Unit-2 Process Management & Deadlock

Lecture – 1

Process Concept

Memory Layout of the process

- **A process is defined as a program in execution**. It is an active entity.
- Each process has its own address space, and it is divided into different sections as shown in the following figure -1 .
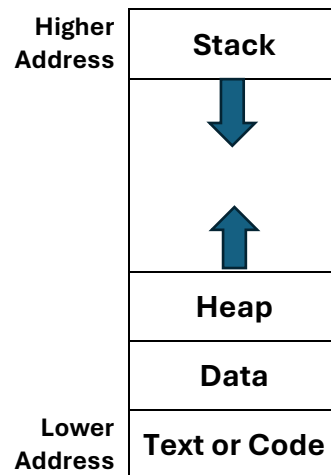

Figure – 1 Memory Layout of the process

- Text or Code Section
  - o It stores the code that the process executes and always present in the lower part of the memory.
  - o The size of the this section depends on the size of the code and its complexity.
- Data Section
  - o It contains global and static variables.
- Heap Section
  - o It is a memory which is dynamically allocated to the process during run time.
- Stack Section
  - o It contains temporary data such as function parameters, local variables, and return address.

Comparison of Program and Process

Process	Program
Process is a program in execution.	Program is a set of instructions written to perform a task.
It is an active entity because it performs actions and uses CPU, memory, etc.	It is a passive entity because it only contains code and does nothing by itself.
Process lasts only while the program is running.	The program stays until deleted.
Process is dynamic as it changes while running.	The program is static as it doesn't change while stored

Process Control Block

- Each process is represented in the operating system by a process control block (PCB), It is also called task control block or process descriptor.
- PCB can also be defined as the data structure maintained by the operating system which contains information about the process.
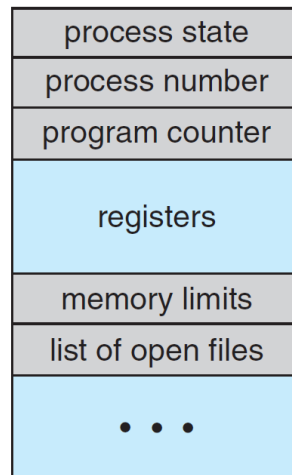- A PCB is shown in the following figure – 2

Figure – 2 Process Control Block

- The following information is stored in the process control block.
- Process state
    - o It contains current state of the process. It may be new, ready, running, waiting, and so on.
- Program counter
    - o It indicates the address of the next instruction to be executed for this process.
- CPU registers
    - o The OS saves the values of all CPU registers (like accumulator, stack pointer, etc.) in the PCB when a process is interrupted.
    - o When the process runs again, these values are restored, so the process continues exactly from where it was paused.
- CPU scheduling information
    - o This information includes a process priority, pointers to scheduling queues, and any other scheduling parameters.
- Memory management information
    - o It stores memory-related information like where the process's memory starts and ends, or page/segment tables, depending on how the OS manages memory.
- Accounting information
    - o This information includes the amount of CPU and real time used, time limits, account numbers, job or process numbers, and so on.
- I/O state information

o This information consists of the I/O devices assigned to the process, the list of files currently open, and other related details.

Process States (Process lifecycle).

- A process state refers to the current condition or status of a process during its lifecycle in the operating system i.e. it defines what the process is doing right now.
- There are five common process states: **NEW, READY, RUNNING, WAITING,** AND **TERMINATED**
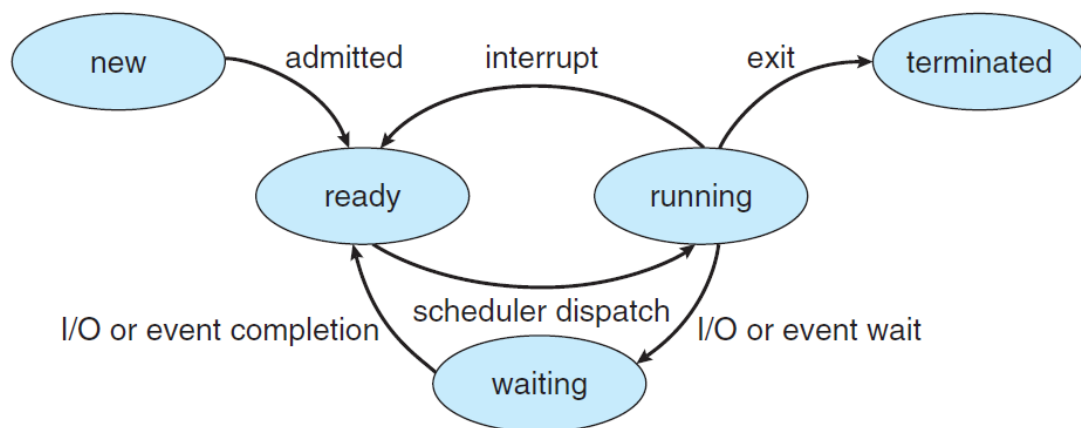- The state diagram corresponding to these states is shown in the figure-3 below.

Figure – 3 Process state diagram

- The Process State Diagram represents the various stages a process goes through during its lifetime in an operating system.
- **NEW**
    o The process is being created.
    o It hasn't yet been admitted into the process queue.
    o Memory and resources are allocated during this phase.
- **READY**
    o The process is loaded in memory and waiting for CPU time.
    o It is ready to execute but is waiting in the ready queue.
- **RUNNING**
    o The process is currently being executed on the CPU.
    o Only one process can be in this state per CPU core at a time.
- **WAITING**
    o The process is waiting for some I/O operation or event to complete (e.g., disk read, user input).
    o It cannot proceed until the I/O is done.
- **TERMINATED**
    o The process has finished execution or was forcefully killed.
    o The OS removes its PCB (Process Control Block) and reclaims resources.

- **Transition between the states**
    - New → Ready: Process is admitted to the ready queue.
    - Ready → Running: Scheduler selects the process to run.
    - Running → Waiting: Process requests I/O or an event.
    - Running → Ready: Process is interrupted (e.g., time slice expired).
    - Waiting → Ready: I/O or event completes.
    - Running → Terminated: Process completes or is killed.

References

- Operating System Concepts: Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Ninth Edition, Wiley India.
- https://www.geeksforgeeks.org/c/memory-layout-of-c-program/
- https://learn.microsoft.com/en-us/sysinternals/downloads/process-explorer
- https://www.youtube.com/watch?v=-ddfZ0atNAU