to the basic operation of the system. For more information, see Chapter 1.
2. A. Except for DIMMs, all options represent some form of secondary storage, all of which are covered in Chapter 2. For more information, see Chapter 1.
3. A, B. Motherboards commonly have RAM slots and expansion slots. Older motherboards even had CPU slots. Modern motherboards have connectors for powering cooling fans. Gyroscopes are most commonly found in mobile devices. Scanners are external devices. Although there might be one or more types of HDD interfaces built into the motherboard, the HDD itself is not. For more information, see Chapter 1.
4. A. DL stands for double or dual layer. With DVDs, the capacity almost doubles, but with Blu-ray discs, it actually does. For more information, see Chapter 2.
5. C. The standard peripheral power connector, or Molex connector, is commonly used on larger drives because it allows more current to flow to the drive than smaller peripheral connectors. For more information, see Chapter 2.
6. C, D. Except for RAID 0, all implementations of RAID offer a way to recover from the failure of at least one drive, which is an example of fault tolerance, through the implementation of some mechanism that stores redundant information for that purpose. Some RAID types offer faster read and/or write performance. RAID 1, for instance does not guarantee either. For more information, see Chapter 2.
7. D. Although technically PCI could be used for graphics adapters, PCIe supports high-speed, 3D graphic video cards. PCIe offers better performance than older graphics adapters. USB and FireWire can stream video, but they are not used for attachment of graphics adapters. For more information, see Chapter 3.
8. C. Digital rights management (DRM), using High-bandwidth Content Protection (HDCP), is supported by adapters and monitors that support HDMI and later versions of DVI. If the content is protected, HDMI in the adapter will use HDCP to encrypt the stream across the cable, and the monitor will use HDCP to decrypt it for playback. From the information given, it cannot be assumed that the monitor changed when the adapter did. As a result, the monitor might have an older DVI-D port that uses a passive converter to receive the HDMI cable's signal but that does not support HDCP. The signal over the HDMI cable is always digital. As a result, a VGA cable, which only supports analog signals, cannot be used when a DVI-D or HDMI interface is involved.

HDMI supports all resolutions supported by a VGA interface. For more information, see Chapter 3.

9. B, C. RJ-11 ports are used in analog telephony, and they allow modems attached to computer serial ports to transmit modulated digital information across the public switched telephone network (PSTN). RJ-45 ports are used by various network interface controller (NIC) cards for attachment to networks such as Ethernet. RG-6 and RG-11 are coaxial cable types, and Thunderbolt connectors are not modular. For more information, see Chapter 3.

10. A. The native resolution refers to how many pixels an LCD screen can display (across and down) without distortion. The native resolution is based on the placement of the actual transistors that create the image by twisting the liquid crystals. The contrast ratio is the measurement between the darkest color and the lightest color that an LCD screen can display. For more information, see Chapter 4.

11. D. Although there *is* a Super AMOLED display, employing active-matrix technology, there is no corresponding "super" passive-matrix version. The other technologies exist and are discussed in further detail in Chapter 4.

12. B. Privacy filters are used to limit the viewing angle for a monitor. With such filters, the screen image becomes indiscernible when viewed at just a few degrees from center. For more information, see Chapter 4.

13. D. A thick client is any computer system with a standard configuration. The gaming PC has enhancements over thick clients to their CPU, video, audio, and cooling. The home server PC must have specialized capabilities and services along with a faster NIC than the thick client and a RAID array. The thin client is a lesser device in comparison to the thick client, but that cost-saving feature is its enhancement. These less expensive computers can connect over the network to servers for their operating system images and applications. For more information, see Chapter 5.

14. C. Virtualization workstations require more RAM than standard systems and need to be equipped with as many multicore processors as possible. Video and audio are not resources that need to be enhanced for such workstations. Although a RAID array is a wise addition whenever servers with valuable information are involved, a virtualization workstation does not require one. For more information, see Chapter 5.

15. A. A TV tuner card is a requirement for a home theater PC but not for a home server. The other options are among those features that are required. For more information, see Chapter 5.

16. C. A router does not pass along broadcasts to computers on other segments. Hubs and switches send broadcasts along because they do not segment traffic at the logical network address level. See Chapter 6 for more information.

17. D. A key role of the Transport layer is to provide error checking. The Transport layer also provides functions such as reliable end-to-end communications, segmentation

and reassembly of larger messages, and combining smaller messages into a single larger message. See Chapter 6 for more information.

18. A. FTP listens on port 21. See Chapter 7 for more information.

19. D. The IMAP and POP3 protocols can be used to retrieve email from mail servers. See Chapter 7 for more information.

20. B. An Internet service provider (ISP) provides direct access to the Internet. See Chapter 8 for more information.

21. C. An ISDN B (bearer) channel provides 64Kbps data throughput. A home-based BRI ISDN provides two B channels. See Chapter 8 for more information.

22. A. The backlight provides light to the LCD screen. The inverter provides power to the backlight, and the screen displays the picture. See Chapter 9 for more information.

23. B. If the laptop is using shared video memory, then the system memory is shared with the video card. If the video card is using 512MB (half a gigabyte), then there is 1.5GB left for the system. See Chapter 9 for more information.

24. D. ExpressCard supports PCIe and USB 3.0. See Chapter 9 for more information.

25. D. Capacitive touchscreens react to slight changes in electrical charges. The human finger is used as an input device for capacitive touchscreens. For more information, see Chapter 10.

26. C. e-Readers use electrophoretic ink, also known as E Ink. E Ink uses less energy than other LCD displays, prolonging battery life. For more information, see Chapter 10.

27. B. Card emulation mode, reader/writer mode, and peer-to-peer mode are the three valid NFC communication modes. For two devices to transmit to each other, they will use peer-to-peer mode. For more information, see Chapter 10.

28. C. The laser creates an image on the photosensitive drum that is then transferred to the paper by the transfer corona. The fuser heats up the toner so that it adheres to the page. The transfer corona charges the page, and the eraser lamp cleans the drum before a page is printed. A rubber blade is also used to remove toner physically from the drum. See Chapter 11 for more information.

29. A. Laser printers use toner, which they melt to the page in the image of the text and graphics being printed. A toner cartridge holds the fine toner dust until it is used in the printing process. See Chapter 11 for more information.

