Survey of
OPERATING SYSTEMS

SIXTH EDITION

JANE HOLCOMBE
CHARLES HOLCOMBE

Mc Graw Hill Education

survey of

Operating Systems

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About the Authors

JANE HOLCOMBE In the early 1980s, Jane Holcombe was the tech support person for a small financial planning company, a role she was assigned at a time when technology was about connecting specialized terminals to expensive industry-specific systems via costly telephone company links. These systems were limited in the reports they generated, and far from user-friendly, and her boss tasked her with researching the emerging technology of the time: IBM Personal Computers. Jane would often discover bookmarked technical magazines on her desk, along with a note from the boss instructing her to check out the articles and research how to move their accounting and contact management systems to PCs. After months of research and after consulting with various experts, she oversaw the move of the accounting and contact management functions to IBM PCs connected via a local area network (LAN) for sharing the data. The network was very slow, and the software for accounting and contact management required memorizing keystrokes for each function. However, the boss was pleased with the ability to make quick changes to the reports these systems generated—something not possible with the old, mainframe-based systems. This project showed Jane the potential of personal computing in business.

One of the many lessons she learned during this time was that one roadblock to bringing PCs into business was the lack of knowledgeable PC support staff. So, her next project was a career move, as she created appropriate courseware and co-founded a company that presented technical PC and network support courses nationwide.

In the early 1990s, she sold her interest in the training company and returned to independent technical consulting and instruction, acquiring experience and certifications for both Novell and Microsoft. Her focus through the 1990s was small business servers and networks. In recent years, she has worked primarily as a technical writer and technical editor.

CHARLES HOLCOMBE has a high-tech background in computing in the nuclear and aerospace fields. In his 15 years at Control Data Corporation, he was successively a programmer, technical sales analyst, salesman, and sales manager in the field marketing force. At corporate headquarters, he ran Control Data's Executive Seminar program, headed sales training for the corporation, was liaison to the worldwide university community, and was market development manager for the Plato computer-based education system. Since then, he has been an instructor and consultant. He has authored and delivered many training courses and is a skilled editor. Currently, he is an independent editor for various clients and collaborates with Jane on writing projects. For a while, he claimed he was semi-retired, but, with his consulting and editing work, he cannot say that any more.

Together the Holcombes have authored textbooks and self-study guides, based on Jane's area of expertise and their collaborative research and testing of new technologies used by consumers, students, and businesses.

About the Contributors

This book was greatly influenced by the comments, suggestions, and feedback from the following group of dedicated instructors. To them we give our heartfelt thanks.

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Acknowledgments

Once again, just as Jane was beginning a search for another project, and Chuck was busy with editing for his clients, Alan Palmer, Senior Product Developer, notified us that McGraw-Hill Higher Education had approved the sixth edition of our Survey of Operating Systems textbook. Because much has happened with operating systems and with personal computing since we wrote the first five editions, we knew it would require a nearly complete rethinking of the content. Along with director Wyatt Morris and Alan, we wrote a suggested Table of Contents that Alan sent to instructors—some of whom were using the fifth edition. The results of this survey helped us create the outline for the sixth edition.

As with previous editions, knowledgeable peer reviewers scrutinized each chapter, giving us invaluable feedback on the relevancy and accuracy of the content. We can't imagine writing a book like this without these technical reviews.

We thank every member of the talented team of people at McGraw-Hill who ensured the book's integrity. They include Wyatt Morris, Alan Palmer, Jeni McAtee, and Kala Ramachandran from SPi Global. We particularly want to thank Wyatt and Alan for their unstinting support, professionalism, and patience. We love the design of this edition, and we greatly appreciate the expertise of the members of the production group who all worked hard to make the book look wonderful. Creating and laying out the many elements of this complex book design was a huge task, and they handled it skillfully.

