Chapter 2: Processes

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Process Management

- A process is a program in execution. It is a unit of work within the system. Program is a *passive entity*, process is an *active entity*.
- Process needs resources to accomplish its task
  - CPU, memory, I/O, files
  - Initialization data
- Process termination requires reclaim of any reusable resources
- Single-threaded process has one **program counter** specifying location of next instruction to execute
  - Process executes instructions sequentially, one at a time, until completion
- Multi-threaded process has one program counter per thread
- Typically system has many processes, some user, some operating system running concurrently on one or more CPUs
  - Concurrency by multiplexing the CPUs among the processes / threads

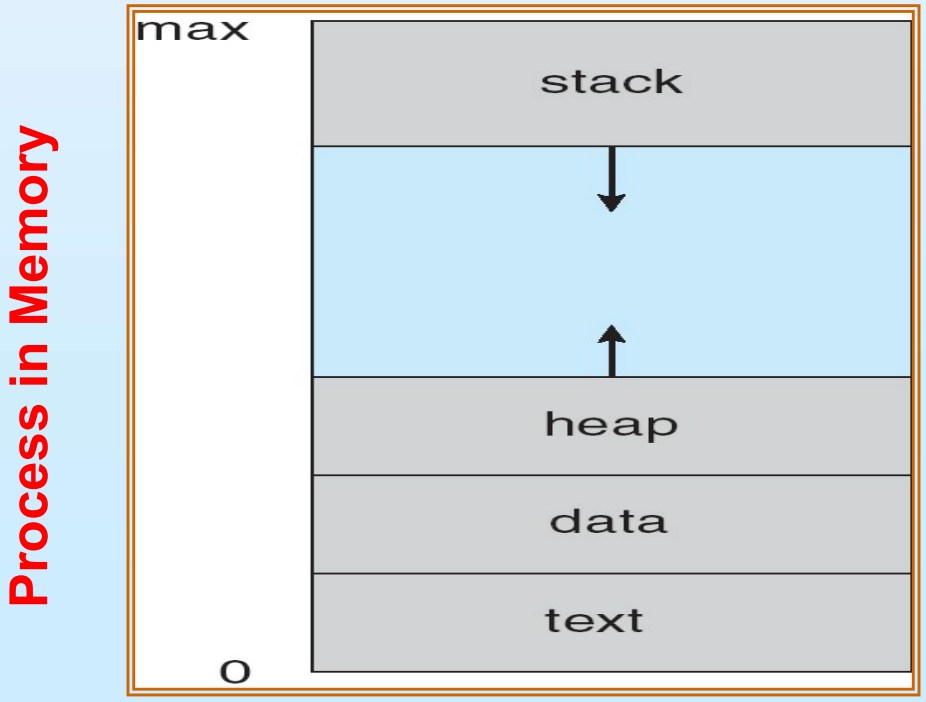
Process Management Activities

The operating system is responsible for the following activities in connection with process management:

- Creating and deleting both user and system processes
- Suspending and resuming processes
- Providing mechanisms for process synchronization
- Providing mechanisms for process communication
- Providing mechanisms for deadlock handling

