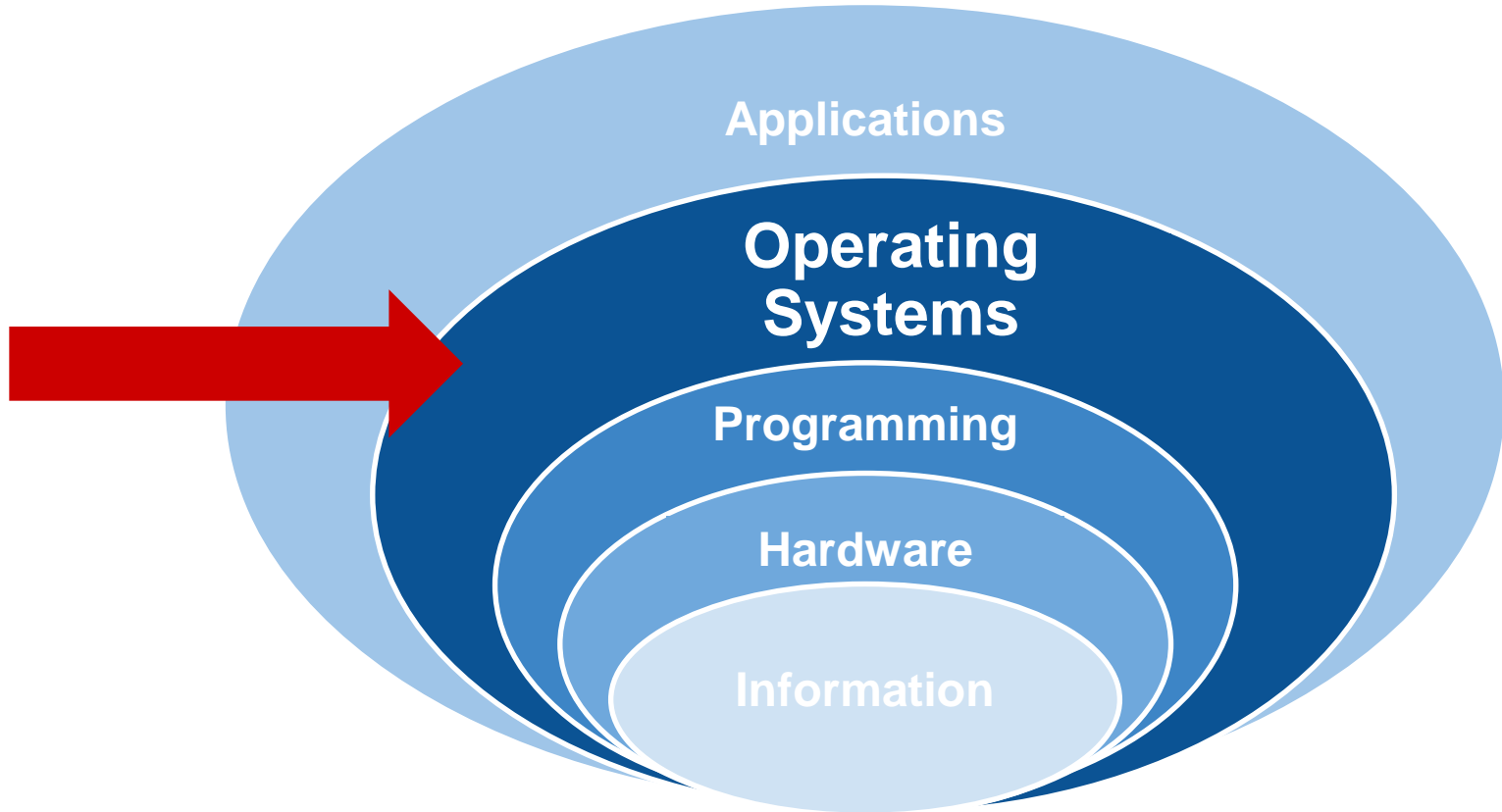


Computer Science Fundamentals

Lecture 6: Operating Systems Layer

Lecturer: Olga Yuqay

Today's focus: Operating Systems



What OS examples do you know?

Examples of Operating System



Agenda

- OS role
- OS architecture

How do OS work? ¹

How do OS work?