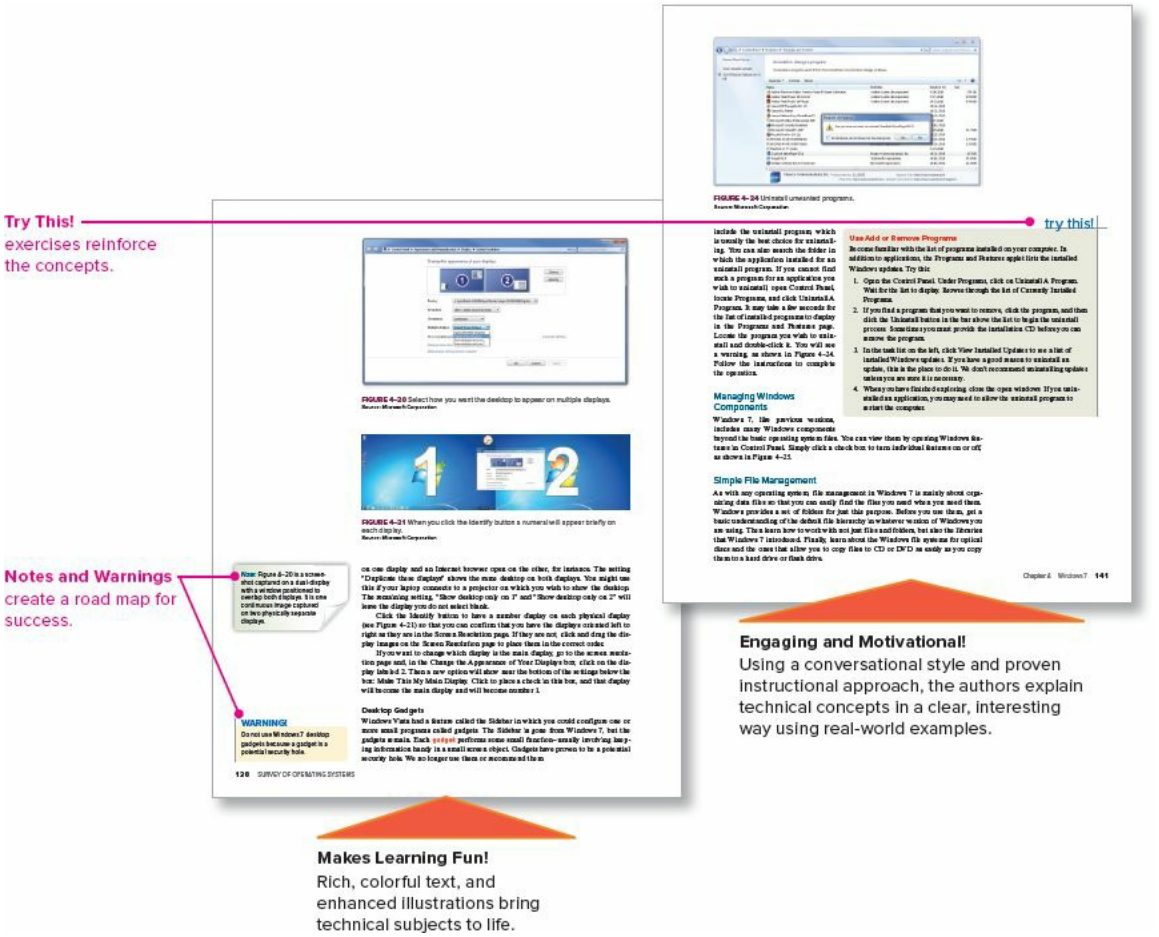
We appreciate all who worked so hard to make this book what it is.

Thank you!