Process Concept

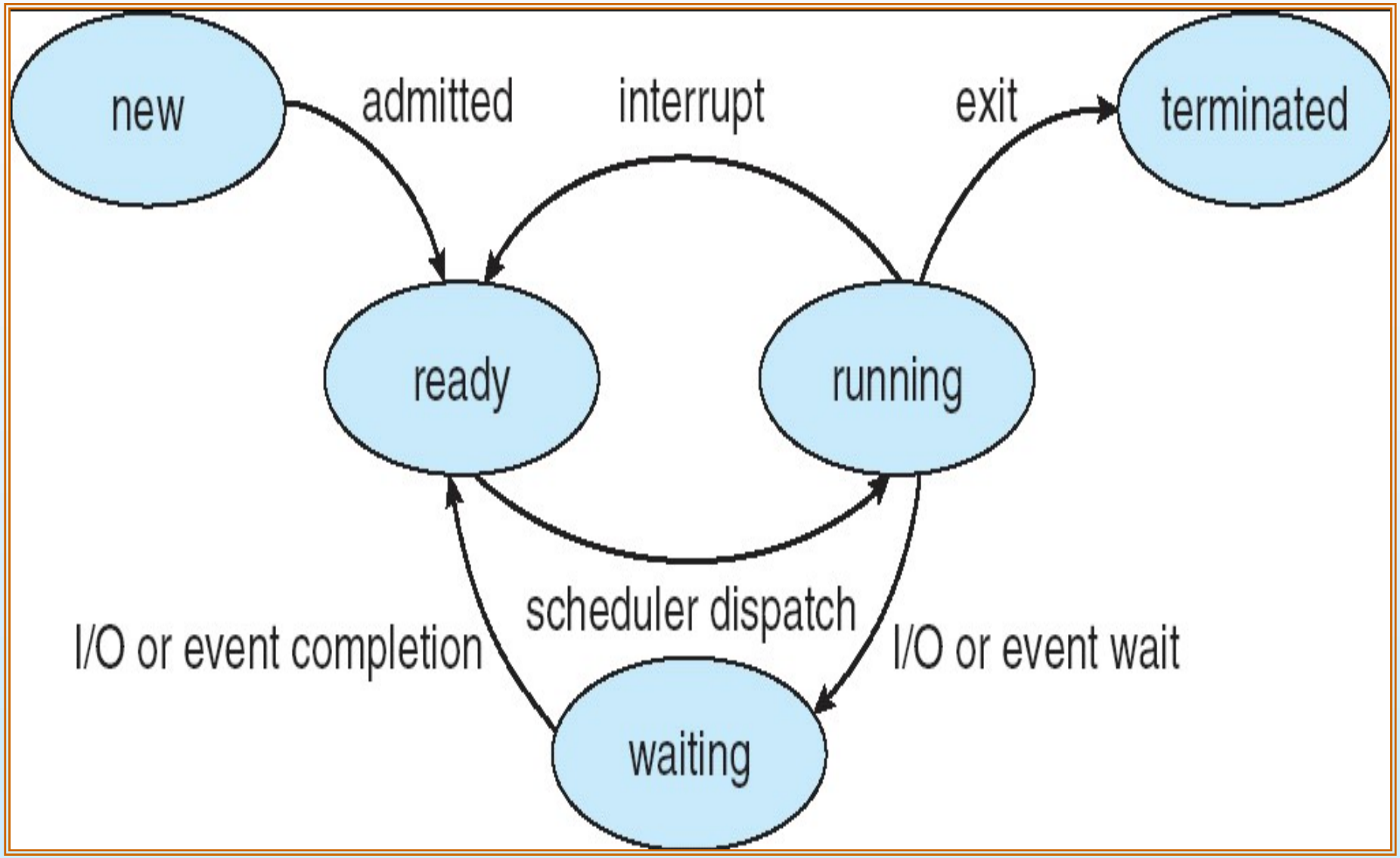
- An operating system executes a variety of programs:
  - Batch system – jobs
  - Time-shared systems – user programs or tasks
- Textbook uses the terms *job* and *process* almost interchangeably
- Process – a program in execution; process execution must progress in sequential fashion
- A process includes:
  - program counter
  - stack
  - data section



Process State

- As a process executes, it changes *state*
  - **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

