Operating Systems

Outlines

- What are Operating Systems?
- All components Description,
- Types of Operating Systems
  - Multi programming systems,
  - Time sharing systems,
  - Parallel systems,
  - Real Time systems,
  - Distributed systems,
- Virtualization: CPU, memory and device,
- Mobile Operating System

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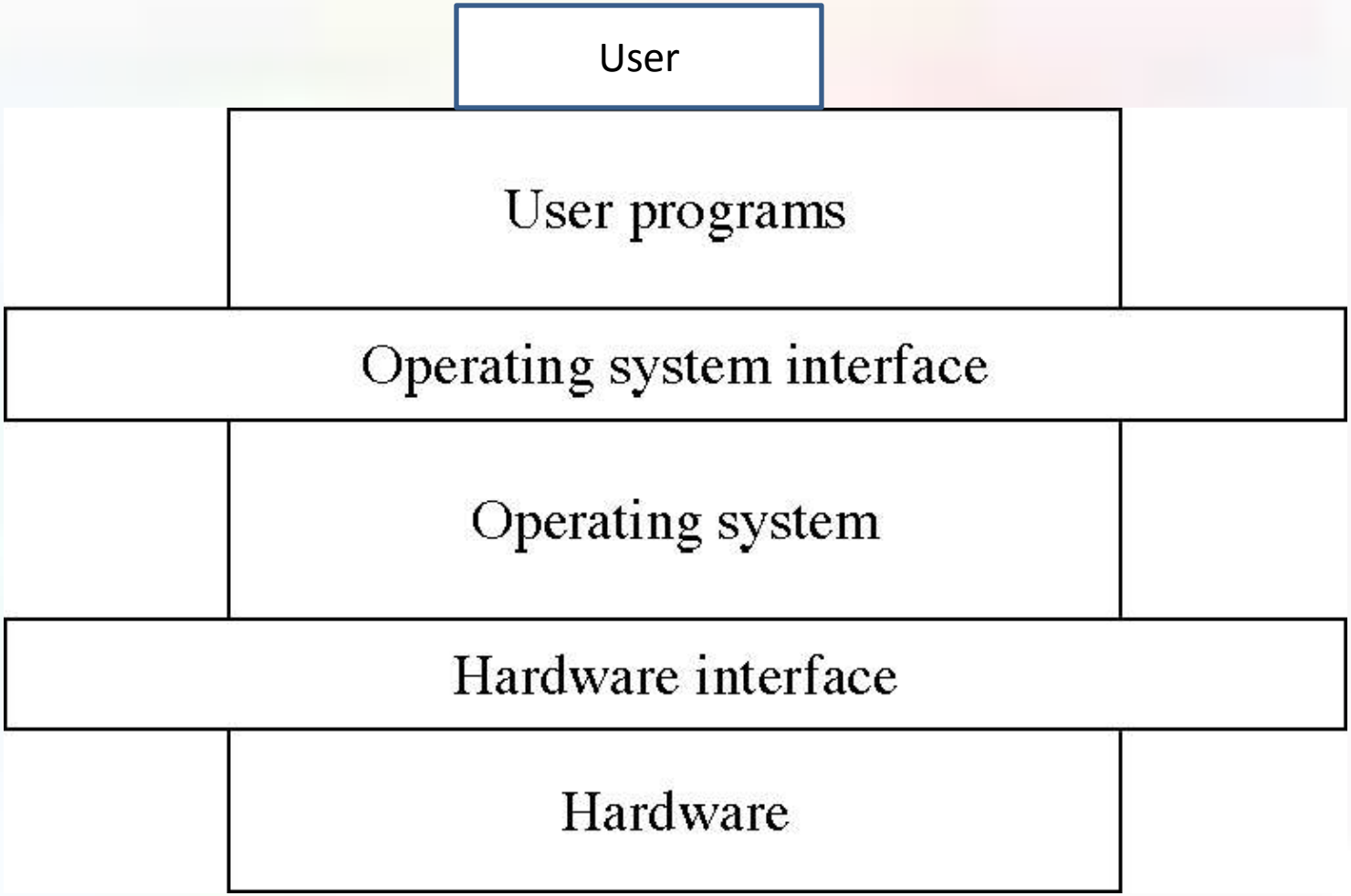
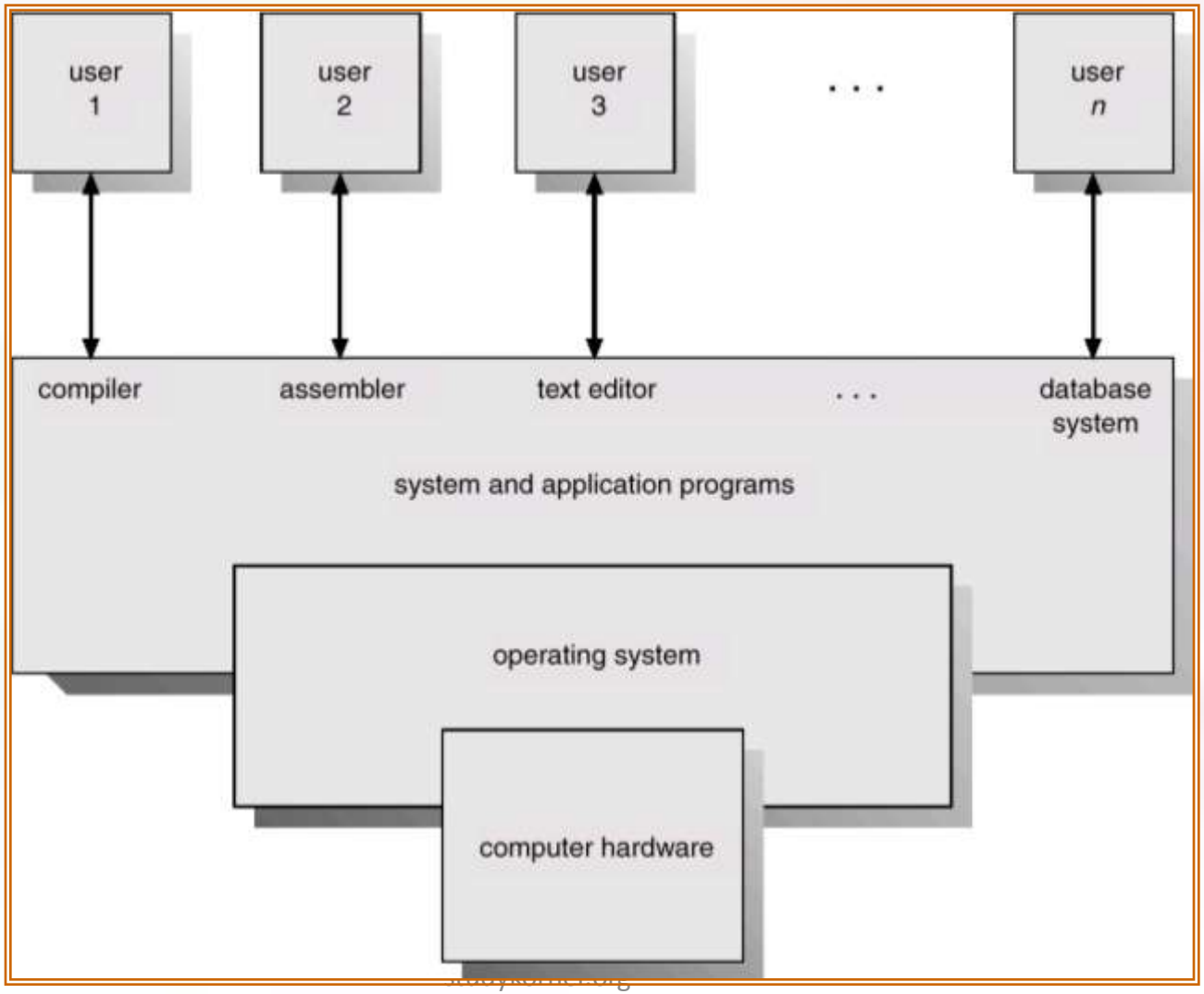
What are Operating Systems?

