Chapter 1: Operating-System Structures

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- Operating System Services
- System Calls
- Types of System Calls
- Operating System Structure
- System Boot

Operating System Services

- *Operating systems provide an environment for the execution of programs and services to programs and users.*

- OS Services provided to the *users* to make their task easier**(U, P, I, F, C,E)**
  - User interface - Almost all operating systems have a user interface (**UI**).
    - ***Command-Line (CLI): a pgm that allows text commands.***
    - ***Graphics User Interface (GUI): use of menus, selections,pointing device to direct I/O.***
    - ***Batch interface: commands are entered into files, files are executed***
  - Program execution - The system must be able to load a program into memory and to run that program, end execution, either normally or abnormally (indicating error).
  - I/O operations - A running program may require I/O, which may involve a file or an I/O device. Users do not directly control I/O, OS must do it.

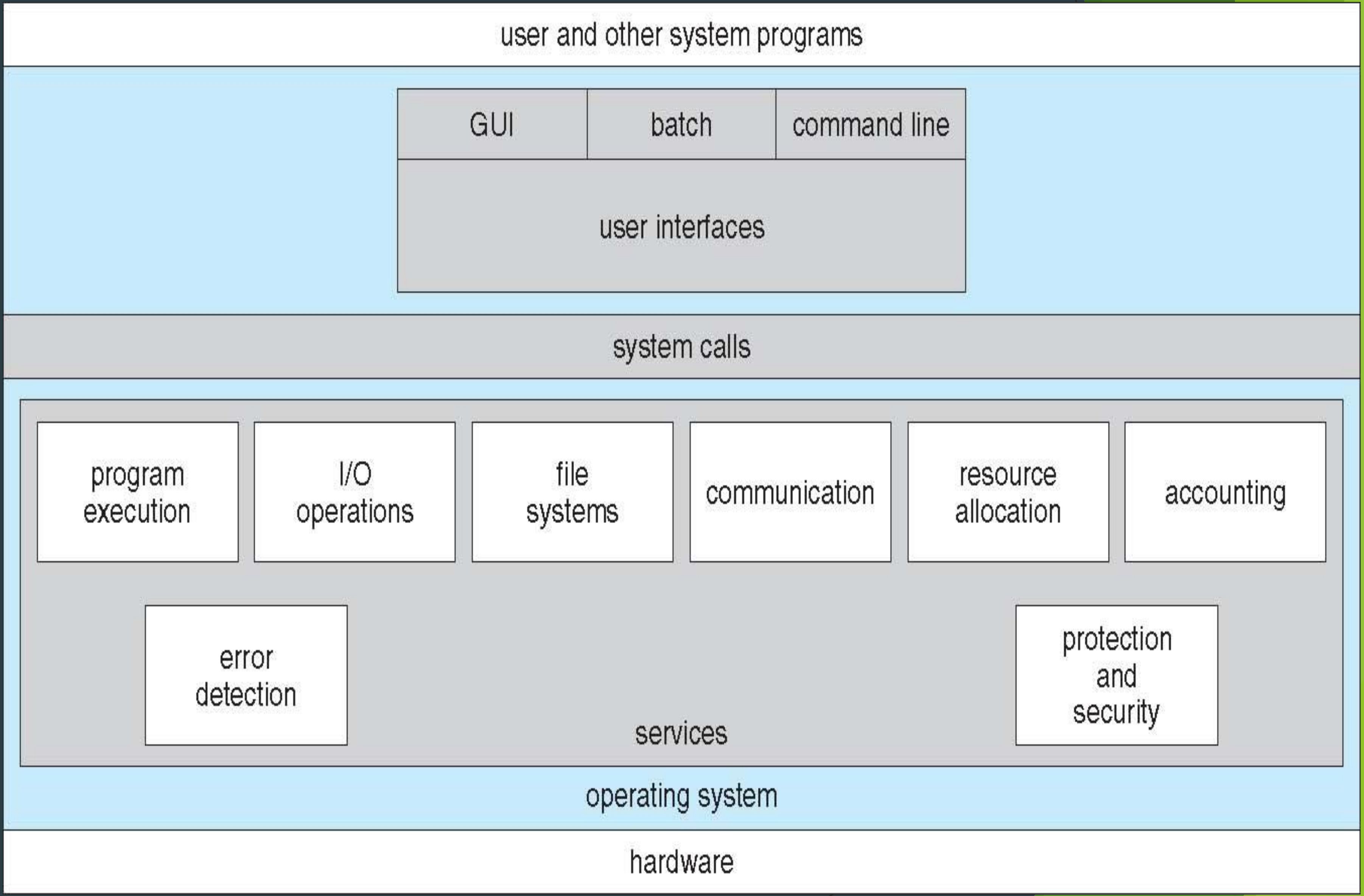
Operating System Services (Cont.)