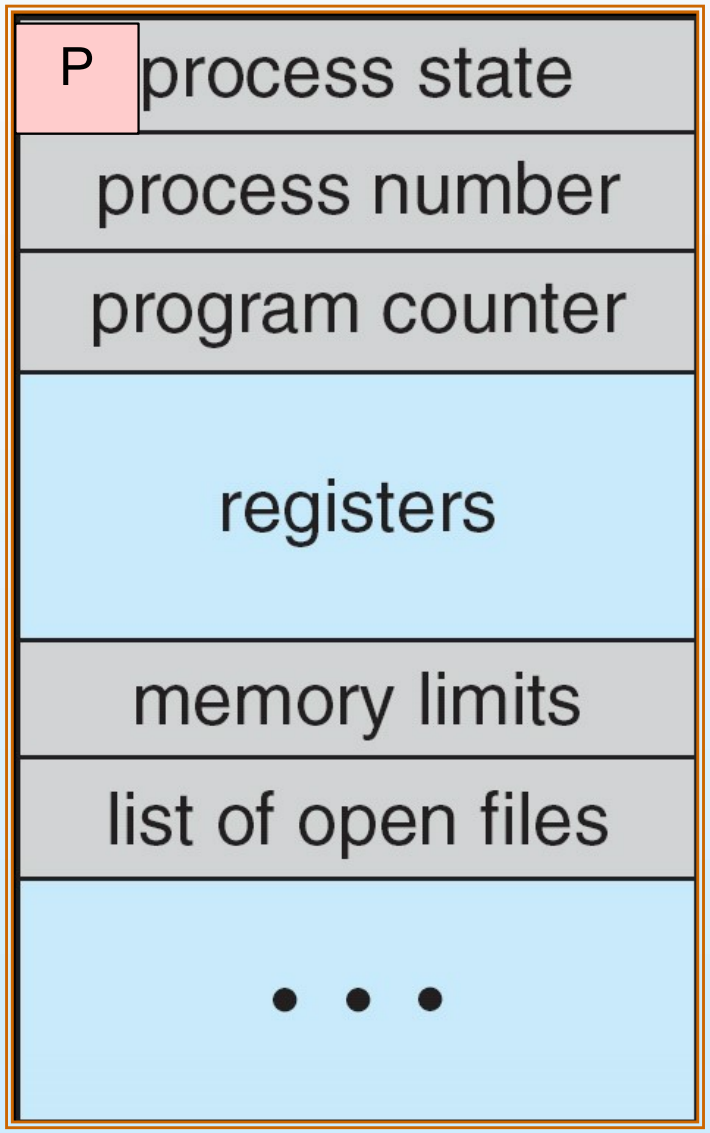
Diagram of Process State



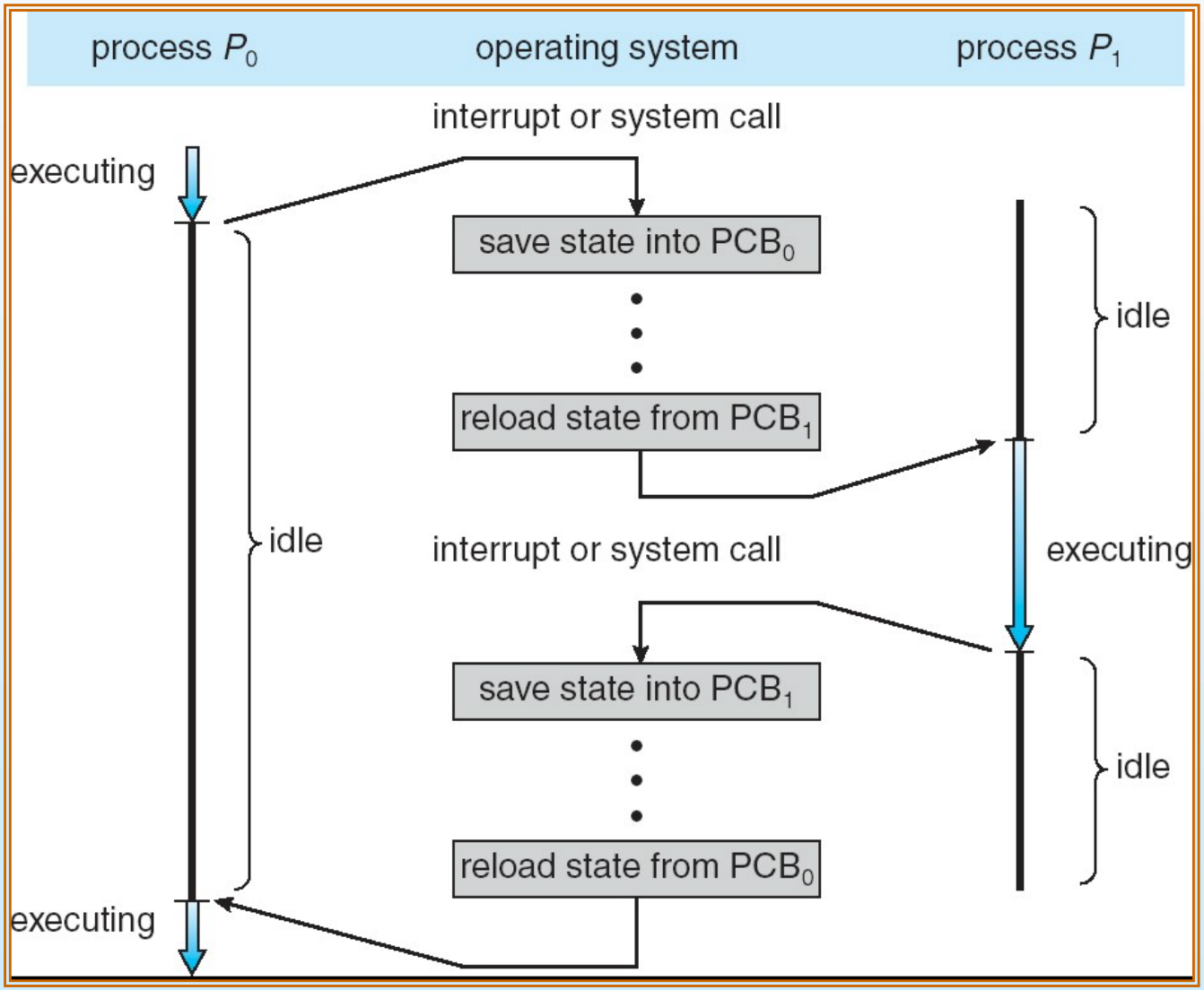
Process Control Block (PCB)

Information associated with each process

- Process state
- Program counter
- CPU registers
- CPU scheduling information
- Memory-management information
- Accounting information
- I/O status information