- "A *program* that controls the execution of application programs and implements an *interface* between the *user* of a computer and the computer *hardware*"
  - Narrow view of a computer and OS
    - Traditional computer with applications running on it (e.g. PCs, Workstations, Servers)
  - Broad view of a computer and OS
    - Anything that needs to manage resources (e.g. router OS, embedded system, cell phone OS ...)

Levels in a computer system



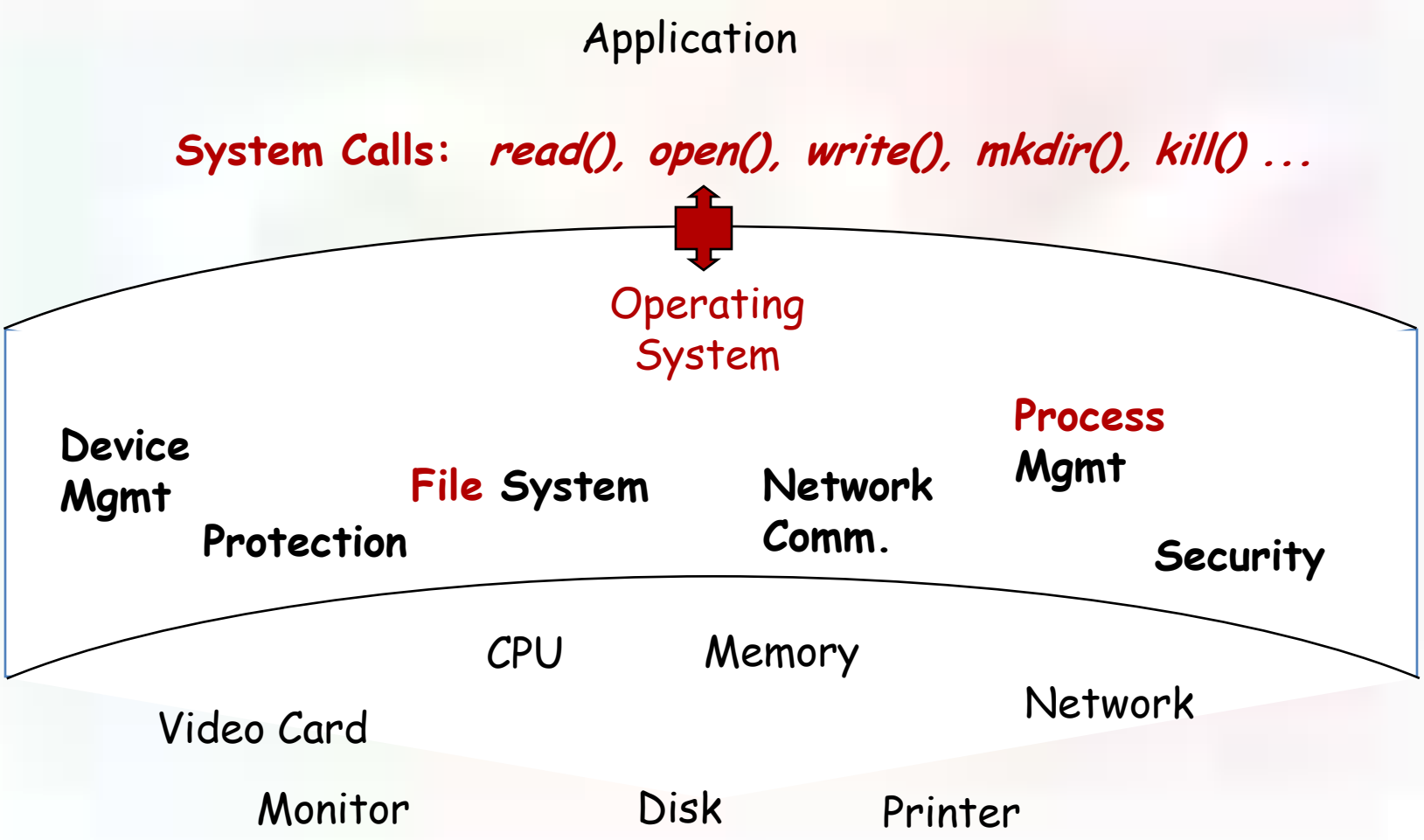
Abstract View of System Components



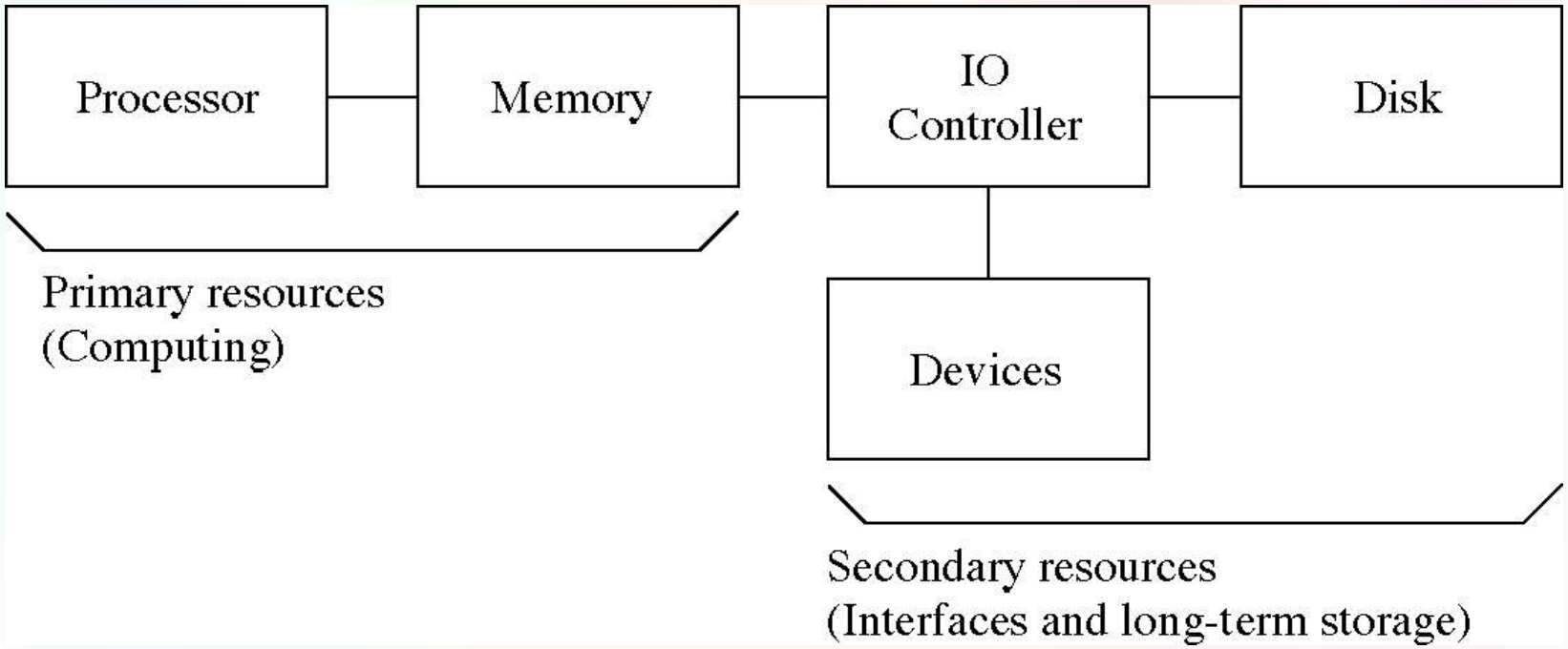
Two key OS functions

- Abstract Machine
  - Hides complex details of the underlying hardware
  - Provides common API to applications and services
  - Simplifies application writing
- Resource Manager
  - Controls (scheduling, multiplexing, transforming etc.) accesses to *shared* resources
    - CPU, memory, disks, network, ...
  - Allows for global policies to be implemented
  - Better utilization of computer hardware