About This Book

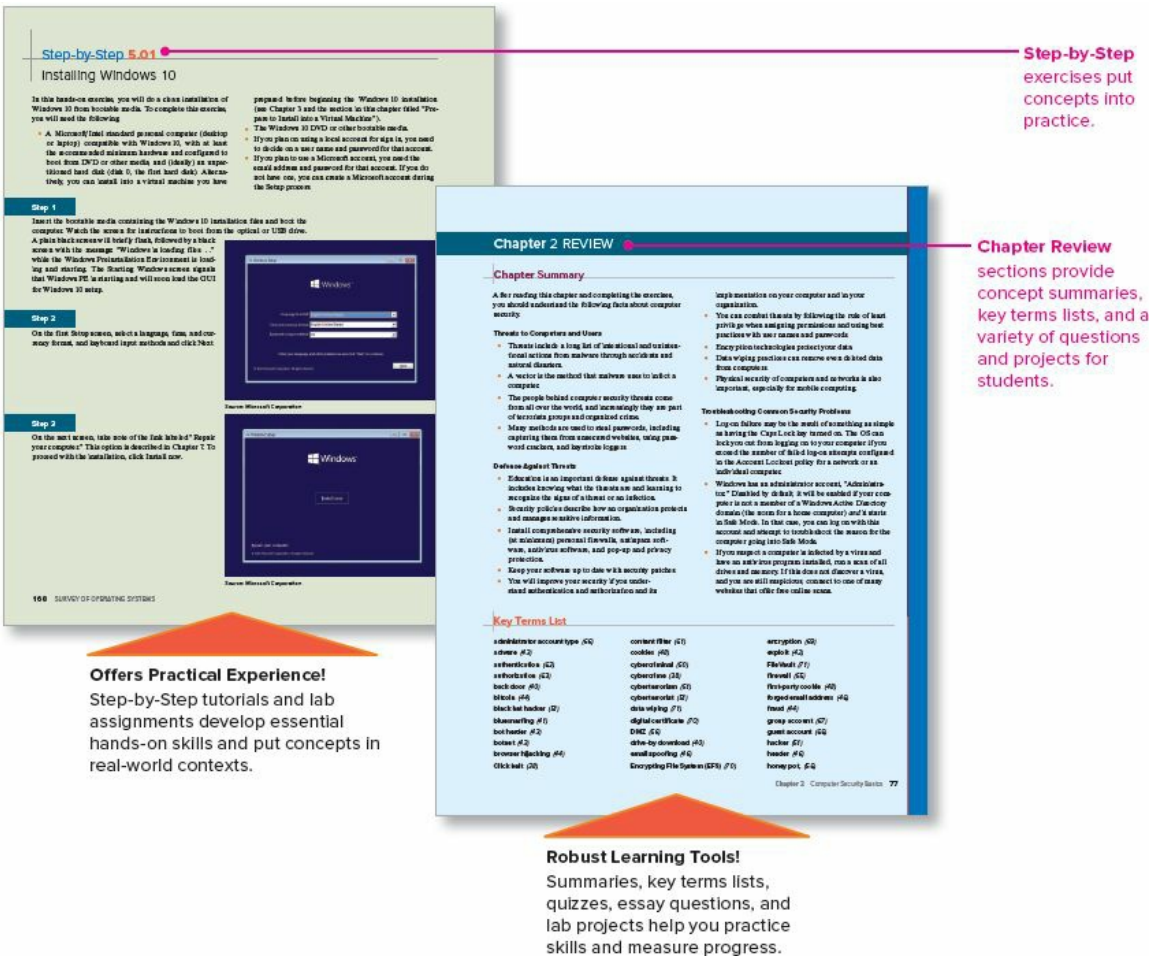
Important Technology Skills

Information technology (IT) offers many career paths, leading to occupations in such fields as PC repair, network administration, telecommunications, Web development, graphic design, and desktop support. To become competent in any IT field, however, you need certain basic computer skills. This book will help you build a foundation for success in the IT field by introducing you to fundamental information about popular desktop and mobile operating systems, a needed basis for working with all types of computing devices.



Effective Learning Tools

The design of this colorful, pedagogically rich book will make learning easy and enjoyable and help you develop the skills and critical thinking abilities that will enable you to adapt to different job situations and troubleshoot problems. Jane and Charles Holcombe's proven ability to explain concepts in a clear, direct, even humorous way makes this book interesting and motivational, and fun.



Each chapter includes:

- **Learning Outcomes** that set measurable goals for chapter-by-chapter progress.
- **Four-Color Illustrations** that give you a clear picture of the technologies.
- **Step-by-Step Tutorials** that teach you to perform essential tasks and procedures hands-on.
- **Try This!** sidebars that encourage you to practice and apply the concepts in real-world settings.
- **Notes** and **Warnings** that guide you through difficult areas.
- **Chapter Summaries** and **Key Terms Lists** that provide you with an easy way to review important concepts and vocabulary.
- **Challenging End-of-Chapter Tests** that include vocabulary-building exercises, multiple-choice questions, essay questions, and on-the-job lab projects.

New to *Survey of Operating Systems*, Sixth Edition

General changes in this Sixth Edition:

- We removed *Windows 8.1*, the Fifth Edition's Chapter 5, and moved appropriate content into *Windows 10*, now Chapter 5.
- We added a new chapter, Chapter 9, *Chrome OS*.
- We added content on the various accounts commonly used on various devices, especially those accounts required for cloud services. Look for this information in Chapter 9, *Chromebooks and Chrome OS*, and in Chapter 11, *Mobile Operating Systems: iOS and Android*.
- In addition to reviewing and updating the content from the Fifth Edition, we worked to tighten the text throughout, improve the flow, and remove topics that are no longer relevant.
- Finally, we updated exercises, figures, and illustrations to support learning.