¹ ClickView. “How Do Operating Systems Work?” *YouTube*, 24 Sept. 2018, www.youtube.com/watch?v=GjNp0bBrjmU. Accessed 8 Nov. 2019.

OS role

An operating system interacts with many aspects of a computer system

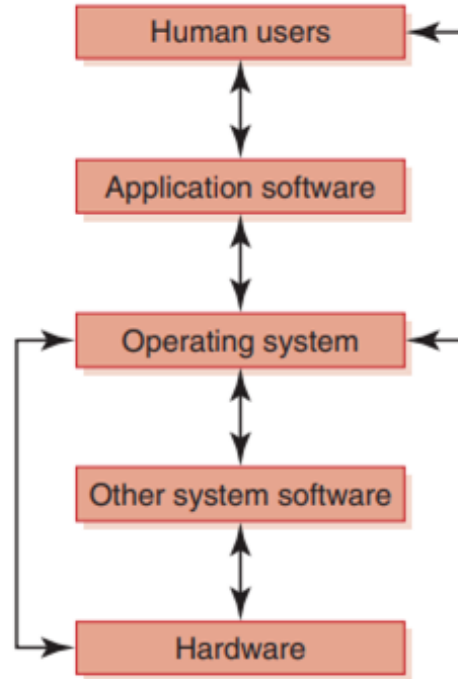
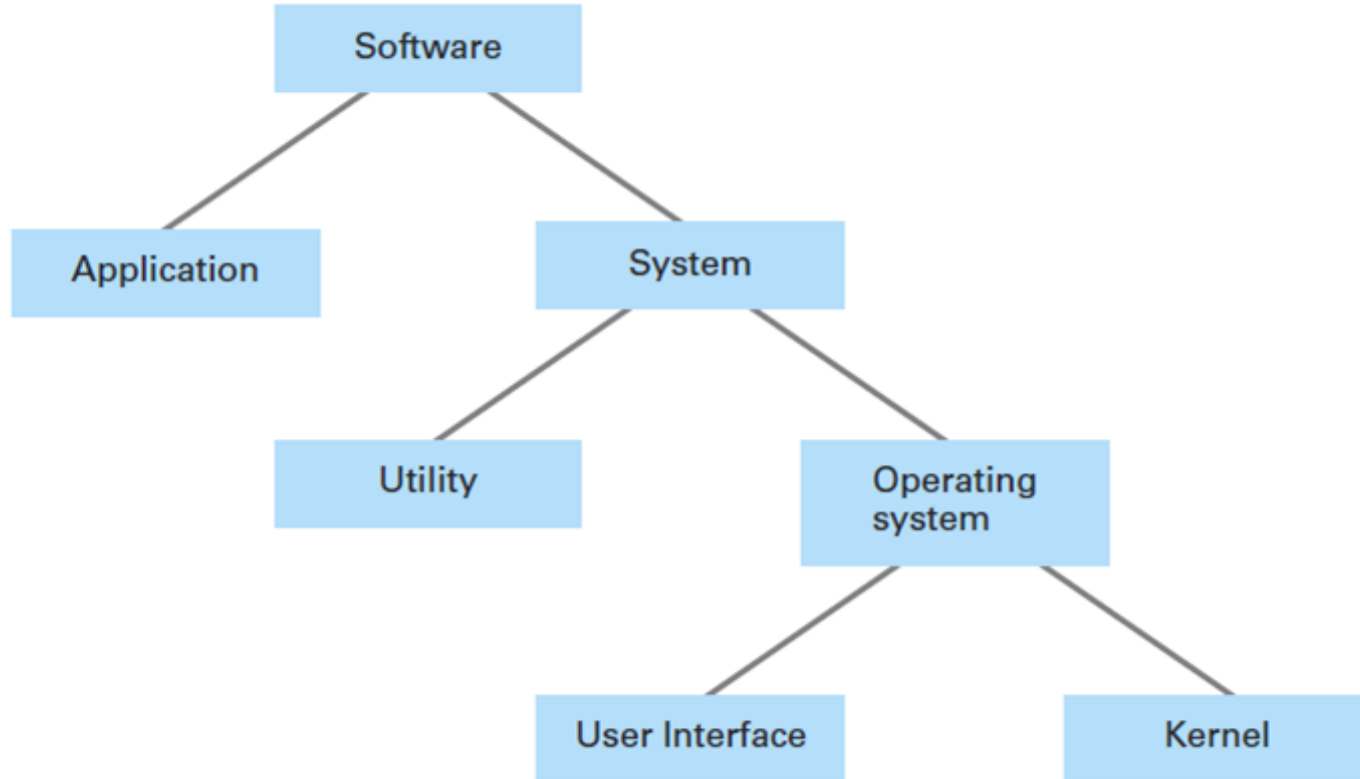