Providing abstraction via system calls



Hardware resources



OS as a resource manager

- Allocating resources to applications across space and time
  - time sharing a resource (scheduling)
  - space sharing a resource (allocation)
- Making efficient use of limited resources
  - improving utilization
  - minimizing overhead
  - improving throughput/good put
- Enforcement of boundaries
  - protecting applications from each other

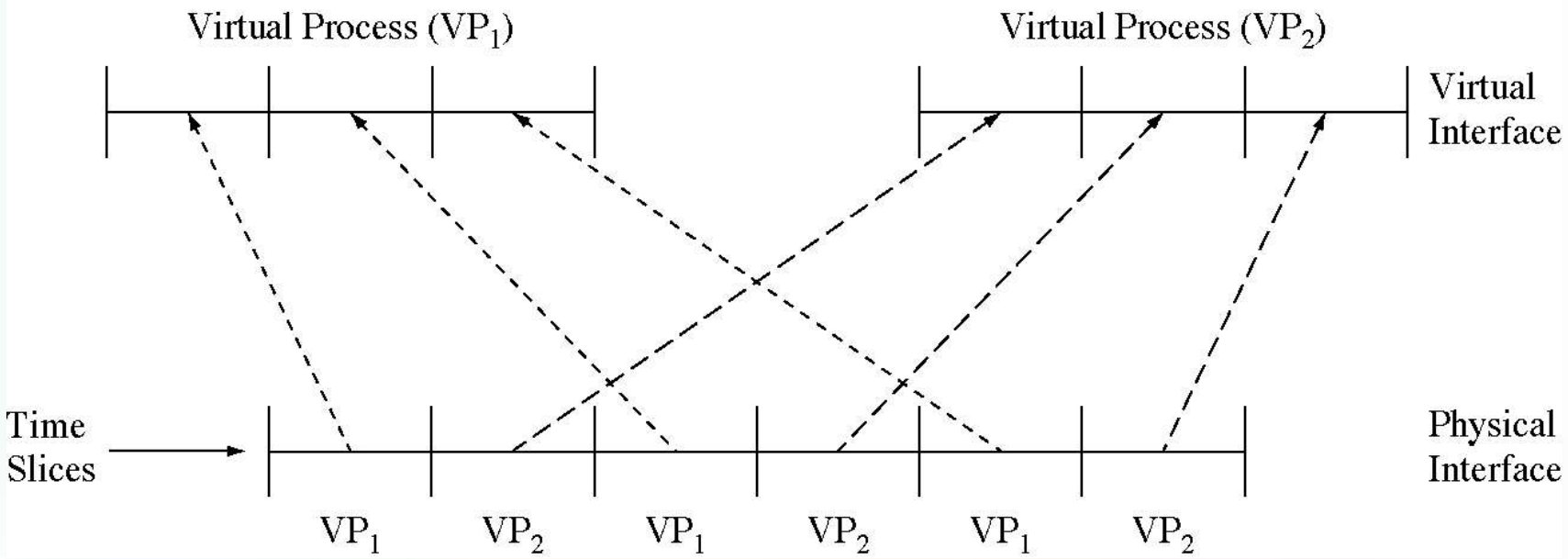
Operating System Definitions

- **Resource allocator** – manages and allocates resources
- **Control program** – controls the execution of user programs and operations of I/O devices
- **Kernel** – lies between software and hardware. The one program running at all times (all else being application programs)