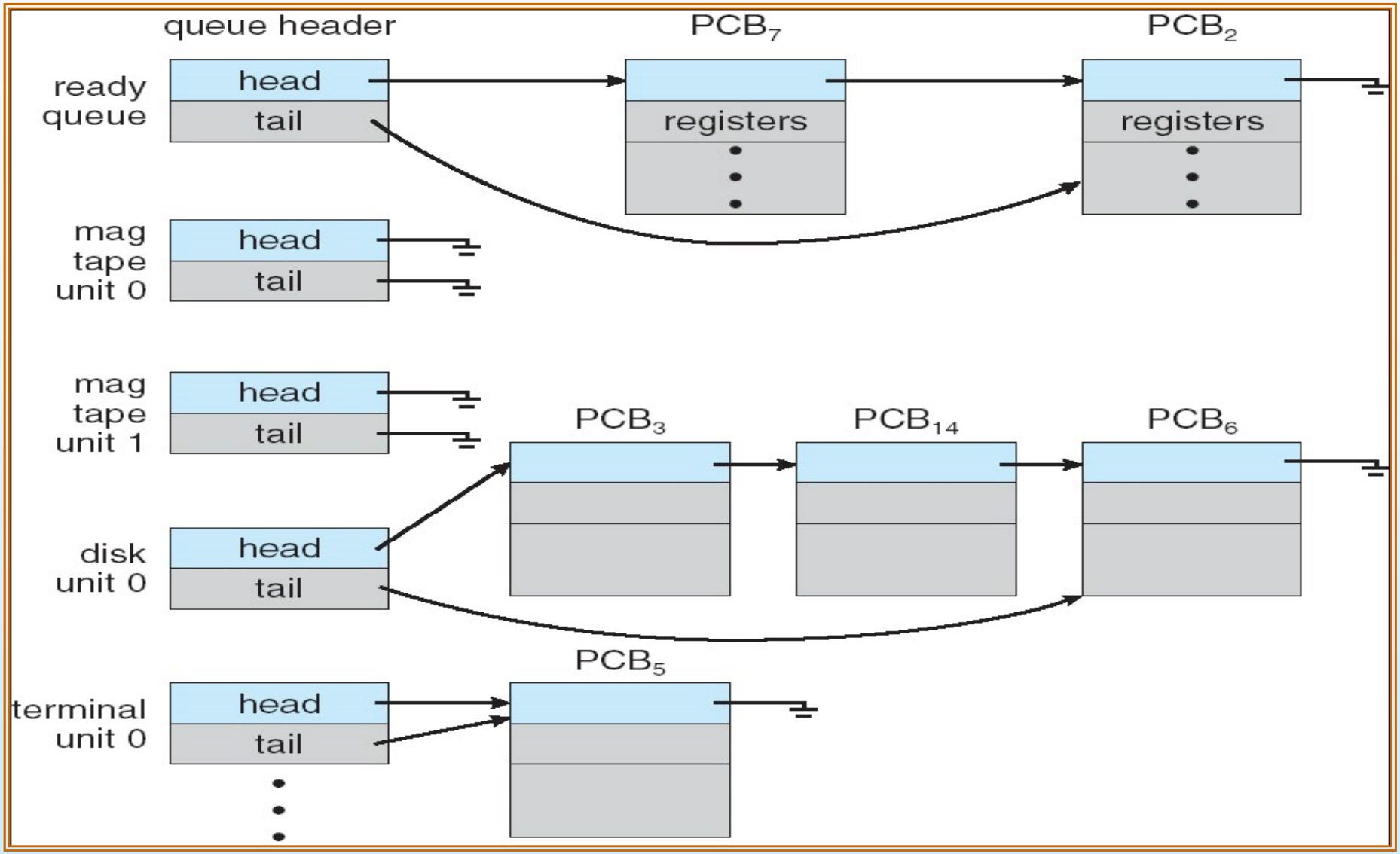
CPU Switch From Process to Process



Process Scheduling Queues

- **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

Ready Queue And Various I/O Device Queues



Representation of Process Scheduling

[continued……]

- **Two types of queue :**
  - -- READY QUEUE. & DEVICE QUEUE.
  - -- RECTANGLES ARE REPRESENTED AS QUEUES.
- **Circles represents resources :**
  - -- SERVES THE QUEUES.
- **Arrows represents flow :**
  - -- EXECUTION FLOW OF PROCESS IN A SYSTEM.
- **Working Procedure :**

-- Process put into ready queue [process selection] & wait [start] for execution.