FIGURE 10.1 An operating system interacts with many aspects of a computer system

OS in software hierarchy



Types of software ²

- **Application software**
 - is written to address our specific needs to solve problems in the real world
 - Ex: Word processing programs, games, inventory control systems, automobile, diagnostic programs, and missile guidance programs
- **System software**
 - manages a computer system at a **fundamental** level and interacts **directly with the hardware**
 - provides the **tools and an environment** in which application software can be created and run. (e.g. library of graphics software that renders images on a display)

Types of software ³

- **System software:**

Utility software (antivirus software, backup software and disk tools), **device drivers** (drivers for keyboards, printers, scanners, digital cameras and external storage devices) and **firmware** (BIOS (Basic Input/Output system) on PC, timing and control systems for washing machines and etc)

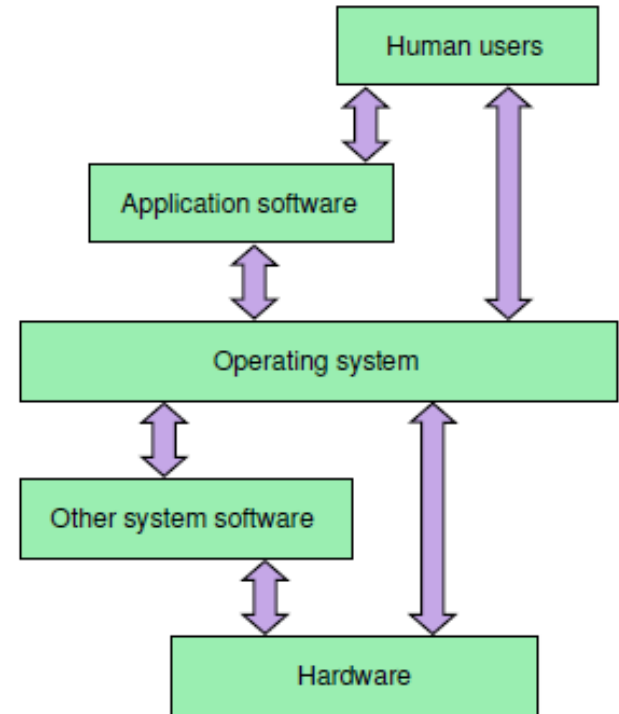
Operating system (the core of system software)

- manages computer resources, such as memory and input/output devices,
- provides an interface through which a human can interact with the computer.

³ Dale, N., & Lewis, J. (2020). Computer Science Illuminated (7th ed.). Jones & Bartlett Learning, Ch 10

What is OS ⁴

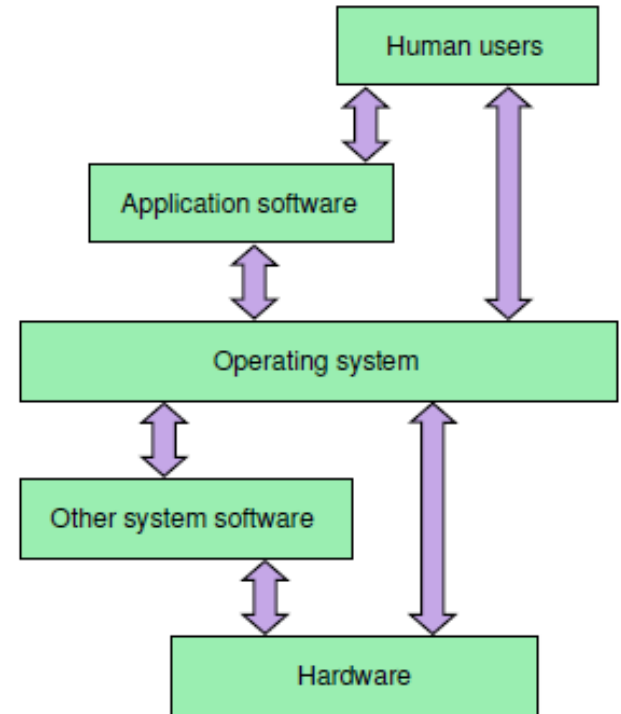
- **glue**
 - that holds the hardware and software together.
- **software foundation**
 - on which all other software rests, allowing us to write programs that interact with the machine.
- **policeman (traffic warden)**
 - an operating system organizes the efficient flow of programs through a computer system.



