Process Management

Prof J P Misra
BITS, Pilani

Process

- Process is an instance of executing program
- Main function of process is to Execute Instruction residing in main memory
- Process is characterized by
  - Its code, Data, stack and set of register
- During its life time, it can be in different states such as running , not running

Reasons for process creation

- Is created in response to submission of new job
- When a new user attempts to login
- Created by OS to provide a service
- Spawned by existing process

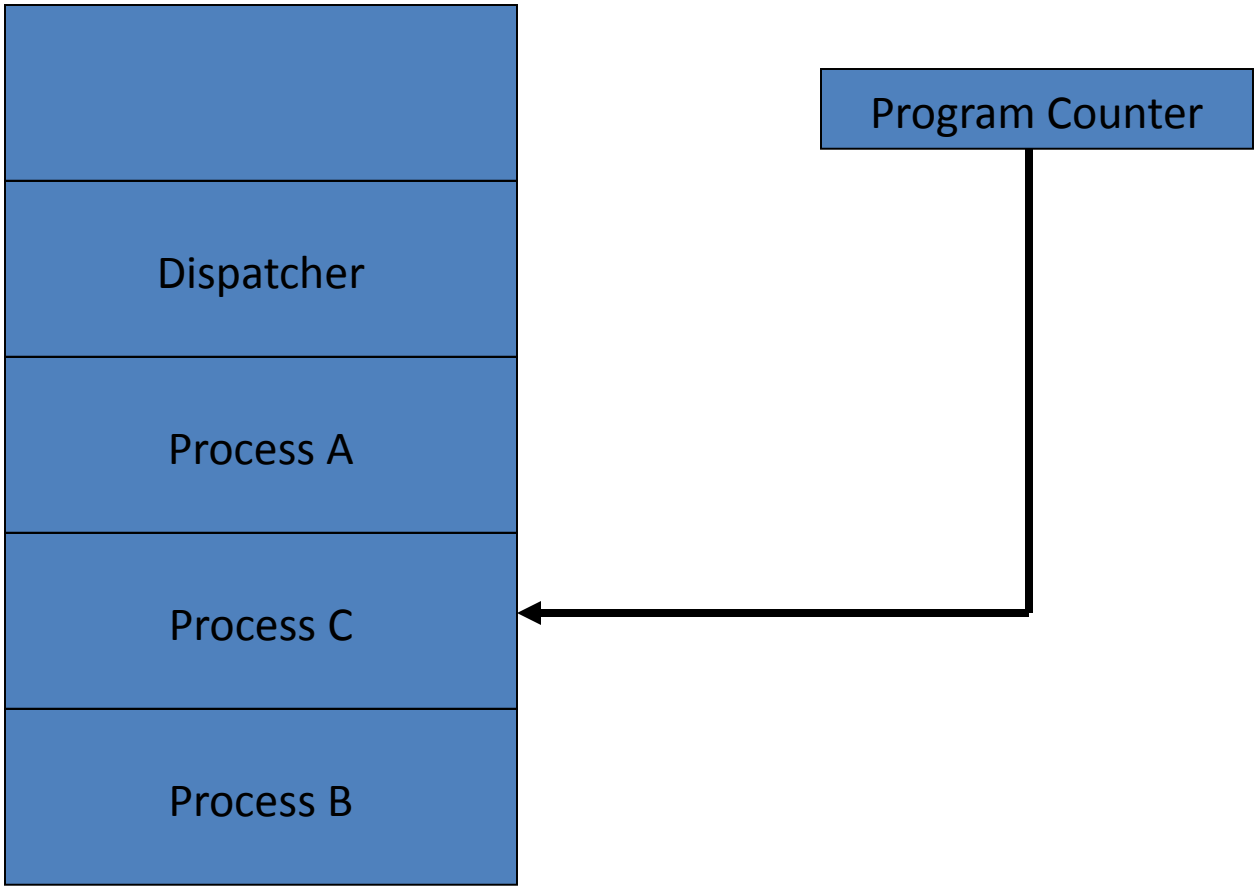
How a program/job is executed ?

- When a new job to be executed, OS creates data structure for holding the context of process
- Loads the job in memory
- At some point of time the scheduler schedules the job and it starts executing.
- Once a running process terminates, its time slice expires or suspended, OS process (Dispatcher) dispatches ready to execute process for execution

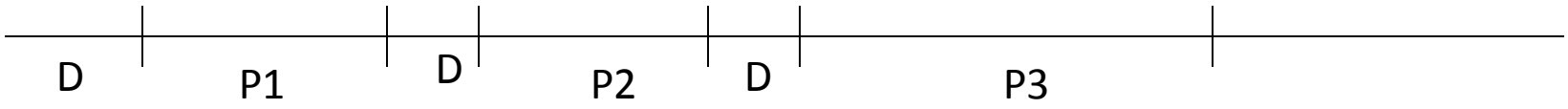
Process & Multiprogramming

- In multiprogramming environment, many jobs can be in memory
- Jobs in memory are ready to execute
- At any point of time one Job might be running and others are in not running state.