30. C. AirPrint was created by Apple to let iPhones and iPads print without installing a printer driver. See Chapter 11 for more information.

31. C. Toner on the transfer corona wire is most likely the cause of white streaks on printouts. A scratch or a groove in the EP drum causes vertical black lines. If the fuser was not heating properly, toner would not bond to the paper and you would have smearing. Faulty print drivers will cause garbage to print or there will be no printing at

all. See Chapter 12 for more information.

32. C. The `IPCONFIG` utility can be used with Windows computers to see the networking configuration values at the command line. It is one of the most commonly used command-line utilities that can be used in troubleshooting and network configurations. To renew IP configuration information, the `IPCONFIG /renew` command is used to force the DHCP server to renew the IP information assigned to the system. See Chapter 12 for more information.

33. A. The most likely cause of those listed is a worn paper feed roller. Stepper motors control the back-and-forth motion of a print head in an inkjet printer. If the fuser assembly were faulty, the images would smear. See Chapter 12 for more information.

34. C. A proxy server can be configured to block access to websites containing potentially objectionable material. See Chapter 20 for more information.

35. A. Google Docs is software, so it is an example of Software as a Service (SaaS). See Chapter 20 for more information.

36. D. The hypervisor is the key piece of software needed for virtualization. See Chapter 20 for more information.

37. A, D. Google's Android and Apple's iOS are two of the most popular operating systems for mobile devices on the market. The other two are not. Although some mobile operating systems are based on Linux or UNIX, Ubuntu is a Linux distribution not used for mobile devices. For more information, see Chapter 21.

38. B. Bluetooth allows you to pair a mobile device to a computer or to a device such as an automotive sound system or headset. Data can be transferred between devices, and media can be streamed from the mobile device. For more information, see Chapter 21.

39. D. Synchronizing a mobile device with a computer system allows you to mirror personal data between the devices, regardless of which one contains the most current data. Calibration refers to matching the device's and user's perceptions of where the user is touching the screen. Remote wipes allow you to remove personal data from a lost or stolen device. Pairing is what must be done in Bluetooth for two Bluetooth devices to connect and communicate. For more information, see Chapter 21.

40. A, C. Monitors and power supplies can retain significant electrical charges, even after they're unplugged. Don't open the back of a monitor or the power supply unless you are specifically trained to do so. See Chapter 23 for more information.

41. C. Roughly half the time spent communicating should be devoted to listening. See Chapter 23 for more information.

42. B. *Chain of custody* describes the procedure used to track handling and the location of evidence in the event of an incident such as discovering illegal or improper material on a user's computer. See Chapter 23 for more information.

43. B. HTTPS connections are secured using either Secure Sockets Layer (SSL) or

Transport Layer Security (TLS).

44. A, D. WiMax and LTE are the two current 4G cellular technologies. GSM and CDMA are 3G technologies.

45. C. PCMCIA 5.0 is also known as CardBus.

46. A. When lifting heavy equipment, center the weight as close to your body as possible. Then, keep your back straight and lift with your legs.

47. A. A controller chip is responsible for encoding data to be stored on the disk platters as well as performing geometry translation for the BIOS. Translation is necessary because the true number of sectors per track of the hard disk drive system usually exceeds what is supported by the BIOS.

48. C. *IDE* (ATA-1) and *EIDE* (ATA-2 and later) were specific nicknames for the ATA series of standards. Although *ATA* is technically accurate, it refers to legacy IDE standards as well as newer SATA standards. Instead of using the term *ATA* to be synonymous with *IDE* and *EIDE*, as had been done in the past, the term *PATA* was coined, referring to the parallel nature of IDE communications. The term *PATA* differentiates the IDE and EIDE form of ATA from Serial ATA. SCSI is a related, yet completely different type of technology.

49. D. The hypervisor is a virtual machine manager—the software that allows the virtual machines to exist.

50. C. Standard permissions are collections of special permissions, including Full Control, Modify, Read & Execute, Read, and Write.

51. C. Windows includes Windows Update, a feature designed to keep Windows current by automatically downloading updates such as patches and security fixes and installing these fixes automatically.

52. B. Windows supports both basic and dynamic storage. Basic can have a primary and an extended partition, while dynamic can be simple, spanned, or striped.

53. C. For applications that don't need to drop all of the way down to Low, this equates to a base priority of 6.

54. A, C, D. EFS is available in the Professional, Enterprise, and Ultimate editions of Windows 7, allowing for encryption/decryption on files stored in NTFS volumes.

55. A. Power over Ethernet (PoE) is a handy technology to supply both power and an Ethernet connection. The purpose of Power over Ethernet (PoE) is pretty much described in its name: Electrical power is transmitted over twisted-pair Ethernet cable (along with data).

56. B. With half duplex, communications travel in both directions but in only one direction at any given time.

57. D. The Sync Center in Windows Vista is the primary interface for configuring

synchronization.

58. C. Component Services allows you to administer as well as deploy component services and configure behavior like security.

59. B. It can be set from 1 to 999.

60. A. Windows Firewall (Start ➢ Control Panel ➢ Windows Firewall) is used to block access from the network (be it internal or the Internet).

61. B. Trojans are programs that enter a system or network under the guise of another program. While rootkits *may* do this, it is not their primary feature and thus not the best answer for this question.

62. C. Degaussing involves applying a strong magnetic field to initialize the media (this is also referred to as disk wiping). This process helps ensure that information doesn't fall into the wrong hands.

63. D. On a number of wireless devices, the term Network Lock is used in place of *MAC filtering*, and the two are synonymous.

64. A. A restore point is a copy of your system configuration at a given point in time. It's like a backup of your configuration but not necessarily your data.

65. C. A computer virus is a small, deviously ingenious program that replicates itself to other computers, generally causing those computers to behave abnormally. Generally speaking, a virus's main function is to reproduce.

Part I: 220-901

Chapter 1
Motherboards, Processors, and Memory

THE FOLLOWING COMPTIA A+ 220-901 OBJECTIVES ARE COVERED IN THIS CHAPTER:

✓ 1.1 Given a scenario, configure settings and use BIOS/UEFI tools on a PC.