⁴ Dale, N., & Lewis, J. (2020). Computer Science Illuminated (7th ed.). Jones & Bartlett Learning, Ch 10

OS roles ⁵

- Coordinates access to physical resources
 - CPU, memory, disk, i/o devices, etc.
- Provides services
 - Protection
 - Scheduling
 - Memory management
 - File systems
 - Synchronization
 - etc.



⁵ Dale, N., & Lewis, J. (2020). Computer Science Illuminated (7th ed.). Jones & Bartlett Learning, Ch 10

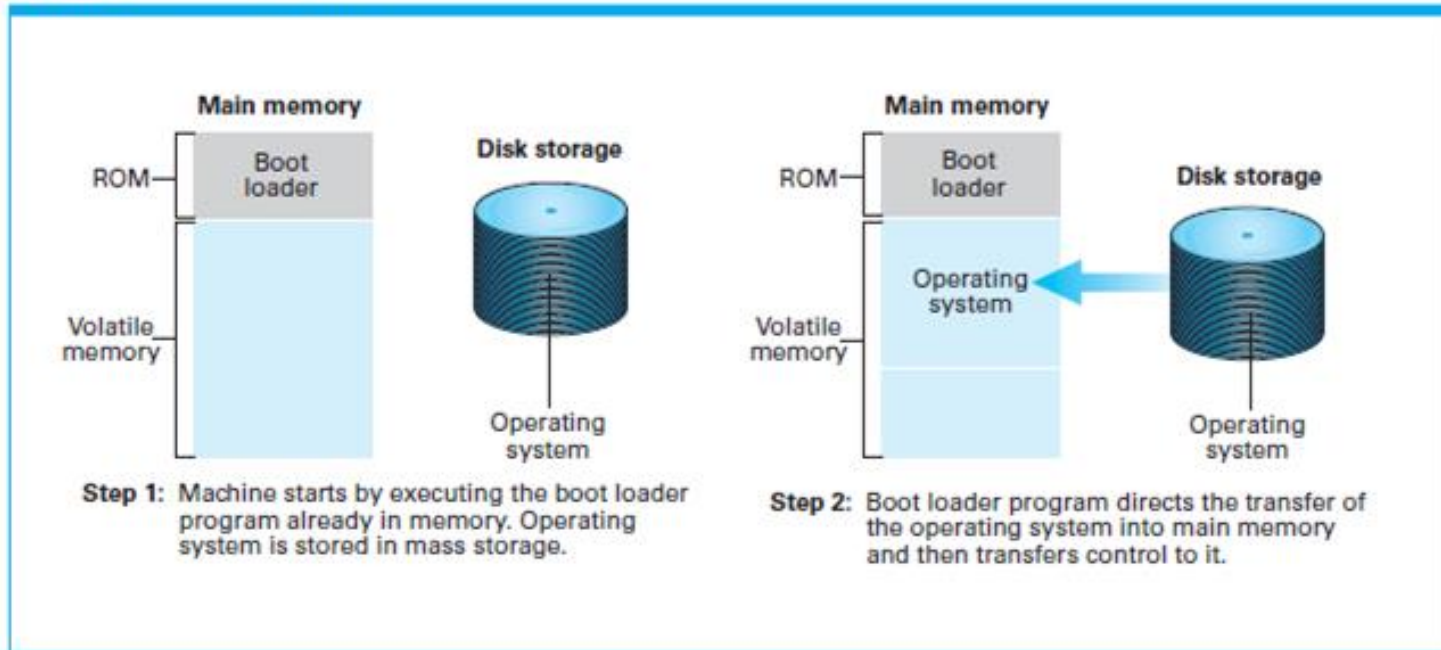
OS as Government ⁶

- Makes lives **easy**
 - Promises everyone a whole machine (dedicated CPU, infinite memory, ...)
 - Provides standardized services (standard libraries, window systems, ...)
- Makes lives **fair**
 - Arbitrates competing resource demands
- Makes lives **safe**
 - Prevents accidental or malicious damage by one program to another