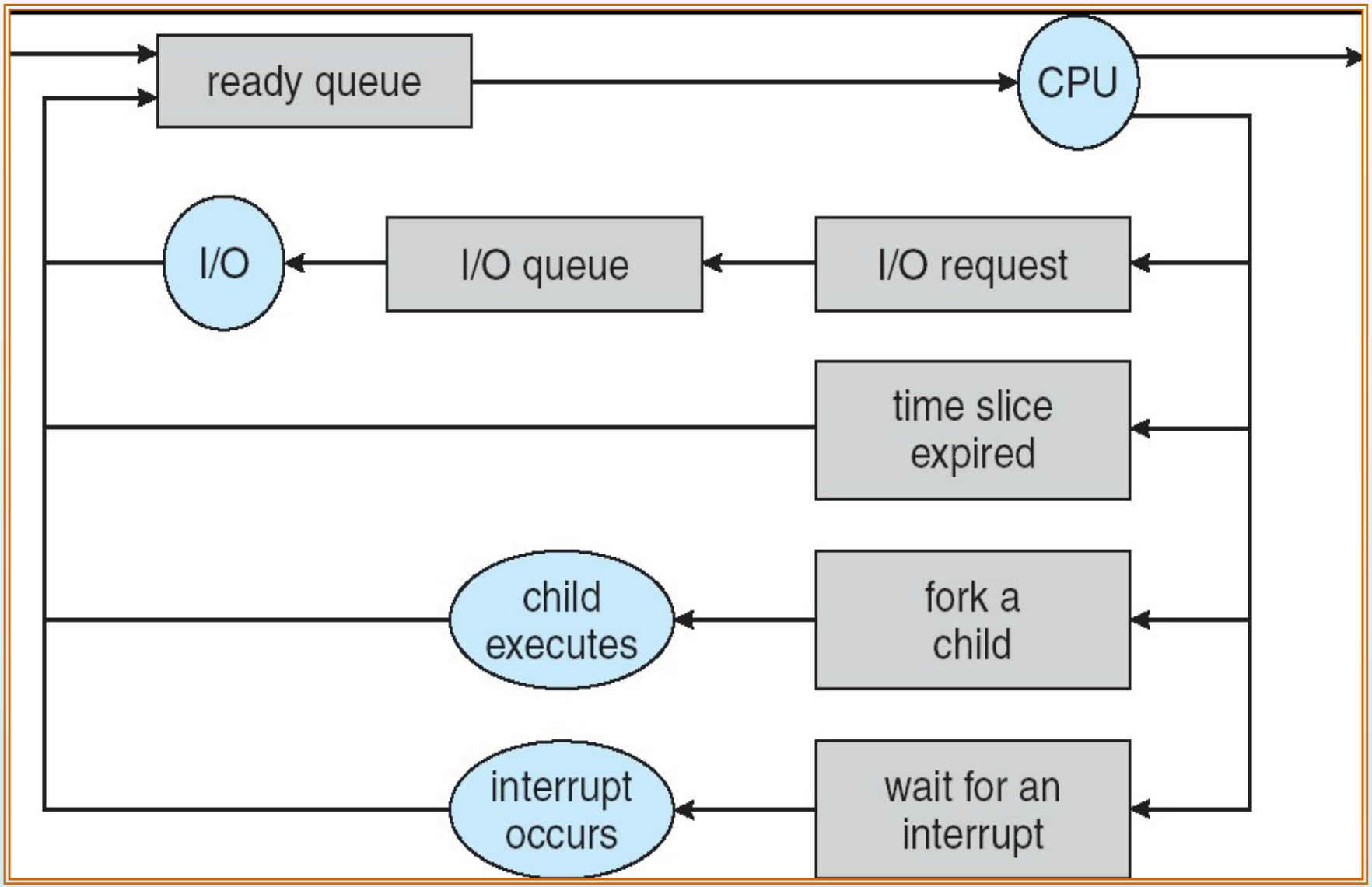
-- Process could issue an I/O request & then place it in I/O queue.

-- Process executes for given time slice until expires ,then CPU switches to other process.

-- Process could create new sub-process [child process] & wait for termination.

-- Interrupt could forcibly removed a process from execution & put it back to ready queue.