Memory Layout



Execution Of Ready Processes

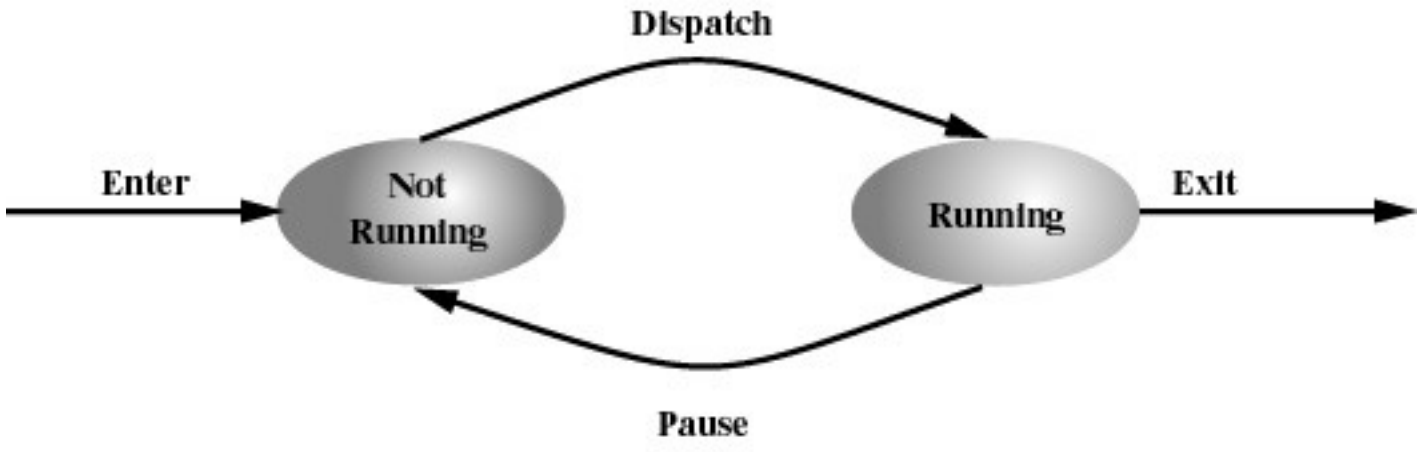


D Dispatcher Process

P1, P2, P3 are user processes

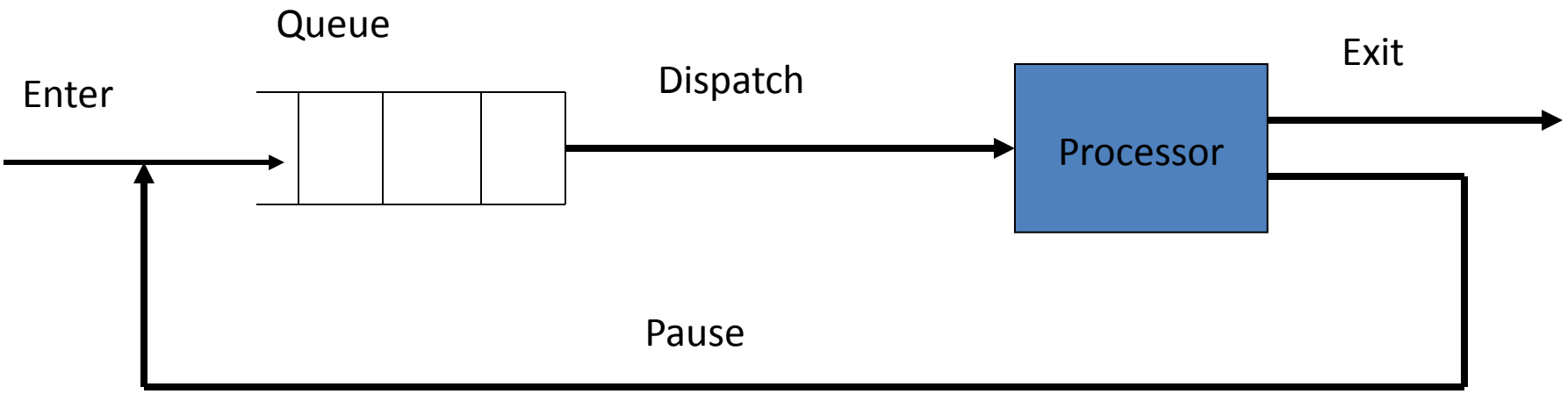
Two State Process Model

- Process may in any of the 2 states
  - Running
  - Not running



(a) State transition diagram

Queuing Diagram



Queue May contain ready and blocked processes

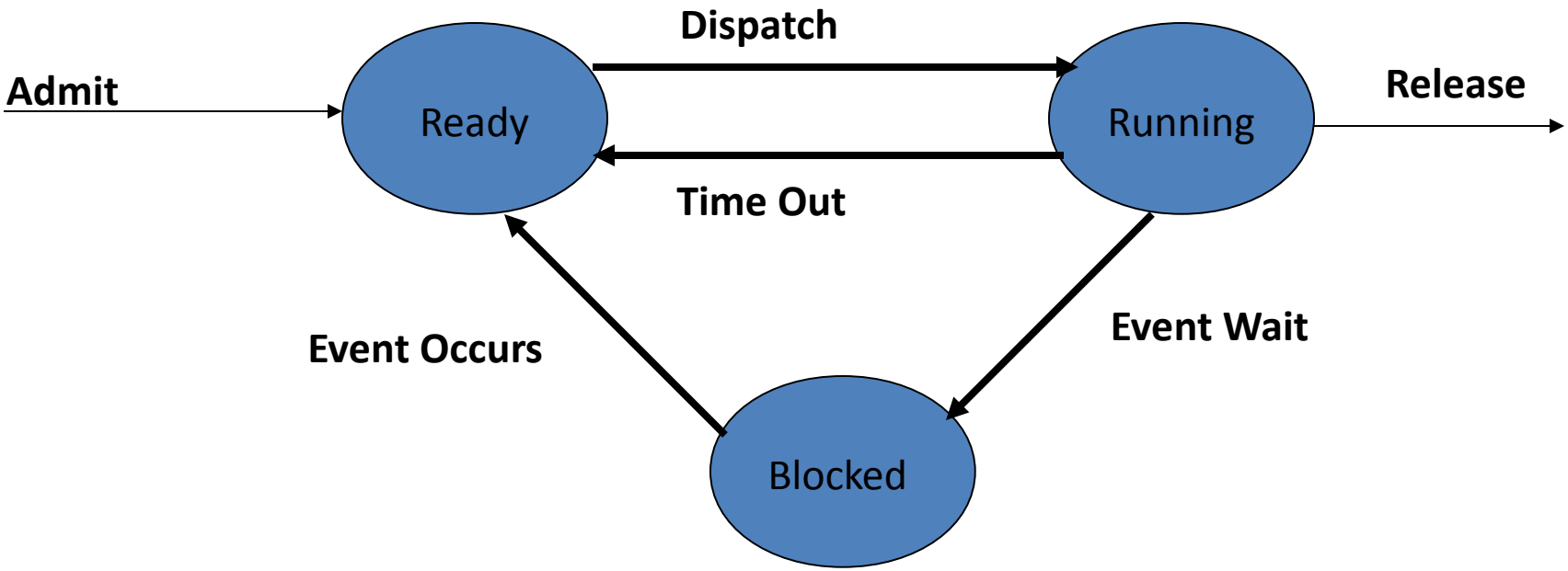
State Transition

- Not running to running state , transition occurs when
  - process in running state finishes execution
  - Makes an I/O request
  - Time slice for executing process expires
- Running to not running state transition occurs when
  - Running process makes an I/O request
  - Time slice of executing process expires

Dispatcher

- Dispatcher schedules a Ready process to CPU for execution.
- In Two State model Not running state contains processes which are :
  - Ready to run
  - Blocked
- Dispatcher is required to linearly search the queue to find Ready to run process which Increases dispatcher overhead.

