Lecture 06 – Operating System

06016402 : Information Technology Fundamentals

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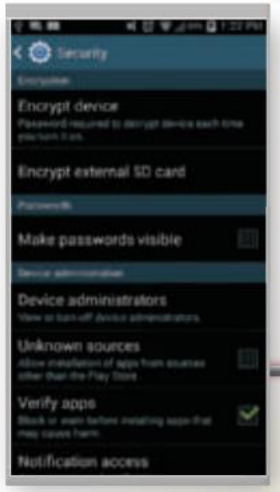
An operating system (OS) is a **set of programs that coordinate all the activities among computer or mobile device hardware**.

Most operating systems perform similar **functions** that include

- starting and shutting down a computer or mobile device,
- providing a user interface,
- managing programs,
- managing memory,
- coordinating tasks,
- configuring devices,
- monitoring performance,
- establishing an Internet connection,
- providing File, Disk, and System Management Tools
- updating operating system software.

Some operating systems also allow users to control a network and administer security

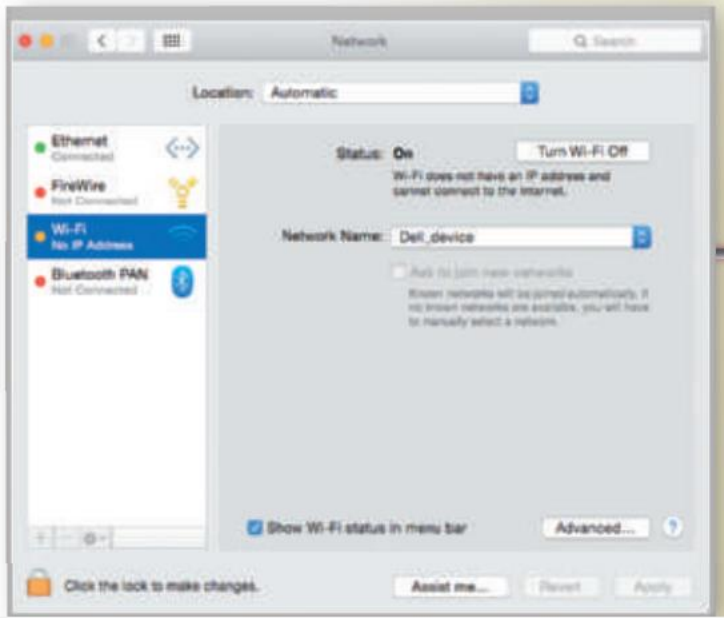
administer security



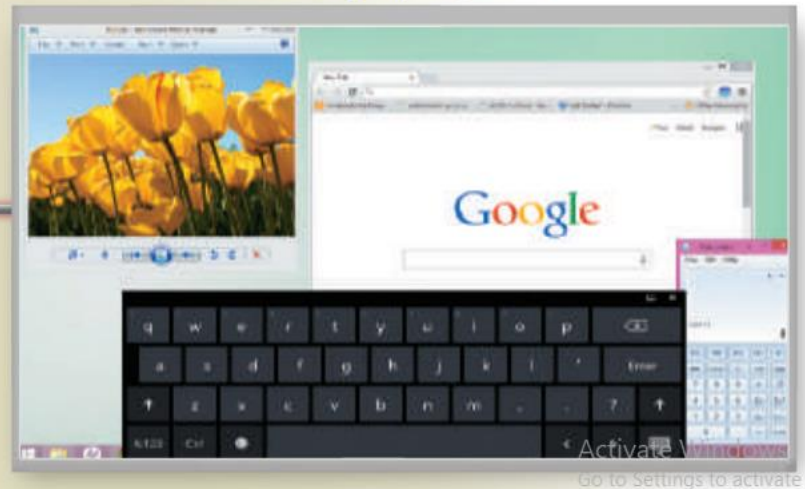
start and shut down the computer

provide a user interface

control a network

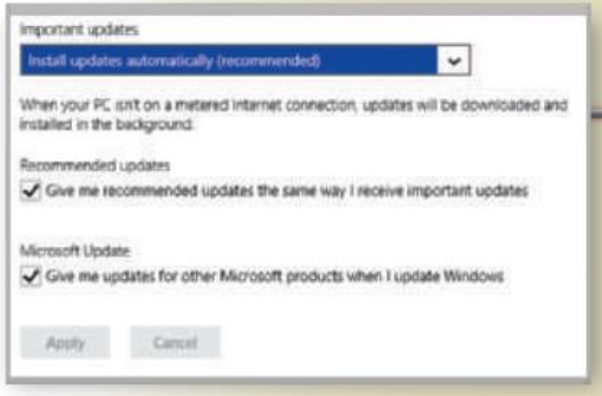


manage programs

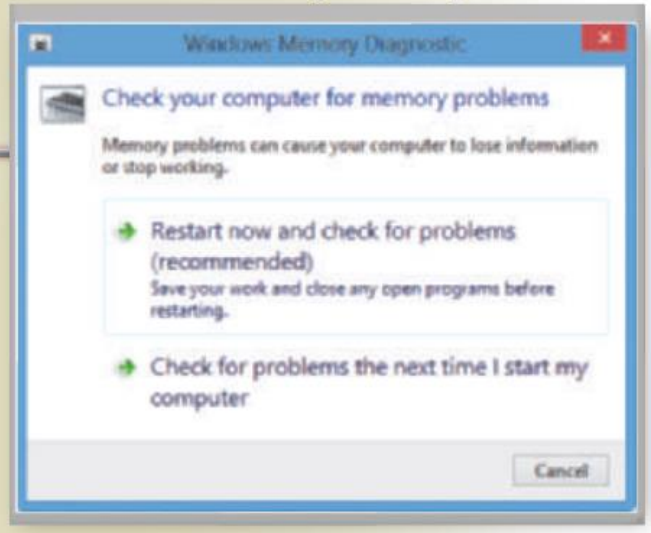


operating system functions

update automatically

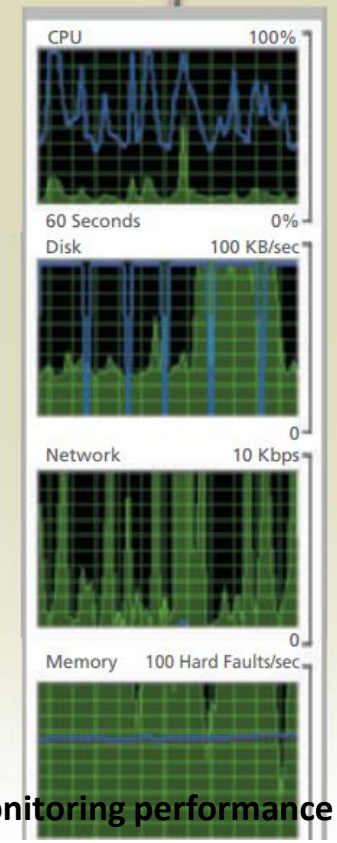


manage memory



provide file management and other tools

establish an Internet connection



monitoring performance

coordinate tasks and configure devices

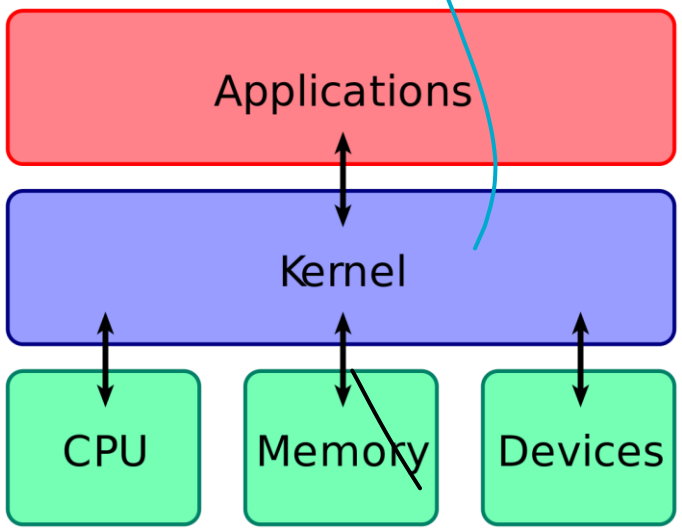
1. Starting Computers and Mobile Devices

Step 1: When you turn, the power supply or battery **sends an electrical current to circuitry** in the computer or mobile device.

Step 2: The charge of electricity causes the processor chip to reset itself and finds the **firmware** that **contains start-up instructions**.

Step 3: The start-up process **executes a series of tests to check the various components**. These tests vary depending on the type of computer or devices and can include checking the buses, system clock, adapter cards, RAM chips, mouse, keyboard, and drives. It also includes making sure that any peripheral devices are connected properly and operating correctly. If any problems are identified, the computer or device may beep, display error messages, or cease operating — depending on the severity of the problem.

1. Starting Computers and Mobile Devices



Step 4: If the tests are successful, the **kernel** of the operating system and other frequently used instructions load from the computer or mobile device's internal storage media to its memory (RAM). The **kernel is the core of an operating system that manages memory and devices**, maintains the internal clock, runs programs, and assigns the resources, such as devices, programs, apps, data, and information.

The kernel is memory resident, which means it remains in memory while the computer or mobile device is running. **Other parts of the operating system are nonresident**; that is, nonresident instructions remain on a storage medium until they are needed, at which time they transfer into memory (RAM).

Step 5: The operating system in memory **takes control of the computer or mobile device and loads system configuration information**. The operating system may verify that the person attempting to use the computer or mobile device is a legitimate user. **Finally, the user interface appears on the screen**, and any start-up applications, such as antivirus software, run.

The process of starting or restarting a computer or mobile device is called **booting.**

Some people use the term **cold boot** to refer to the process of starting a computer or mobile device from a state when it is powered off completely.

Similarly, **warm boot** refers to the process of restarting a computer or mobile device while it remains powered on.

A warm boot generally is faster than a cold boot because it skips some of the operating system start-up instructions that are included as part of a cold boot.

If you suspect a hardware problem, it is recommended that you use a **cold boot** to start a computer or device because this process detects and checks connected hardware devices.

If a program or app stops working, a **warm boot** often is sufficient to restart the device because this process clears memory

2. Shutting Down Computers and Mobile Devices

Power options include **shutting down** (powering off) the computer or mobile device, placing it in **sleep mode**, or placing it in **hibernate mode**.

Both sleep mode and hibernate mode are designed to save time when you resume work on the computer or device.

Sleep mode saves any open documents and running programs or apps to **RAM**, turns off all unneeded functions, and **then places the computer in a low-power state**. If, for some reason, power is removed from a computer or device that is in sleep mode, **any unsaved work could be lost.** saved to RAM

Hibernate mode, by contrast, saves any open documents and running programs or apps to an **internal hard drive** before removing power from the computer or device. saved to HDD

3. Providing a user interface

You interact with an operating system through its user interface. That is, a user interface (UI) controls how you enter data and instructions and how information is displayed on the screen

GUI

graphical user interface (GUI), you interact with menus and visual images by touching, pointing, tapping, or clicking buttons and other objects to issue commands

cmd

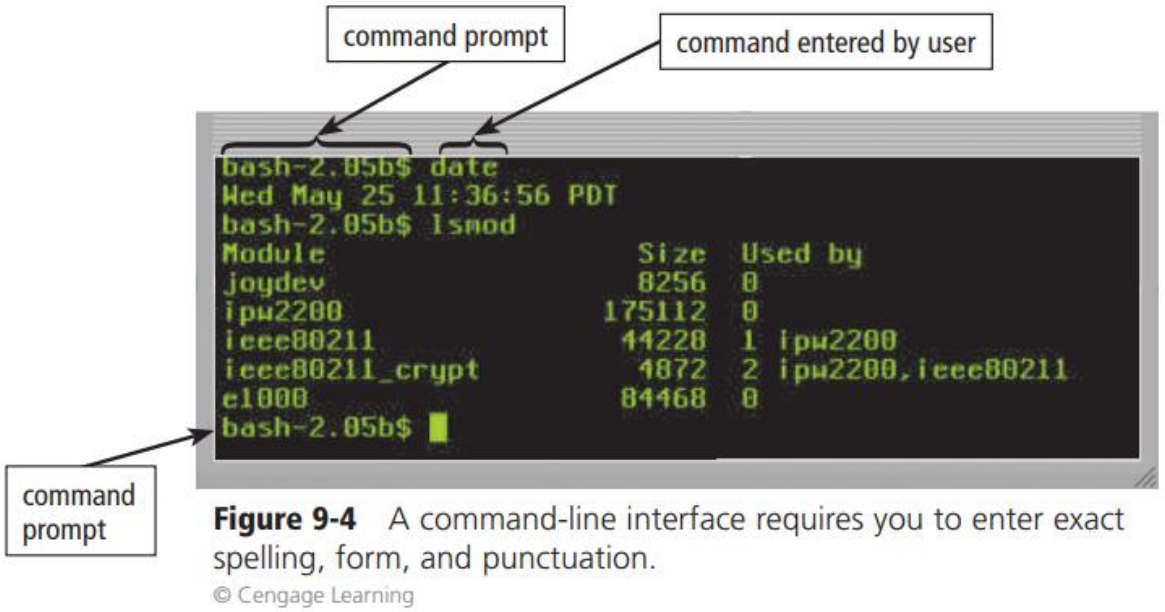


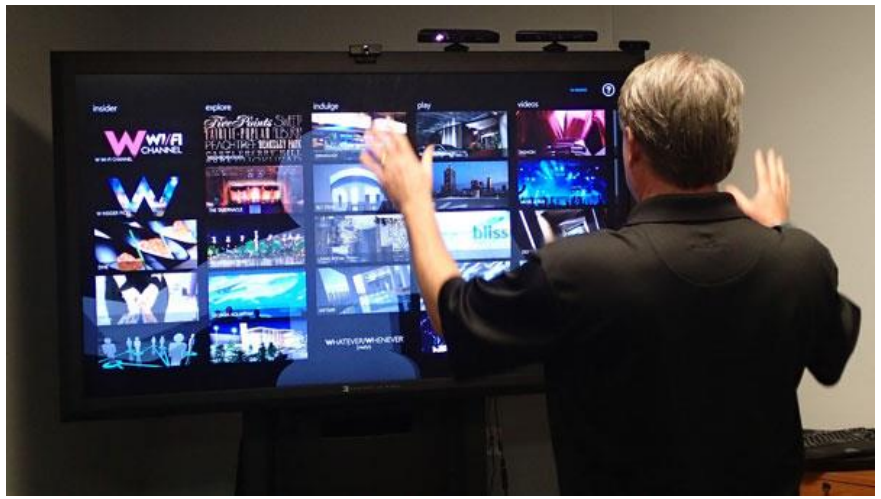
Figure 9-4 A command-line interface requires you to enter exact spelling, form, and punctuation.

command-line interface, a user types commands represented by short keywords or abbreviations (such as dir to view a directory, or list of files) or presses special keys on the keyboard to enter data and instructions

What is a natural user interface?

