1.6 Operating Systems

Operating systems are software systems that make using computers more convenient for users, application developers and system administrators. They provide services that allow each application to execute safely, efficiently and *concurrently* (i.e., in parallel) with other applications. The software that contains the core components of the operating system is called the **kernel**. Popular desktop operating systems include Linux, Windows and macOS (formerly called OS X)—we used all three in developing this book. The most popular mobile operating systems used in smartphones and tablets are Google's Android and Apple's iOS (for iPhone, iPad and iPod Touch devices).

1.6.1 Windows—A Proprietary Operating System

In the mid-1980s, Microsoft developed the **Windows operating system**, consisting of a graphical user interface built on top of DOS (Disk Operating System)—an enormously popular personal-computer operating system that users interacted with by typing commands. Windows borrowed from many concepts (such as icons, menus and windows) developed

by Xerox PARC and popularized by early Apple Macintosh operating systems. Windows 10 is Microsoft's latest operating system—its features include enhancements to the **Start** menu and user interface, Cortana personal assistant for voice interactions, Action Center for receiving notifications, Microsoft's new Edge web browser, and more. Windows is a *proprietary* operating system—it's controlled by Microsoft exclusively. Windows is by far the world's most widely used desktop operating system.

1.6.2 Linux—An Open-Source Operating System

The **Linux operating system** is perhaps the greatest success of the *open-source* movement. **Open-source software** departs from the *proprietary* software development style that dominated software's early years. With open-source development, individuals and companies *contribute* their efforts in developing, maintaining and evolving software in exchange for the right to use that software for their own purposes, typically at *no charge*. Open-source code is often scrutinized by a much larger audience than proprietary software, so errors often get removed faster. Open source also encourages innovation. Enterprise systems companies, such as IBM, Oracle and many others, have made significant investments in Linux open-source development.

Some key organizations in the open-source community are

- the Eclipse Foundation (the Eclipse Integrated Development Environment helps programmers conveniently develop software)
- the Mozilla Foundation (creators of the Firefox web browser)
- the Apache Software Foundation (creators of the Apache web server used to develop web-based applications)
- GitHub (which provides tools for managing open-source projects—it has millions of them under development).

Rapid improvements to computing and communications, decreasing costs and open-source software have made it much easier and more economical to create a software-based business now than just a decade ago. A great example is Facebook, which was launched from a college dorm room and built with open-source software.

The **Linux kernel** is the core of the most popular open-source, freely distributed, full-featured operating system. It's developed by a loosely organized team of volunteers and is popular in servers, personal computers and embedded systems (such as the computer systems at the heart of smartphones, smart TVs and automobile systems). Unlike that of proprietary operating systems like Microsoft's Windows and Apple's macOS, Linux source code (the program code) is available to the public for examination and modification and is free to download and install. As a result, Linux users benefit from a huge community of developers actively debugging and improving the kernel, and the ability to customize the operating system to meet specific needs.

A variety of issues—such as Microsoft's market power, the small number of user-friendly Linux applications and the

diversity of Linux distributions, such as Red Hat Linux, Ubuntu Linux and many others—have prevented widespread Linux use on desktop computers. Linux has become extremely popular on servers and in embedded systems, such as Google's Android-based smartphones.

1.6.3 Apple's macOS and Apple's iOS for iPhone®, iPad® and iPod Touch® Devices

Apple, founded in 1976 by Steve Jobs and Steve Wozniak, quickly became a leader in personal computing. In 1979, Jobs and several Apple employees visited Xerox PARC (Palo Alto Research Center) to learn about Xerox's desktop computer that featured a graphical user interface (GUI). That GUI served as the inspiration for the Apple Macintosh, launched with much fanfare in a memorable Super Bowl ad in 1984.

The Objective-C programming language, created by Brad Cox and Tom Love at Stepstone in the early 1980s, added capabilities for object-oriented programming (OOP) to the C programming language. Steve Jobs left Apple in 1985 and founded NeXT Inc. In 1988, NeXT licensed Objective-C from StepStone and developed an Objective-C compiler and libraries which were used as the platform for the NeXTSTEP operating system's user interface, and Interface Builder—used

to construct graphical user interfaces.

Jobs returned to Apple in 1996 when Apple bought NeXT. Apple's macOS operating system is a descendant of NeXTSTEP. Apple's proprietary operating system, **iOS**, is derived from Apple's macOS and is used in the iPhone, iPad, iPod Touch, Apple Watch and Apple TV devices. In 2014, Apple introduced its new Swift programming language, which became open source in 2015. The iOS app-development community is shifting from Objective-C to Swift.

1.6.4 Google's Android

Android—the fastest growing mobile and smartphone operating system—is based on the Linux kernel and Java. Android apps can also be developed in C++ and C. One benefit of developing Android apps is the openness of the platform. The operating system is open source and free.

The Android operating system was developed by Android, Inc., which was acquired by Google in 2005. In 2007, the Open Handset Alliance™

```
http://www.openhandsetalliance.com/oha_members.html
```

was formed to develop, maintain and evolve Android, driving innovation in mobile technology and improving the user experience while reducing costs. According to Statista.com, as of Q3 2016, Android had 87.8% of the global smartphone

market share, compared to 11.5% for Apple.[7] The Android operating system is used in numerous smartphones, e-reader devices, tablets, in-store touch-screen kiosks, cars, robots, multimedia players and more.

7. https://www.statista.com/statistics/266136/global-market-share-held-by-smartphone-operating-systems

We present an introduction to Android app development in our textbook, *Android How to Program, Third Edition*, and in our professional book, *Android 6 for Programmers: An App-Driven Approach, Third Edition*. After you learn Java, you'll find it straightforward to begin developing and running Android apps. You can place your apps on Google Play (`play.google.com`), and if they're successful, you may even be able to launch a business. Just remember—Facebook, Microsoft and Dell were all launched from college dorm rooms.