

Operating Systems

Processes

Chapter 3: Processes

- Process Concept
- Process Scheduling
- Operations on Processes
- Interprocess Communication

Process Concept (1/3)

Program vs. Process

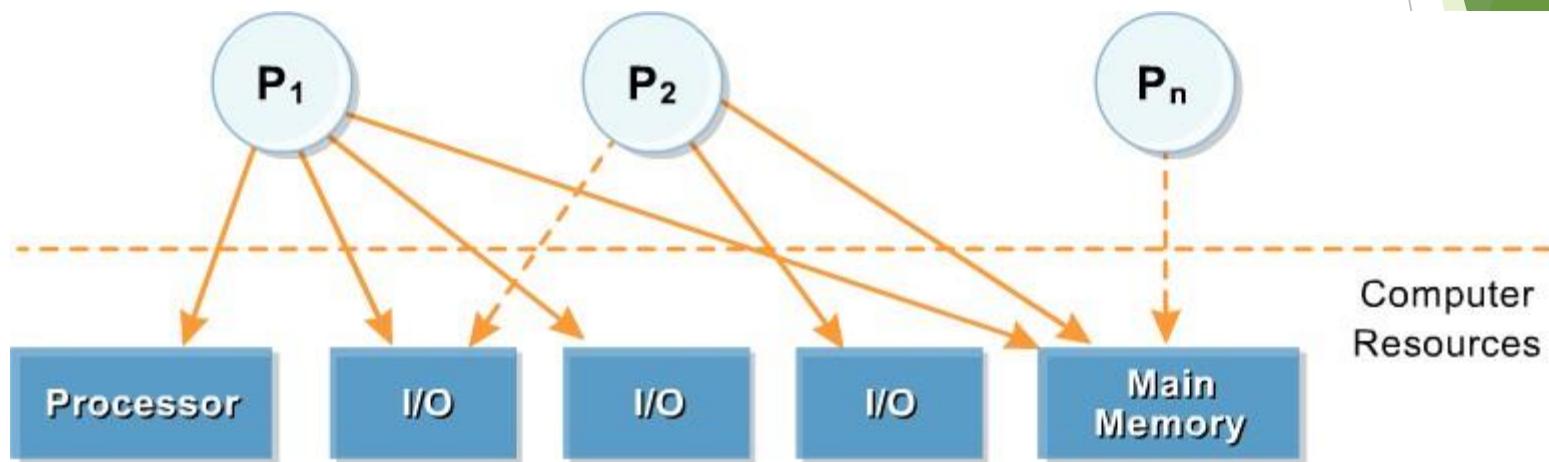
- A **program** is a **passive** entity such as the file that contains the list of instructions stored on a disk always referred to as an **executable file**.
- A program becomes a **process** when an executable file is loaded into the memory and then becomes an **active** entity.

Process Concept (2/3)

- The fundamental task of any operating system is the **process management**.
- Processes include not only a text but also include a set of resources such as open files and pending signals. Processes also contain internal kernel data, processor state, an address space, and a data section.

Process Concept (3/3)

- OS must **allocate resources to processes**, enable sharing of information, protect resources, and enable the synchronization among processes.

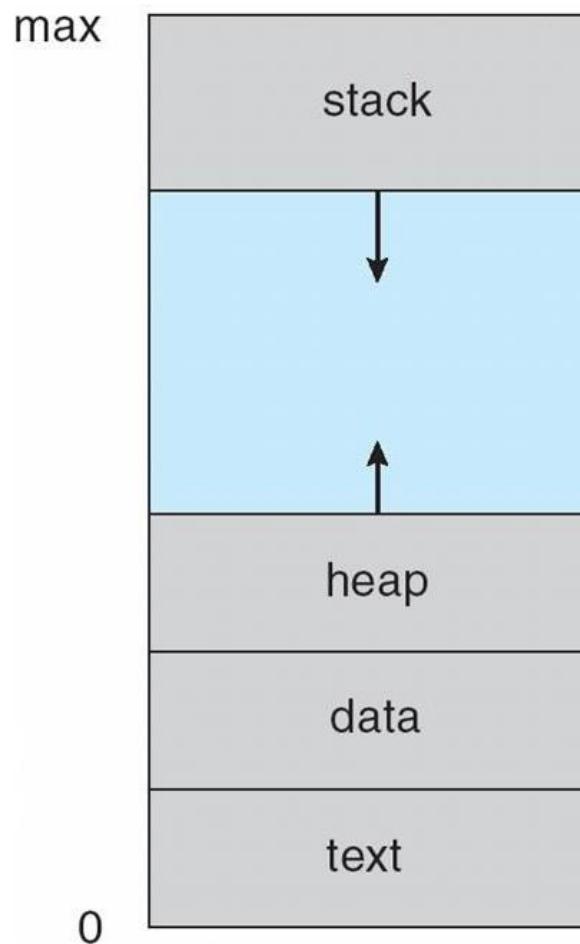


Process Elements (1/2)