NUI

With a natural user interface (NUI), users interact with the software through ordinary, intuitive behavior. NUIs are implemented in a variety of ways: touch screens (touch input), gesture recognition (motion input), speech recognition (voice input), and virtual reality (simulations).



4. Managing Programs

How an operating system handles programs directly affects your productivity

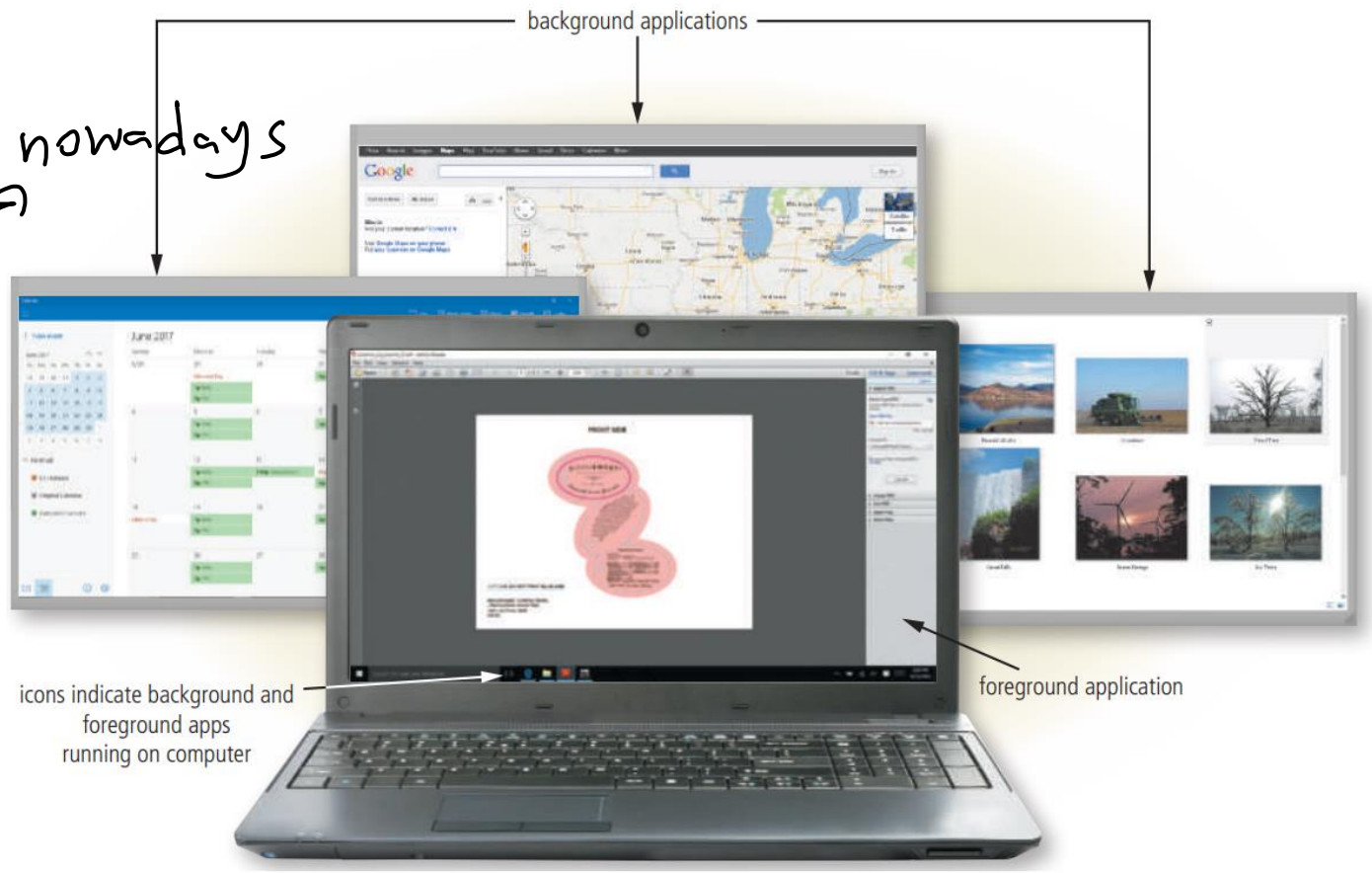
→ in embedded com.

A single tasking operating system allows only one program or app to run at a time. ***Operating systems on embedded computers*** and ***some mobile devices*** use a single tasking operating system.

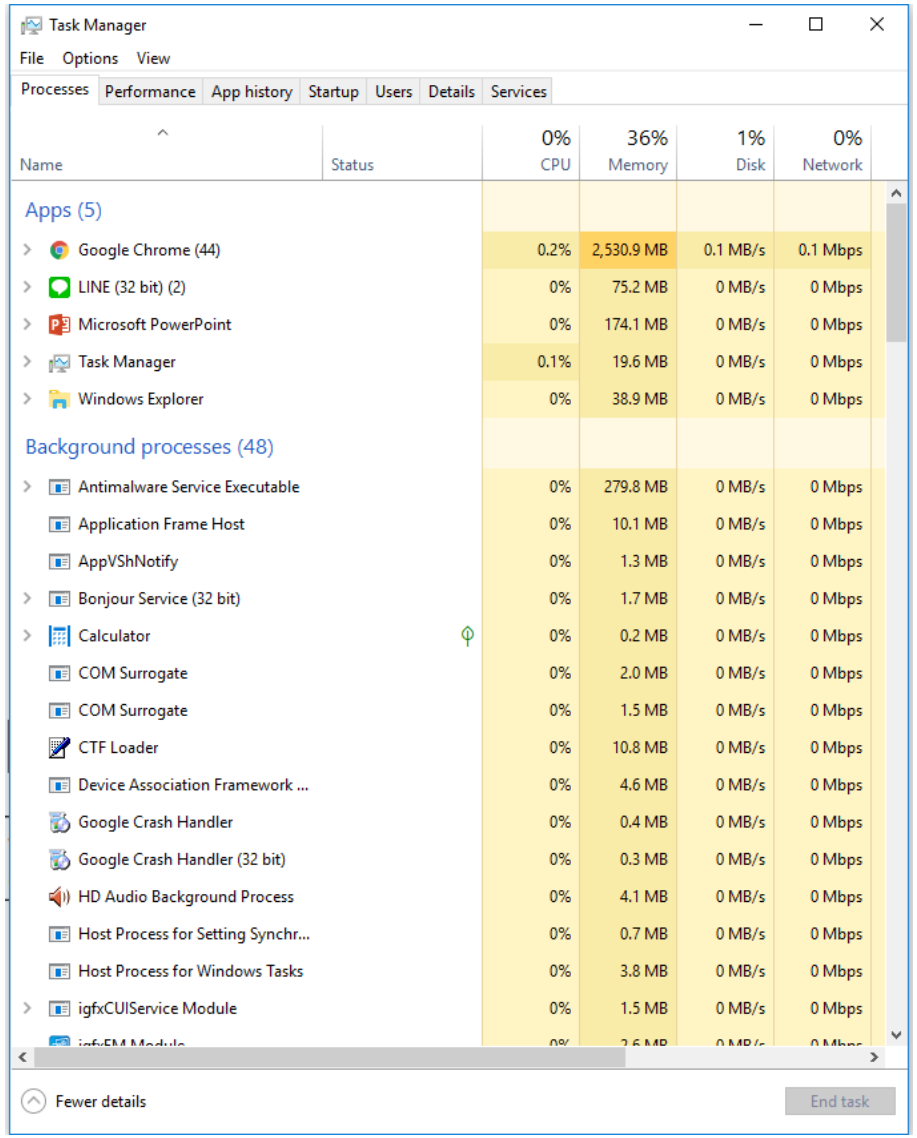
nowadays

Most operating systems today are **multitasking**. A multitasking operating system allows two or more programs or apps to reside in memory at the same time.

When a computer is running multiple programs concurrently, one program is in the foreground and the others are in the background.



4. Managing Programs



An operating system manages multiple programs and processes while you use a computer or mobile device.

Some operating systems support a **single user**; others support thousands of users running multiple programs.

A **multiuser operating system** enables two or more users to run programs simultaneously.

Networks, servers, and supercomputers allow hundreds to thousands of users to connect at the same time and, thus, use multiuser operating systems.

5. Managing Memory

The purpose of memory management is to optimize the use of a computer or device's internal memory. ทำให้ memory ไม่มากเกินไป ทำให้ดีอย่างมีประสิทธิภาพ

The operating system allocates, or assigns, data and instructions to an area of memory while they are being processed.

Then, it carefully monitors the contents of memory.

Finally, the operating system releases these items from being monitored in memory when the processor no longer requires them.

5. Managing Memory

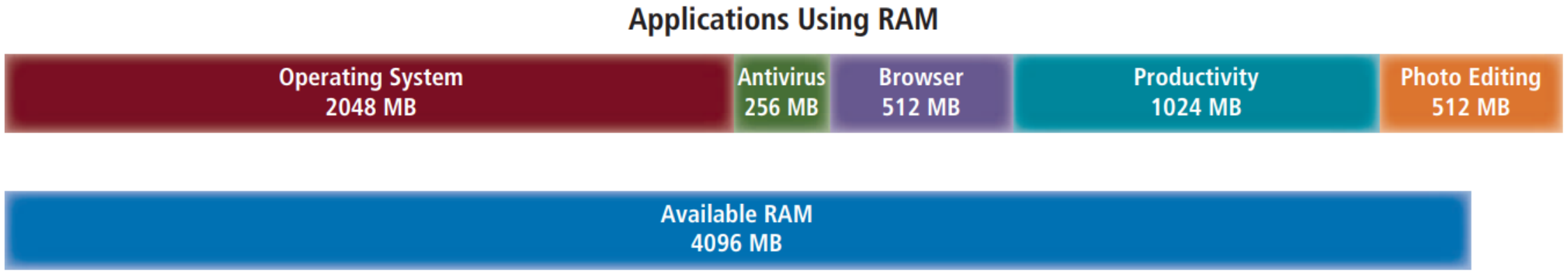


Figure 9-7 Many applications running at the same time may deplete a computer's or device's available RAM.

The operating system may have to use **virtual memory** in order to run all of the applications at the same time.

When a computer or mobile device runs low on available RAM, this often results in the computer or mobile device running sluggishly

5. Managing Memory

With **virtual memory**, the operating system allocates **a portion of a storage medium**, such as a hard drive or a USB flash drive, to **function as additional RAM**.

As you interact with a program, part of it may be in physical RAM, while the rest of the program is on the hard drive as virtual memory.
Because virtual memory is slower than RAM, users may notice the computer slowing down while it uses virtual memory.

The area of the hard drive used for virtual memory is called a swap file because it swaps (exchanges) data, information, and instructions between memory and storage.

A page is the amount of data and program instructions that can swap at a given time.

The technique of swapping items between memory and storage, called **paging**.

