3.1 Process States and Process Control Block

Process States and Process Control Block (PCB)

What is a Process?

- A **process** is an instance of a program that is being executed. It contains the program code and its current activity. A process requires resources such as CPU time, memory, files, and I/O devices to accomplish its task.

Process States

A process can be in one of several states during its execution. The state represents the current status of the process in terms of its activity.

1. New:

- **Definition:** The process is being created.
- **Explanation:** The operating system has created the process, but it is not yet ready for execution. It is in the process of being initialized.

2. Ready:

- **Definition:** The process is ready to run but waiting for CPU time.
- **Explanation:** The process has all the resources it needs except the CPU. It is waiting in a queue for CPU allocation.

3. Running:

- **Definition:** The process is currently being executed by the CPU.
- **Explanation:** The process is actively using the CPU to perform its tasks. Only one process can be in this state on a single-core processor at any time.

4. Blocked/Waiting:

- **Definition:** The process is waiting for some event (like I/O completion) to occur.
- **Explanation:** The process cannot proceed until the event it is waiting for is completed, such as waiting for data from an input device.

5. Terminated/Exit:

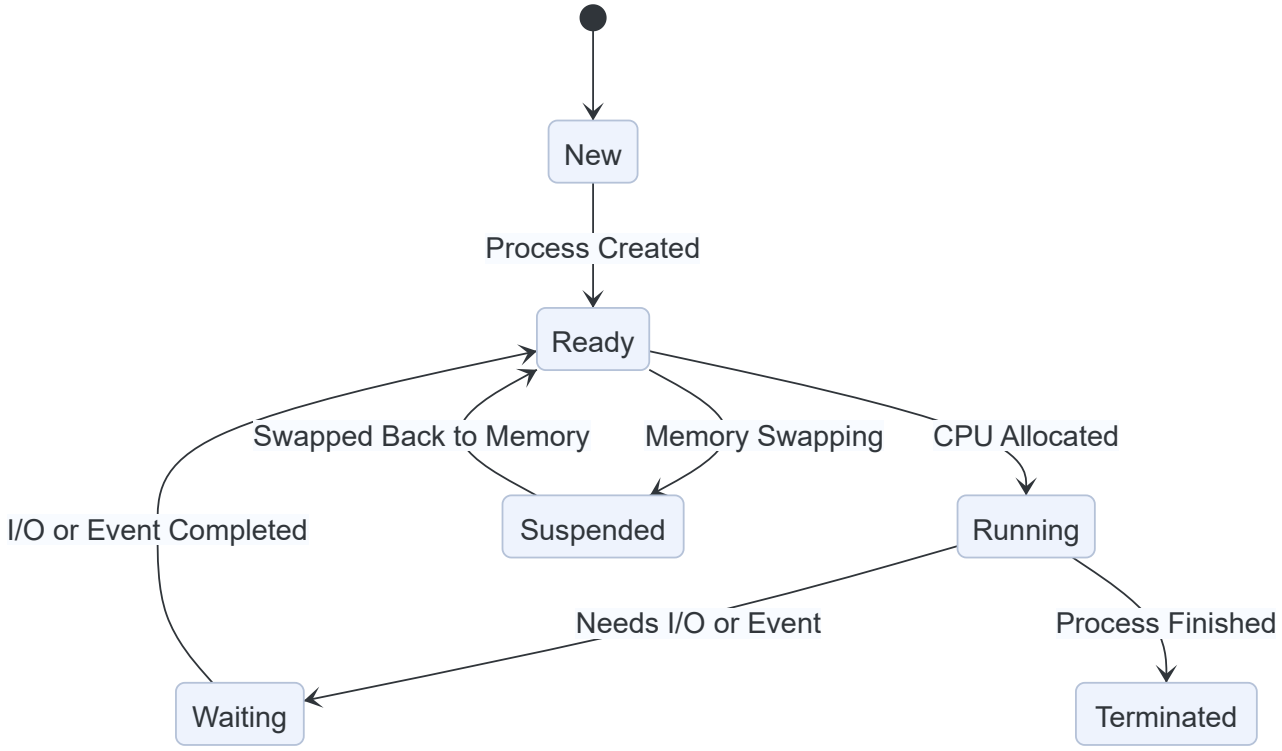
- **Definition:** The process has completed its execution.