- Install firmware upgrades – flash BIOS
- BIOS component information: RAM, Hard drive, Optical drive, CPU, Boot sequence, Enabling and disabling devices, Date/time, Clock speeds, Virtualization support
- BIOS security (passwords, drive encryption: TPM, lo-jack, secure boot)
- Use built-in diagnostics
- Monitoring: Temperature monitoring, Fan speeds, Intrusion detection/notification, Voltage, Clock, Bus speed

✓ 1.2 Explain the importance of motherboard components, their purposes, and properties.

- Sizes: ATX, Micro-ATX, Mini-ITX, ITX)
- Expansion slots: PCI, PCI-X, PCIe, miniPCI
- RAM slots
- CPU sockets
- Chipsets: Northbridge/Southbridge, CMOS battery
- Power connections and types
- Fan connectors
- Front/top panel connectors: USB, Audio, Power button, Power light, Drive activity lights, Reset button
- Bus speeds

✓ 1.3 Compare and contrast RAM types and features.

- Types: DDR, DDR2, DDR3, SODIMM, DIMM, Parity vs. non-parity, ECC vs. non-ECC, RAM configurations (Single channel vs. dual channel vs. triple channel), Single sided vs. double sided, Buffered vs. unbuffered
- RAM compatibility and speed

✓ 1.6 Differentiate among various CPU types and features, and select the appropriate cooling method.

- Socket types: Intel (775, 1155, 1156, 1366, 1150, 2011), AMD (AM3, AM3+, FM1,

FM2, FM2+)

- Characteristics (Speeds, Cores, Cache size/type, Hyperthreading, Virtualization support, Architecture [32-bit vs. 64-bit], Integrated GPU, Disable execute bit)
- Cooling (Heat sink, Fans, Thermal paste, Liquid-based, Fanless/passive)

A personal computer (PC) is a computing device made up of many distinct electronic components that all function together in order to accomplish some useful task, such as adding up the numbers in a spreadsheet or helping you write a letter. Note that this definition describes a computer as having many distinct parts that work together. Most computers today are modular. That is, they have components that can be removed and replaced with another component of the same function but with different specifications in order to improve performance. Each component has a specific function. In this chapter, you will learn about the core components that make up a typical PC, what their functions are, and how they work together inside the PC.

Unless specifically mentioned otherwise, throughout this book the terms *PC* and *computer* are used interchangeably.

In this chapter, you will learn how to identify system components common to most personal computers, including the following:

- Motherboards
- Processors
- Memory
- Cooling systems

Identifying Components of Motherboards

The spine of the computer is the *motherboard*, otherwise known as the system board or mainboard. This is the *printed circuit board (PCB)*, which is a conductive series of pathways laminated to a nonconductive substrate that lines the bottom of the computer and is often of a uniform color, such as olive, brown, or blue. It is the most important component in the computer because it connects all of the other components together. Figure 1.1 shows a typical PC system board, as seen from above. All other components are attached to this circuit board. On the system board, you will find the central processing unit (CPU), underlying circuitry, expansion slots, video components, random access memory (RAM) slots, and a variety of other chips. We will be discussing each of these components throughout this book.

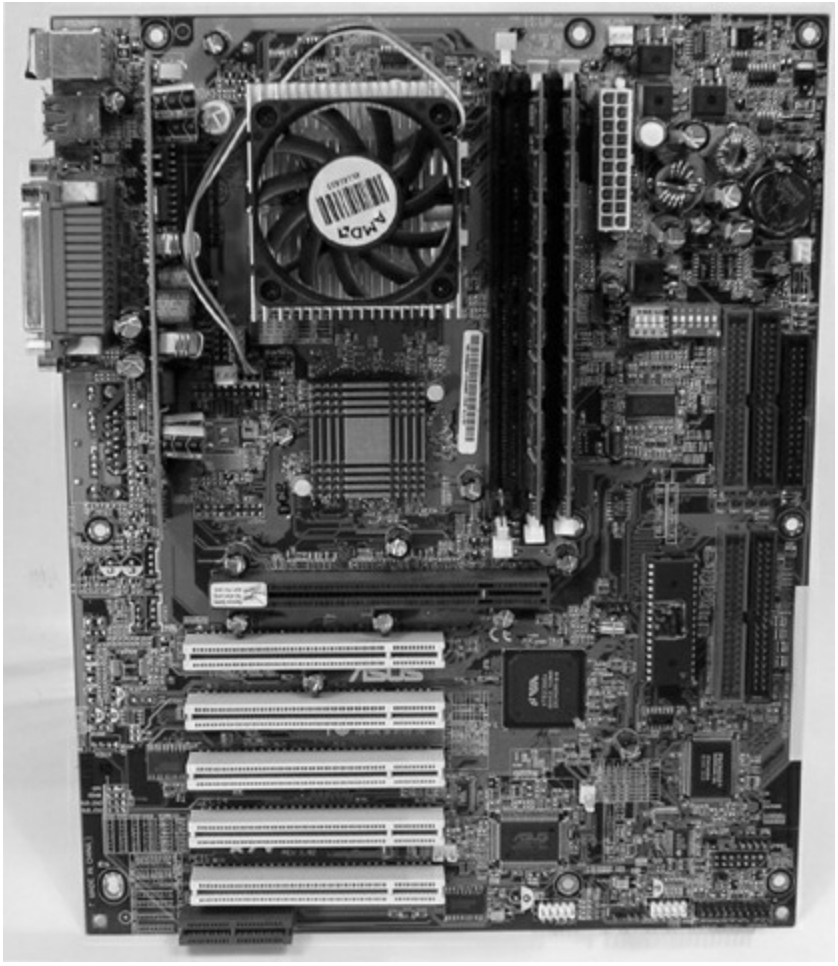

Figure 1.1 A typical system board

System Board Form Factors

System boards are classified by their form factor (design), such as ATX, micro ATX, and ITX. Exercise care and vigilance when acquiring a motherboard and case separately. Some cases are less accommodating than others, and they might not be physically compatible with the motherboard you choose.