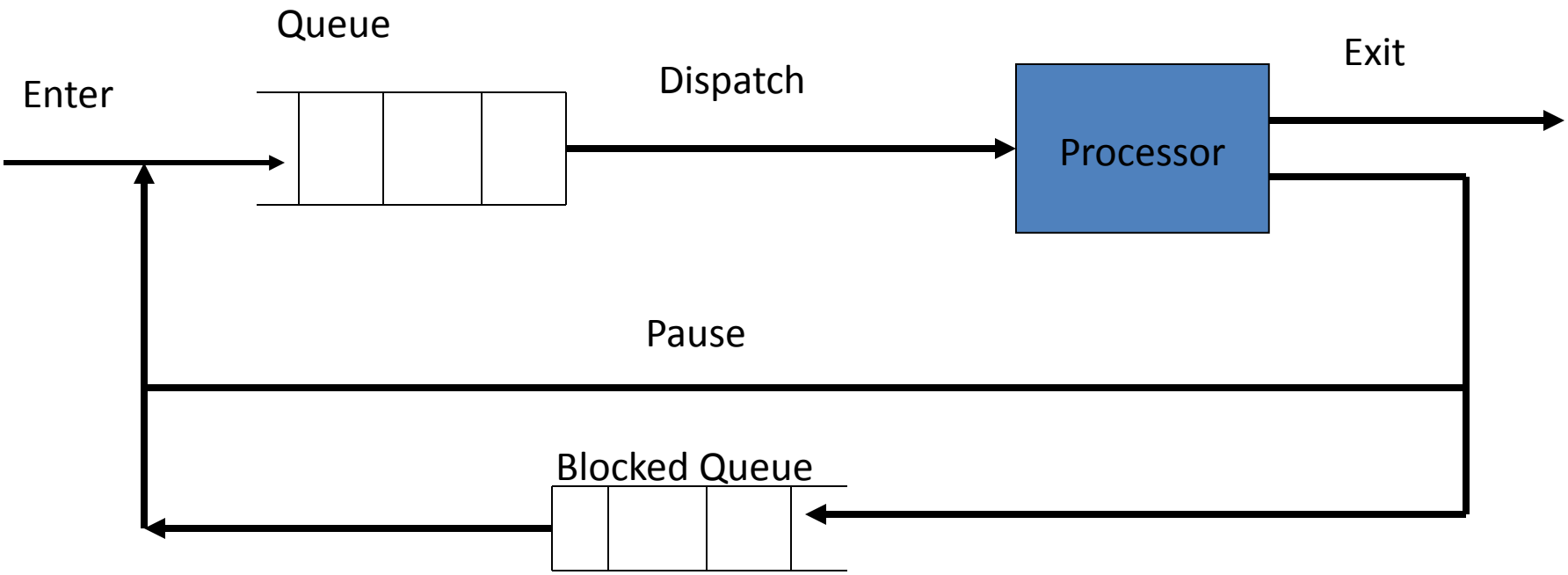
Three State Model



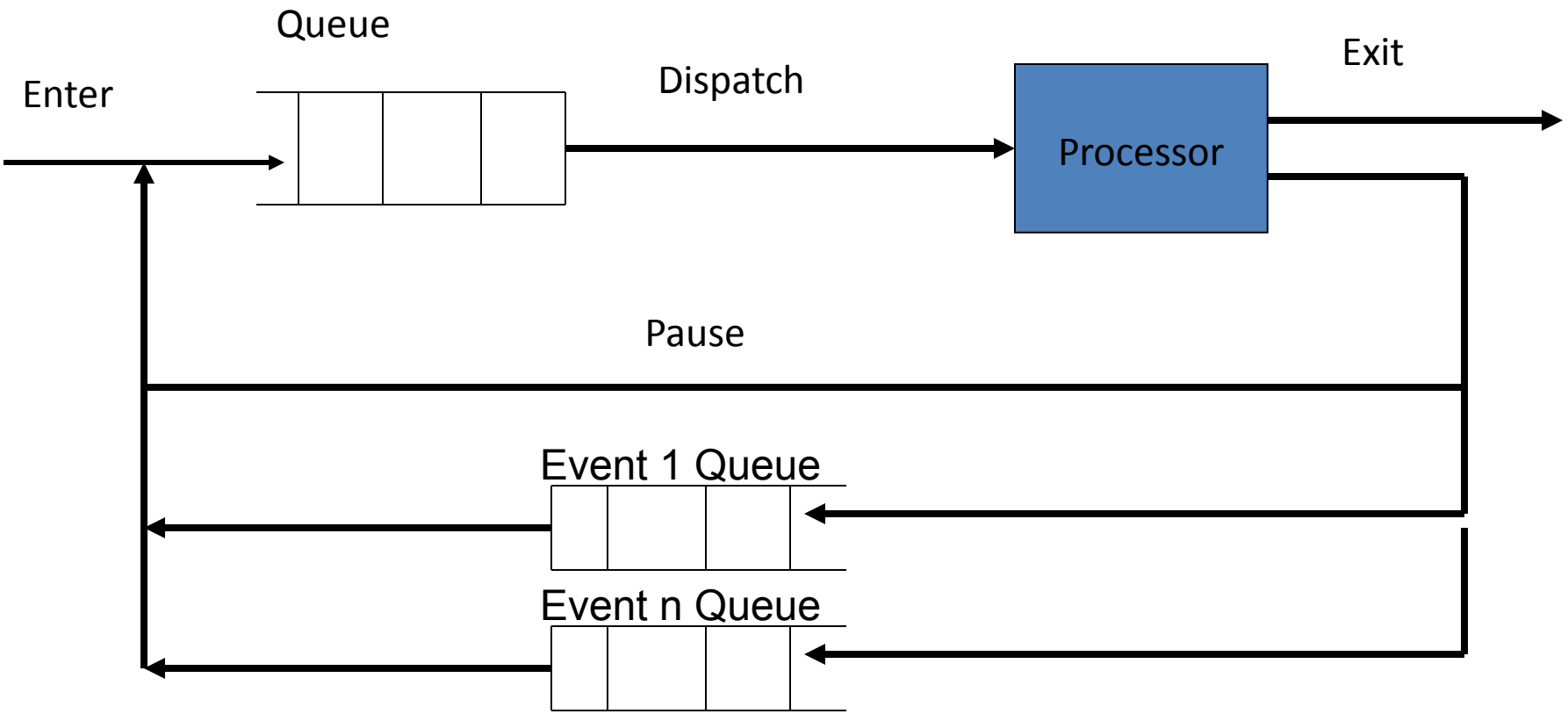
Process States

- **Running**: The process that is currently being executed
- **Ready**: A process that is prepared to execute when given the opportunity
- **Blocked** : A process that can not execute until some events occur
- Occurrence of event is usually indicated by interrupt signal

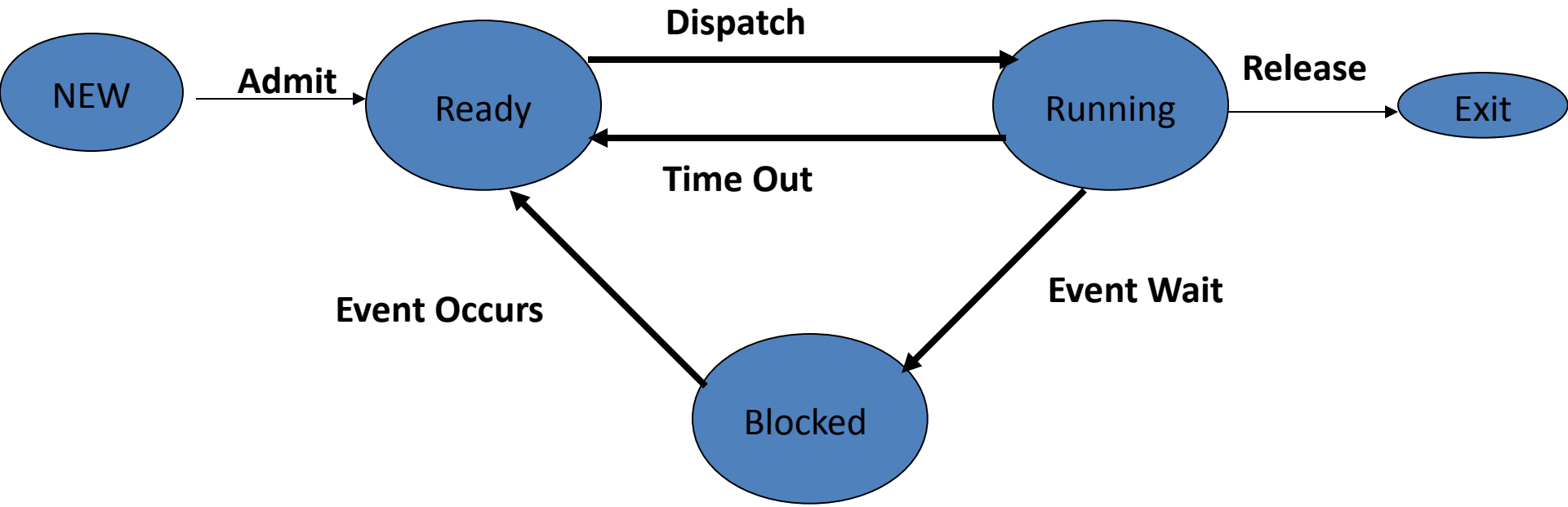
Queuing Diagram



Queuing Diagram



Five State Model



Why do we need “New” state

- Whenever a job is submitted , OS creates data structure for keeping track of the process context and then it tries to load the process. While loading the process
  - System May not have enough memory to hold the process
  - If we attempt to load Jobs as they are submitted, there may not be enough resource to execute processes in efficient manner
  - To efficiently execute processes, system may put a maximum limit on processes in ready queue