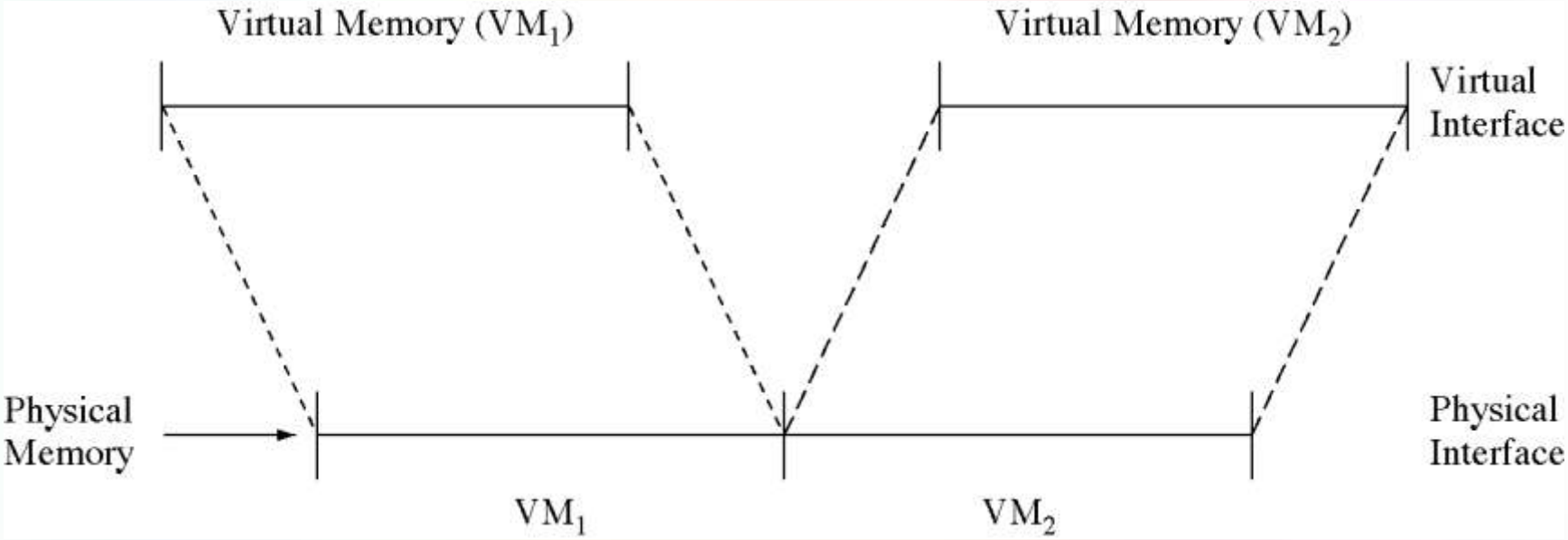
Types of multiplexing

- Time multiplexing
  - time-sharing
  - scheduling a serially-reusable resource among several users
- Space multiplexing
  - space-sharing
  - dividing a multiple-use resource up among several users

