Operating System: Process, Program, and Process Management

1) Process

A process is basically a program in execution. The execution of a process must progress in a sequential fashion.

To put it in simple terms, we write our computer programs in a text file and when we execute this program, it becomes a process which performs all the tasks mentioned in the program. Process operations can be easily controlled with the help of PCB (Process Control Block).

You can consider it as the brain of the process, which contains all the important information related to processing like process id, priority, state, CPU registers, etc. The Process Control Block is also known as a (Task Control Block). A process contains three components:

- An executable program.
- The associated data needed by the program (variables, workspace، buffers, etc.).
- The execution context (or "process state") of the program.

When a program is loaded into the memory and it becomes a process، it can be divided into four sections - stack, heap, data and text. The following image shows a simplified layout of a process inside main memory.

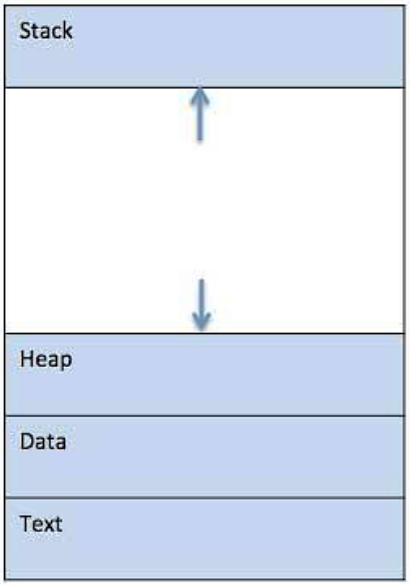

Fig. Shows a simplified layout of a process inside main memory

Process Components & Description in memory

1. **Stack:**

   The process Stack contains the temporary data such as method/function parameters, return address and local variables.

2. **Heap:**

   This is dynamically allocated memory to a process during its run time.

3. **Data:**

   This section contains the global and static variables.

4. **Text:**

   This includes the current activity represented by the value of Program Counter and the contents of the processor's registers.

2) Program

A program is a piece of code that may be a single line or millions of lines. A computer program is usually written by a computer programmer in a programming language. For example, here is a simple program that is written in C programming language:

```
#include <stdio.h>
int main() {
        printf("Hello, World! \n");
        return 0;
        }
```

A computer program is a collection of instructions that performs a specific task when executed by a computer. When we compare a program with a process, we can conclude that a process is a dynamic instance of a computer program.

A part of a computer program that performs a well-defined task is known as an algorithm. A collection of computer programs, libraries and related data are referred to as a software.

3) Process Management

Process Life Cycle or Process State: When a process executes, it passes through different states. These states may differ in different operating systems, and the names of these states are also not standardized. In general, a process can have one of the following five states at a time.

1. **Start:**

   This is the initial state when a process is first started/created.

2. **Ready:**

   The process is waiting to be assigned to a processor. Ready processes are waiting to have the processor allocated to them by the operating system so that they can run. Process may come into this state after Start state or while running it by but interrupted by the scheduler to assign CPU to some other process.

3. **Running:**

   Once the process has been assigned to a processor by the OS scheduler, the process state is set to running and the processor executes its instructions.

4. **Waiting:**

   Process moves into the waiting state if it needs to wait for a resource, such as waiting for user input, or waiting for a file to become available.

5. **Terminated or Exit:**

   Once the process finishes its execution, or it is terminated by the operating system, it is moved to the terminated state where it waits to be removed from main memory.

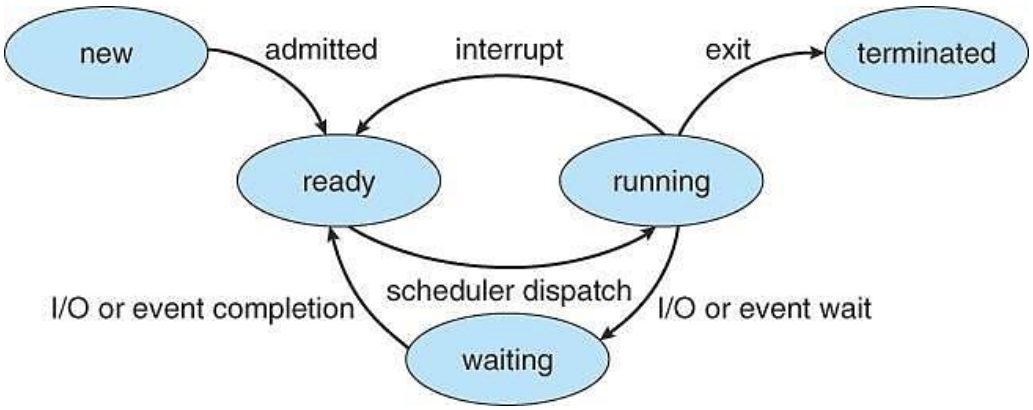

Fig: Diagram of Process Life Cycle or Process State