When an operating system spends much of its time paging, instead of executing application software, it is said to be **thrashing.** → paging ในขอความนี้

5. Managing Memory

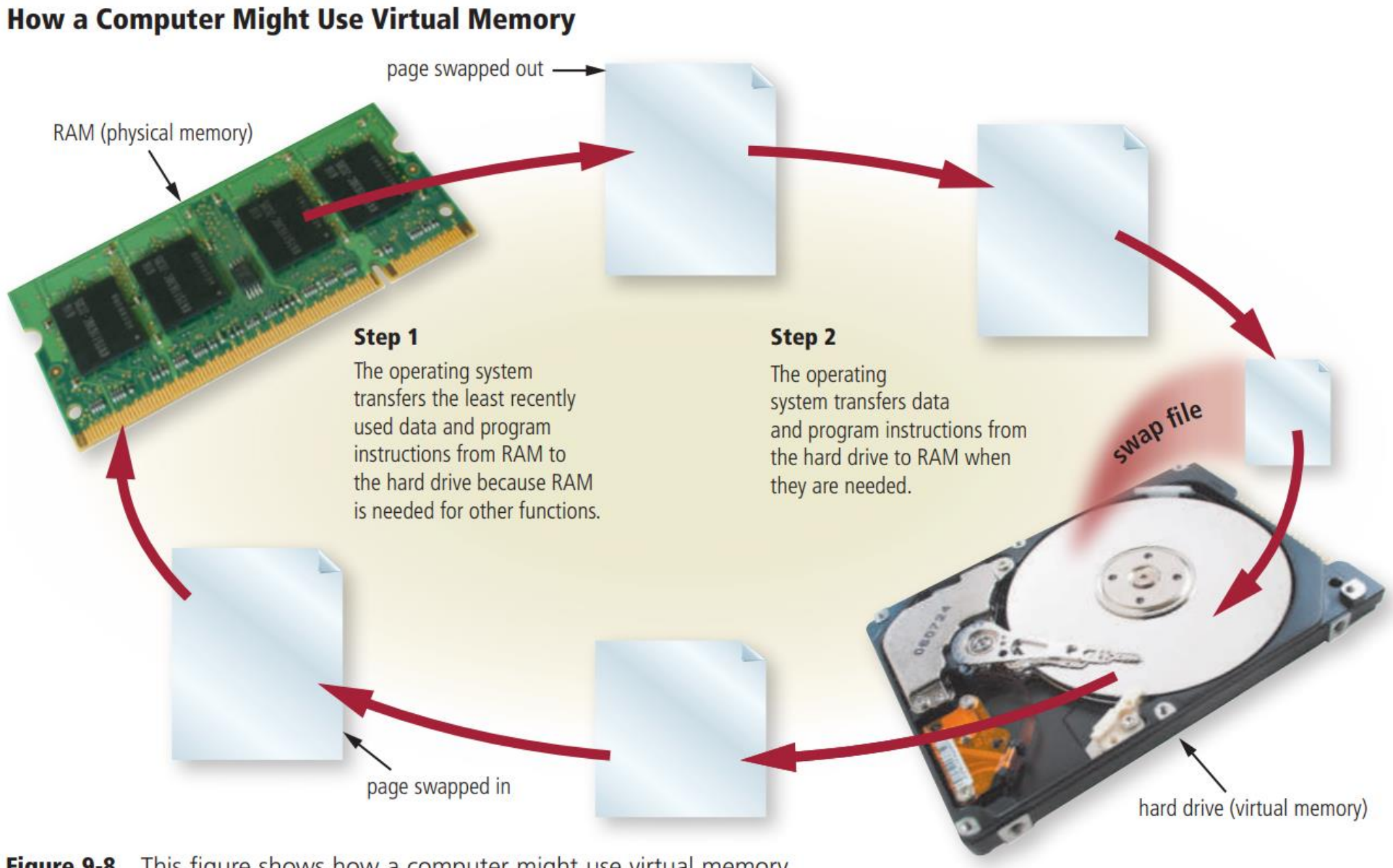


Figure 9-8 This figure shows how a computer might use virtual memory.

6. Coordinating tasks

The operating system determines the order in which tasks are processed.

Tasks , or **job**, include receiving data from an input device, processing instructions, sending information to an output device, and transferring items from storage to memory and from memory to storage.

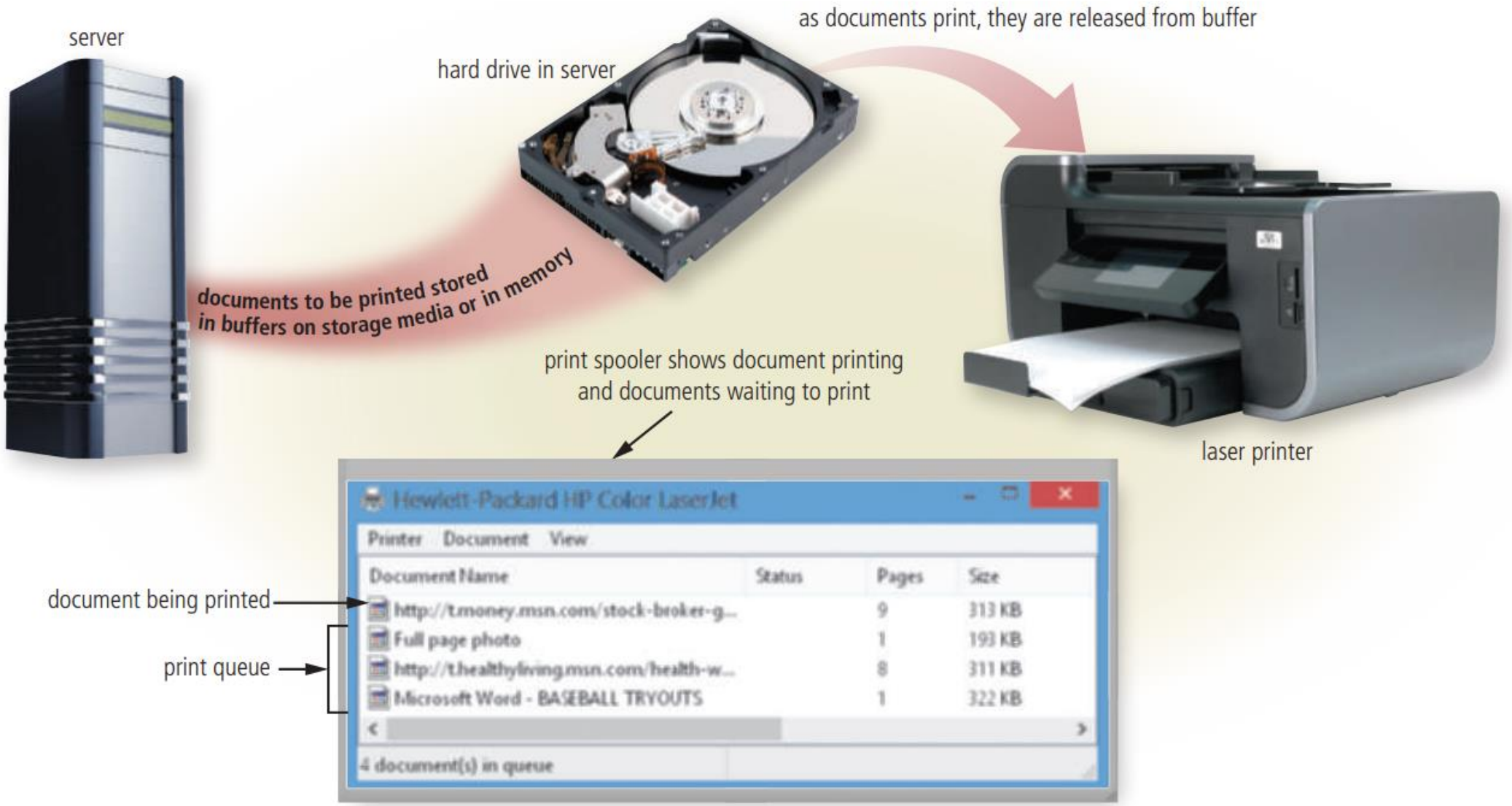
A **buffer** is a segment of memory or storage in which items are placed while waiting to be transferred from an input device or to an output device.

An operating system commonly uses buffers with printed documents.

This process, called **spooling**, sends documents to be printed to a buffer instead of sending them immediately to the printer.

Multiple documents line up in a queue in the buffer. A program, called a **print spooler**, intercepts documents to be printed from the operating system and places them in the queue.

6. Coordinating tasks

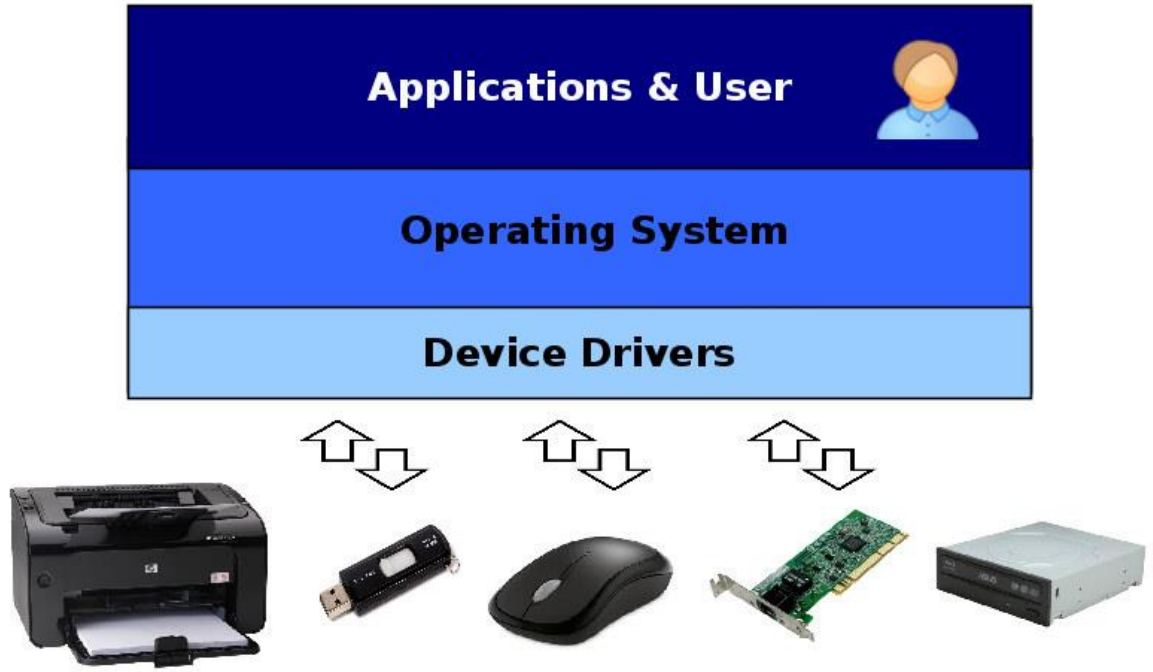


7. Configuring devices

A driver, short for device driver, is a small program that tells the operating system how to communicate with a specific device.

Each device connected to a computer, has its own specialized set of commands and, thus, requires its own specific driver. A driver must be installed before you can use the device.

Driver OS → สื่อสาร I/O อีกทอด



7. Configuring devices

เสียบปั๊ปใช้ได้เลย

Today, most devices and operating systems support Plug and Play.

Plug and Play means the operating system automatically configures new devices as you install or connect them.

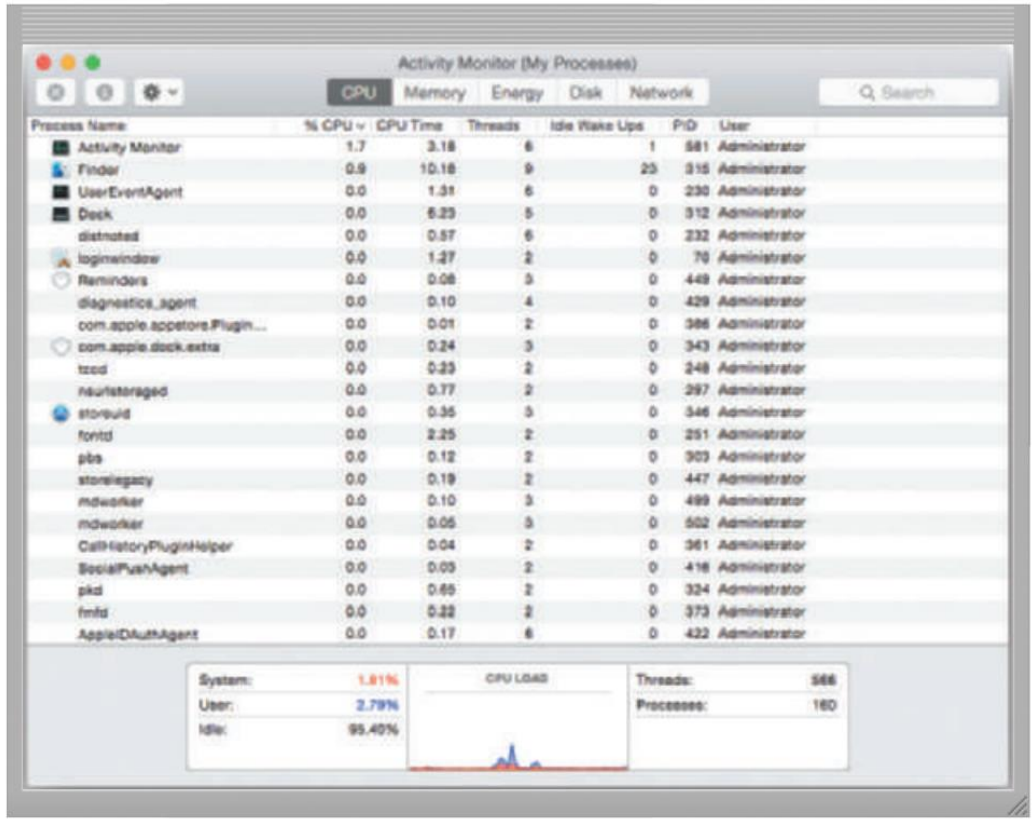
Specifically, it assists you in the device's installation by loading the necessary drivers automatically from the device and checking for conflicts with other devices.