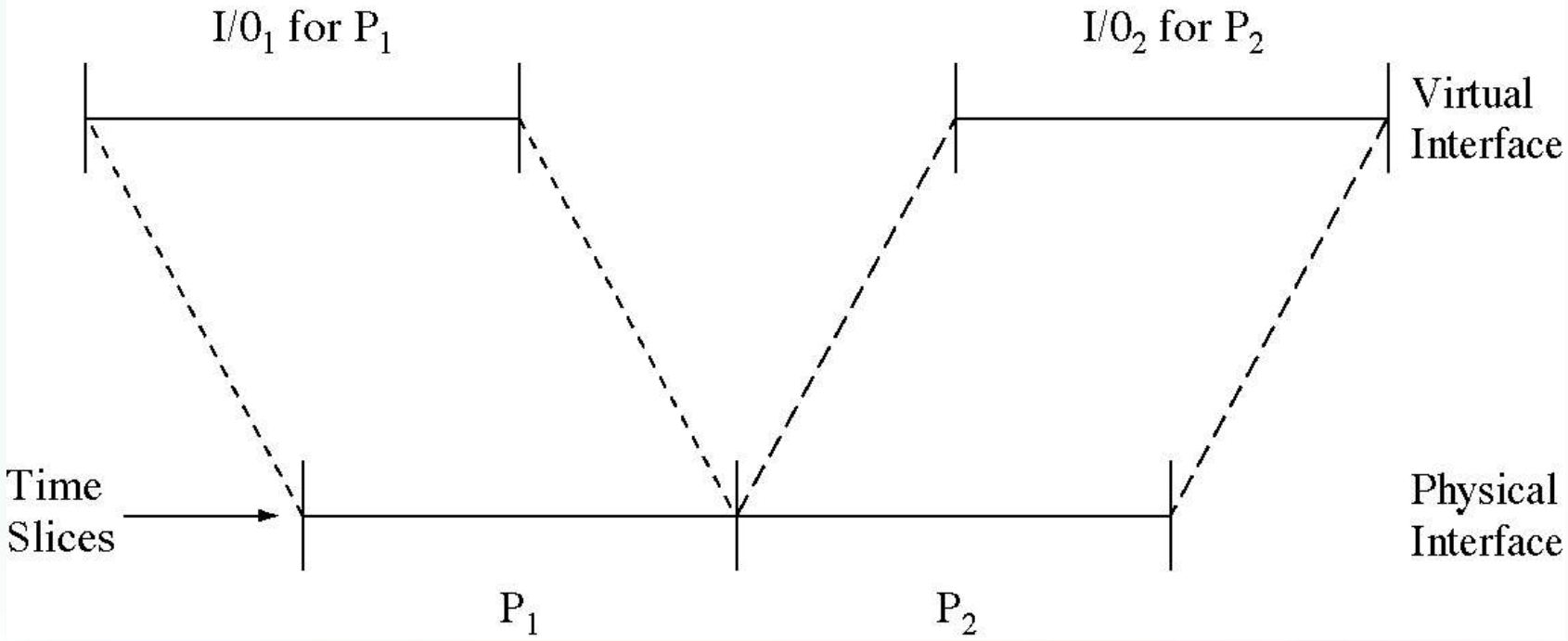
Time-multiplexing the processor



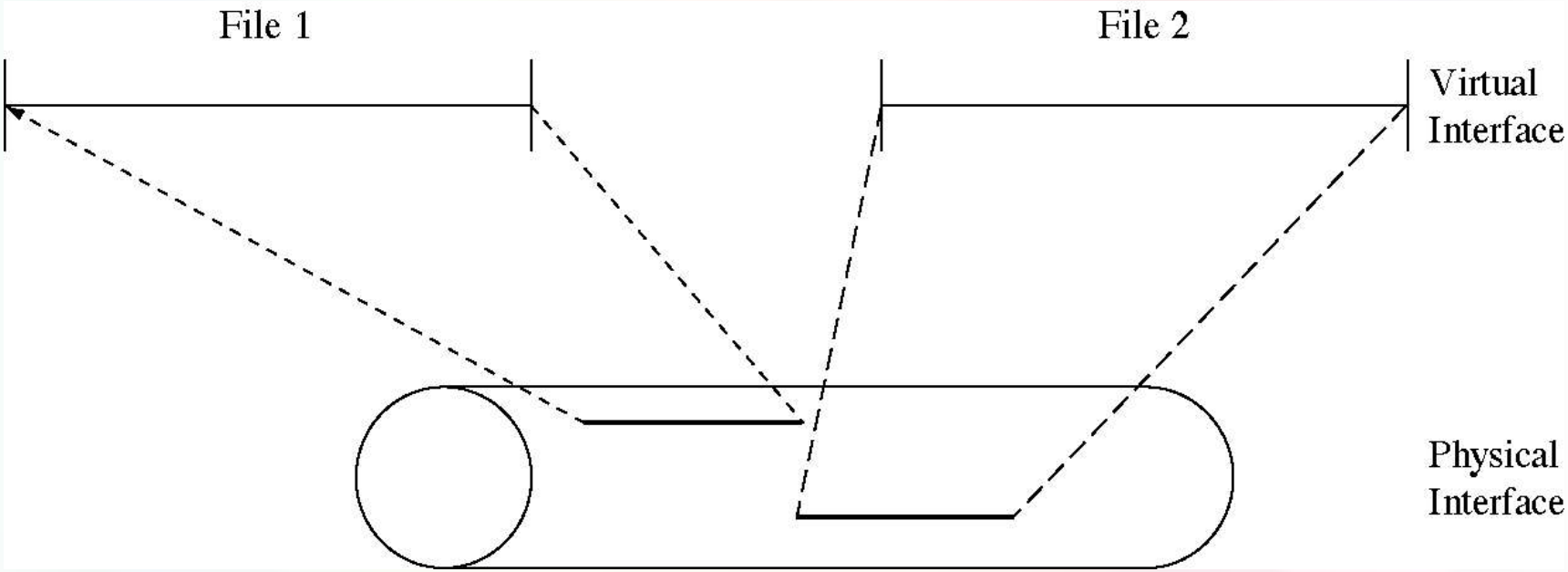
Space-multiplexing memory



Time-multiplexing I/O devices



Space-multiplexing the disk



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O.S. Components

- Process management
- Main memory management
- File management
- I/O system management
- Secondary storage management
- Networking
- Protection system
- Command interpreter system

Process Management

- A *process* is a program in execution.
  - Needs (CPU time, memory, files, and I/O devices).
- The OS is responsible for the following activities in connection with process management.
  - Process creation and deletion.
  - process suspension and resumption.
  - Provision of mechanisms for:
    - process synchronization
    - process communication

Main-Memory Management

- Memory is a large array of words or bytes, each with its own address. It is a repository of quickly accessible data
  - shared by the CPU and I/O devices.
- Main memory is a volatile storage device.
  - It loses its contents in the case of system failure.
- The operating system is responsible for the following activities in connections with memory management:
  - Keep track of which parts of memory are currently being used and by whom.
  - Decide which processes to load when memory space becomes available.
  - Allocate and de-allocate memory space as needed.

File Management

- A file is a collection of related information defined by its creator. Commonly, files represent programs (both source and object forms) and data.
- The operating system is responsible for the following activities in connections with file management:
  - File creation and deletion.
  - Directory creation and deletion.
  - Support of primitives for manipulating files and directories.
  - Mapping files onto secondary storage.
  - File backup on stable (nonvolatile) storage media.

I/O System Management

- The I/O system consists of:
  - A buffer-caching system
  - A general device-driver interface