- **Explanation:** The process has finished its task, and its resources are released back to the operating system.

6. Suspended/Swapped Out:

- **Definition:** The process is temporarily removed from main memory and stored on disk.
- **Explanation:** This is done to free up memory for other processes. The process will be brought back to the ready state when resources are available.

Diagram: Process State Transitions



Process Control Block (PCB)

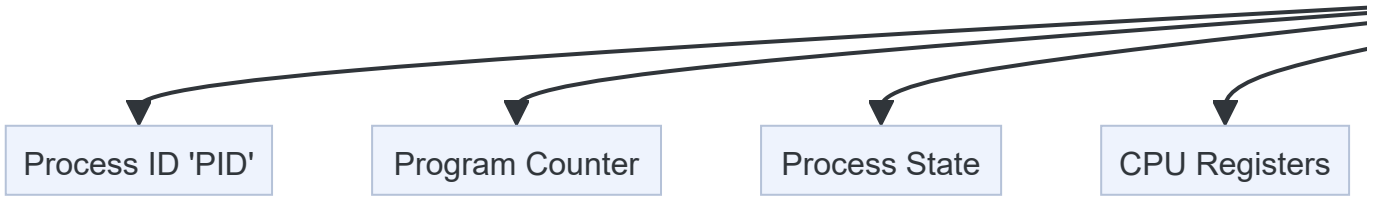
The **Process Control Block (PCB)** is a data structure used by the operating system to store all the information about a process.

Key Components of PCB:

Component	Description
Process ID (PID)	Unique identifier for the process.
Program Counter	Holds the address of the next instruction to be executed for the process.
Process State	Current state of the process (New, Ready, Running, etc.).
CPU Registers	Values of CPU registers for the process.
Memory Management Info	Information about the process's memory allocation, page tables, or segment tables.

Component	Description
I/O Status Information	List of I/O devices allocated to the process and their status.
Priority	Priority level of the process.
Accounting Info	Information related to CPU usage, time limits, job numbers, etc.
List of Open Files	Files currently opened by the process.

Diagram: Process Control Block Structure



Summary Table of Process States and PCB Components

Aspect	Description
Process States	Represents different stages a process can be in: New, Ready, Running, Waiting, Terminated, Suspended.
New State	Process is being created.
Ready State	Process is ready to run but waiting for CPU time.
Running State	Process is currently being executed by the CPU.
Blocked State	Process is waiting for an event or I/O operation to complete.
Terminated State	Process has completed execution and is released from memory.
Suspended State	Process is temporarily removed from memory to disk.
PCB Components	Key data structure storing process information: PID, Program Counter, State, CPU Registers, Memory Management Info, I/O Status, Priority, etc.

Explanation in Simple Terms:

- A **process** is like a person doing a job on a computer. It has different stages, like starting the job (New), waiting for its turn (Ready), doing the job (Running), waiting for something (Blocked), or finishing (Terminated).
- The **Process Control Block (PCB)** is like a file folder that keeps all the information about the person doing the job, such as their ID, what they are doing, and what they need to do next.

Different Perspectives and Scenarios:

1. **Example in a Classroom:**
   - Imagine students (processes) taking turns to use a computer (CPU). Each student waits in line (Ready), uses the computer (Running), waits for their turn again (Blocked), or finishes their assignment (Terminated).

2. **Scenario in an Operating System:**
   - A process may be downloading a file (Blocked state while waiting for I/O) or waiting to execute a function (Ready state). Once it has access to the CPU, it performs its task (Running state).

3. **Real-World Example:**
   - Your phone running multiple apps: When you switch between apps, some may be running (like music playing), some are in the background waiting (Ready), and others might be paused (Blocked).