- Segments of a process represents the following
 - ▶ components:
 - Text Section: the program code. This is typically read-only, and might be shared by a number of processes.
 - Data Section: containing global variables.
 - Heap: containing memory dynamically allocated during run time.
 - Stack: containing temporary data.
 - Function parameters, return addresses, local variables.

Process Elements (2/2)

- Process in Memory



Process Control Block (PCB)

- For better control of processes, operating systems need to consider their dynamic behaviors.
- Each process is represented in the OS by a Process Control Block (PCB).



Process Control Block (PCB) (2/2)

- Process Control Block (PCB) (1/3)

- **Process identification information**

- Process identifier: numeric identifiers represent the unique process identifier
 - User identifier: the user who is responsible for the job).
 - Identifier of the parent process that created this process.

Process Control Block (PCB) (2/2)

- Process Control Block (PCB) (2/3)
 - Processor state Information
 - Process state – running, waiting, etc
 - Program counter
 - location of instruction to next execute
 - CPU registers
 - contents of all process-centric registers

Process Control Block (PCB) (2/2)

- Process Control Block (PCB) (3/3)

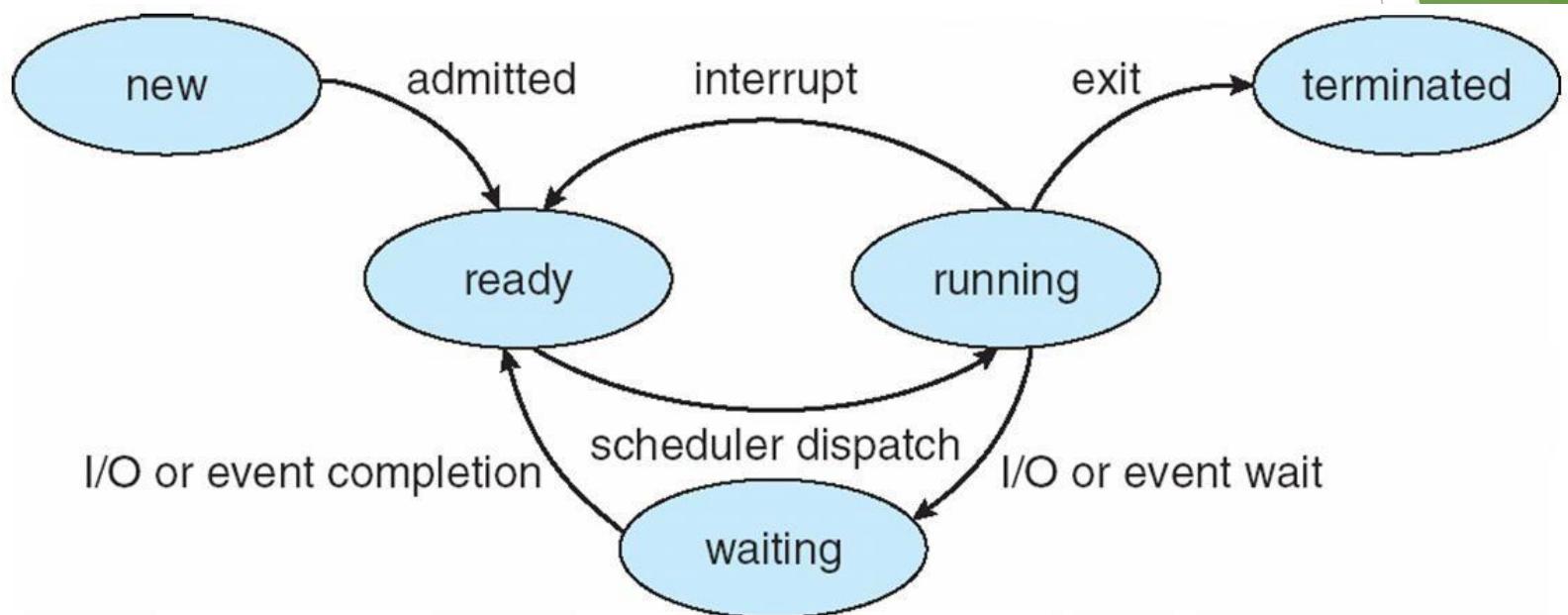
- **CPU scheduling information**
 - priorities, scheduling queue pointers
- **Memory-management information**
 - memory allocated to the process
- **Accounting information**
 - CPU used, clock time elapsed since start, time limits
- **I/O status information**
 - I/O devices allocated to process, list of open files