  - Drivers for specific hardware devices

Secondary-Storage Management

- Secondary storage is permanent and non-volatile.
- The operating system is responsible for the following activities in connection with disk management:
  - Free space management
  - Storage allocation
  - Disk scheduling

Networking (Distributed Systems)

- A *distributed* system is a collection of processors that do not share memory or a clock. Each processor has its own local memory.
- The processors in the system are connected through a communication network.
- Communication takes place using a *protocol.*
- Access to a shared resource allows:
  - Computation speed-up
  - Increased data availability
  - Enhanced reliability

Protection System

- *Protection* refers to a mechanism for controlling access by programs, processes, or users to both system and user resources.
- The protection mechanism must:
  - distinguish between authorized and unauthorized usage.
  - specify the controls to be imposed.
  - provide a means of enforcement.

Command-Interpreter System

- Many commands are given to the operating system by control statements which deal with:
  - process creation and management
  - I/O handling
  - secondary-storage management
  - main-memory management
  - file-system access
  - protection
  - Networking
- The program that reads and interprets control statements is called variously:
  - command-line interpreter
  - shell (in UNIX)

Modes of execution

- User mode.
- Supervisory (or Kernel) mode.

- Some instructions (e.g. controlling the system hardware) are not offered to everyone for use.
- These instructions are called privileged instructions and allowed to only privileged users for use.

Problems an OS must solve

- Time sharing the CPU among applications
- Space sharing the memory among applications
- Space sharing the disk among users
- Time sharing access to the disk
- Time sharing access to the network

More problems an OS must solve

- Protection
  - of applications from each other
  - of user data from other users
  - of hardware/devices
  - of the OS itself!