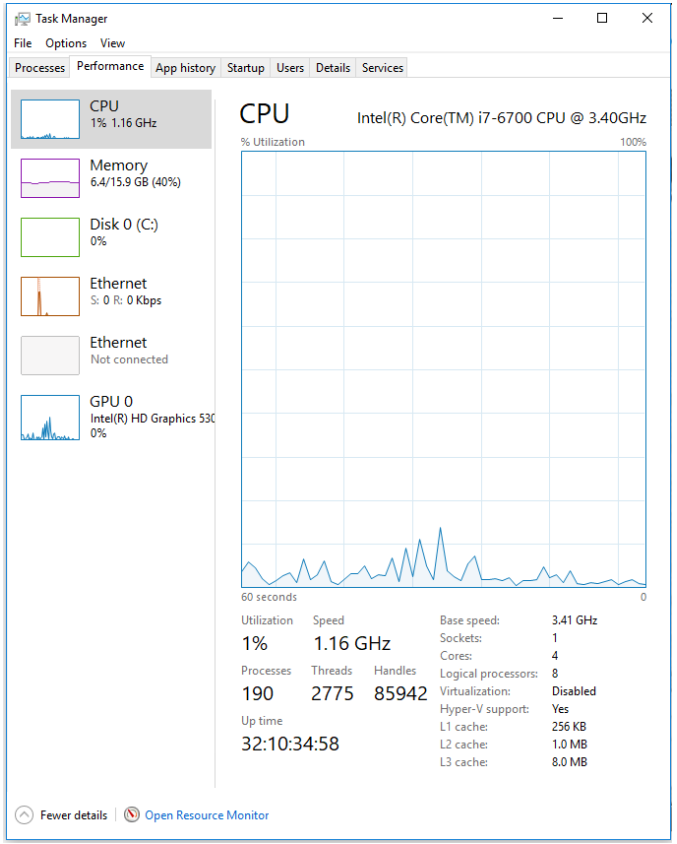
8. Monitoring performance

A performance monitor is a program that assesses and reports information about various computer resources and devices .

Task Manager

For example, users can monitor the processor, drives, network, and memory usage.



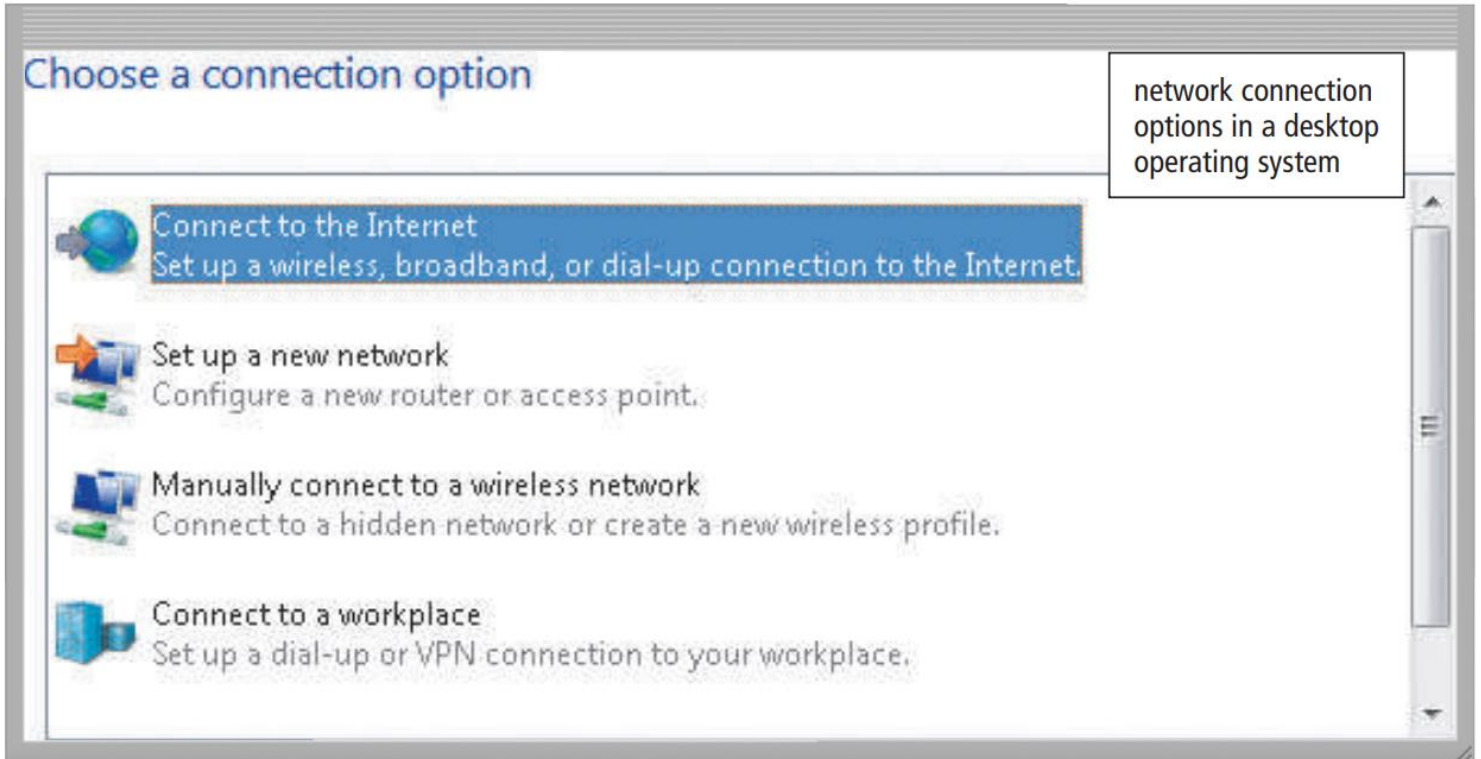


9. Establishing an Internet connection

Operating systems typically provide a means to establish Internet connections.

Some operating systems also include a **browser** and an **email program**, enabling you to begin using the web and communicating with others as soon as you set up an Internet connection.

Operating systems also sometimes include **firewalls** and other tools to protect computers and mobile devices from unauthorized intrusions and unwanted software.



network connection options in a desktop operating system

Wi-Fi connection options in a mobile operating system

10. Providing File, Disk, and System Management Tools

Operating systems often provide users with a variety of tools related to managing a computer, its devices, or its programs.

Table 9-1 File, Disk, and System Management Tools

Tool	Function
File Manager	Performs functions related to displaying files; organizing files in folders; and copying, renaming, deleting, moving, and sorting files
Search	Attempts to locate files on your computer or mobile device based on specified criteria
Image Viewer	Displays, copies, and prints the contents of graphics files
Uninstaller	Removes a program or app, as well as any associated entries in the system files
Disk Cleanup	Searches for and removes unnecessary files
Disk Defragmenter	Reorganizes the files and unused space on a computer's hard disk so that the operating system accesses data more quickly and programs and apps run faster ต้องช่วยจัดเรียงไฟล์ในคอม
Screen Saver	Causes a display's screen to show a moving image or blank screen if no keyboard or mouse activity occurs for a specified time
File Compression	Shrinks the size of a file(s)
PC Maintenance	Identifies and fixes operating system problems, detects and repairs drive problems, and includes the capability of improving a computer's performance
Backup and Restore	Copies selected files or the contents of an entire storage medium to another storage location

11. Updating operating system software

Many programs, including operating systems, include an **automatic update** feature that - regularly provides new features or corrections to the program.

With an operating system, these updates can include fixing program errors, improving program functionality, expanding program features, enhancing security, and modifying device drivers.

Many software makers provide free downloadable updates, sometimes called a **service pack**, to users who have registered and/or activated their software.

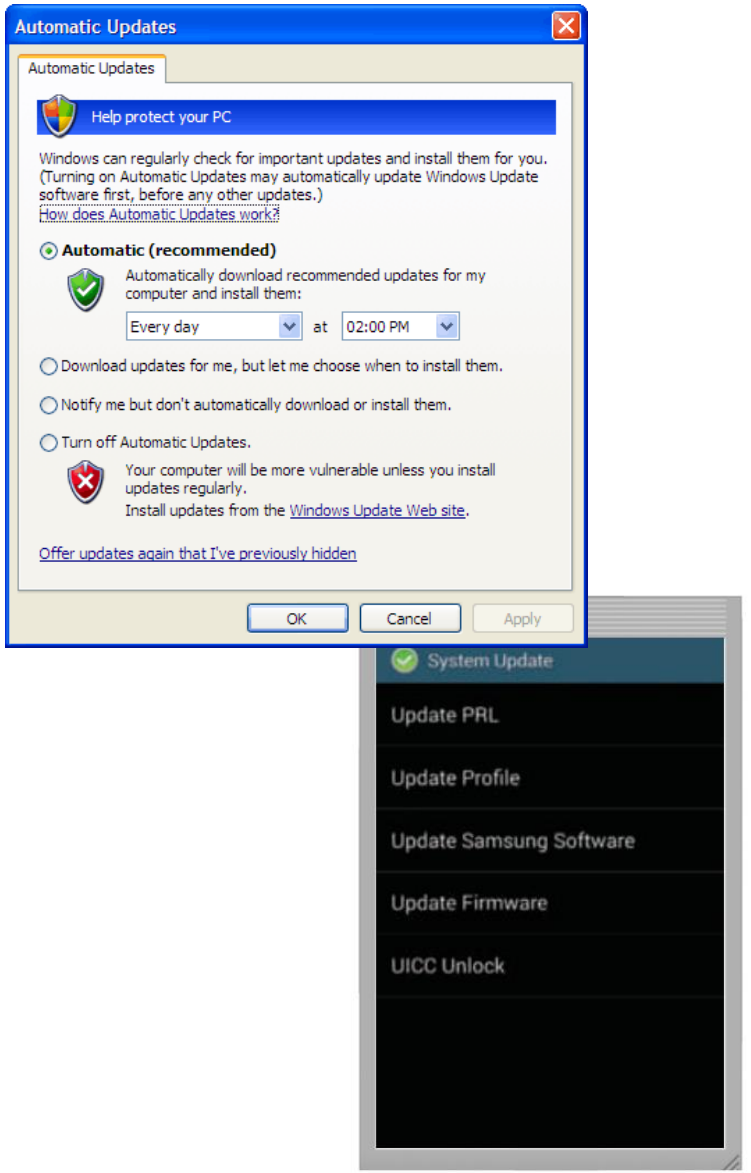


Figure 9-12 An operating system usually includes a means to download and install important updates.
Source: Google Inc.

12. Controlling a Network

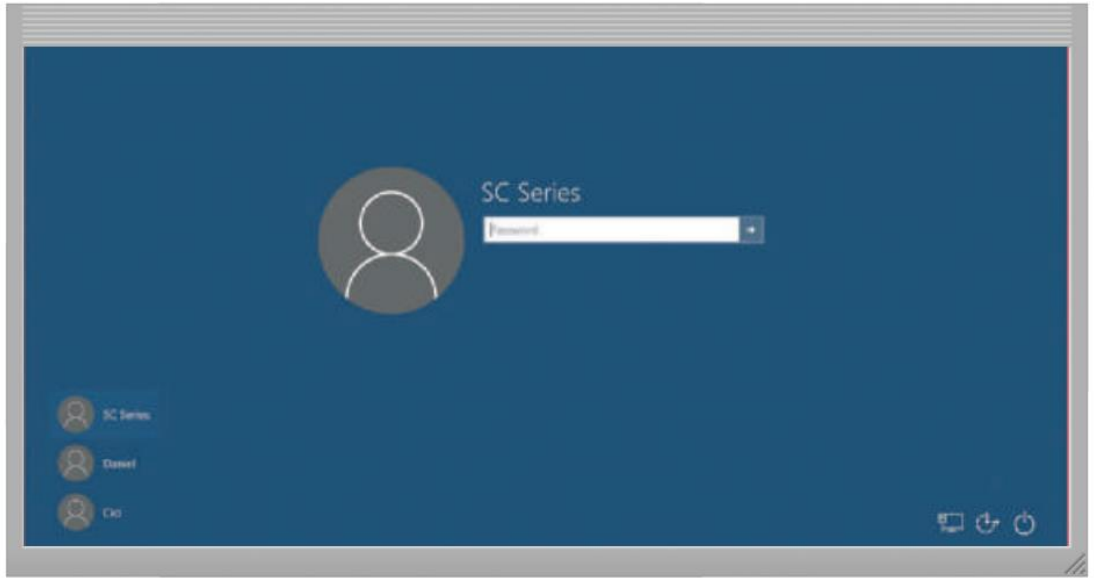
Some operating systems are designed to work with a server on a network. These multiuser operating systems allow multiple users to share a printer, Internet access, files, and programs.

The **network administrator**, the person overseeing network operations, uses the server operating system to add and remove users, computers, and other devices to and from the network.

Network administrators, as well as owners of computers, typically have an administrator account that enables them to access all files and programs, install programs, and specify settings that affect all users on a computer, mobile device, or network.

12. Controlling a Network

Settings include creating user accounts and establishing **permissions**. These permissions define who can access certain resources and when they can access those resources.