Valid State Transitions

- New to ready
- Ready to running
- Running to exit
- Running to ready
- Running to blocked
- Blocked to ready
- Ready to exit
- Blocked to exit

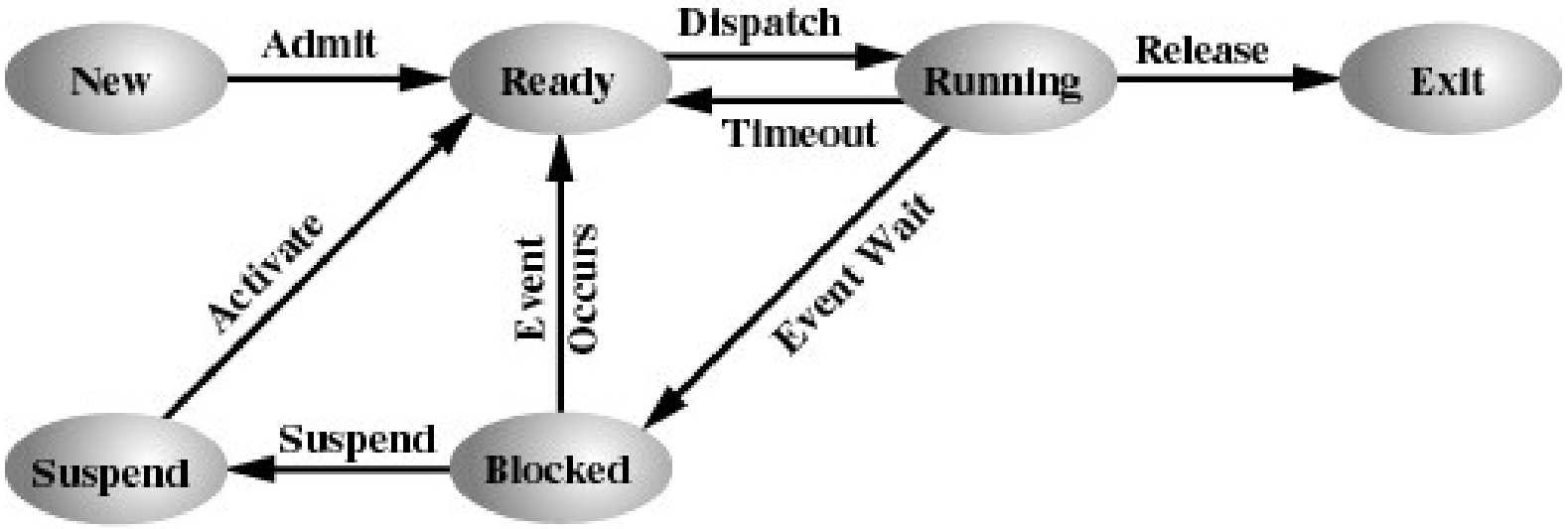
Consider a scenario

All ready processes get blocked on I/O one by one, the system tries to bring in a process from new to ready state and it is found no memory is available to accommodate this process