⁶ Dale, N., & Lewis, J. (2020). Computer Science Illuminated (7th ed.). Jones & Bartlett Learning, Ch 10

The booting process ⁷

Figure 3.5 The booting process



Dual-boot or multi-boot ⁸

- Computer could have two or more OS from which user chooses when the computer is turned on
- Only one OS controls the computer at any given time

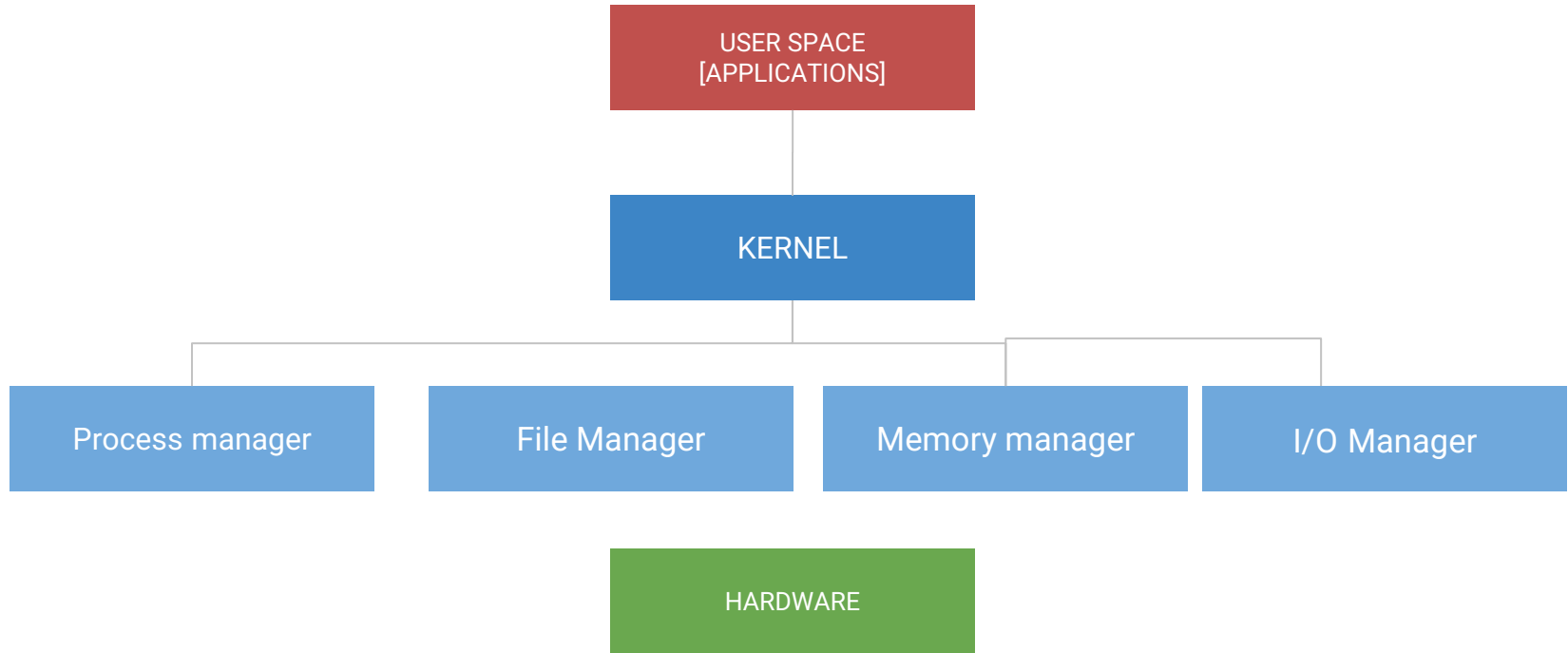
OS Architecture

Recall OS main responsibilities ⁹

- OS has to:
 - manage computer resources
 - provide interface for system interaction
- OS manages **multiprogramming**
 - process management
 - memory management
 - CPU scheduling

⁹ Dale, N., & Lewis, J. (2020). Computer Science Illuminated (7th ed.). Jones & Bartlett Learning, Ch 10