- One set of operating-system services provides functions that are helpful to the user (Cont.):
  - **File-system manipulation** - Programs need to read and write files and directories, create and delete them, search them, list file Information, and permission management.
  - **Communications** – Processes may exchange information, on the same computer or between computers over a network.
    - Communications may be via shared memory or through message passing (packets moved by the OS).
  - **Error detection** – OS needs to be constantly aware of possible errors
    - May occur in the CPU and memory hardware(memory error/power failure); I/O devices(conn failure in n/w, lack of paper in printer); user program(arithmetic overflow, access illegal memory location, too great use of CPU).
    - For each type of error, the OS should take the appropriate action to ensure correct and consistent computing
    - Debugging facilities can enhance -the user's and programmer's abilities to efficiently use the system.

Operating System Services (Cont.)

- OS functions ***to ensure the efficient operation of the system itself*** RAP
  - Resource allocation - When multiple users or multiple jobs running concurrently, resources must be allocated to each of them
    - Many types of resources - CPU cycles, main memory, file storage, I/O devices.
  - Accounting - To keep track of which users use how much and what kinds of computer resources
  - Protection and security - The owners of information stored in a multiuser or networked computer system may want to control use of that information, concurrent processes should not interfere with each other
    - **Protection** involves ensuring that all access to system resources is controlled
    - **Security** of the system from outsiders requires user authentication, and extends to defending external I/O devices from invalid access attempts Resource-sharing