Q. What do we do ?

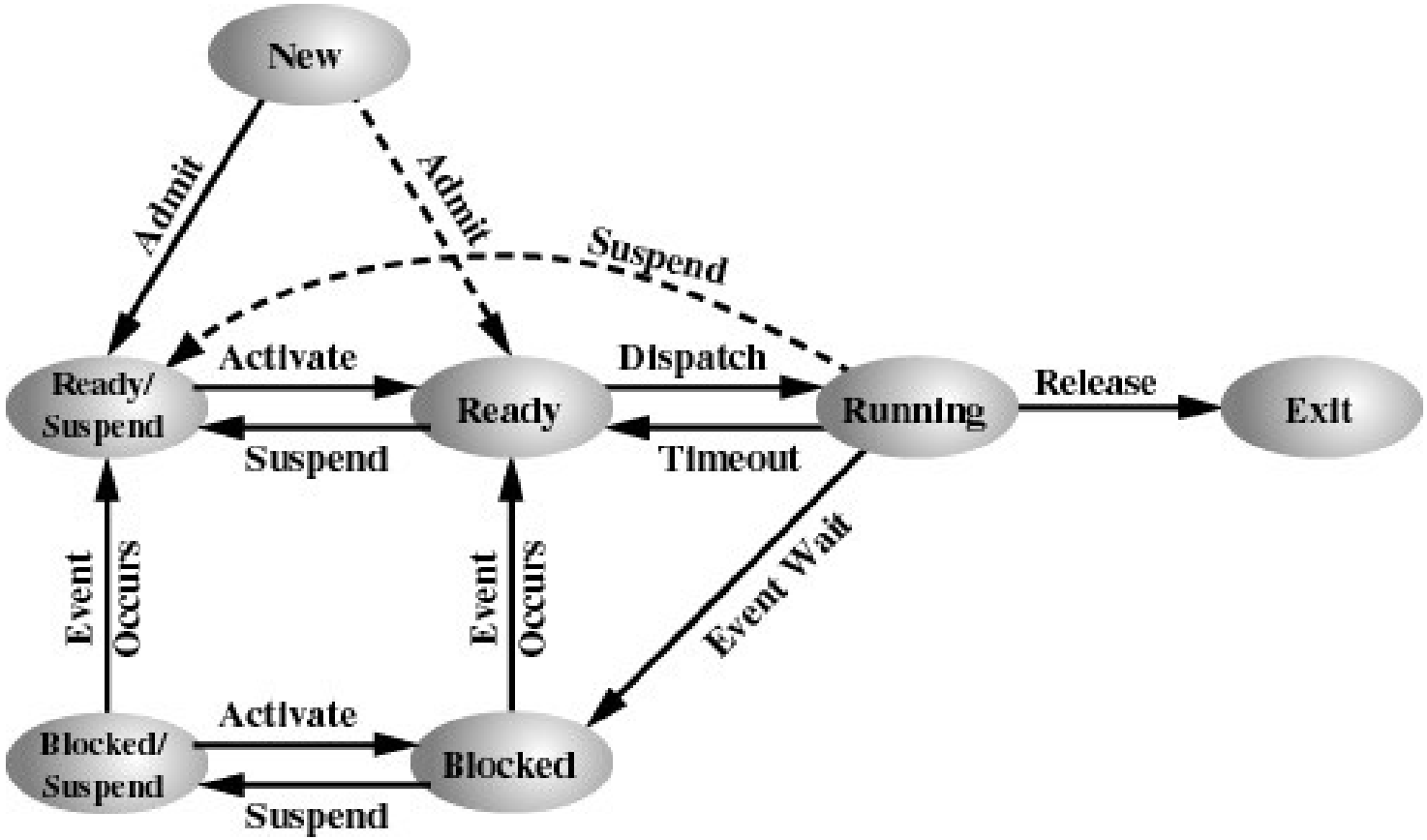
Ans. Swapping

One Suspend State



(a) With One Suspend State

Two Suspend State



(b) With Two Suspend States

State Transitions

- Blocked ⟶ Blocked/suspended:
  - If Ready queue is empty and insufficient memory is available then one of the blocked process can be swapped out
  - If currently running process requires more memory
  - If OS determines that ready process will require more memory

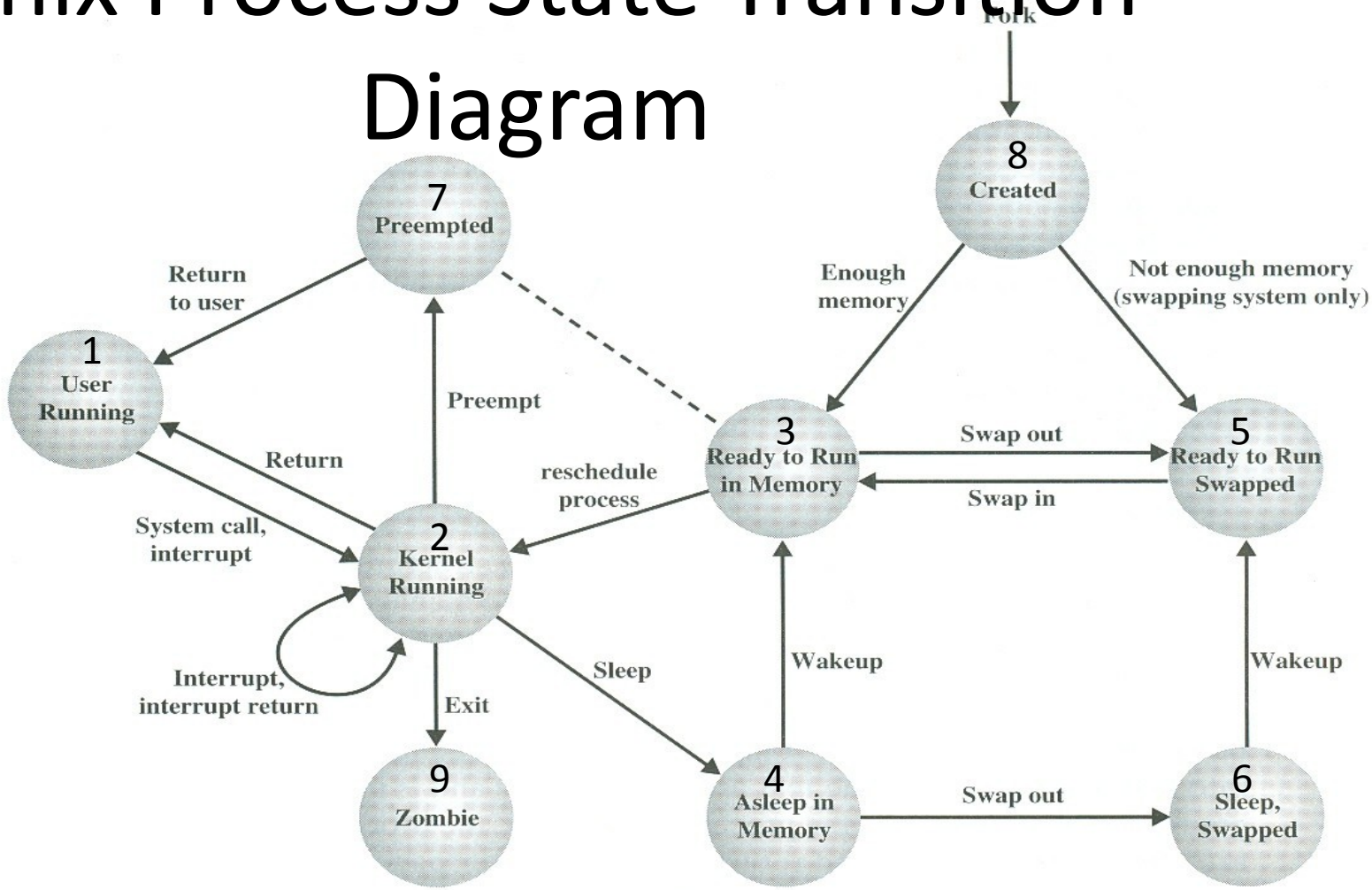
State Transitions

- Blocked/ Suspended → Ready/suspended
  - When the event for which process has been waiting occurs
- Note :
  - State information concerning to suspended process must be accessible to the OS.
- Ready-suspended → Ready
  - If Ready queue is empty