Advanced Technology Extended

Intel developed the *Advanced Technology Extended (ATX)* motherboard in the mid-1990s to improve upon the classic AT-style motherboard architecture that had ruled the PC world for many years. The ATX motherboard has the processor and memory slots at right angles to the expansion cards. This arrangement puts the processor and memory in line with the fan output of the power supply, allowing the processor to run cooler. And because those components are not in line with the expansion cards, you can install full-length expansion cards—adapters that extend the full length of the inside of a standard computer case—in an ATX motherboard machine. ATX (and its derivatives) is the primary motherboard in use today. Standard ATX motherboards measure 12" × 9.6" (305mm × 244mm).

Micro ATX

A form factor that is designed to work in standard ATX cases, as well as its own smaller cases, is known as *micro ATX* (also referred to as µATX). Micro ATX follows the ATX principle of component placement for enhanced cooling over pre-ATX designs but with a smaller footprint. Some trade-offs come with this smaller form. For the compact use of space, you must give up quantity; that is, quantity of memory slots, motherboard headers, expansion slots, and integrated components. You also have fewer micro ATX chassis bays, although the same small-scale motherboard can fit into much larger cases if your original peripherals are still a requirement.

Be aware that micro ATX systems tend to be designed with power supplies of lower wattage in order to help keep power consumption and heat production down. This is generally acceptable with the standard, reduced micro ATX suite of components. As more off-board USB ports are added and larger cases are used with additional in-case peripherals, a larger power supply might be required.

Micro ATX motherboards share their width, mounting hole pattern, and rear interface pattern with ATX motherboards but are shallower and square, measuring 9.6" × 9.6" (244mm × 244mm). They were designed to be able to fit into full-size ATX cases. Figure 1.2 shows a full-size ATX motherboard next to a micro ATX motherboard.

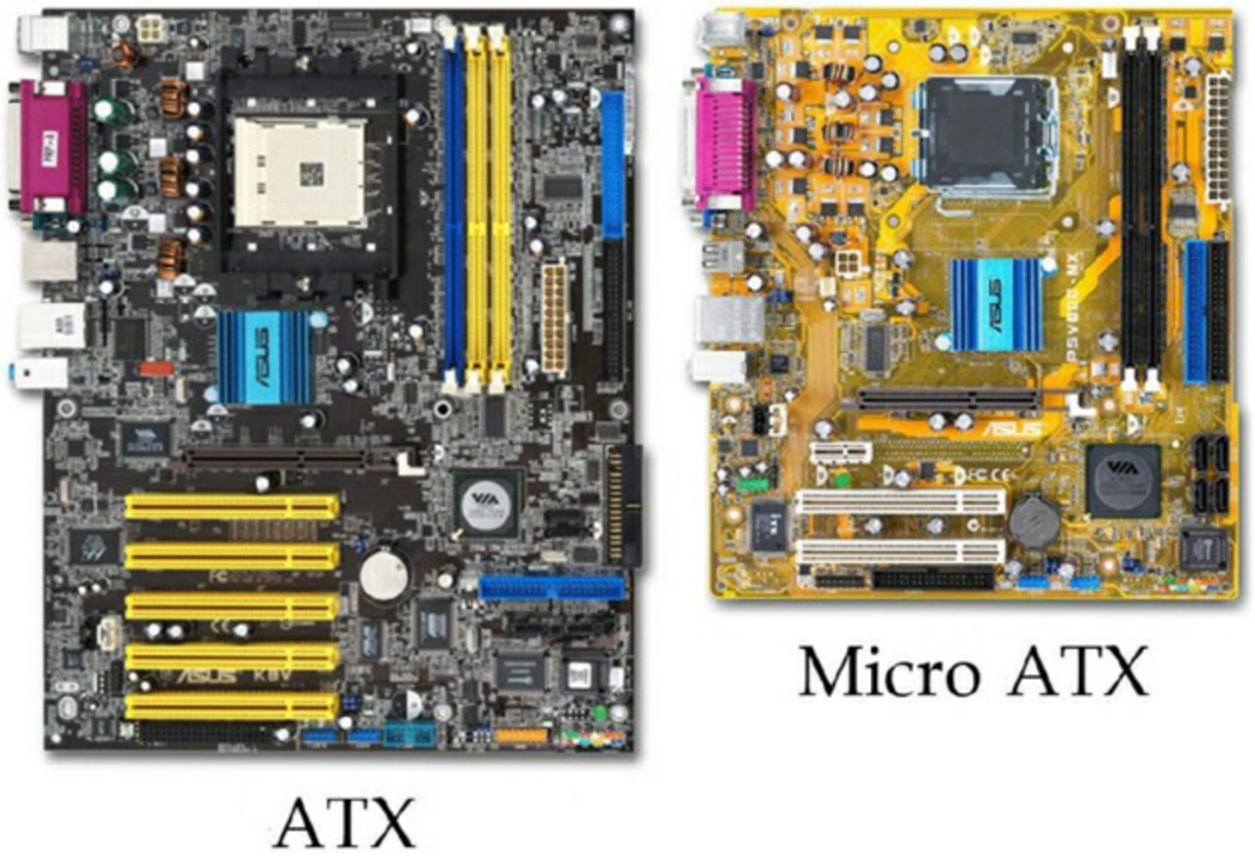

Figure 1.2 ATX and micro ATX motherboards

VIA Mini-ITX Form Factor Comparison by VIA Gallery from Hsintien, Taiwan - VIA Mini-ITX Form Factor Comparison uploaded by Kozuch. Licensed under CC BY 2.0 via Commons

ITX

The *ITX* line of motherboard form factors was developed by VIA as a low-power, small

form factor (SFF) board for specialty uses, such as home-theater systems and embedded components. ITX itself is not an actual form factor but a family of form factors. The family consists of the following form factors:

- Mini-ITX—6.7" × 6.7" (170mm × 170mm)
- Nano-ITX—4.7" × 4.7" (120mm × 120mm)
- Pico-ITX—3.9" × 2.8" (100mm × 72mm)
- Mobile-ITX—2.4" × 2.4" (60mm × 60mm)

The *mini-ITX* motherboard has four mounting holes that line up with three or four of the holes in the ATX and micro ATX form factors. In mini-ITX boards, the rear interfaces are placed in the same location as those on the ATX motherboards. These features make mini-ITX boards compatible with ATX chassis. This is where the mounting compatibility ends because despite the PC compatibility of the other ITX form factors, they are used in embedded systems, such as set-top boxes, and lack the requisite mounting and interface specifications. Figure 1.3 shows the three larger forms of ITX motherboard.