A View of Operating System Services



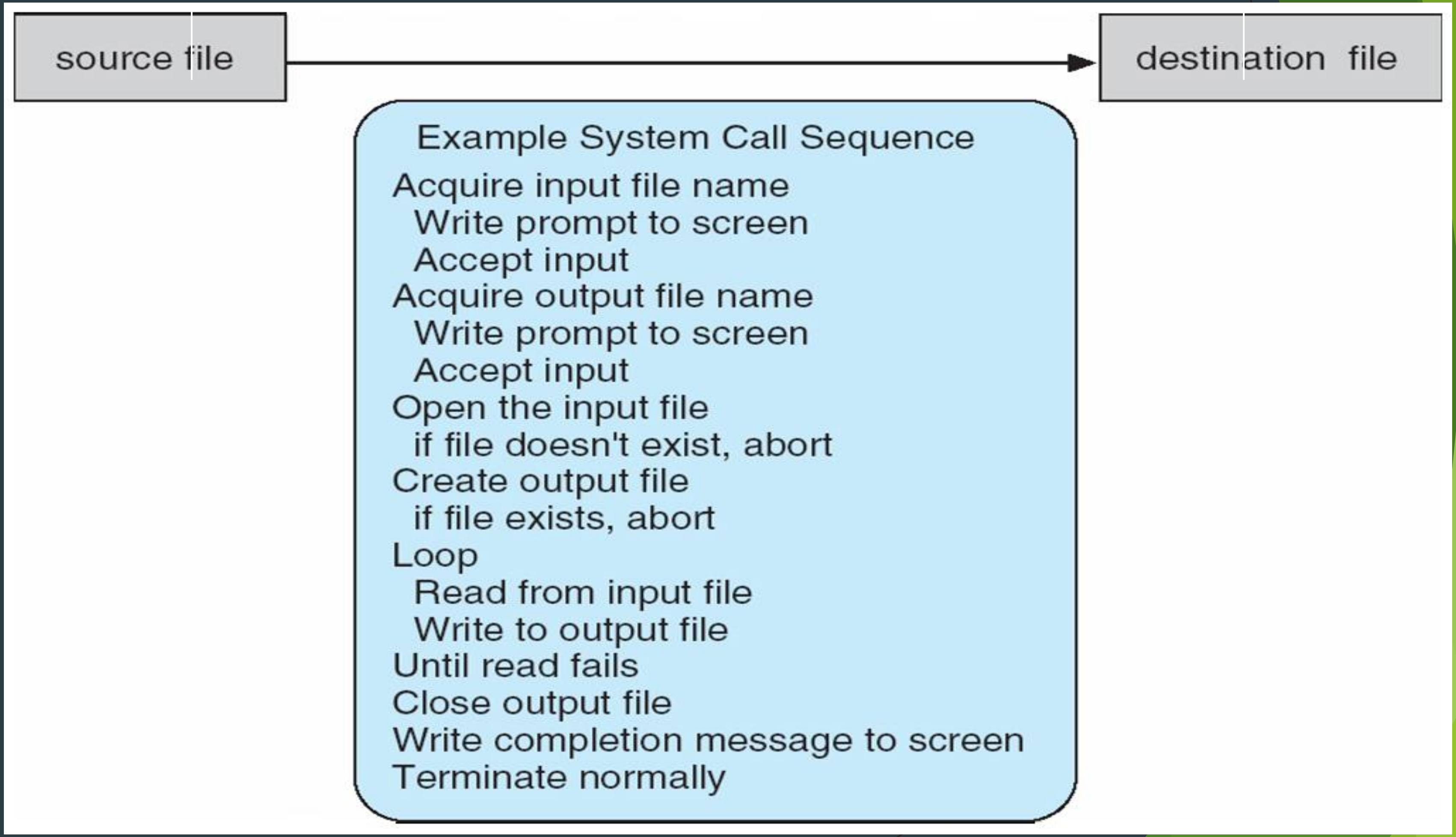
System Calls

- Programming interface to the services provided by the OS.
- Typically written in a high-level language (C or C++).
- Mostly accessed by programs via a high-level **Application Programming Interface (API)** rather than direct system call use.
- The three most common APIs are :