State Transitions

- Ready → Ready/Suspend
  - Normally a blocked process is suspended
  - Suspend Ready process if it is the only way to free memory
  - Suspend a lower priority ready process than higher priority blocked process ?
- Blocked Suspended → Blocked
- Running → Ready suspended
- Various → Exit

Unix Process State Transition Diagram



UNIX Process State Transition Diagram

Unix Process State Transition

1. Process is executing in user mode
2. Process is executing in kernel mode
3. Process is ready to run as soon as kernel schedules it
4. Process is sleeping in memory
5. Process is ready to run but swapper must bring process into main memory
6. Swapped out to secondary storage
7. Process is returning from kernel to user mode but kernel preempts it and schedule another process
8. Newly created process: this state is start state for all processes except process 0

Unix System V

- Unix uses two categories of process
  - **System Process** : Runs in kernel mode and performs administrative and house keeping functions such as memory allocation, process swapping, scheduling etc.
  - **User Process** : Runs in user Mode to execute user program and utilities and in kernel mode to execute instructions belonging to kernel
- A user process enters in kernel mode
  - by issuing a system call or
  - exception / interrupt

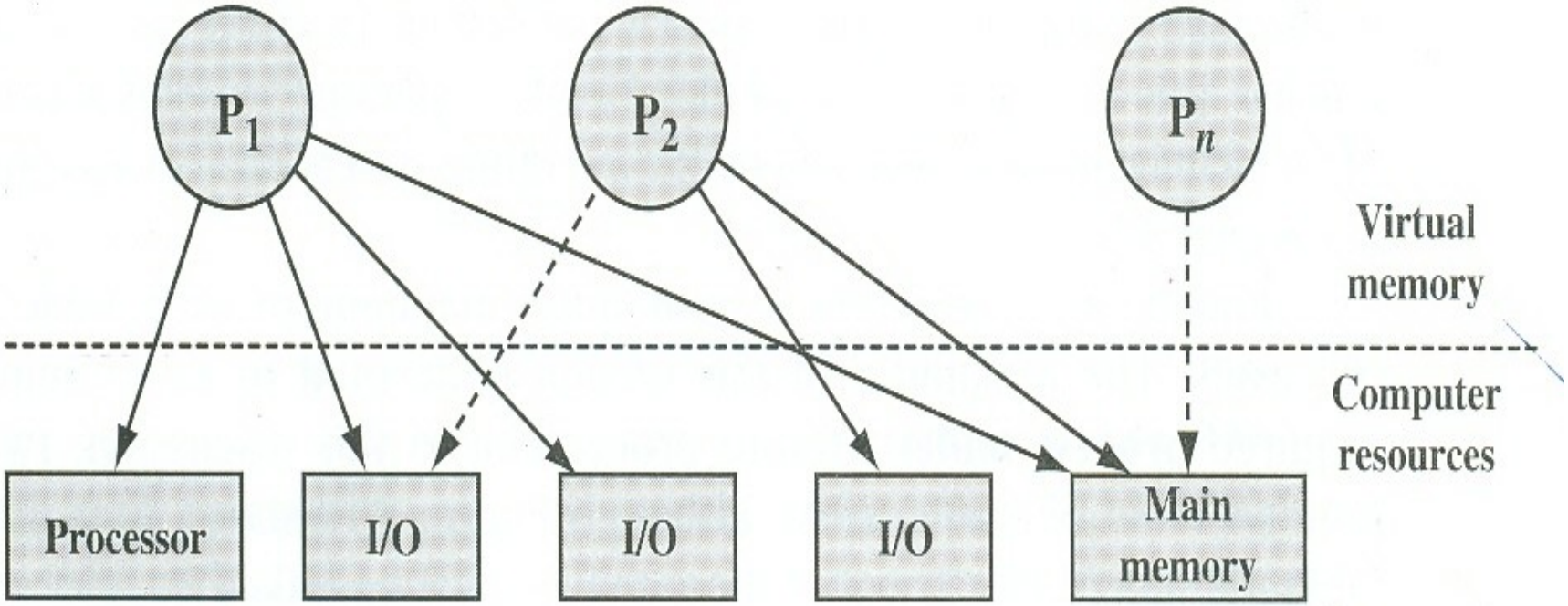
Process 0 & Process 1

- Process 0 (Swapper Process) is predefined as data structure, loaded at boot time .
- Process 0 spawns process 1
- Process 1(Init Process) is ancestor of all other processes except process 0

Process Summary

- Process is an instance of executing program
- In multiprogramming environment number of process can reside in system
- At any instance of time processes can be in different state such as ready, Blocked, Running etc. and processes move from one state to another state depending upon certain conditions.
- Processes use available system resources
- OS is responsible for managing all the processes in the system

Process & Resource at some instance of time



Process & resource snapshot at some instance of time

OS as Process Manager

- OS must have information about
  - the current state of processes
  - the current state of Resources in the system
- OS must keep track of utilization of resources by processes
- OS must constructs tables (control structure) to maintain information about each entity it is managing