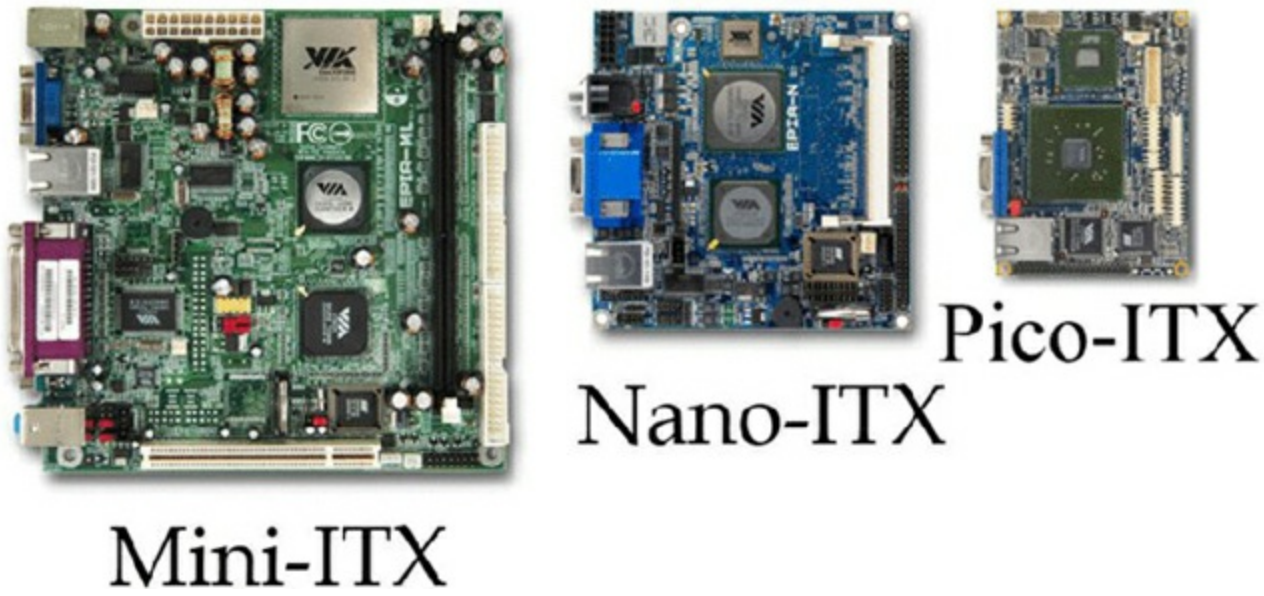

Figure 1.3 ITX motherboards

VIA Mainboards Form Factor Comparison by VIA Gallery from Hsintien, Taiwan - VIA Mainboards Form Factor Comparison uploaded by Kozuch. Licensed under CC BY 2.0 via Commons

System Board Components

Now that you understand the basic types of motherboards and their form factors, it's time to look at the components found on the motherboard and their locations relative to each other. Many of the following components can be found on a typical motherboard:

- Chipsets
- Expansion slots and buses
- Memory slots and external cache

- CPUs and their sockets
- Power connectors
- Onboard disk drive connectors
- Keyboard connectors
- Integrated peripheral ports and headers
- BIOS/firmware
- CMOS battery
- Front-panel connectors

In the following sections, you will learn about some of the most common components of a motherboard, what they do, and where they are located on the motherboard. We'll show what each component looks like so that you can identify it on most any motherboard that you run across. In the case of some components, this chapter provides only a brief introduction, with more detail to come in later chapters.

Before we can talk about specific components, however, you need to understand the concepts underlying serial and parallel connectivity, the two main categories of bus architecture.

Bus Architecture

There has been a quiet revolution taking place in the computer industry for quite some time now. Unlike in the early days of personal computing, when parallel communication pathways (made up of multiple synchronized wires or traces) dominated single-file serial connections, this revolution has brought a shift toward serial communications. Once engineers created transmitters and receivers capable of sustaining data rates many times those of parallel connections, they found no need to tie these pathways together in a parallel circuit. The downside of parallel communications is the loss of circuit length and throughput—how far the signal can travel and the amount of data moved per unit of time, respectively—due to the careful synchronization of the separate lines, the speed of which must be controlled to limit skewing the arrival of the individual signals at the receiving end.

The only limitation of serial circuits is in the capability of the transceivers, which tends to grow over time at a refreshing rate due to technical advancements. Examples of specifications that have heralded the migration toward the dominance of serial communications are Serial ATA (SATA), Universal Serial Bus (USB), IEEE 1394/FireWire, and Peripheral Component Interconnect Express (PCIe).

Parallel computer-system components work on the basis of a bus. A *bus*, in this sense, is a common collection of signal pathways over which related devices communicate within the computer system. Slots are incorporated at certain points in expansion buses of various architectures, such as PCI, to allow for the insertion of external devices, or

adapters, usually with no regard as to which adapters are inserted into which slots; insertion is generally arbitrary. Other types of buses exist within the system to allow communication between the CPU and components with which data must be exchanged. Except for CPU slots and sockets and memory slots, there are no insertion points in such closed buses because no adapters exist for such an environment.

The term *bus* is also used in any parallel or bit-serial wiring implementation where multiple devices can be attached at the same time in parallel or in series (daisy-chained). Examples include Small Computer System Interface (SCSI), USB, and Ethernet.

The various buses throughout a given computer system can be rated by their bus speeds. The higher the bus speed, the higher the performance of which the bus is capable. In some cases, various buses must be synchronized for proper performance, such as the system bus and any expansion buses that run at the frontside-bus speed. Other times, one bus will reference another for its own speed. The internal bus speed of a CPU is derived from the frontside-bus clock, for instance. The buses presented throughout this chapter are accompanied by their speeds, where appropriate.

Chipsets

A *chipset* is a collection of chips or circuits that perform interface and peripheral functions for the processor. This collection of chips is usually the circuitry that provides interfaces for memory, expansion cards, and onboard peripherals, and it generally dictates how a motherboard will communicate with the installed peripherals.

Chipsets are usually given a name and model number by the original manufacturer. Typically, the manufacturer and model also tell you that your particular chipset has a certain set of features (for example, type of RAM supported, type and brand of onboard video, and so on).