Components of OS



Core functions of OS kernel ¹⁰

Process management

Device management

Memory management

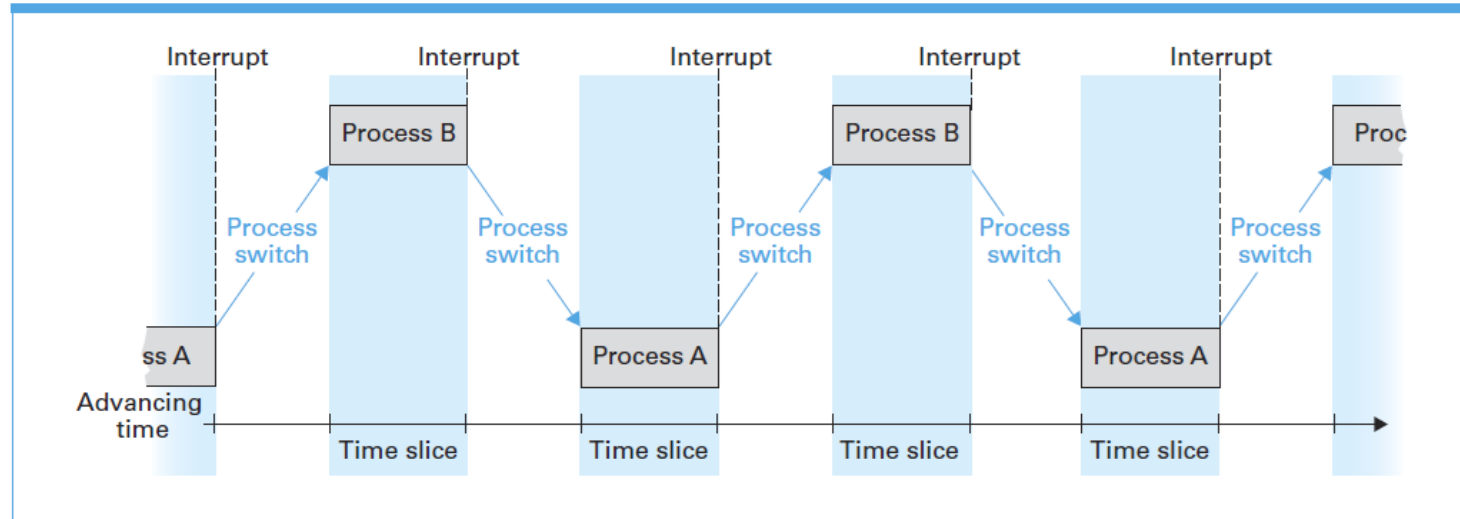
Interrupt handling

I/O communication

What is multiprogramming? ¹¹

- Technique of keeping **multiple** programs in main memory at the same time, competing for the CPU

Figure 3.6 Multiprogramming between process A and process B



¹¹ Dale, N., & Lewis, J. (2020). Computer Science Illuminated (7th ed.). Jones & Bartlett Learning, Ch 10

What is multiprogramming? ¹²

- **Coordinating the Machine's Activities**
- **Some terminology:**
 - **Process** - The activity of executing a program under the control of the OS
 - **Process state** - current status of the activity
- OS manages these processes so that
 - each process has needed resources (peripheral devices, space in main memory, access to files, and access to a CPU)
 - independent processes do not interfere with one another, and that processes that need to exchange information are able to do so.

Multiprogramming ¹³

- **Memory management** - The act of keeping track of how and where programs are loaded in main memory
- **Process management** - The act of keeping track of information for active processes
- **CPU scheduling** – The act of determining which process in memory is given access to the CPU so that it may execute

Operating System components ¹⁴

- **User interface**
 - Older systems: shell – text based
 - Newer systems: GUI, e.g. Window system
- **Kernel**
 - **File manager** - groups files into directories
 - collection of **device drivers** - programs that let the OS communicate with the computer hardware (E.g. Graphic card, Sound card, Computer printer)
 - **Memory manager** - coordinates the machine's use of main memory.
 - **Scheduler** - determines which activities are to be considered for execution
 - **Dispatcher** - controls the allocation of time to these activities.

User Interface - UI

WIMP

- Windows
- Icons
- Menus
- Pointing device

is the most common combination of these elements in a graphical user interface technology.

These elements are usually embedded in the system by widgets.

