Module – II
Process Management

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Process Concept

A *process* is a program in execution. A process is more than the program code, which is sometimes known as the **text section**. It also includes the current activity, as represented by the value of the **program counter** and the contents of the processor's registers. In addition, a process generally includes the **process stack**, which contains temporary data (such as method parameters, return addresses, and local variables), and a **data section**, which contains global variables.

A program is a passive entity, such as the contents of a file stored on disk, whereas a process is an active entity, with a program counter specifying the next instruction to execute and a set of associated resources.

Process State

As a process executes, it changes state. The state of a process is defined in part by the current activity of that process. Each process may be in one of the following states:

- **New:** The process is being created.
- **Running:** Instructions are being executed.

- **Waiting:** The process is waiting for some event to occur (such as an I/O completion or reception of a signal).
- **Ready:** The process is waiting to be assigned to a processor.
- **Terminated:** The process has finished execution.

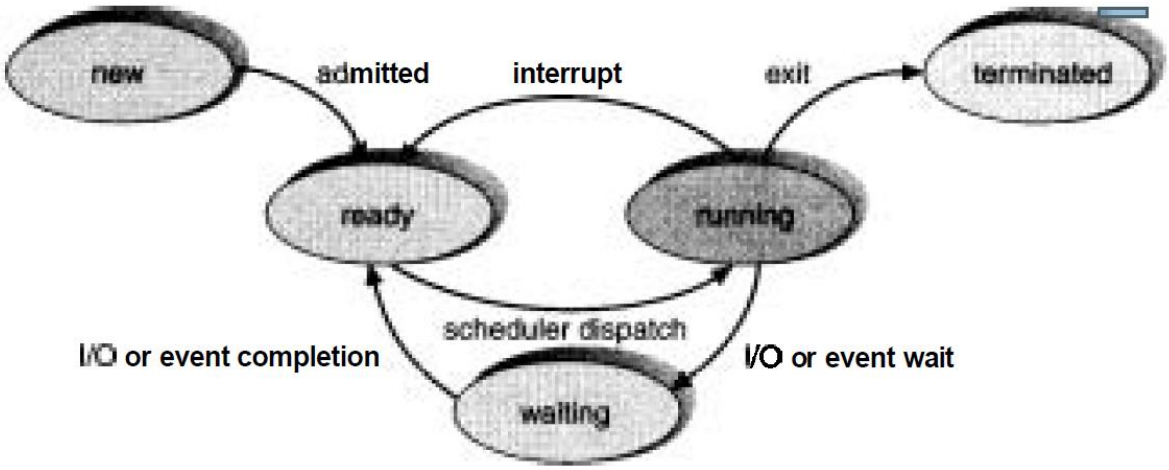


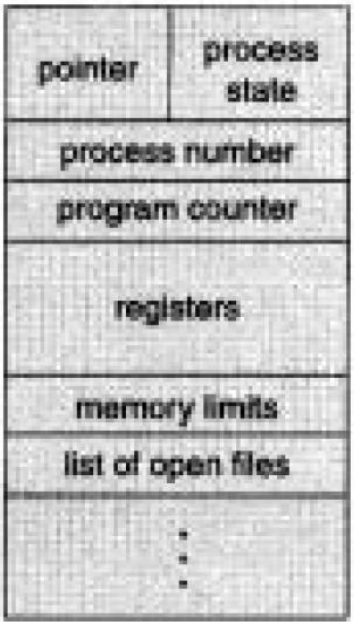
Figure 4.1 Diagram of process state.

Only one process can be running on any processor at any instant, although many processes may be ready and waiting. The state diagram corresponding to these states is presented in Figure 4.1.

Process Control Block

Each process is represented in the operating system by a process control block (PCB)-also called a task control block. A PCB is shown in Figure below. It contains many pieces of information associated with a specific process, including these:

Fig: Process Control Block



Process state: The state may be new, ready, running, waiting, halted, and so on.

Program counter: The counter indicates the address of the next instruction to be executed for this process.

CPU registers: The registers vary in number and type, depending on the computer architecture. They include accumulators, index registers, stack pointers, and general-purpose registers, plus any condition-code information. Along with the program counter, this state information must be saved when an interrupt occurs, to allow the process to be continued correctly afterward.

CPU-scheduling information: This information includes a process priority, pointers to scheduling queues, and any other scheduling parameters.

Memory-management information: This information may include such information as the value of the base and limit registers, the page tables, or the segment tables, depending on the memory system used by the operating system.

Accounting information: This information includes the amount of CPU and real time used, time limits, account numbers, job or process numbers, and so on.

Status information: The information includes the list of I/O devices allocated to this process, a list of open files, and so on.

The PCB simply serves as the repository for any information that may vary from process to process.

Scheduling Criteria

CPU utilization: We want to keep the CPU as busy as possible. CPU utilization may range from 0 to 100 percent. In a real system, it should range from 40 percent (for a lightly loaded system) to 90 percent (for a heavily used system).

Throughput: If the CPU is busy executing processes, then work is being done. One measure of work is the number of processes completed per time unit, called throughput. For long processes, this rate may be 1 process per hour; for short transactions, throughput might be 10 processes per second.

Turnaround time: From the point of view of a particular process, the important criterion is how long it takes to execute that process. The interval from the time of submission of a process to the time of completion is the turnaround time. Turnaround time is the sum of the periods spent waiting to get into memory, waiting in the ready queue, executing on the CPU, and doing I/O.

Waiting time: The CPU-scheduling algorithm does not affect the amount of time during which a process executes or does I/O; it affects only the amount of time that a process spends waiting in the ready queue. Waiting time is the sum of the periods spent waiting in the ready queue.

Response time: Another measure is the time from the submission of a request until the first response is produced. This measure, called response time, is the amount of time it takes to start responding, but not the time that it takes to output that response. The turnaround time is generally limited by the speed of the output device.

We want to maximize CPU utilization and throughput, and to minimize turnaround time, waiting time, and response time.

Scheduling Algorithms

Done in class