OS as Process Manager

- To manage processes, OS maintains following tables
  - Memory Tables
  - I/O Table
  - File Table
  - Process table

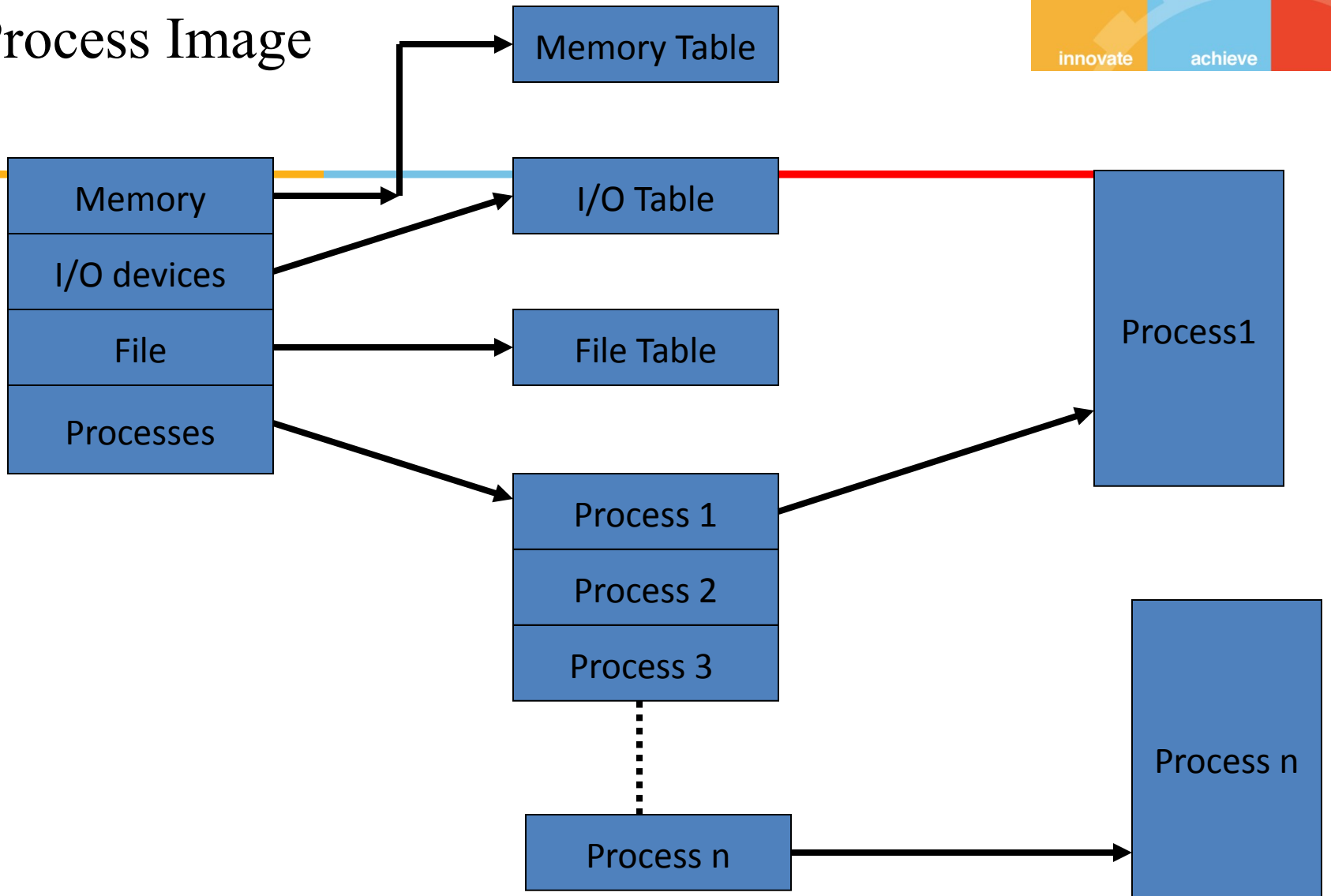
Memory Table & I/O Table

- **Memory Tables keep track**
  - of allocation of main memory to processes
  - of Allocation of secondary memory to processes
  - Of protection attributes of main & secondary memory such as which processes can access certain shared memory region
  - Information needed to manage ***virtual*** memory
- **I/O Table:** To keep track of
  - resource allocation,
  - resource availability
  - I/O request

File Table & Process Table

- **File Table**
  - Provide information about
  - Existence of file
  - Location on secondary memory
  - Current status and attributes of file
- **Process table**
  - keep track of processes

Process Image



Primary process Table

Process Image

- Process image consists of
  - User Data
  - User program
  - System Stack
  - Process control block
    - Containing processes attributes

Process Management

- To manage/control a process OS must know
  - Where process is located
  - Attributes of processes eg. Process id, state etc.
  - Collection of attributes are held in Process control block

Process Attributes

- Process identification
- Processor State Information
- Processes control information

Process Identification

- Identifier of the process
- Identifier of the process that created this process
- User identifier

Processor State Information

- User Visible registers
- Control and status registers
  - Program counter
  - Flags
  - Status register
- Stack pointer

Processes Control Information

- Scheduling and state information
- Inter process communication
- Process privileges
- Memory management
- Resource ownership & utilization

Functions of OS kernel

- Process Management
  - Process creation & termination
  - Process scheduling & dispatching
  - Process switching
  - Process synchronization & support for IPC
  - Management of process control block
- Memory Management
  - Allocation of address space to process
  - Swapping

Functions of OS kernel Cont…

- I/O Management
  - Buffer management
  - Allocation of I/O channels & devices to processes
- Support Services
  - Interrupt handling
  - Accounting
  - monitoring