User interface



Search



Safari



Messages



Contacts



Calendar



Reminders



FaceTime



iTunes



App Store



Game Center



Notes



Launchpad



Maps



Time Machine



iBooks



System Preferences



Start

User 

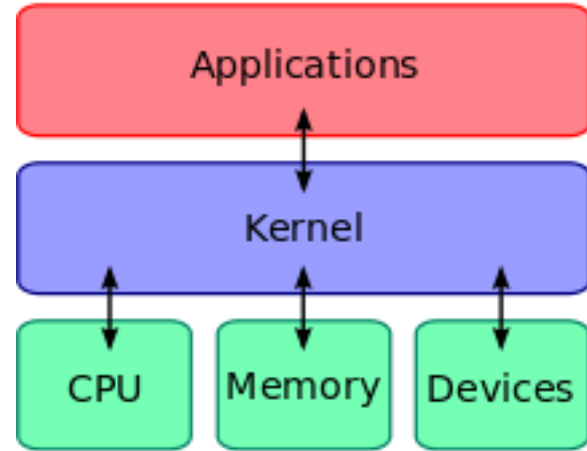


The Start menu displays a grid of application tiles. The tiles are arranged in four rows and two main columns. The first column contains tiles for Scanner, Games, Photos, Calendar, Maps, Internet Explorer, People, Calculator, Weather, Videos, Mail, PC Settings, Reader, Store, Camera, Music, SkyDrive, and Upload Center. The second column contains tiles for Word 2013, OneNote, Excel 2013, Outlook 2013, PowerPoint 2013, Visio 2013, Spreadsheet, and Dashboard. A decorative fish graphic is visible in the top right corner of the background.

 Scanner	 Games	 Photos	 Calendar		 Word 2013	 OneNote	
 Maps	 Internet Explorer	 People	 Calculator	 Weather	 Excel 2013	 Outlook 2013	
 Videos		 Mail		 PC Settings	 Reader	 PowerPoint 2013	 Visio 2013
 Store	 Camera	 Music	 SkyDrive	 Upload Center	 Spreadsheet	 Dashboard	

Kernel ¹⁵

- A **kernel** is the **central** part of an OS.
- It manages the tasks of the computer and the hardware
- A computer user **never interacts directly with the kernel**. Kernel runs behind the scenes and cannot be seen, except for the text logs that it prints.



Kernel: File manager ¹⁶

- maintains
 - records of all the files stored in mass storage
 - file location
 - which users are allowed to access the various files,
 - which portions of mass storage are available for new files or extensions to existing files.
 - **directory** or **folder**
 - **directory path** - A chain of directories within directories
WIUT/Semester2/CSF

Kernel: Device drivers ¹⁷

- **Device drivers** - programs that let OS communicate with the computer hardware (E.g. Graphic card, Sound card, Computer printer)
- Each device driver is **uniquely designed** for its particular type of device (such as a printer, disk drive, or monitor) and **translates** generic requests into the more technical steps required by the device assigned to that driver.

Kernel: Memory manager ¹⁸

- coordinates the machine's use of **main memory**.
- In multiuser or multitasking environments
 - many programs and blocks of data must reside in main memory **concurrently**.
- Memory manager **must find and assign memory space** for these needs and ensure that the actions of each program are restricted to the program's allotted space.
- Moreover, as the needs of different activities come and go, the memory manager **must keep track of those memory areas no longer used**.

Kernel: scheduler and dispatcher ¹⁹

- **scheduler** - determines which activities are to be considered for execution, i.e. scheduled for execution,
- **dispatcher** - controls the allocation of time to these activities.

Recommended actions

- Dale, Computer Science Illuminated, Chapter 10, 11, end of the book exercises
- [Major Operating Systems and historical evolution](#)
- Watch Crash Course computer science series related to OS
 - <https://www.youtube.com/watch?v=26QPDBe-NB8&t=2s>

References

1. Dale, N., & Lewis, J. (2020). Computer Science Illuminated (7th ed.). Jones & Bartlett Learning, Chapter 10, 11
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4. P, The Avinash, and ey. “10 Examples of Operating System | Types of Operating System.” Quick Learn Computer, 14 Jan. 2022, quicklearncomputer.com/examples-of-operating-system-types-of-operating-system/. Accessed 8 June 2022.