Process State

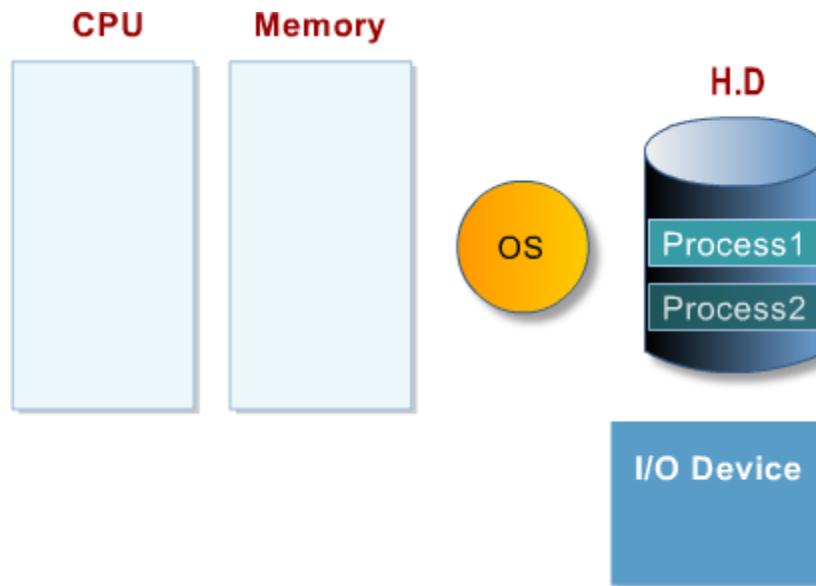
- As a process executes, it changes **state** (1/3)
 - **new**: The process is being created
 - **running**: Instructions are being executed
 - **waiting**: The process is waiting for some event to occur
 - **ready**: The process is waiting to be assigned to a processor
 - **terminated**: The process has finished execution

Process State

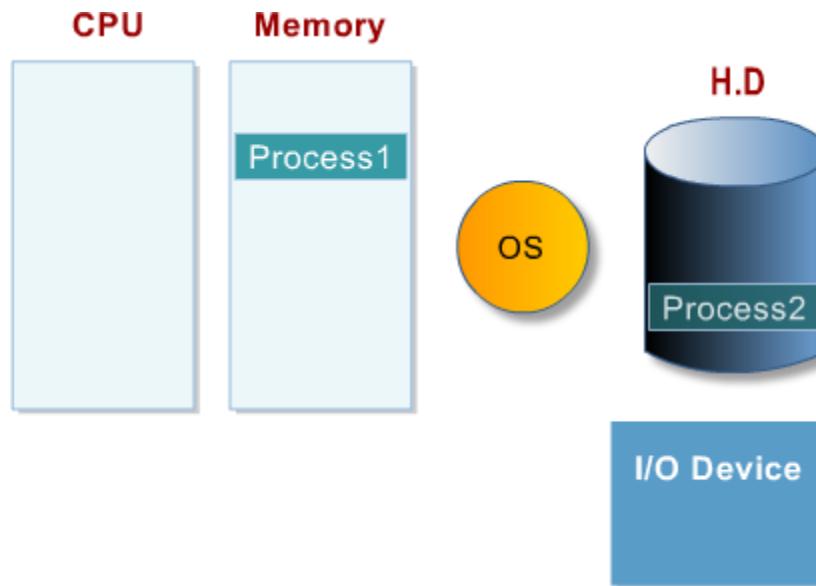
- Diagram of Process State (2/3)