A user account enables a use to sign in to, or access resources on, a network or computer

– A **user name**, or user ID, identifies a specific user

– A **password** is a private combination of characters associated with the user name

Type of Operating Systems

Table 9-2 Examples of Operating Systems by Category	
Category	**Name**
Desktop	Windows
	OS X
	UNIX
	Linux
	Chrome OS
Server	Windows Server
	Mac OS X Server
	UNIX
	Linux
Mobile	Google Android
	Apple iOS
	Windows Phone

OS ใหม่รองรับ program เก่าๆ

New versions of an operating system - usually are **backward compatible**, which means they recognize and work with applications written for an earlier version of the operating system (or platform).

program เก่าอาจ Run ได้ไม่สมบูรณ์ ใน OS ใหม่

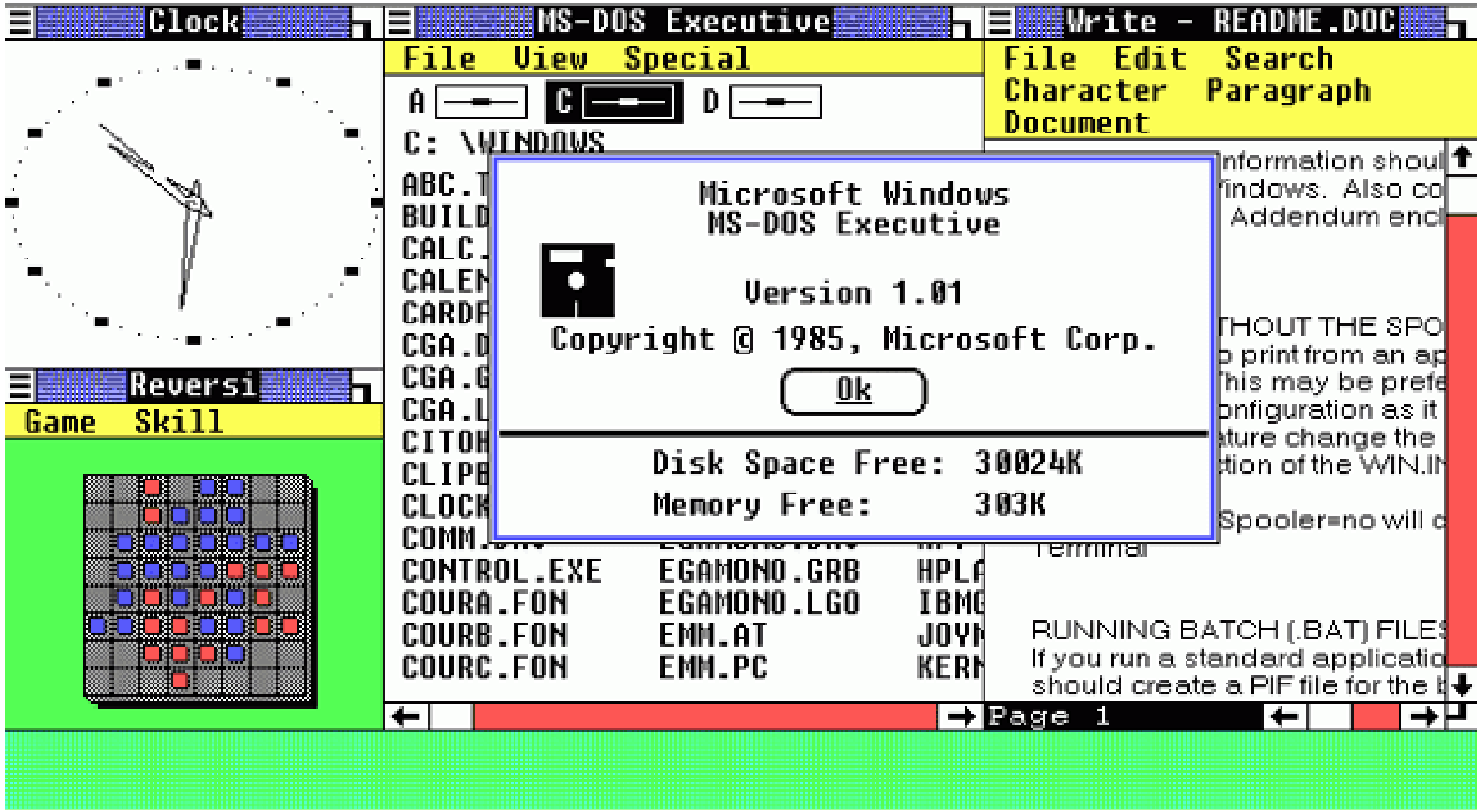
The application, by contrast, may or may not be **upward compatible**, meaning it may or may not run on new versions of the operating system.

Windows

In the mid-1980s, Microsoft developed its first version of Windows, which provided a graphical user interface. มี GUI แล้ว

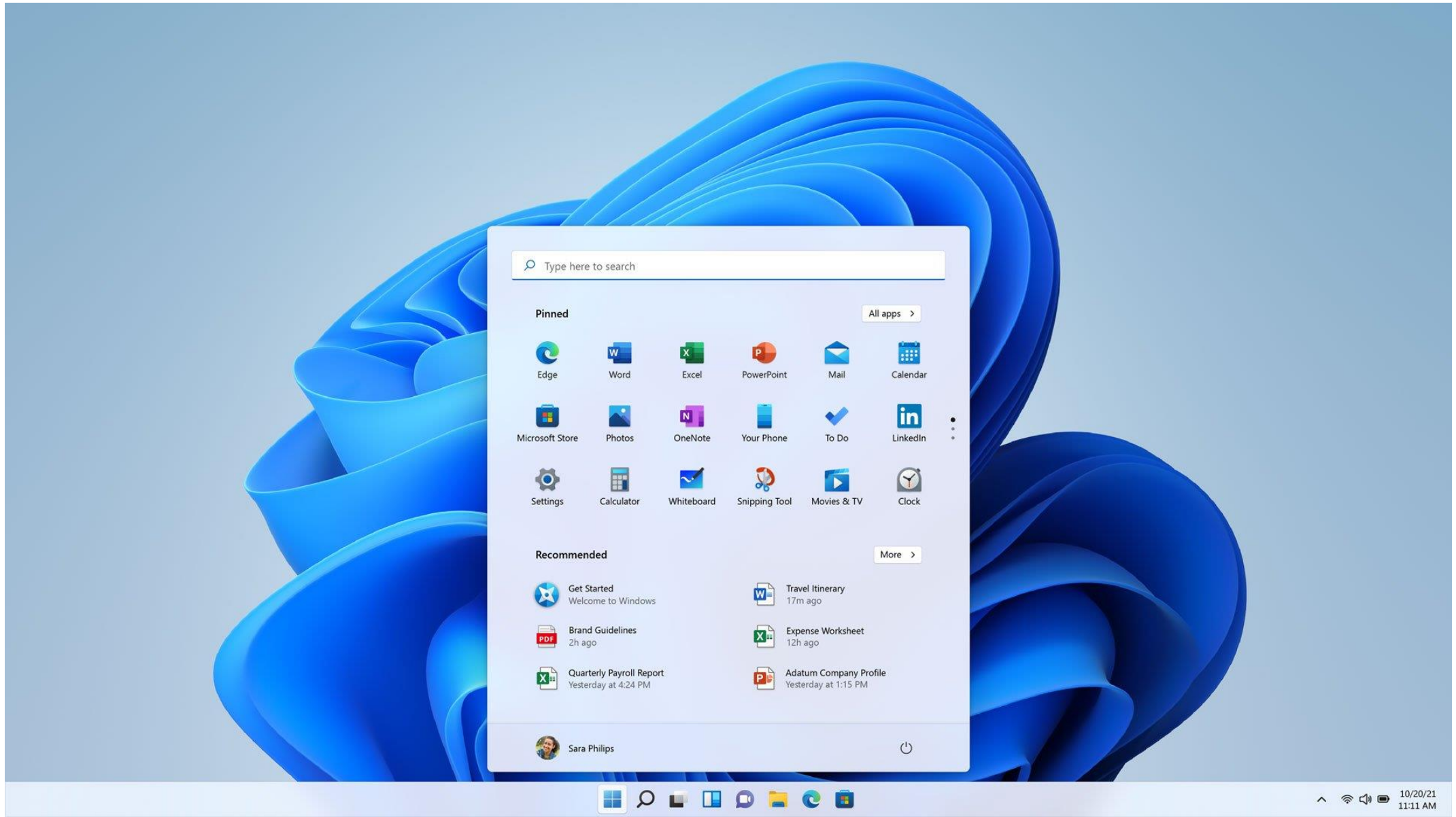
the latest versions of Windows offer these features:

- Uses tiles to access apps
- Includes the desktop interface
- Support for input via touch, mouse, and keyboard
- Email app, calendar app, and browser (Internet Explorer) included
- Photos, files, and settings can sync with OneDrive, Microsoft's cloud server
- Enhanced security through an antivirus program, firewall, and automatic updates
- Windows Store offers additional applications for purchase



The original **Windows 1** was released in November 1985 and was Microsoft's first true attempt at a graphical user interface in 16-bit.

Development was spearheaded by Microsoft founder Bill Gates and ran on top of MS-DOS, which relied on command-line input.



Windows 11 was released to the public on **October 5, 2021**.