- Win32 API for Windows,
- POSIX API for POSIX-based systems (including virtually all versions of UNIX, Linux, and Mac OS X),
- Java API for the Java virtual machine (JVM)

Note that the system-call names used throughout this text are generic

Example of System Calls

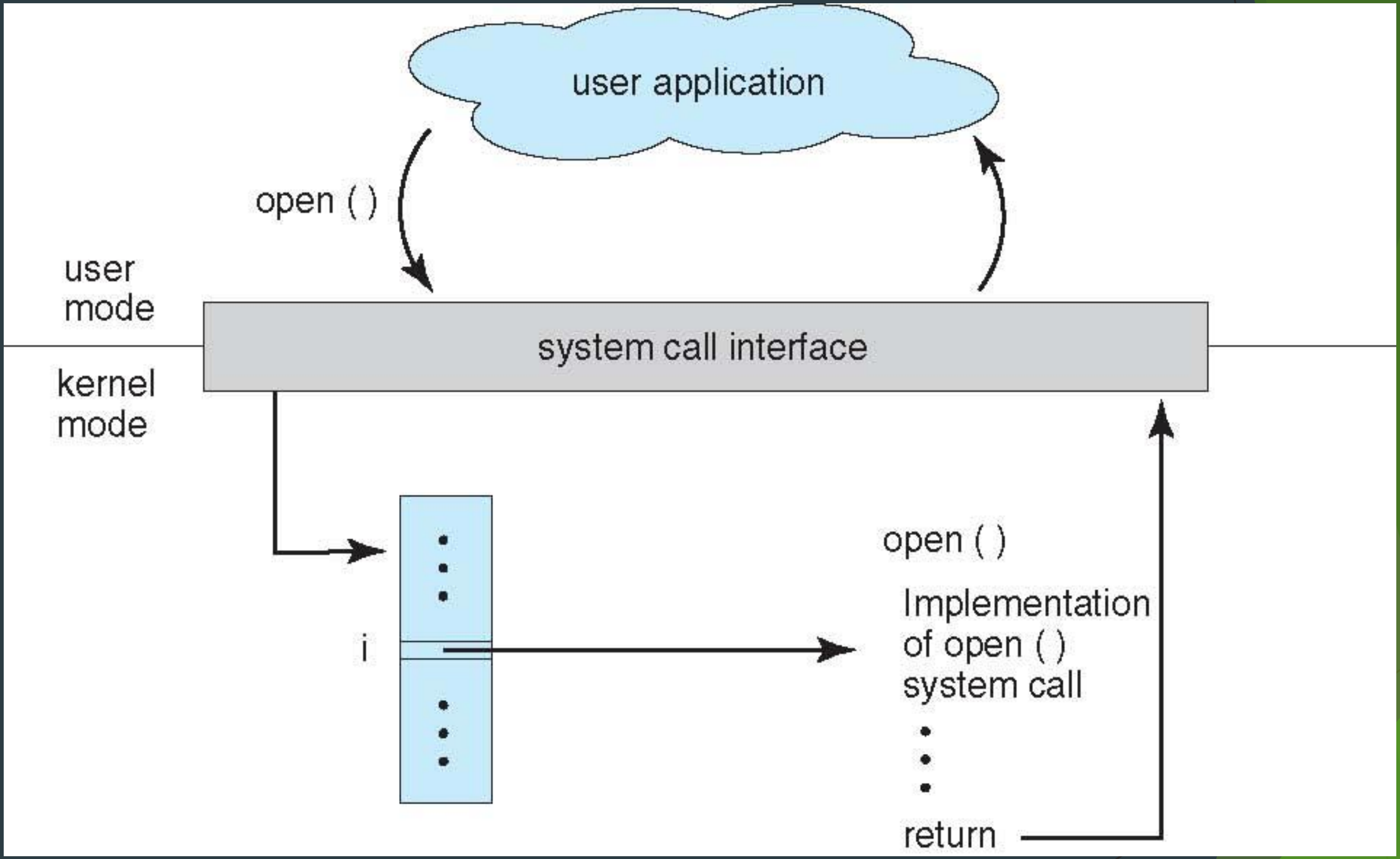
- System call sequence to copy the contents of one file to another file