Operating System Services

- Program execution
- I/O operations
- File-system manipulation
- Communications
- Error detection

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Mainframe Systems

First Computer used to tackle many commercial and scientific applications

Batch Systems

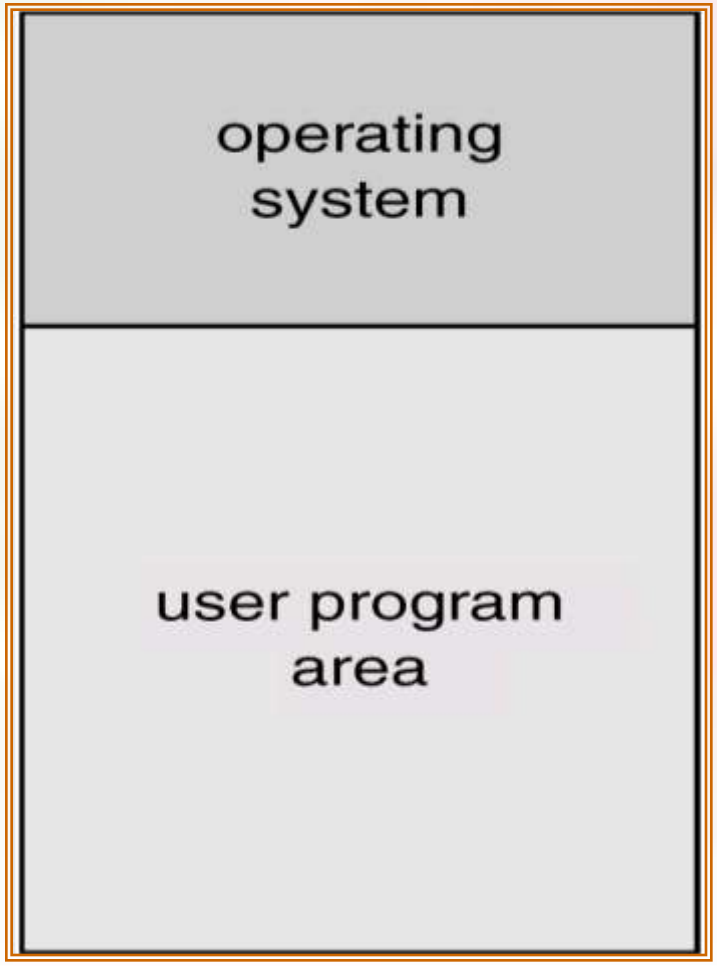
Multi-programmed Systems

Time-Sharing Systems–Interactive

Batch Systems

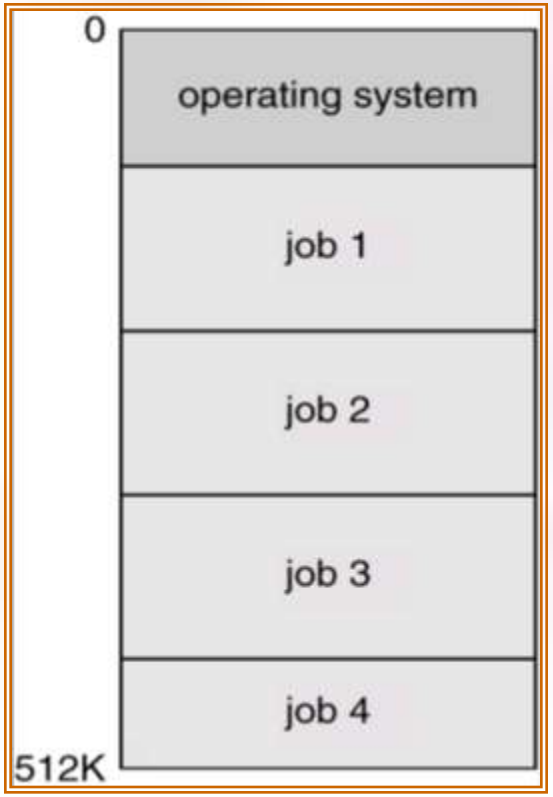
- Reduce setup time by batching similar jobs
- Automatic job sequencing – automatically transfers control from one job to another. First rudimentary operating system
- Input devices: Card Reader and Tape drive
- Output Devices :Line printer , Tape drive and Punch cards.

Memory Layout for a Simple Batch System



Multiprogrammed Systems

- Several jobs are kept in main memory at the same time, and the CPU is multiplexed among them.



OS Features Needed for Multiprogramming

- Job scheduling: jobs (disk -> memory).
- Memory management – memory allocation to several jobs
- CPU scheduling – jobs (ready to run)
- Allocation of devices

Time-Sharing Systems–Interactive Computing

- Batch and Multi-programmed system do not provide interaction with user during program execution.
- The CPU is multiplexed among several jobs that are kept in memory and on disk (the CPU is allocated to a job only if the job is in memory).
- A job swapped in and out of memory to the disk.