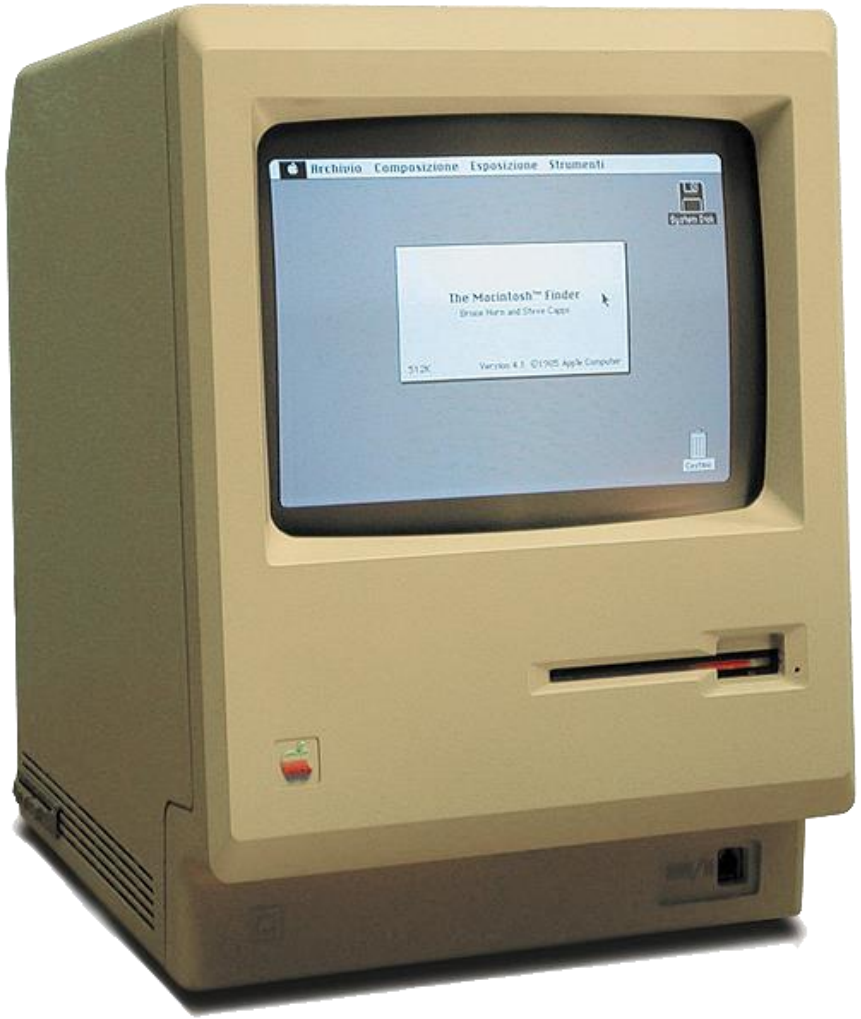
Mac OS

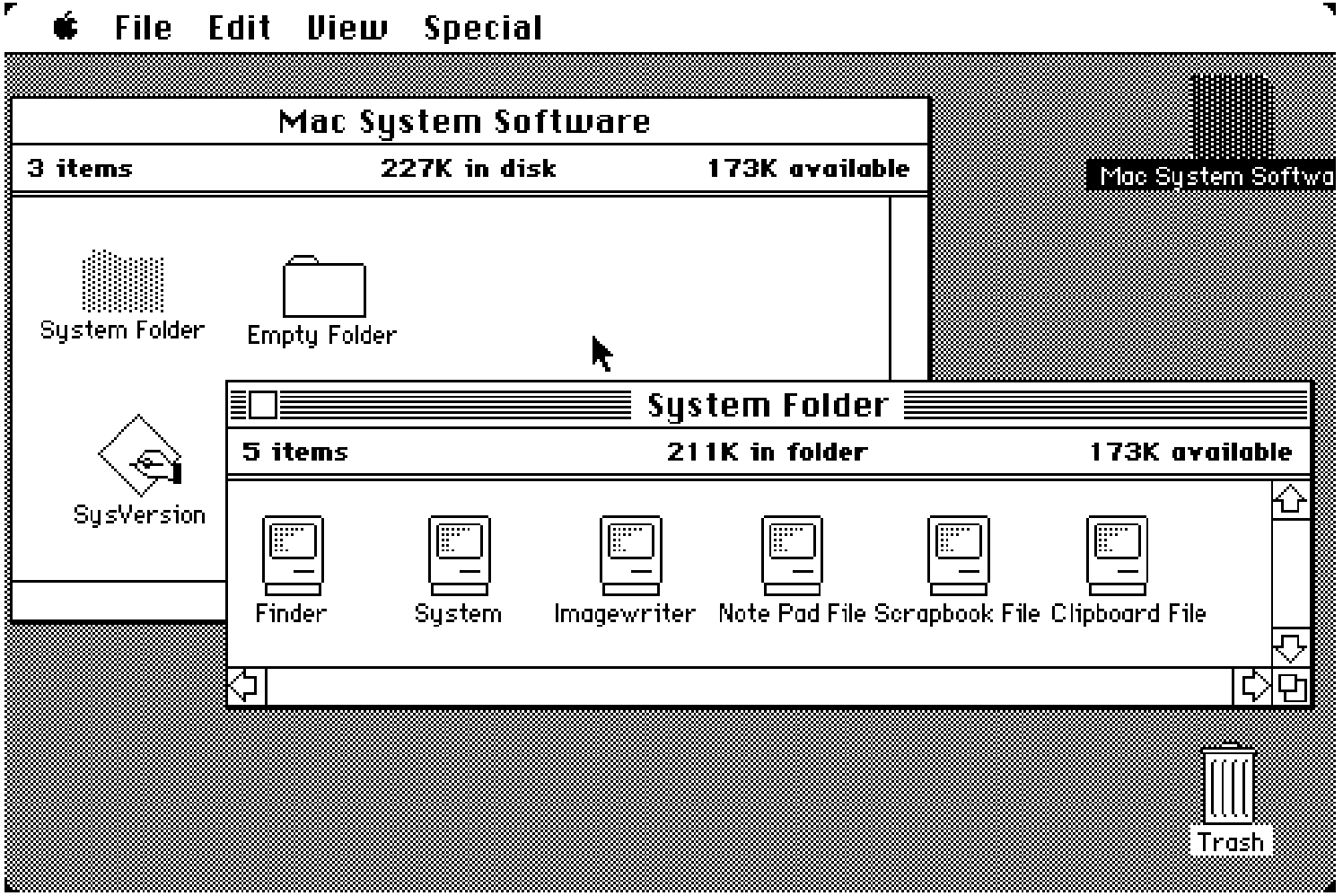
Since it was released in 1984 with Macintosh computers, Apple's Macintosh operating system (Mac OS) has earned a reputation for its ease of use and has been the model for most of the new GUIs developed for non-Macintosh systems.

The latest version, OS X, is a multitasking operating system available for computers manufactured by Apple.

Features of the latest version of OS X include the following:

- Mail, calendars, contacts, and other items sync with iCloud, Apple's cloud server
- Communicate and play games with users of mobile devices running Apple's mobile operating system (iOS)
- Built-in Facebook and Twitter support allows you to post a status, comments, or files from any app
- Browser (Safari)
- Open multiple desktops at once
- Dictated words convert to text
- Support for Braille displays
- Mac App Store provides access to additional apps and software updates



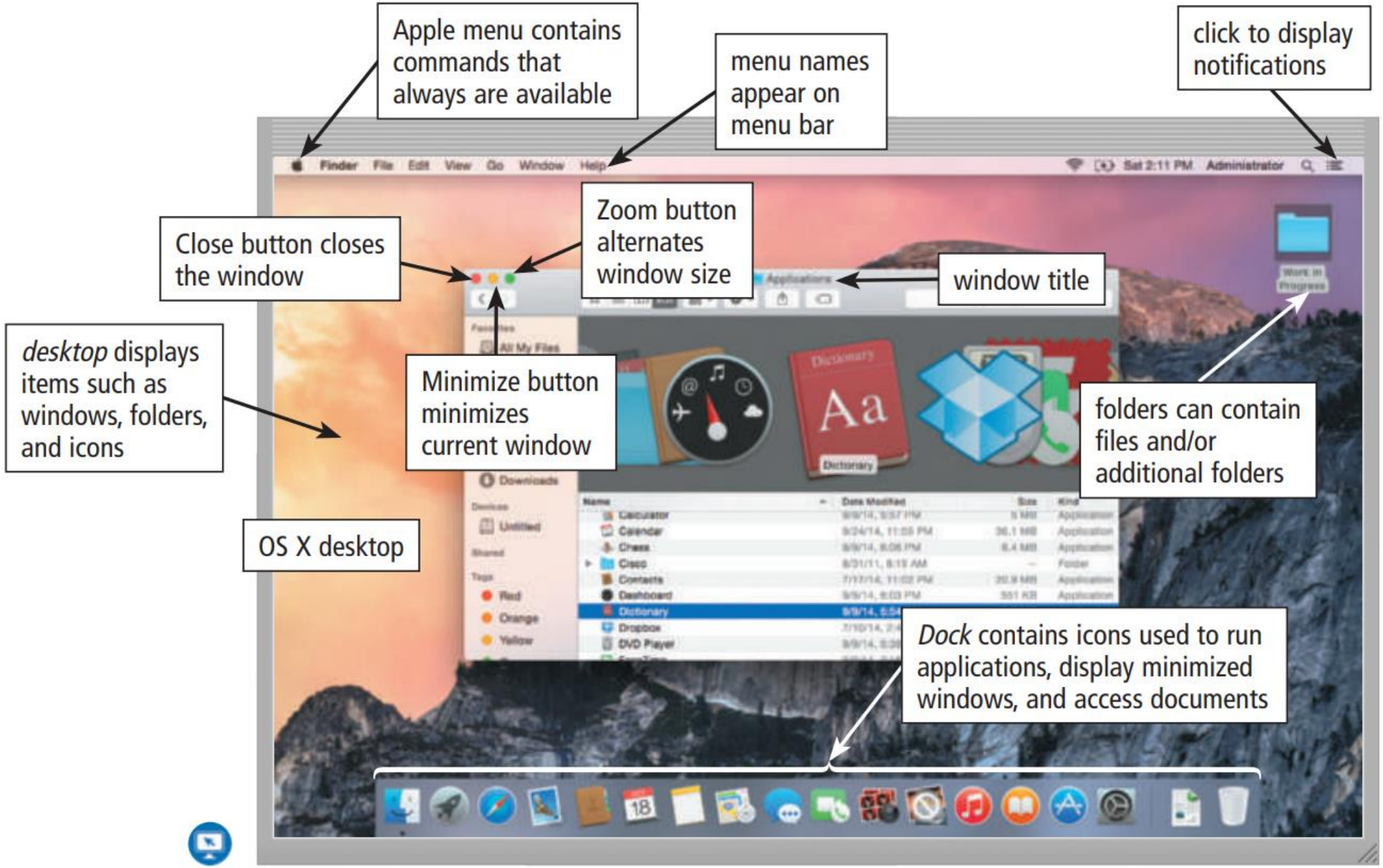


The original Macintosh System Software released in 1984

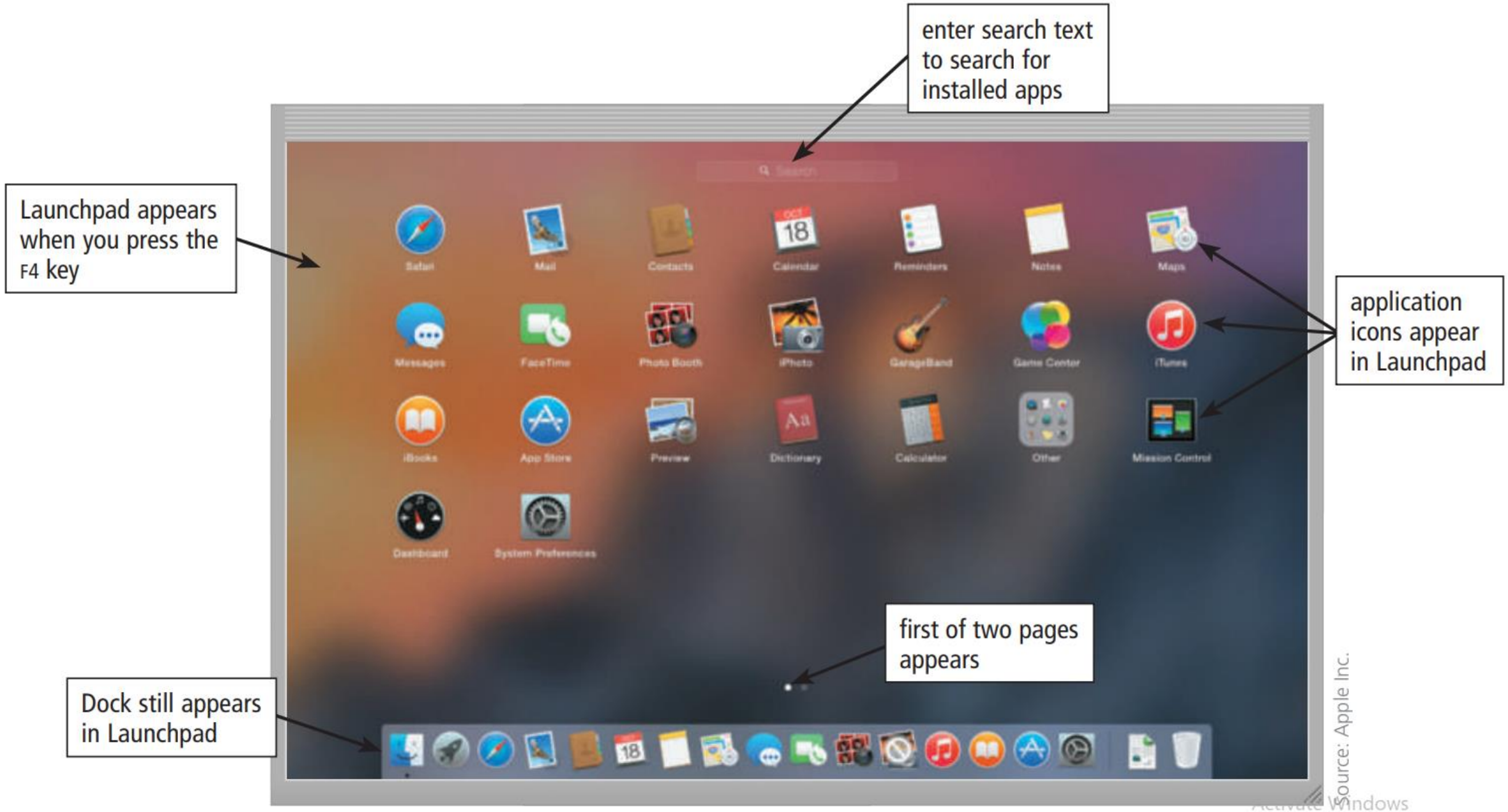
Source: https://www.apple.com/th/newsroom/2023/06/macos-sonoma-brings-new-capabilities-for-elevating-productivity-and-creativity/

macOS 14: Sonoma (Sunburst) – Beta, full release expected in October 2023

masOS 15: Sequoia (Beta), Announced in June 10, 2024



Source: Apple Inc.


enter search text to search for installed apps
Launchpad appears when you press the F4 key
application icons appear in Launchpad
first of two pages appears
Dock still appears in Launchpad
Source: Apple Inc.

Mac OS based on UNIX

UNIX

UNIX is a multitasking operating system developed in the early 1970s by scientists at Bell Laboratories.

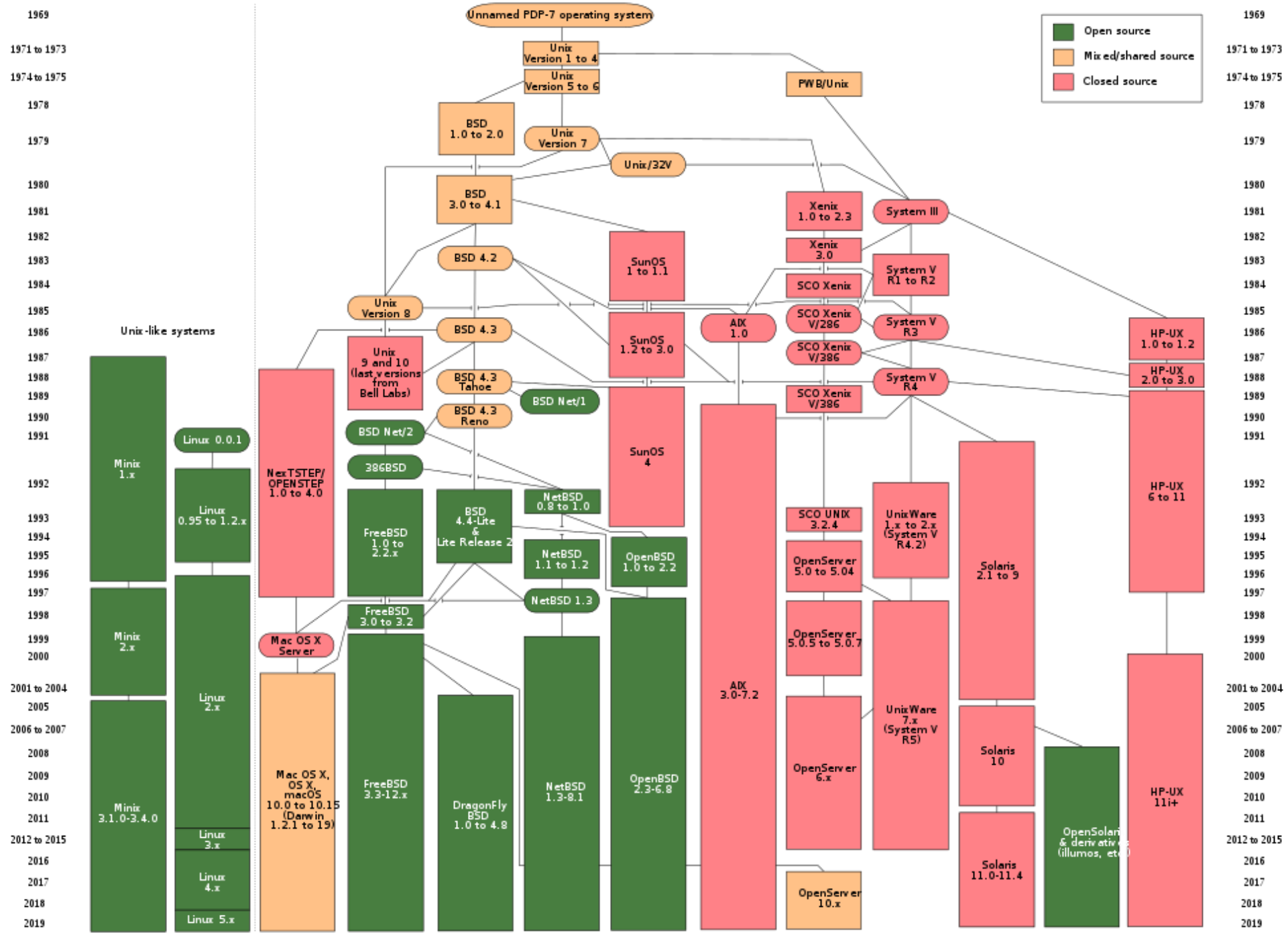
Bell Labs (a subsidiary of AT&T) was prohibited from actively promoting UNIX in the commercial marketplace because of federal regulations.