Example System Call Sequence

```
Acquire input file name
  Write prompt to screen
  Accept input
Acquire output file name
  Write prompt to screen
  Accept input
Open the input file
  if file doesn't exist, abort
Create output file
  if file exists, abort
Loop
  Read from input file
  Write to output file
Until read fails
Close output file
Write completion message to screen
Terminate normally
```

API – System Call – OS Relationship



Types of System Calls

- Process control
  - create process, terminate process
  - end, abort
  - load, execute
  - get process attributes, set process attributes
  - wait for time
  - wait event, signal event
  - allocate and free memory
  - Dump memory if error
  - Debugger for determining bugs, single step execution
  - Locks for managing access to shared data between processes

Types of System Calls

- File management
  - create file, delete file
  - open, close file
  - read, write, reposition
  - get and set file attributes

- Device management
  - request device, release device
  - read, write, reposition
  - get device attributes, set device attributes
  - logically attach or detach devices

Types of System Calls (Cont.)

- Information Maintenance
  - Get time or date, set time or date
  - Get system data, set system data
  - Get and set process, file, or device attributes

- Communications
  - Create, delete communication connection
  - Send, and receive messages if the message passing model to the hostname or process name
    - From client to server
  - Shared-memory model create and gain access to memory regions
  - transfer status information
  - attach and detach remote devices

Types of System Calls (Cont.)

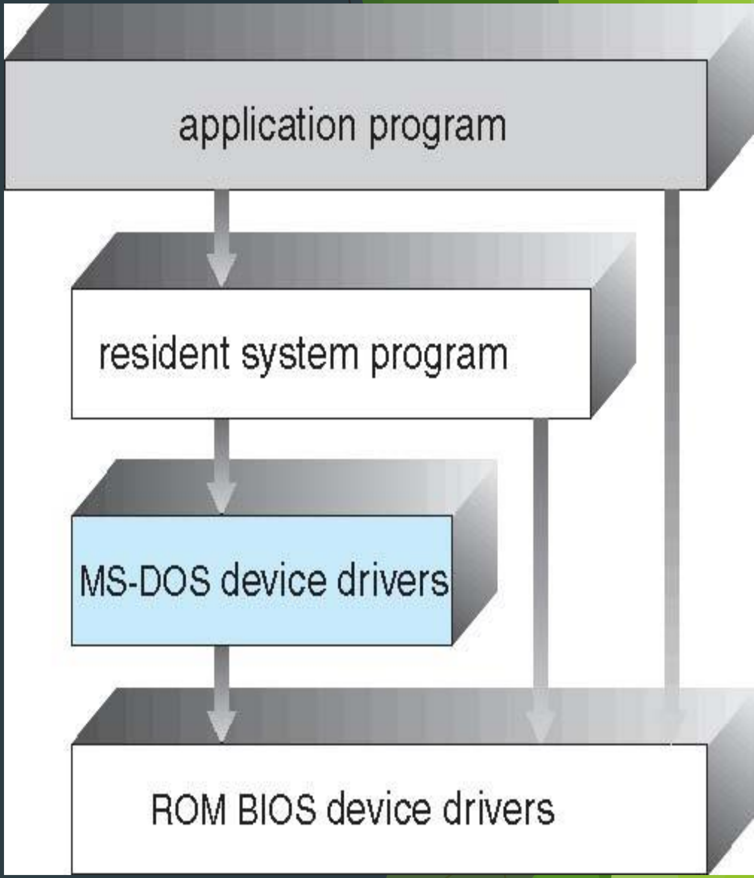
- Protection
  - Control access to resources
  - Get and set permissions
  - Allow and deny user access