Time-Sharing Systems–Interactive Computing

- Multitasking systems
- Multiuser
- Interactive computer system

Computer system architecture

- Single processor systems
  - one general-purpose CPU
- Multiprocessor (Parallel/tightly coupled) system
  - high throughput
  - more reliable/fault tolerant
  - less costly
  - Asymmetric and symmetric multiprocessing (SMP)
- Clustered systems
  - Multiple systems connected (e.g. LAN)
  - Shared storage

Parallel Systems

- In parallel computing, all processors may have access to a shared memory to exchange information between processors.

Distributed Systems

- In distributed computing, each processor has its own private memory (distributed memory). Information is exchanged by passing messages between the processors.
- "A distributed system consists of a collection of autonomous computers linked to a computer network and equipped with distributed system software."
- "A distributed system is a collection of processors that do not share memory or a clock."
- "Distributed systems is a term used to define a wide range of computer systems from a weakly-coupled system such as wide area networks, to very strongly coupled systems such as multiprocessor systems."
- Distribute the computation among several physical processors

Features of DOS

- Resource sharing
- Reliability
- Computation speed up
- Communication
- Incremental growth

Key concepts and techniques used in DOS

- Distributed control
- Transparency
- RPC

Parallel vs Distributed systems

- The main difference between parallel systems and distributed systems is the way in which these systems are used.
- A parallel system uses a set of processing units to solve a single problem.
- A distributed system is used by many users together.

Other types of systems

- Real-Time Systems
  - Hard real-time systems
    - Ex. Satellite launch system
  - Soft real-time systems
    - Ex. Multimedia presentation system
- Handheld Systems
  - RTOS running on a mobile device

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Virtualization: CPU, memory and device

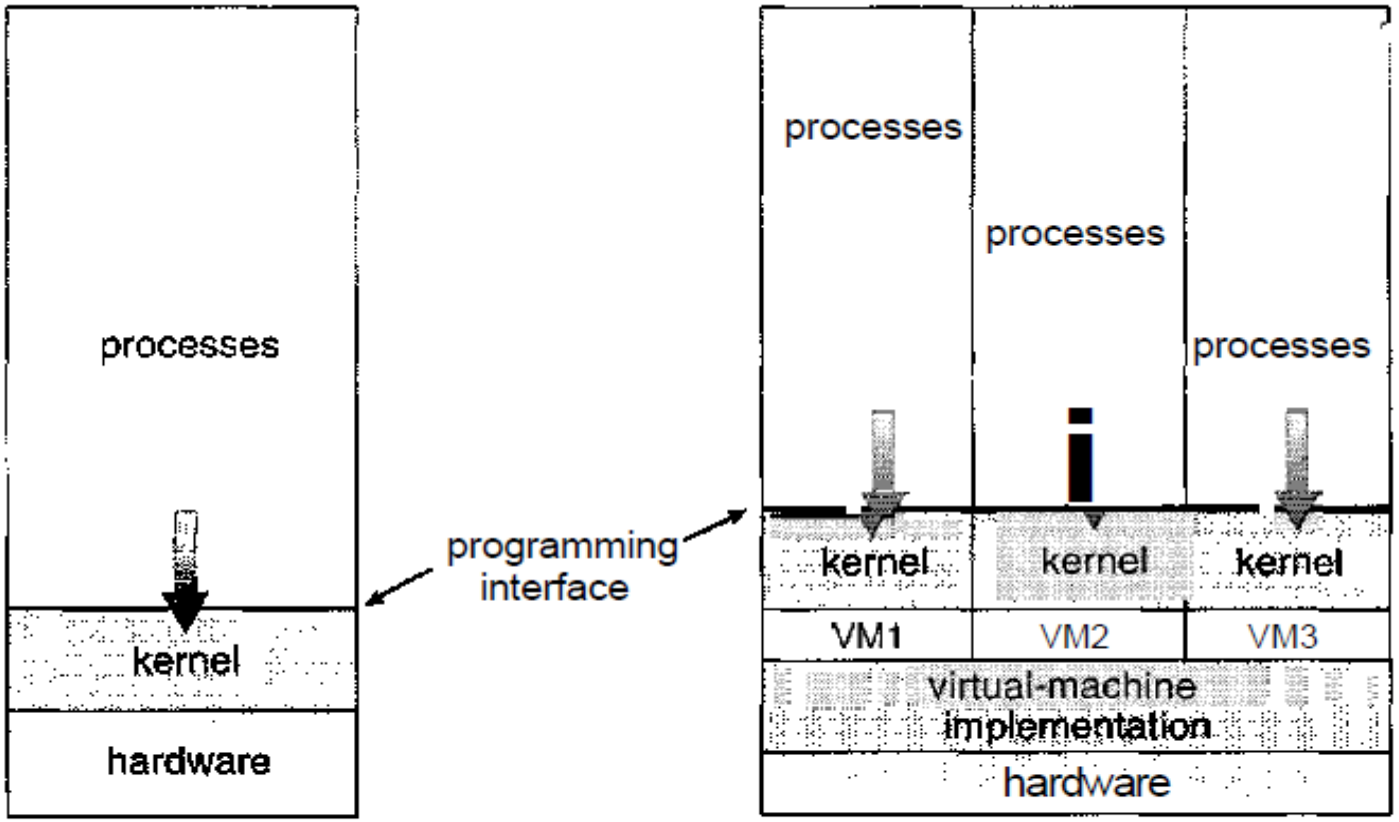

Figure 2.15 System models. (a) Nonvirtual machine. (b) Virtual machine.

Thank you