Chipsets can be made up of one or several integrated circuit chips. Intel-based motherboards, for example, typically use two chips. To know for sure, you must check the manufacturer's documentation, especially because cooling mechanisms frequently obscure today's chipset chips, sometimes hindering visual brand and model identification.

Chipsets can be divided into two major functional groups, called Northbridge and Southbridge. Let's take a brief look at these groups and the functions they perform.

Northbridge

The *Northbridge* subset of a motherboard's chipset is the set of circuitry or chips that performs one very important function: management of high-speed peripheral communications. The Northbridge is responsible primarily for communications with integrated video using PCIe, for instance, and processor-to-memory communications. Therefore, it can be said that much of the true performance of a PC relies on the specifications of the Northbridge component and its communications capability with the peripherals it controls.

When we use the term *Northbridge*, we are referring to a functional subset of a motherboard's chipset. There isn't actually a Northbridge brand of chipset.

The communications between the CPU and memory occur over what is known as the *frontside bus (FSB)*, which is just a set of signal pathways connecting the CPU and main memory, for instance. The clock signal that drives the FSB is used to drive communications by certain other devices, such as PCIe slots, making them local-bus technologies. The *backside bus (BSB)*, if present, is a set of signal pathways between the CPU and Level 2 or Level 3 (external) cache memory. The BSB uses the same clock signal that drives the FSB. If no backside bus exists, cache is placed on the frontside bus with the CPU and main memory.

The Northbridge is directly connected to the Southbridge (discussed next). It controls the Southbridge and helps to manage the communications between the Southbridge and the rest of the computer.

Southbridge

The *Southbridge* subset of the chipset is responsible for providing support to the slower onboard peripherals (PS/2, parallel ports, serial ports, Serial and Parallel ATA, and so on), managing their communications with the rest of the computer and the resources given to them. These components do not need to keep up with the external clock of the CPU and do not represent a bottleneck in the overall performance of the system. Any component that would impose such a restriction on the system should eventually be developed for FSB attachment.

In other words, if you're considering any component other than the CPU, memory and cache, or PCIe slots, the Southbridge is in charge. Most motherboards today have integrated PS/2, USB, LAN, analog and digital audio, and FireWire ports for the Southbridge to manage, for example, all of which are discussed in more detail later in this chapter or in Chapter 3, "Peripherals and Expansion." The Southbridge is also responsible for managing communications with the slower expansion buses, such as PCI, and legacy buses.

Figure 1.4 is a photo of the chipset of a motherboard, with the heat sink of the Northbridge at the top left, connected to the heat-spreading cover of the Southbridge at the bottom right.

Figure 1.4 A modern computer chipset

Figure 1.5 shows a schematic of a typical motherboard chipset (both Northbridge and Southbridge) and the components with which they interface. Notice which components interface with which parts of the chipset.

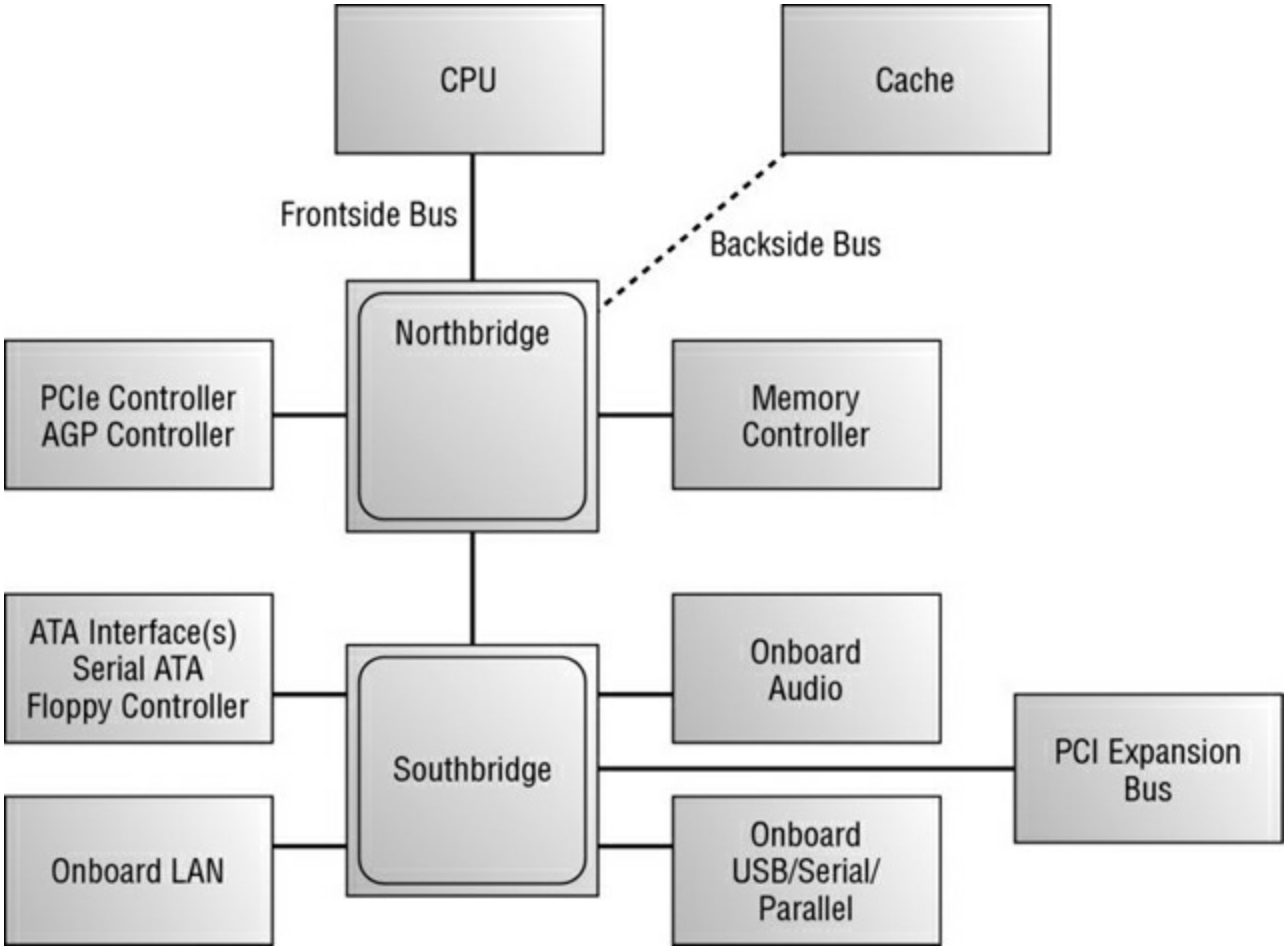

Figure 1.5 A schematic of a typical motherboard chipset

Expansion Slots

The most visible parts of any motherboard are the *expansion slots*. These are small plastic slots, usually from 1 to 6 inches long and approximately 1/2-inch wide. As their name suggests, these slots are used to install various devices in the computer to expand its capabilities. Some expansion devices that might be installed in these slots include video, network, sound, and disk interface cards.