Chapter 1 Introduction to Operating Systems

- We added introductory information about Chromebooks and Chrome OS.
- We updated text and images throughout the chapter.

Chapter 2 Computer Security Basics

- We updated chapter content and images, as appropriate.

Chapter 3 Desktop Virtualization

- We updated chapter content and images, and increased the number of hands-on Step-by-Step exercises to five (from three in the last edition).

Chapter 4 Windows 7

- We updated the text and appropriate images.

Chapter 5 Windows 10

- Windows 10 is no longer the big news in operating system, so we pared down the content to focus on what we feel is important in this mature OS, including recently added features. We also moved some key terms from the former Windows 8.1 chapter to this chapter.

Chapter 6 Supporting and Troubleshooting Windows

- We updated chapter content and images.

Chapter 7 Apple macOS on the Desktop

- We updated chapter content and images.

Chapter 8 Linux on the Desktop

- We updated chapter content and images.

Chapter 9 Chromebooks and Chrome OS

- This new chapter is a recognition of the importance of Chromebooks and the Chrome OS at school, in the office, and at home. This chapter emphasizes skills for working with both Web apps and Android apps, as well as the tasks of printing and file management in the cloud.

Chapter 10 Connecting Desktops and Laptops to Networks

- We updated content and images, where appropriate.

Chapter 11 Mobile Operating Systems: iOS and Android

- We updated content and images to include tasks for working with multiple accounts on mobile devices and how to secure devices first through primary accounts (Google Android or Apple iOS) associated with the device, and then via settings on the device.

Appendix A: Windows Mouse and Keyboard Shortcuts

- We updated this list.

Appendix B: Chromebook & Chrome Browser Keyboard Shortcuts

- The new Chromebook keyboards are physically different from those found on other laptop computers and have new functions assigned to them, which are listed in this appendix. In addition, because it is an OS derived from the Chrome browser, we list the Chrome Browser shortcut for use within the browser. Finally, we include a list of Chrome editing shortcuts. Most of these will be familiar to both Windows and Apple macOS users.

Contents

Introduction

What Will You Learn?

The first five editions of this book were well received by instructors and students. This sixth edition updates the material and presents new information that is relevant to the topic of desktop operating systems, including Windows, Apple macOS, Linux, and Chrome OS. In addition to these operating systems, this edition includes new information on mobile operating systems, as well as chapters on subjects peripheral to operating systems, such as computer security, desktop virtualization, and connecting computers and mobile devices to networks. We carefully revised every chapter as needed, with more illustrations and plenty of hands-on opportunities. We have added content throughout, while working to streamline the book in response to feedback we received from instructors.

How Will You Learn?

We don't want to simply give you an encyclopedia of information because it can feel like you're standing in front of an information fire hose, and we've been there ourselves many times in the past decades. Rather, keeping in mind that "less is more," we present just the key points about operating systems, and guide you in your own exploration of the specifics of the technology. One book simply can't give you everything you need to know about operating systems, but we do hope to empower you and to increase your ability to use widely available tools and resources to figure out the answers to your questions. Such tools as the Internet and the help program in your OS are aids you should turn to when you need to learn more about a topic, and when you want to enhance your skills in working with each of these operating systems—and with computers in general.

Each chapter uses many techniques to help you learn. We start by listing learning outcomes, follow that up with a lucid explanation of each topic, and support it with real-world experience and a liberal use of graphics and tables. To give you hands-on experience and to help you "walk the walk," each chapter contains detailed Step-by-Step tutorials and short Try This! exercises to reinforce the concepts. To build vocabulary to help you "talk the talk," each chapter contains computer term definitions, highlighted in a Key Terms List and compiled into a Glossary at the end of the book.

We've also included notes, which provide handy pieces of knowledge to use with your desktop OS. Warnings will help you prevent mishaps.

You can measure what you've learned with end-of-chapter Key Terms, Multiple-Choice, and Essay quizzes. In addition, Lab Projects challenge you to independently complete tasks related to what you've just learned.