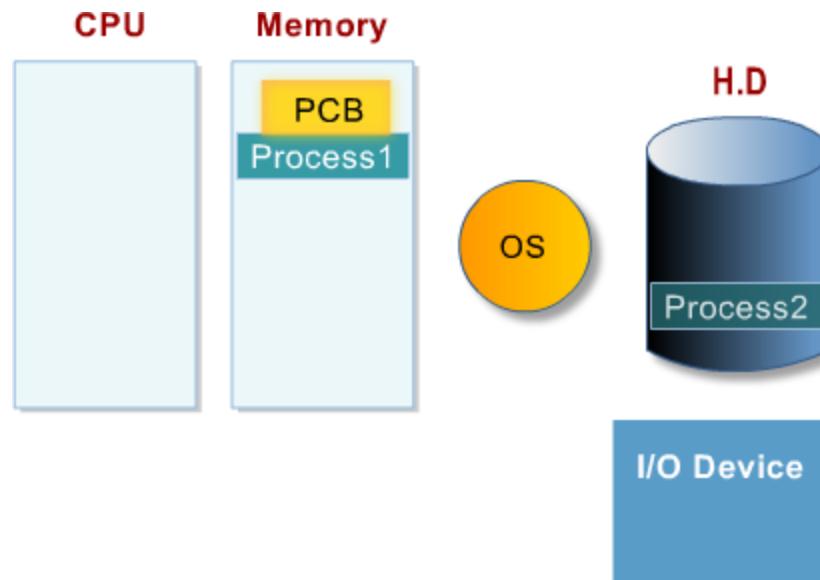
Process State (3/3)



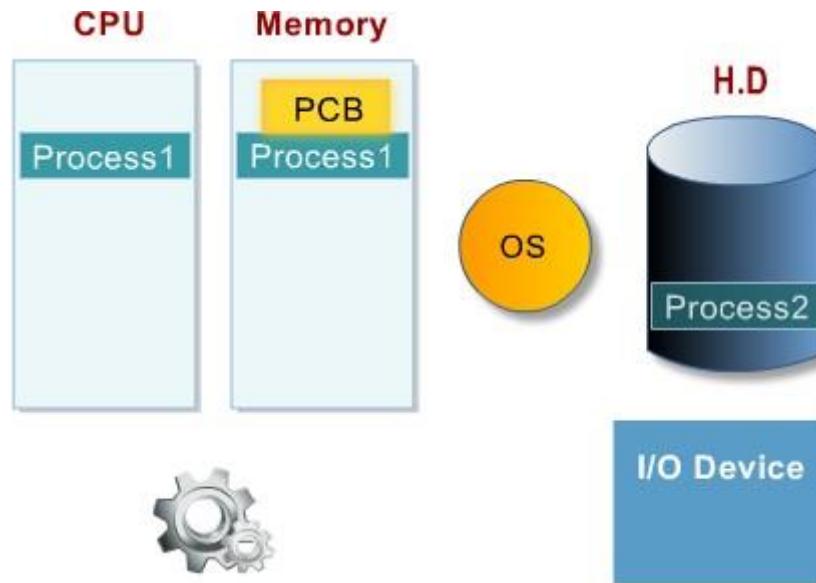
Process State (3/3)



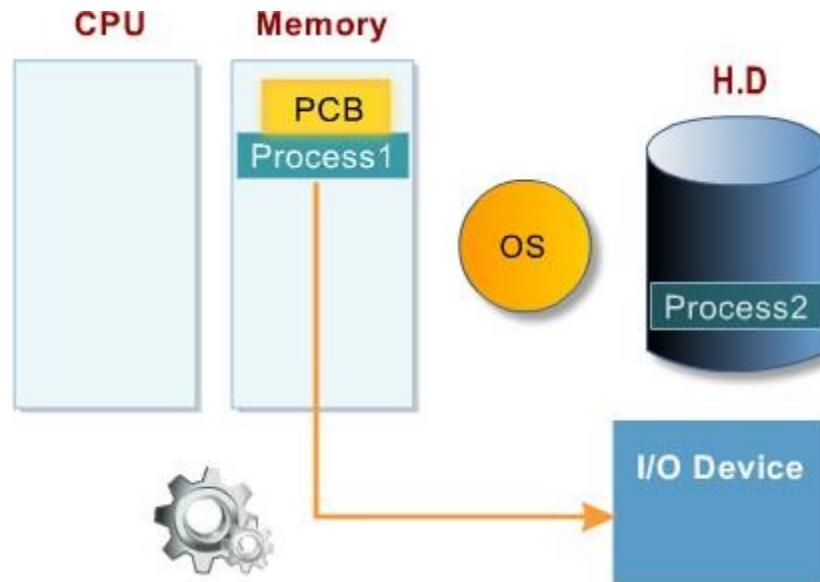
Process State (3/3)