Bell Labs instead licensed UNIX for a low fee to numerous colleges and universities, where UNIX obtained a wide following.

Although some versions of UNIX have a command-line interface, most versions of UNIX offer a graphical user interface.

มีทั้ง GUI และ CMD

https://th.wikipedia.org/wiki/%E0%B8%A2%E0%B8%B9%E0%B8%99%E0%B8%B4%E0%B8%81%E0%B8%8B%E0%B9%8C


Open source
Mixed/shared source
Closed source
Unix-like systems
1969
1971 to 1973
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2012 to 2015
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2018
2019
Unnamed PDP-7 operating system
Unix Version 1 to 4
Unix Version 5 to 6
Unix Version 7
Unix/32V
Unix Version 8
Unix 9 and 10 (last versions from Bell Labs)
PWB/Unix
BSD 1.0 to 2.0
BSD 3.0 to 4.1
BSD 4.2
BSD 4.3
BSD 4.3 Tahoe
BSD 4.3 Reno
BSD Net/1
BSD Net/2
386BSD
FreeBSD 1.0 to 2.2.x
FreeBSD 3.0 to 3.2
FreeBSD 3.3-12.x
BSD 4.4-Lite & Lite Release 2
NetBSD 0.8 to 1.0
NetBSD 1.1 to 1.2
NetBSD 1.3
NetBSD 1.3-8.1
OpenBSD 1.0 to 2.2
OpenBSD 2.3-6.8
DragonFly BSD 1.0 to 4.8
SunOS 1 to 1.1
SunOS 1.2 to 3.0
SunOS 4
Xenix 1.0 to 2.3
Xenix 3.0
SCO Xenix
SCO Xenix V/286
SCO Xenix V/386
SCO UNIX 3.2.4
OpenServer 5.0 to 5.04
OpenServer 5.0.5 to 5.0.7
OpenServer 6.x
OpenServer 10.x
AIX 1.0
AIX 3.0-7.2
System III
System V R1 to R2
System V R3
System V R4
UnixWare 1.x to 2.x (System V R4.2)
UnixWare 7.x (System V R5)
HP-UX 1.0 to 1.2
HP-UX 2.0 to 3.0
HP-UX 6 to 11
HP-UX 11i+
Solaris 2.1 to 9
Solaris 10
Solaris 11.0-11.4
OpenSolaris & derivatives (illumos, etc)
Minix 1.x
Minix 2.x
Minix 3.1.0-3.4.0
Linux 0.0.1
Linux 0.95 to 1.2.x
Linux 2.x
Linux 3.x
Linux 4.x
Linux 5.x
NeXTSTEP/ OPENSTEP 1.0 to 4.0
Mac OS X Server
Mac OS X, OS X, macOS 10.0 to 10.15 (Darwin 1.2.1 to 19)

```
ramkumar@trusty:~$pwd
/home/ramkumar
ramkumar@trusty:~$pushd .
~ ~
ramkumar@trusty:~$pushd /opt/ros/
/opt/ros ~ ~
ramkumar@trusty:/opt/ros$pushd /opt/chefdk/
/opt/chefdk /opt/ros ~ ~
ramkumar@trusty:/opt/chefdk$popd
/opt/ros ~ ~
ramkumar@trusty:/opt/ros$pwd
/opt/ros
ramkumar@trusty:/opt/ros$popd
~ ~
ramkumar@trusty:~$pwd
/home/ramkumar
ramkumar@trusty:~$dirs
~ ~
ramkumar@trusty:~$popd
~
ramkumar@trusty:~$pwd
/home/ramkumar
ramkumar@trusty:~$
```

Linux

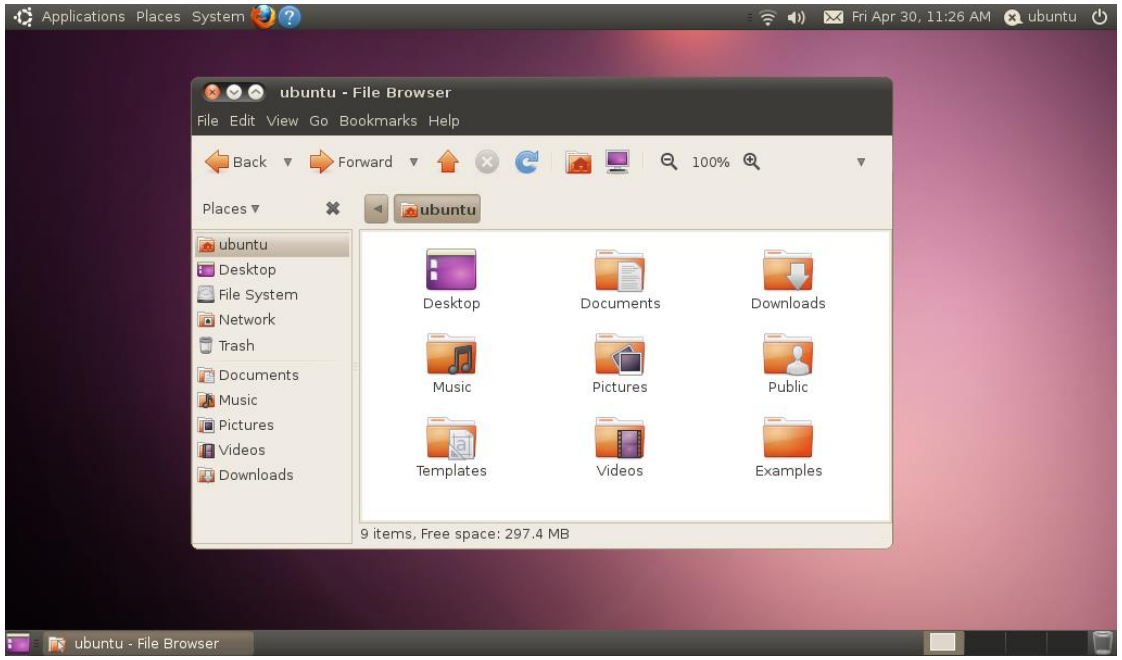
Linux introduced in 1991, is a popular, multitasking UNIX-based operating system that runs on a variety of personal computers, servers, and devices.

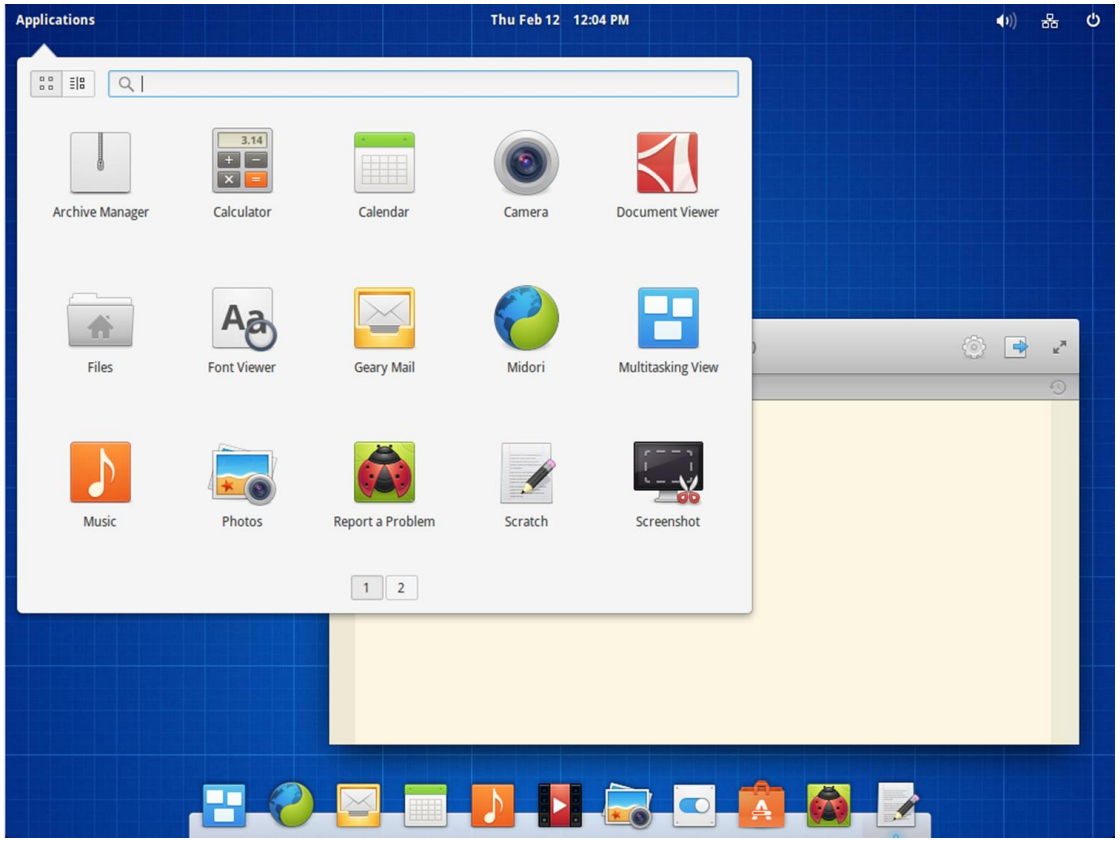
In addition to the basic operating system, Linux also includes many free tools and programming languages.

Linux is not proprietary software like the operating systems discussed thus far. Instead, Linux is **open source software**, which means its code is provided for use, modification, and redistribution.

Many programmers have donated time to modify and redistribute Linux to make it the most popular UNIX-based operating system.

https://th.wikipedia.org/wiki/%E0%B8%A5%E0%B8%B4%E0%B8%99%E0%B8%B8%E0%B8%81%E0%B8%8B%E0%B9%8C


Applications Places System
Fri Apr 30, 11:26 AM ubuntu
ubuntu - File Browser
File Edit View Go Bookmarks Help
Back Forward 100%
Places
ubuntu
ubuntu
Desktop
File System
Network
Trash
Documents
Music
Pictures
Videos
Downloads
Desktop
Documents
Downloads
Music
Pictures
Public
Templates
Videos
Examples
9 items, Free space: 297.4 MB
ubuntu - File Browser


Applications
Thu Feb 12 12:04 PM
Archive Manager
Calculator
Calendar
Camera
Document Viewer
Files
Font Viewer
Geary Mail
Midori
Multitasking View
Music
Photos
Report a Problem
Scratch
Screenshot
1
2