Let's Get Down to Work

OK, enough of this introductory stuff. This is the last time in this book that you'll see so many words without illustrations. From now on it's downright exciting. Learn a lot and *have fun!*

Supplements

For teachers using this book in the classroom, a powerful collection of teaching tools written by the authors is available online at **www.mhhe.com/holcombe6**:

- An Instructor's Manual that maps to the organization of the textbook and provides additional instructor tips and activities to use with the book.
- A test bank for each chapter available online in either Word or EZ Test format.
- Engaging PowerPoint slides on the lecture topics, including key points and illustrations from the chapters.
- Solutions to the end-of-chapter quizzes.

Jane Holcombe
Charles Holcombe

chapter

1 Introduction to Operating Systems

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Learning Outcomes

In this chapter, you will learn how to:

LO **1.1** Describe the purpose and functions of operating systems.

LO **1.2** Describe major events in the evolution of operating systems.

LO **1.3** List and compare the common desktop operating systems in use today.

LO **1.4** List the most common mobile OSs, the devices associated with them, and the features found in most of these devices.

Understanding operating systems (OSs) is critical to your future success in life. It is. Just believe us. You don't? You say you drive a car just fine, but you don't understand its engine, transmission, or other systems? So why can't you just use your computer? Why do you have to even know it has an OS? Just as you can use a car without in-depth knowledge of how it works, you can use your computer to write a letter, send email, create a report, surf the Internet, participate in social networking, and much more without understanding operating systems. You only have to know how to turn it on, call up the application program you wish to use, perform tasks, and turn it off.

If you want to get the most out of the computers you use in your work, school, and private life, you need to understand how the most critical software component, the computer's operating system, works.

This chapter provides an overview of microcomputer operating systems—specifically, those commonly found on desktop and laptop computers and the personal mobile devices we use today. We'll begin with a brief look at microcomputers—their components and their general types. Then we'll explore the functions that operating systems perform. Finally, we introduce you to the OSs in all types of microcomputers including those in home and office computers as well as tablets and smartphones.

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LO 1.1 | Overview of Microcomputer Operating Systems

This section is an introduction to the common operating systems used in today's computing devices (microcomputers). We begin by answering a few general questions you may have: What is an operating system? What is a microcomputer? What microcomputers are you using today? Then we briefly explore the events that led to the devices we use today as well as the operating systems that make them useable to us.

Operating Systems Defined

An **operating system (OS)** is a collection of programs that controls all of the interactions among the various system components, freeing application programmers from needing to include such functions in their programs. An **application (app)** is software that allows a user to perform useful functions, such as writing a report, picking up email, editing graphics, calculating a budget, and much more. Microsoft Word and Adobe Photoshop are applications. Applications send commands to the OS to interact with the hardware.

Note: The OS is an interpreter between the user and the hardware.

Microcomputers Defined

Consumers encountered their first microcomputers in 1977 with the introduction of the Apple II, Radio Shack TRS-80, and the Commodore PET. The Apple II best combined the critical elements that defined a microcomputer at the time: these included a keyboard, monitor display, available peripherals, an operating system, useful applications, and a reasonable price tag. Today, microcomputers are everywhere, and many of us have them in various forms.

A typical PC with components.
©Denis Rozhnovsky/Alamy

Our friend Brianna uses a PC at work and an Apple iMac at home, and she always has her smartphone handy. She will soon take night classes in which she will use either a tablet or a laptop that she will carry to and from school. She is considering a Chromebook, running the Chrome OS, because the school requires that students use the Internet-based Google Cloud and its associated apps. She wants to learn more about the computers she uses each day, beginning with the hardware.

Hardware Components

- A **computer** is a device that performs calculations. A typical modern computer is an electronic device that can perform a huge number of useful tasks for its owner.
- Any computer, small or large, has a **central processing unit (CPU)** that performs the calculations, or processing for the computer.
- A **microcomputer** is a computer small enough and cheap enough for the use of one person. The CPU in a microcomputer is a **microprocessor**, although many still refer to it simply as a CPU or processor.
- An important invention that led to the miniaturization of computers was the **integrated circuit (IC)**, a small electronic component made up of transistors (tiny switches) and other miniaturized parts.

> *Note:* Common slang for an integrated circuit is “chip.”

- Interaction with a computer is **input/output (I/O)**. When we send something into the

computer, we call it input. You are inputting through input devices when you type on the keyboard, tap on a touch screen, or talk to a computer through a microphone. Output is processed information of many types: sounds sent through the speakers, visual output to the display screen or printer and data files saved or sent over a network.