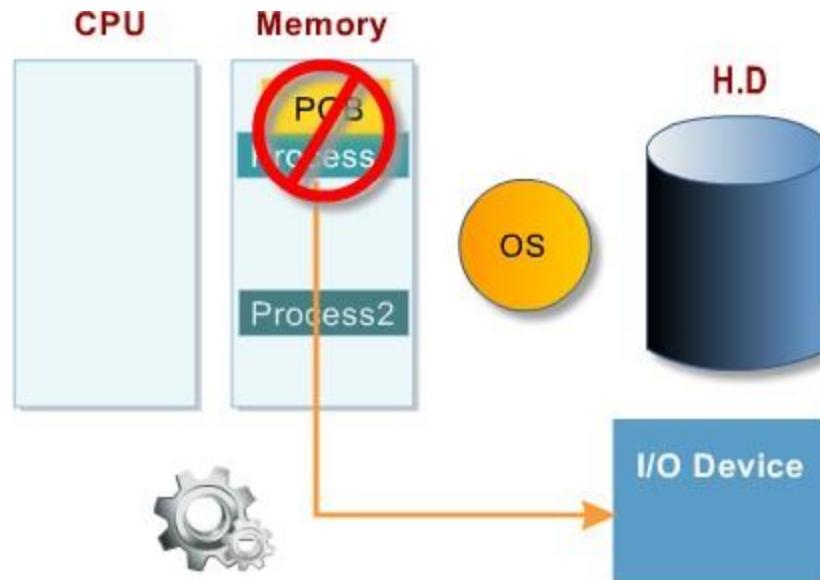
Process State (3/3)



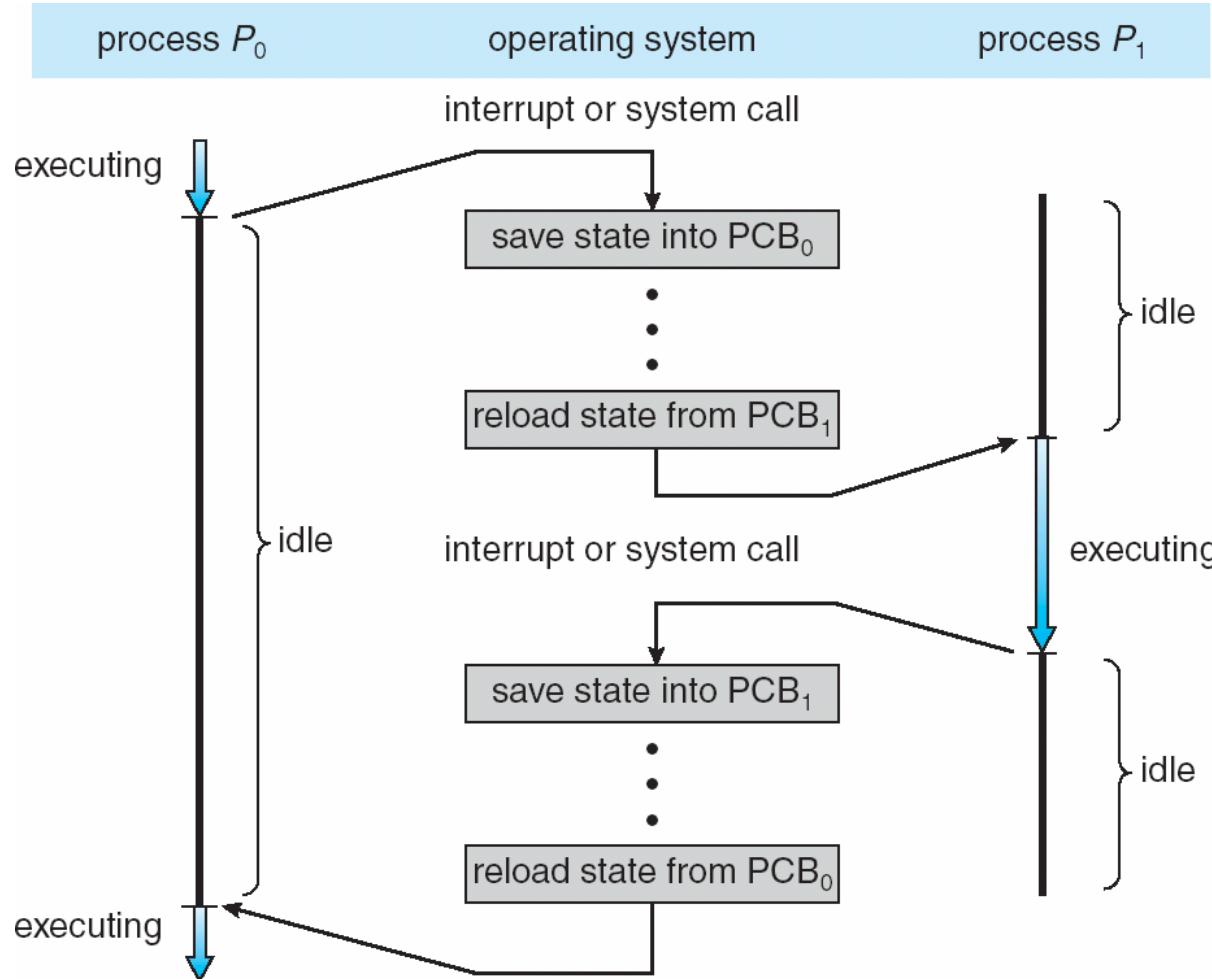
Process State (3/3)