If you look at the motherboard in your computer, you will more than likely see one of the main types of expansion slots used in computers today:

- PCI
- PCIe
- PCI-X

Each type differs in appearance and function. In the following sections, we will cover how to visually identify the different expansion slots on the motherboard. Personal Computer Memory Card International Association (PCMCIA) buses, such as PC Card, CardBus, Mini PCI, ExpressCard, and PCIe Mini, are more related to laptops than to desktop computers, and they are covered in Chapter 9, “Understanding Laptops.”

PCI Expansion Slots

The motherboards of many computers in use today contain 32-bit *Peripheral Component Interconnect (PCI)* slots. They are easily recognizable because they are only around 3-inches long and classically white, although modern boards take liberties with the color. PCI slots became extremely popular with the advent of Pentium-class processors. Although popularity has shifted from PCI to PCIe, the PCI slot's service to the industry cannot be ignored; it has been an incredibly prolific architecture for many years.

PCI expansion buses operate at 33MHz or 66MHz (version 2.1) over a 32-bit (4-byte) channel, resulting in data rates of 133MBps and 266MBps, respectively, with 133MBps being the most common, server architectures excluded. PCI is a shared-bus topology, however, so mixing 33 MHz and 66MHz adapters in a 66MHz system will slow all adapters to 33MHz. Older servers might have featured 64-bit PCI slots as well, since version 1.0, which double the 32-bit data rates. See the sidebar in this chapter titled "Arriving at the Exact Answer" for help with understanding the math involved in frequencies and bit rates.

PCI slots and adapters are manufactured in 3.3V and 5V versions. Universal adapters are keyed to fit in slots based on either of the two voltages. The notch in the card edge of the common 5V slots and adapters is oriented toward the front of the motherboard, and the notch in the 3.3V adapters toward the rear. Figure 1.6 shows several PCI expansion slots. Note the 5V 32-bit slot in the foreground and the 3.3V 64-bit slots. Also notice that a universal 32-bit card, which has notches in both positions, is inserted into and operates fine in the 64-bit 3.3V slot in the background.

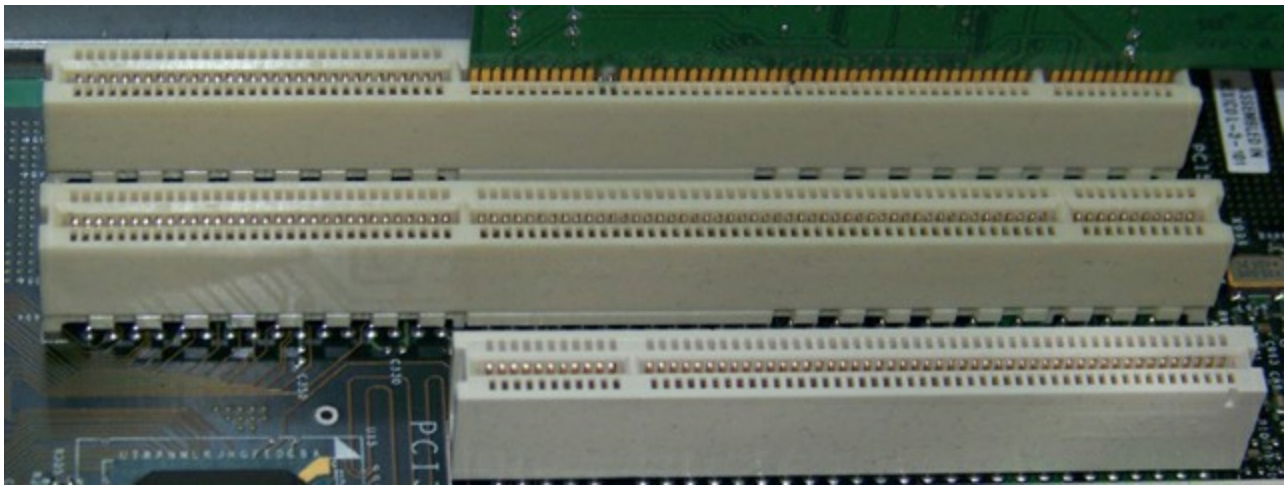

Figure 1.6 PCI expansion slots

Arriving at the Exact Answer

To get the math exactly right when dealing with frequencies and data rates ending in 33 and 66, you have to realize that every 33 has an associated one-third (1/3), and every 66 has an associated two-thirds (2/3). The extra quantities are left off of the final result but must be added back on to get the math exactly right. The good news is that omitting these small values from the equation still gets you close, and a bit of experience with the numbers leads to being able to make the connection on the fly.

PCI-X Expansion Slots

Visually indistinguishable from 64-bit PCI, because it uses the same slots, *PCI-Extended (PCI-X)* takes the 66MHz maximum frequency of PCI to new heights. Version 1.0 of the specification provided a 66MHz (533MBps) implementation as well as the most commonly deployed PCI-X offering, 133MHz (1066MBps). Version 2.0 introduced the current—and likely final—maximum, 533MHz. With an 8-byte (64-bit) bus, this translates to maximum throughput of 4266MBps, roughly 4.3GBps. Additionally, PCI-X version 2.0 supports a 266MHz (2133MBps) bus. Because PCI-X slots are physically compatible with PCI adapters, and because all PCI-X slots support the 66MHz minimum clock rate, PCI-X slots are compatible with 66MHz PCI adapters.