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- In a microcomputer, the internal components include at least one microprocessor, **random-access memory (RAM)** that acts as the main **memory** for holding active programs and associated data, firmware, and various other supporting circuitry, all installed onto a **motherboard**.

> *Note:* Random-access memory (RAM) is volatile: when you turn off the computer the contents in RAM disappear.

- The typical microcomputer also has some form of storage, such as a hard drive, and it has at least one means each for input and output.

Firmware

Each computer device you use has special software resident in integrated circuits called **firmware** containing small programs for providing basic communications between the operating system and the hardware.

- **System firmware** contains program code that informs the processor of the devices present and how to communicate with them.
- Most components and peripheral devices that connect to a computer (such as the video and network adapters, USB ports, and digital cameras) have their own firmware, which is often limited to small programs for providing basic communication between the operating system and the component.

Although you may never be aware of the firmware on a mobile device, on an older PC or laptop you may see evidence of the system and other firmware as they perform tests of the hardware. Carefully, watch the screen as you power up the computer, as shown in Figure 1–1. If status and error messages display in plain text on a black background during startup, they are the result of tests run by the system firmware or the tests by additional firmware on the computer's components. More recent computers may show a message only if there is a serious problem with the computer.

Today's Microcomputers

The miniaturization of computers led to computers being built into all types of machinery, including vehicles, aircraft, and appliances. Computers touch our lives 24/7, and each has some form of operating system.

Servers. A **server** is a computer that provides one or more services to other computers over a

network. What services do servers provide? A file server stores data files for network-connected users. If a server has one or more printers connected to it that it shares with users on the network, it is a print server. We call a server doing both tasks a file and print server; even though it sounds like two services, they combine into one service.

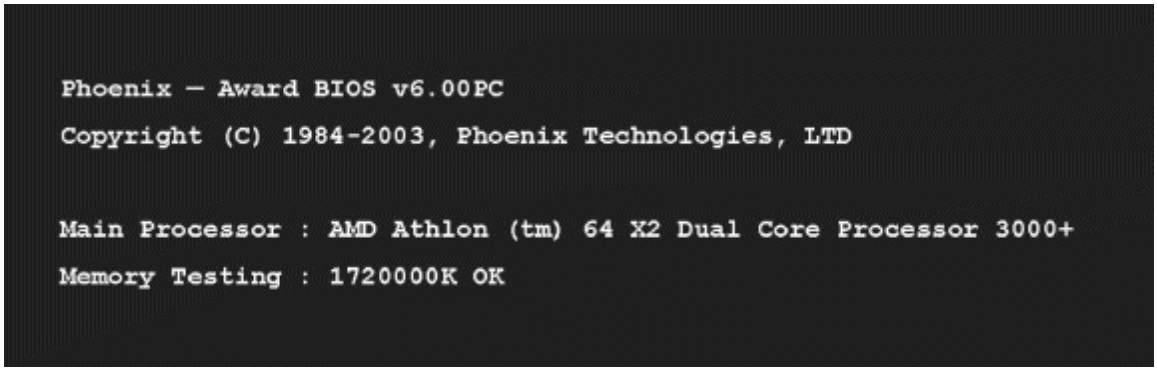

FIGURE 1–1 An example of a firmware start-up message on an old PC.

Source: Phoenix Technologies Ltd.

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Other services include messaging services (email and fax), Web services, and many others. It takes specialized software to provide each type of server service, and complementary client software to request each type of service over a network. A computer on the user end of these services is a **client**. Today's client computers include the PCs, laptops, tablets, and smartphones discussed in this book. A server can offer multiple services at the same time while also being a client to other servers.

Note: The focus of this book is on using common desktop, laptop, and mobile operating systems. Therefore, it does not include details of server operating systems. Nor does it discuss the operating systems in the various devices included in the Internet of Things (IoT).

A desktop or laptop computer can act as a server for a few network clients. However, a server to which hundreds or thousands of clients must connect requires much more capable hardware to provide more storage, faster processing, and faster network access. It also requires specialized software, beginning with the operating systems. There are versions of Windows, Apple macOS, Linux, and UNIX especially designed as servers. The hardware for a high-quality server can run into the tens of thousands of dollars and upward, versus the much lower cost of a consumer-grade PC at a few hundred dollars.