Process State (3/3)

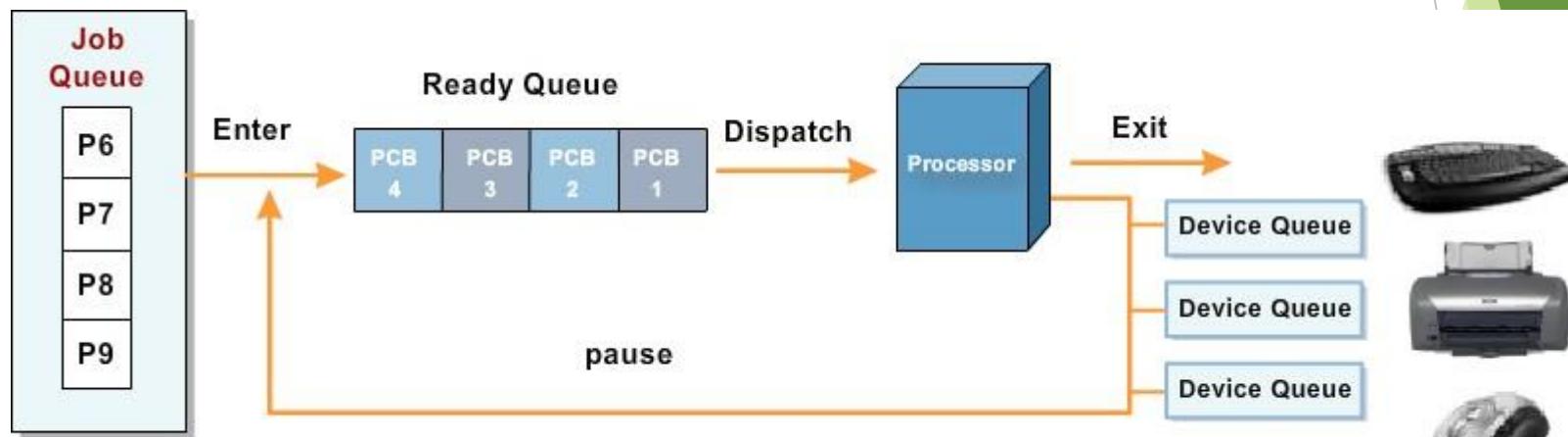


CPU Switch From Process to Process

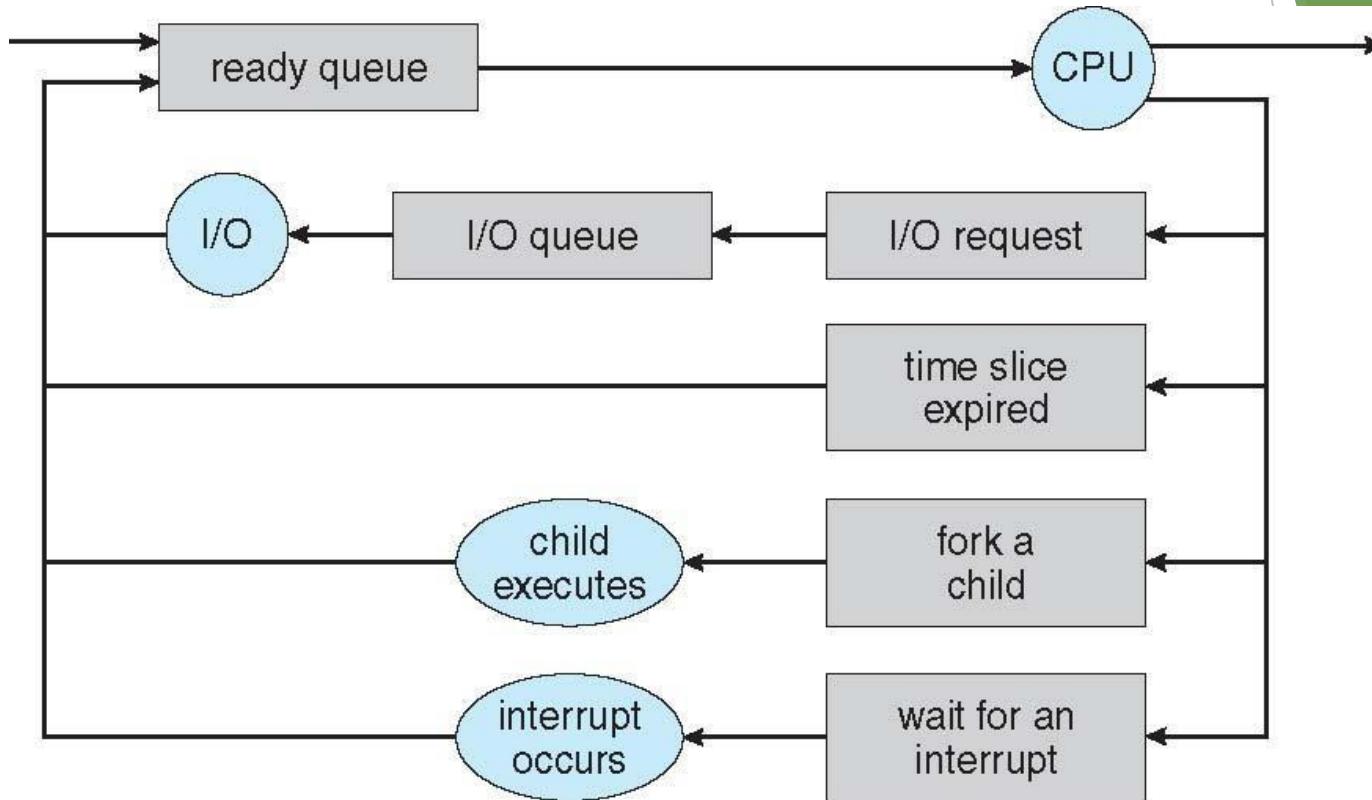


Process Scheduling (1/2)

- **Job queue** – set of all processes in the system