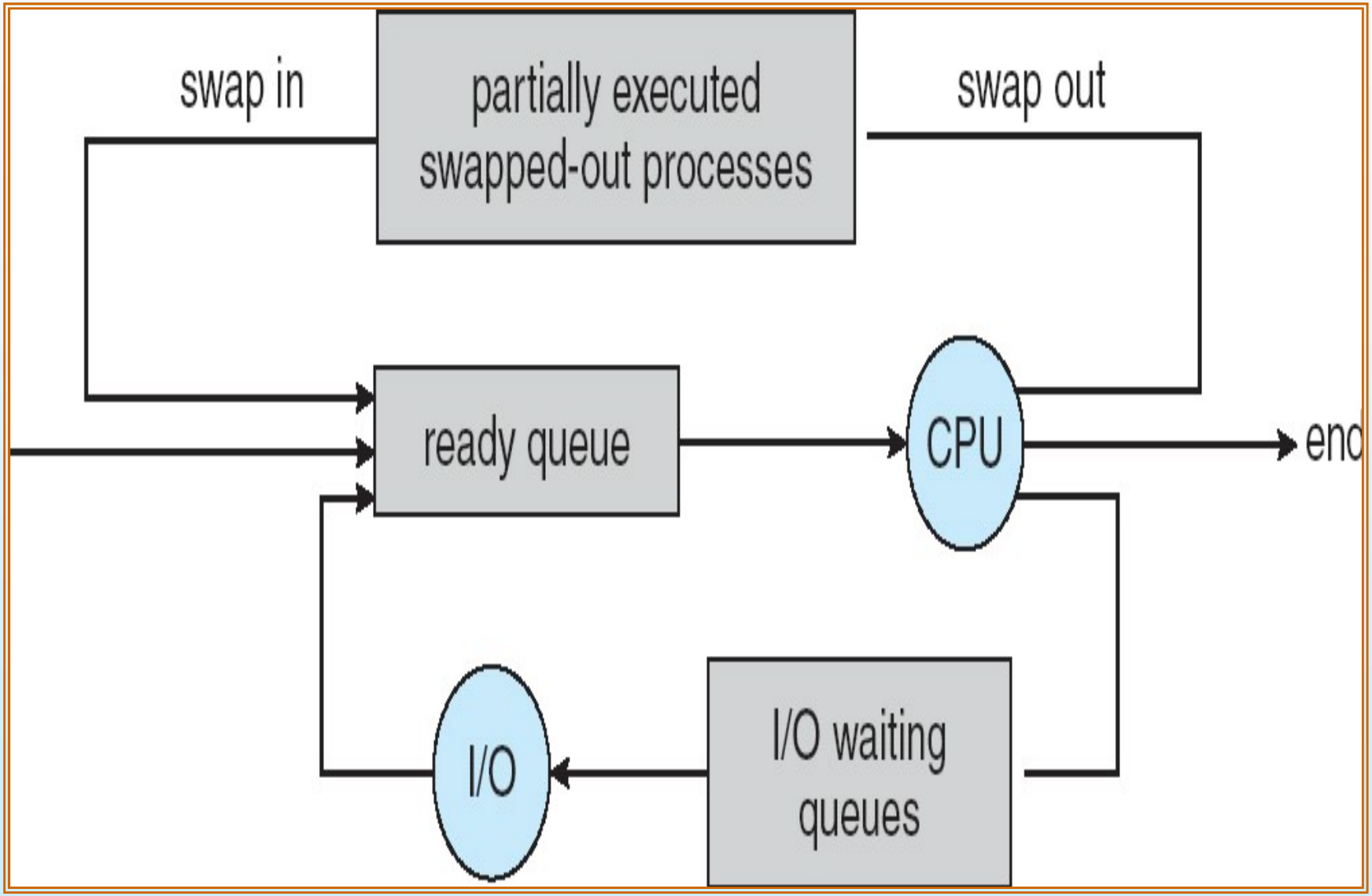
Representation of Process Scheduling



Schedulers

- ✓ **During process life time , it switches from one scheduling queue to another.**
- ✓ **Process selection is carried out by scheduler.**
- **Long-term scheduler** (or job scheduler) –
  - selects which processes should be brought into ready queue from disk
  - Executes less frequently.
  - Controls degree of multiprogramming
    - **Avg. No. of process creation = Avg. No. of process termination.**
- **Short-term scheduler** (or CPU scheduler) –
  - selects which process should be executed next and allocates CPU
  - CPU selects process & execute quite frequently.

Addition of Medium Term Scheduling



Schedulers (Cont.)

- Short-term scheduler is invoked very frequently (milliseconds) ⇒ (must be fast)
- Long-term scheduler is invoked very infrequently (seconds, minutes) ⇒ (may be slow)
- The long-term scheduler controls the *degree of multiprogramming*
- Processes can be described as either:
  - **I/O-bound process** – spends more time doing I/O than computations, many short CPU bursts
  - **CPU-bound process** – spends more time doing computations; few very long CPU bursts

Context Switch

- When CPU switches to another process, the system must save the state of the old process and load the saved state for the new process
- Context-switch time is overhead; the system does no useful work while switching
- Time dependent on hardware support

End of Chapter 2