Operating System Structure

- General-purpose OS is a very large program
- Various ways to structure one
  - Simple structure – MS-DOS
  - Layered – an abstraction

Simple Structure -- MS-DOS

- MS-DOS – written to provide the most functionality in the least space
  - Not divided into modules
  - Although MS-DOS has some structure, its interfaces and levels of functionality are not well separated
  - It has a monolithic structure.
  - The user programs can directly access the basic I/O routines
  - Hence, if user pgm fails, the system crashes.



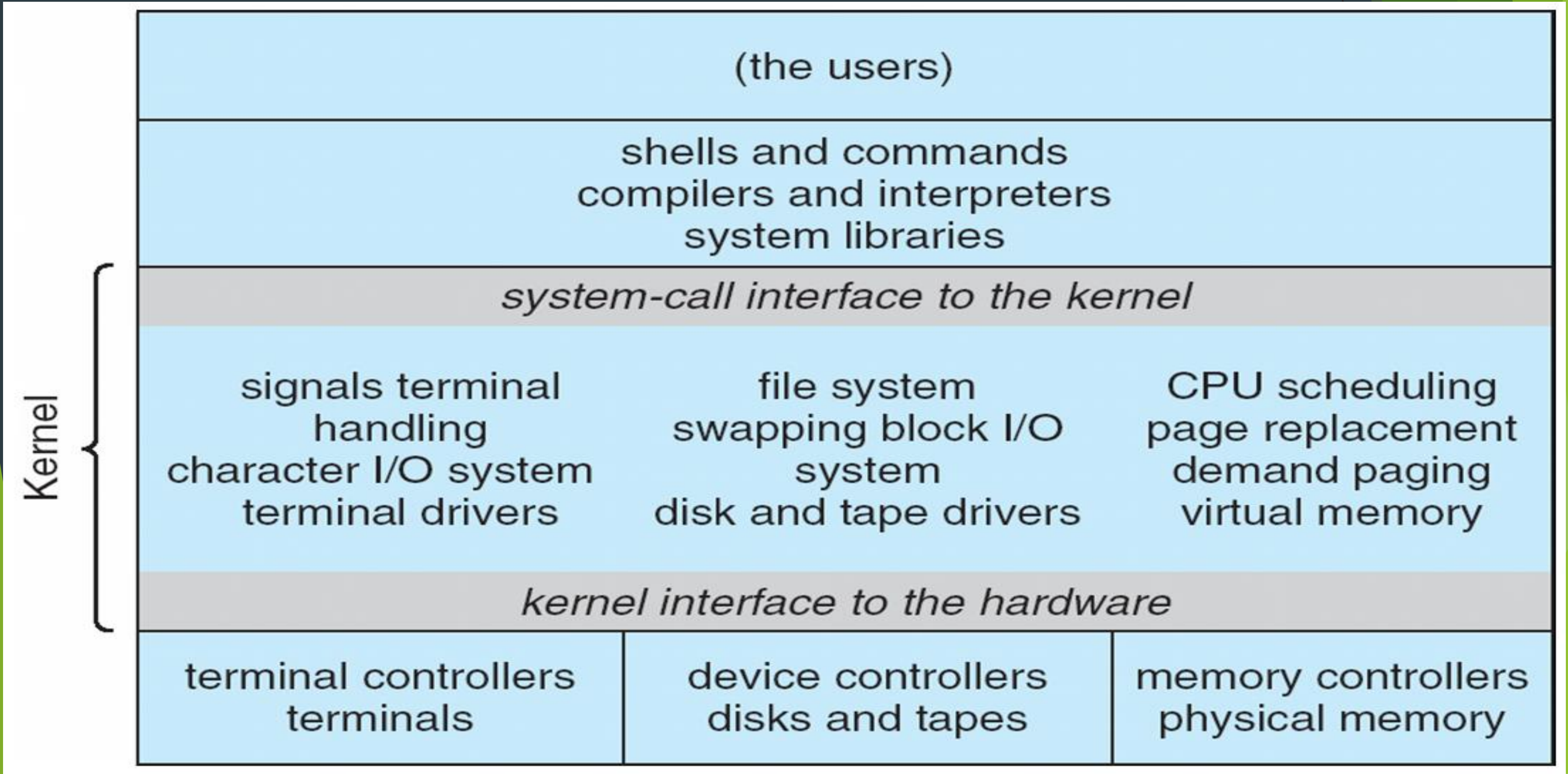
Non Simple Structure -- UNIX

UNIX – limited by hardware functionality, the original UNIX operating system had limited structuring. The UNIX OS consists of two separable parts

- Systems programs
- The kernel
  - Consists of everything below the system-call interface and above the physical hardware
  - Provides the file system, CPU scheduling, memory management, and other operating-system functions; a large number of functions for one level

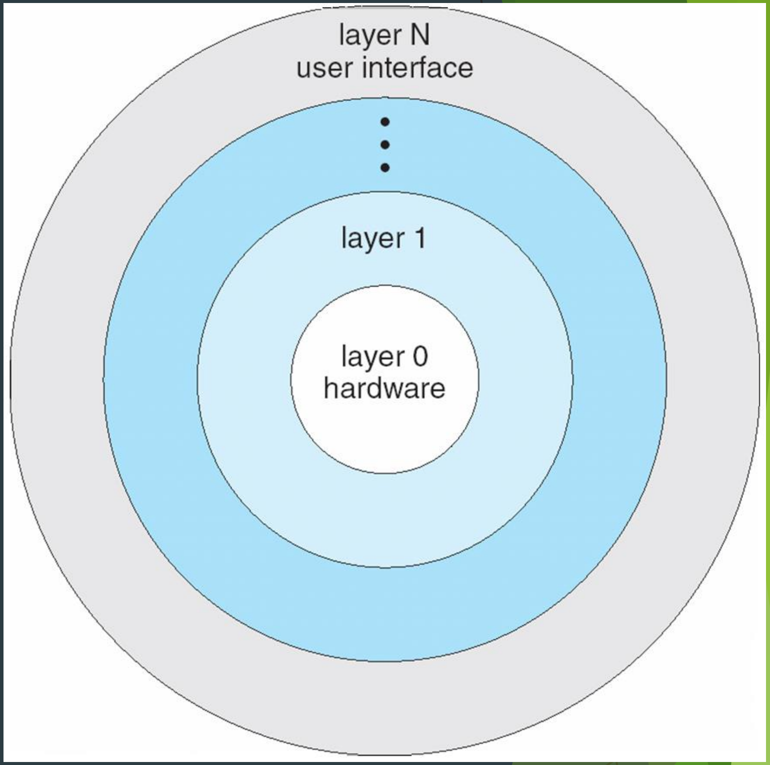
Traditional UNIX System Structure

- Traditional UNIX OS –limited by h/w functionality.
- Consists of 2 parts: the kernel and the system pgms.
- Kernel consists of device drivers and interfaces.
- The layer *below system call interface* and *above physical h/w* is the kernel .
- The kernel functionality is enormous ;difficukt to implement and maintain



Layered Approach

- The operating system is divided into a number of layers (levels), each built on top of lower layers. The bottom layer (layer 0), is the hardware; the highest (layer N) is the user interface.
- With modularity, layers are selected such that each uses functions (operations) and services of only lower-level layers



System Boot

- When power is initialized on the system, execution starts at a fixed memory location
  - Firmware ROM used to hold the initial boot code
- Operating system must be made available to hardware so hardware can start it
  - Small piece of code – **bootstrap loader**, stored in **ROM** or **EEPROM** locates the kernel, loads it into memory, and starts it
  - Sometimes two-step process where the **boot block** at a fixed location is loaded by ROM code, which loads the bootstrap loader from the disk
- Common bootstrap loader, **GRUB**, allows selection of kernel from multiple disks, versions, kernel options
- Kernel loads and the system is then **running**

To be explored:

RAM
ROM
Primary Memory
Cache
Secondary Memory
Firmware
Device Drivers
Disadvantages of the layered approach of OS
Distributed systems
I/O routines