- **Ready queue** – set of all processes residing in main memory, ready and waiting to execute
- **Device queues** – set of processes waiting for an I/O device
- Processes migrate among the various queues



Process Scheduling (2/2)



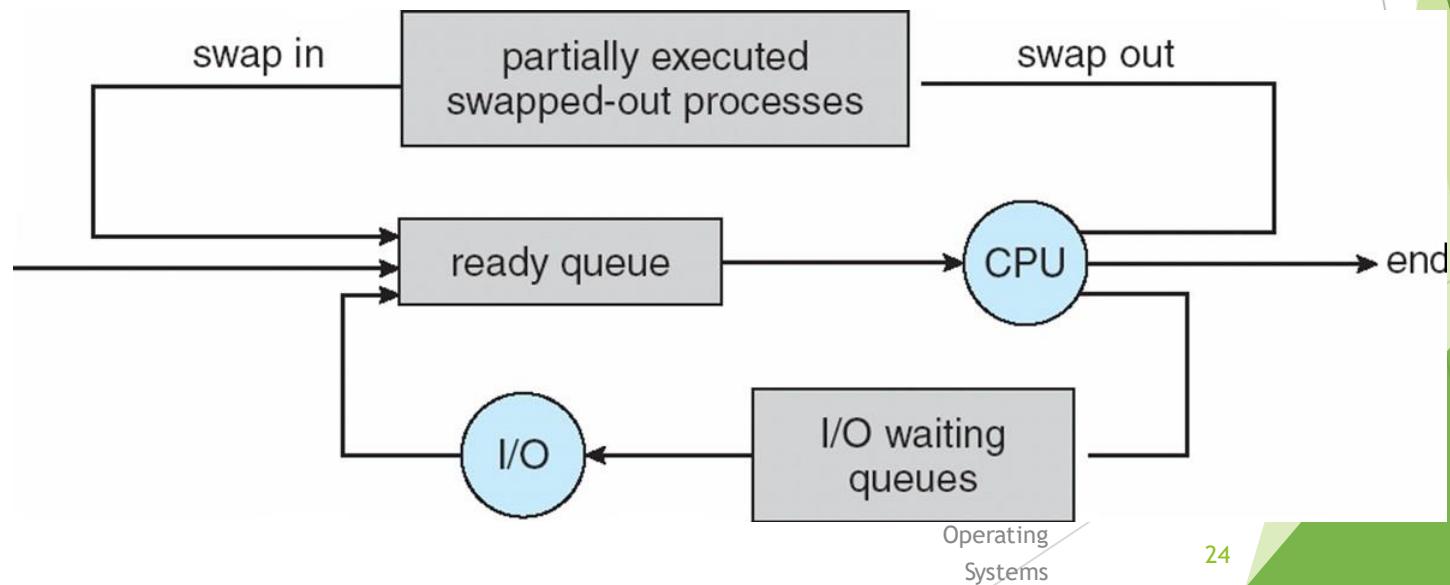
Schedulers (1/2)