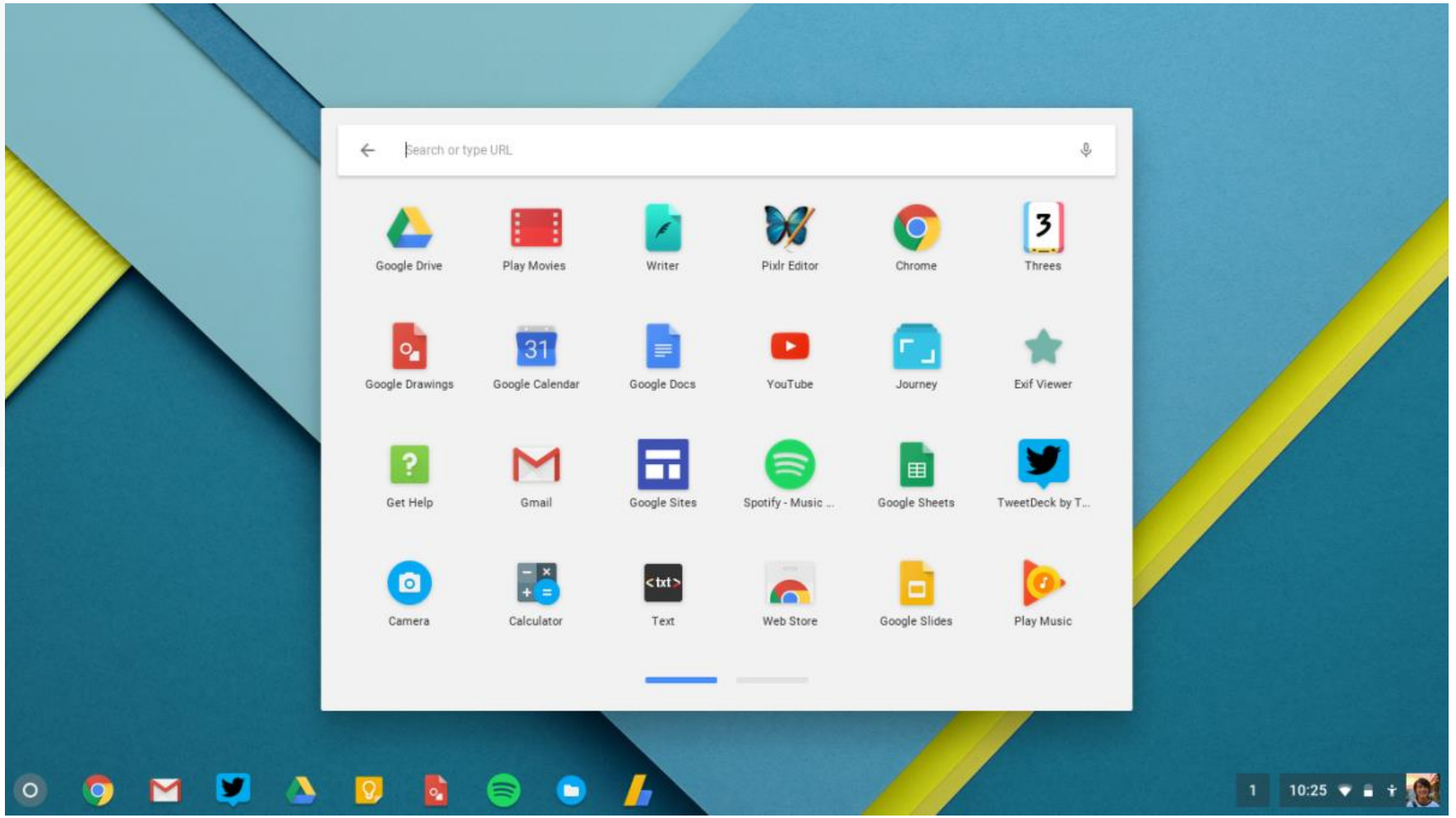
Chrome OS

Chrome OS, introduced by Google, is a Linux-based operating system designed to work primarily with web apps. Apps are available through the Chrome Web Store, and data is stored on Google Drive.

A specialized laptop that runs Chrome OS is called a **Chromebook**, and a specialized desktop that runs Chrome OS is called a **Chromebox**.

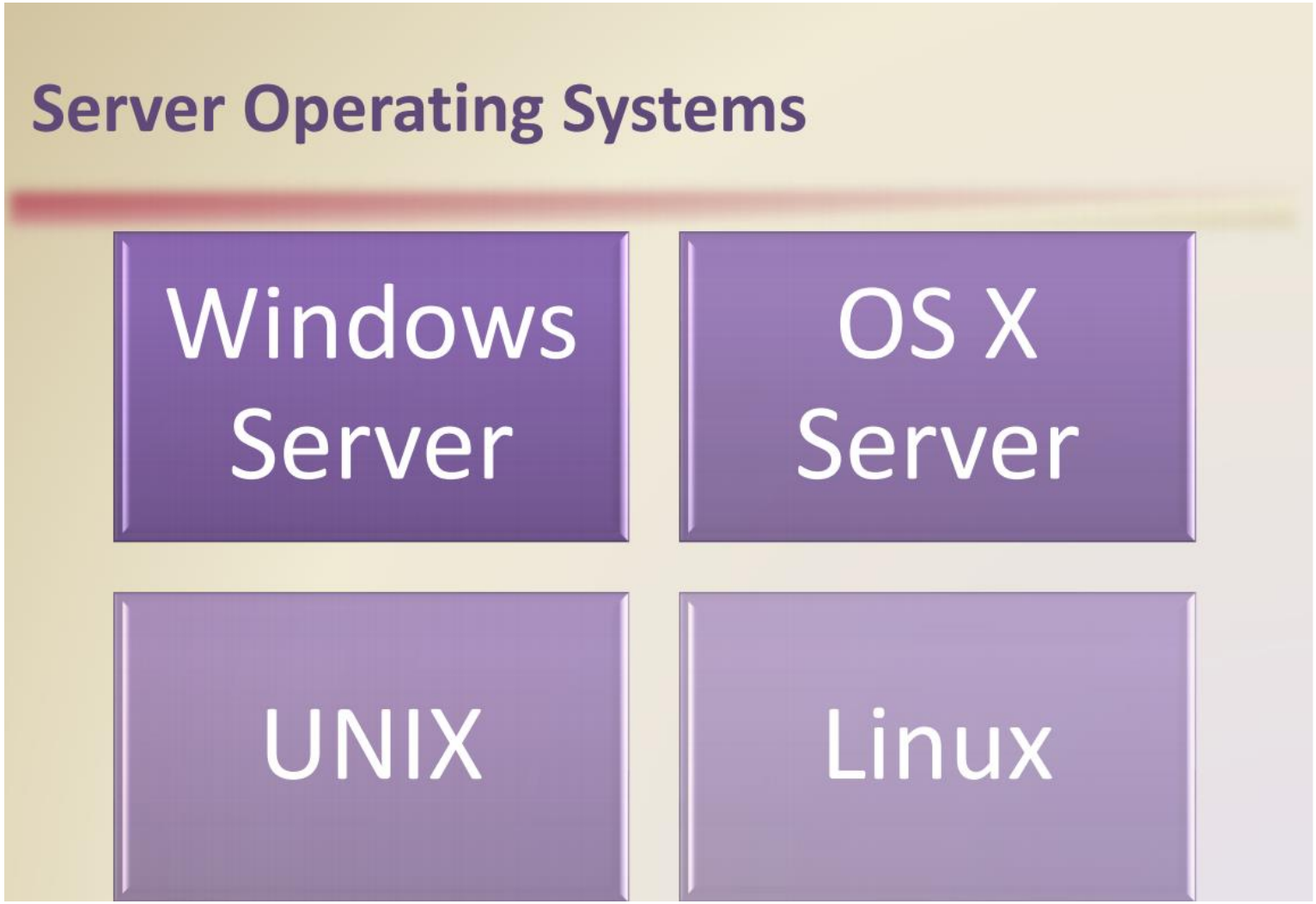
Chromebooks and Chromeboxes typically use SSDs for internal storage. Because computers running Chrome OS work mostly with web apps, they do not require as much internal storage capacity as other desktop operating systems

มี Service ของ Google เป็นส่วนใหญ่



https://www.google.com/chromebook/chrome-os/

A server operating system is a multiuser operating system that organizes and coordinates how multiple users access and share resources on a network.



Mobile Operating Systems

Linux based

Figure 9-17 An Android phone and tablet.

Android

Android is an open source, Linux-based mobile operating system designed by Google for smartphones and tablets (Figure 9-17). A variety of manufacturers produce devices that run the Android operating system, adding their own interface elements and bundled software. As a result, an Android smartphone manufactured by Samsung may have different user interface features from one manufactured by Google.

Features unique to recent versions of the Android operating system include the following:

- *Google Play* app store provides access to apps, songs, books, and movies.
- *Google Drive* provides access to email, contacts, calendar, photos, files, and more.
- Face recognition or fingerprint scanner can unlock the device.
- Share contacts and other information by touching two devices together (using NFC technology).
- Speech output assists users with vision impairments.
- Voice recognition capability enables users to speak instructions.
- Built-in heart rate monitor works with phone apps.

Name	Internal codename	Version number(s)	Initial stable release date	Supported (security fixes)	API level
Android 1.0	N/A	1.0	September 23, 2008	No	1
Android 1.1	Petit Four	1.1	February 9, 2009	No	2
Android Cupcake	Cupcake	1.5	April 27, 2009	No	3
Android Donut	Donut	1.6	September 15, 2009	No	4
Android Eclair	Eclair	2.0	October 27, 2009	No	5
		2.0.1	December 3, 2009	No	6
		2.1	January 11, 2010	No	7
Android Froyo	Froyo	2.2 – 2.2.3	May 20, 2010	No	8
Android Gingerbread	Gingerbread	2.3 – 2.3.2	December 6, 2010	No	9
		2.3.3 - 2.3.7	February 9, 2011	No	10
Android Honeycomb	Honeycomb	3.0	February 22, 2011	No	11
		3.1	May 10, 2011	No	12
		3.2 - 3.2.6	July 15, 2011	No	13
Android Ice Cream Sandwich	Ice Cream Sandwich	4.0 – 4.0.2	October 18, 2011	No	14
		4.0.3 - 4.0.4	December 16, 2011	No	15
Android Jelly Bean	Jelly Bean	4.1 – 4.1.2	July 9, 2012	No	16
		4.2 - 4.2.2	November 13, 2012	No	17
		4.3 - 4.3.1	July 24, 2013	No	18
Android KitKat	Key Lime Pie	4.4 – 4.4.4	October 31, 2013	No	19
		4.4W - 4.4W.2	June 25, 2014	No	20
Android Lollipop	Lemon Meringue Pie	5.0 – 5.0.2	November 4, 2014	No	21
		5.1 - 5.1.1	March 2, 2015	No	22
Android Marshmallow	Macadamia Nut Cookie	6.0 – 6.0.1	October 2, 2015	No	23
Android Nougat	New York Cheesecake	7.0	August 22, 2016	No	24
		7.1 - 7.1.2	October 4, 2016	No	25
Android Oreo	Oatmeal Cookie	8.0	August 21, 2017	No	26
		8.1	December 5, 2017	Yes	27
Android Pie		9	August 6, 2018	Yes	28
Android 10	Quince Tart	10	September 3, 2019	Yes	29
Android 11	Red Velvet Cake	11	September 8, 2020	Yes	30
Android 12	Snow Cone	12	October 4, 2021	Yes	31

Android Oreo	Oatmeal Cookie	8.0	26	August 21, 2017	January 2021
		8.1	27	December 5, 2017	October 2021
Android Pie	Pistachio Ice Cream[20]	9	28	August 6, 2018	January 2022
Android 10	Quince Tart[21]	10	29	September 3, 2019	October 2022
Android 11	Red Velvet Cake[21]	11	30	September 8, 2020	
Android 12	Snow Cone	12	31	October 4, 2021	
Android 12L	Snow Cone v2	12.1[a]	32	March 7, 2022	
Android 13	Tiramisu[23]	**13**	33	August 15, 2022	
Android 14	Upside Down Cake[24]	14	34	Q3 2023	—

Legend: Old version | Older version, still maintained | **Latest version** | Future release

Andriod 15 Vanilla Ice Cream

ตีรามีซู (อิตาลี: *tiramisù*, แปลตามตัวอักษรว่า "ดึงฉันขึ้นไปซิ" หรือ "พาฉันขึ้นไปซิ" โดยปริยายหมายถึง "ทำให้ฉันมีแรง (กายหรือใจ) ซิ" หรือ "ทำให้ฉันตื่นตัวซิ")
เป็น ขนมอิตาลีที่มีเอกลักษณ์เป็นการใช้กาแฟมาเป็นส่วนผสมหลัก (wikipedia)

Figure 9-18 An iOS phone and tablet.

iOS

iOS (originally called iPhone OS), developed by Apple, is a proprietary mobile operating system specifically made for Apple's mobile devices (Figure 9-18). Supported devices include the iPhone, iPod Touch, and iPad. Features unique to recent versions of the iOS operating system include the following:

- *Siri*, a voice recognition app, enables you to speak instructions or questions to which it takes actions or responds with speech output.
- Apple Pay provides a centralized, secure location for credit and debit cards, coupons, boarding passes, loyalty cards, and mobile payment accounts.
- iCloud enables you to sync mail, calendars, contacts, and other items.
- *iTunes Store* provides access to music, books, podcasts, ringtones, and movies.
- Integrates with iPod to play music, video, and other media.
- Improves connectivity with other devices running the Mac operating system.
- Mac App Store provides access to additional apps and software updates.

iOS 搭載 iPhone

搭載 iPad

Source: Apple Inc.

Source: Apple Inc.

Windows Phone

Windows Phone, developed by Microsoft, is a proprietary mobile operating system that runs on some smartphones (Figure 9-19). Features unique to recent versions of the Windows Phone operating system include the following:

- Sync photos, files, and settings with OneDrive.
- Use your phone as a remote control for your television.
- Access a global catalog of music, videos, or podcasts, or listen to iTunes music.
- Geofencing enables your phone to send or receive notification when you enter or exit a geographic location. (Read Ethics & Issues 8-2 in Chapter 8 for other uses of geofencing.)
- *Windows Phone Store* provides access to additional apps and software updates.
- *Wallet* app provides a centralized location for coupons, credit cards, loyalty cards, and memberships in a single, easily accessible location.

Figure 9-19 A Windows Phone.

Windows Phone (**WP**) is a family of discontinued mobile operating systems developed by Microsoft for smartphones as the replacement successor to Windows Mobile and Zune.

Windows Phone featured a new user interface derived from Metro design language.

In January 2019, Microsoft announced that support for Windows 10 Mobile would end on December 10, 2019, and that Windows 10 Mobile users should migrate to iOS or Android phones.

Window Phone ended on December 10, 2019

https://en.wikipedia.org/wiki/Windows_Phone