PCI-X is targeted at server platforms with its speed and support for hot-plugging, but it is still no match for the speeds available with PCIe, which all but obviates PCI-X today and made PCI-X version 2.0 obsolete not long after its release. PCI-X also suffers from the same shared-bus topology as PCI, resulting in all adapters falling back to the frequency of the slowest inserted adapter.

PCIe Expansion Slots

The latest expansion slot architecture that is being used by motherboards is *PCI Express (PCIe)*. It was designed to be a replacement for AGP, or accelerated graphics port, and PCI. PCIe has the advantage of being faster than AGP while maintaining the flexibility of PCI. PCIe has no plug compatibility with either AGP or PCI. As a result, modern PCIe motherboards can be found with regular PCI slots for backward compatibility, but AGP slots have not been included for many years.

PCIe is casually referred to as a bus architecture to simplify its comparison with other bus technologies. True expansion *buses* share total bandwidth among all slots, each of which taps into different points along the common bus lines. In contrast, PCIe uses a switching component with point-to-point connections to slots, giving each component full use of the corresponding bandwidth and producing more of a star topology versus a bus. Furthermore, unlike other expansion buses, which have parallel architectures, PCIe is a serial technology, striping data packets across multiple serial paths to achieve higher data rates.

PCIe uses the concept of *lanes*, which are the switched point-to-point signal paths between any two PCIe components. Each lane that the switch interconnects between any two intercommunicating devices comprises a separate pair of wires for both directions of traffic. Each PCIe pairing between cards requires a negotiation for the highest mutually supported number of lanes. The single lane or combined collection of lanes that the switch interconnects between devices is referred to as a *link*.

There are seven different link widths supported by PCIe, designated x1 (pronounced “by 1”), x2, x4, x8, x12, x16, and x32, with x1, x4, and x16 being the most common. The x8 link

width is less common than these but more common than the others. A slot that supports a particular link width is of a physical size related to that width because the width is based on the number of lanes supported, requiring a related number of wires. As a result, a x8 slot is longer than a x1 slot but shorter than a x16 slot. Every PCIe slot has a 22-pin portion in common toward the rear of the motherboard, which you can see in Figure 1.7, in which the rear of the motherboard is to the left. These 22 pins comprise mostly voltage and ground leads.

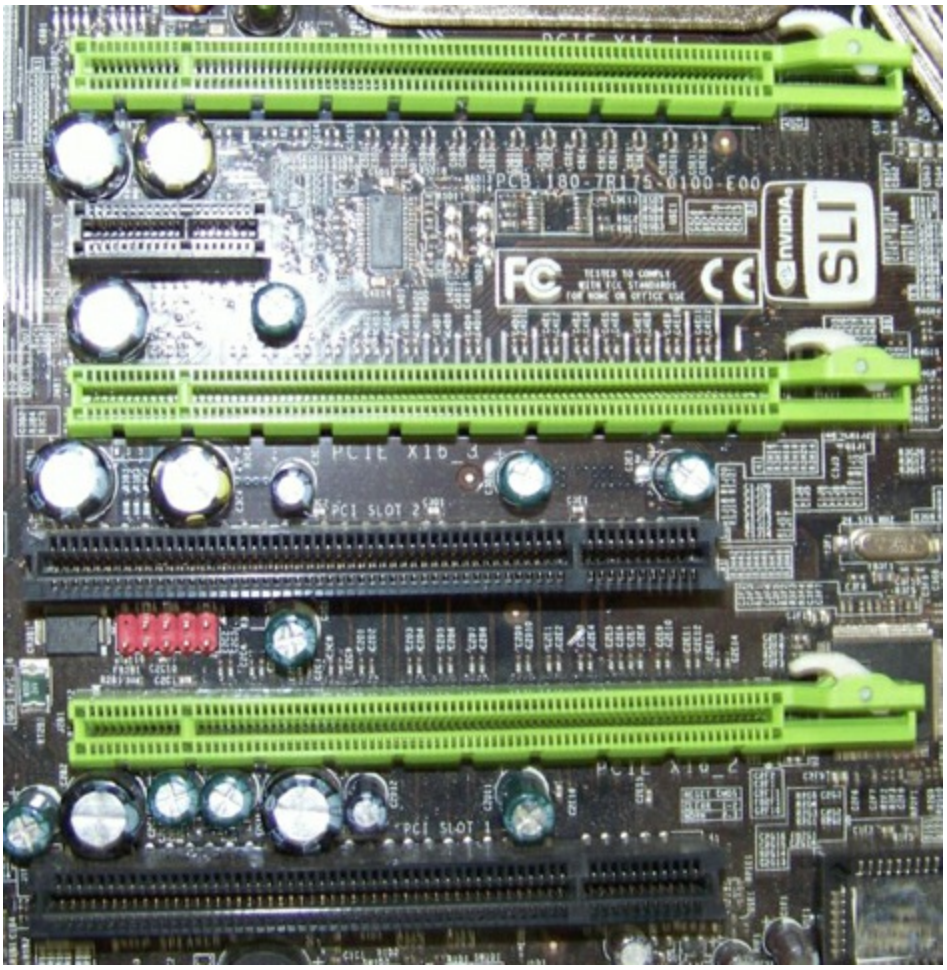

Figure 1.7 PCIe expansion slots

There are four major versions of PCIe currently specified: 1.x, 2.x, 3.0, and 4.0. For the four versions, a single lane, and hence a x1 slot, operates in each direction (or transmits and receives from either communicating device's perspective), at a data rate of 250MBps (almost twice the rate of the most common PCI slot), 500MBps, approximately 1GBps, and roughly 2GBps, respectively.

An associated bidirectional link has a nominal throughput of double these rates. Use the doubled rate when comparing PCIe to other expansion buses because those other rates are for bidirectional communication. This means that the 500MBps bidirectional link of a x1 slot in the first version of PCIe was comparable to PCI's best, a 64-bit slot running at 66MHz and producing a throughput of 533MBps.

Combining lanes results in a linear multiplication of these rates. For example, a PCIe 1.1 x16 slot is capable of 4GBps of throughput in each direction, 16 times the 250MBps x1 rate. Bidirectionally, this fairly common slot produces a throughput of 8GBps. Later PCIe