- **Short-term scheduler (or CPU scheduler)**
 - Selects which process should be executed next and allocates CPU.
 - Invoked frequently (milliseconds) → (must be fast).
- **Long-term scheduler (or job scheduler)**
 - Selects which processes should be brought into the ready queue.
 - Invoked infrequently (seconds, minutes) → (may be slow).
 - Controls the degree of multiprogramming.

Schedulers (2/2)

- **Medium-term scheduler**

- Can be added if degree of multiple programming needs to decrease
- Remove process from memory, store on disk, bring back in from disk to continue execution: **swapping**

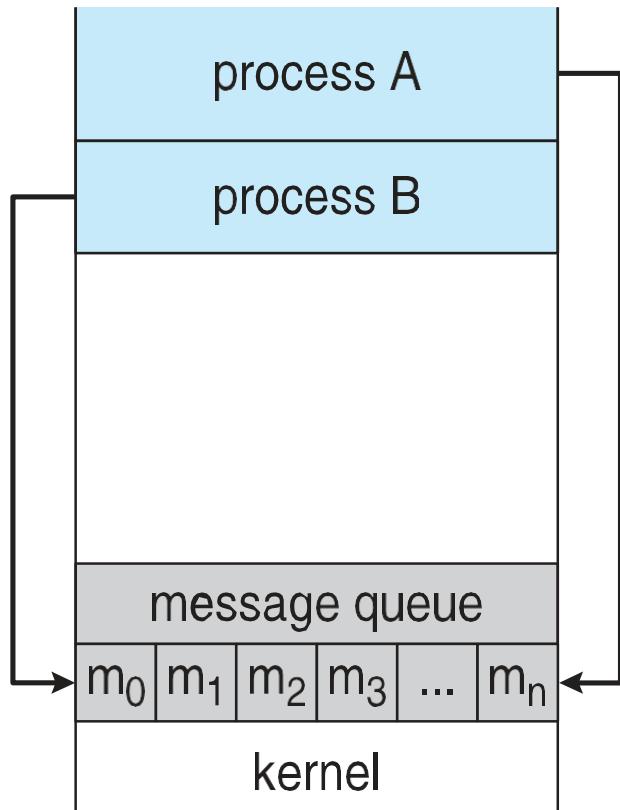


Interprocess Communication (1/2)

- Processes within a system may be **independent** or cooperating.
 - Cooperating process can affect or be affected by other processes, including sharing data.
 - Cooperating process need interprocess communication (IPC).
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- Two models of IPC:
 - **Shared memory**
 - **Message passing**

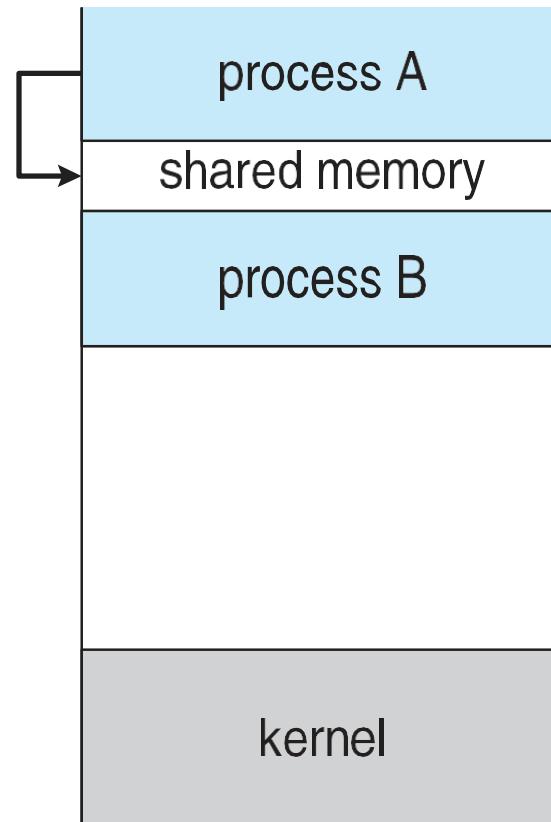
Interprocess Communication (2/2)

(a) Message passing.



(a)

(b) shared memory.



(b)

Thank You