

Deadlocks

- In a multiprogramming environment, several processes may compete for a finite number of resources.
- A process requests resources; if the resources are not available at that time, the process enters a waiting state.
- Sometimes, a waiting process is never again able to change state, because the resources it has requested are held by other waiting processes. This situation is called a deadlock.

Under the normal mode of operation, a process may utilize a resource in only the following sequence:

1. Request - The process requests the resource. If the request cannot be granted immediately (for example, if the resource is being used by another process), then the requesting process must wait until it can acquire the resource.

S	M	T	W	T	F	S
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

2. Use - The process can operate on the resource (for example, if the resource is a printer, the process can print on the printer).
3. Release - The process releases the resource.

Deadlock Characterization

- A deadlock situation can arise if the following four conditions hold simultaneously in a system:

1. Mutual exclusion - At least one resource must be held in a nonsharable mode; that is, only one process at a time can use the resource. If another process requests that resource, the requesting process must be delayed until the resource has been released.

2. Hold and wait - A process must be holding at least one resource and waiting to acquire additional resources that are currently being held by other processes.

3. No Preemption - Resources cannot be preempted; that is, a resource can be released only voluntarily by the process holding it, after that process has completed its task.

4. Circular wait - A set $\{P_0, P_1, \dots, P_n\}$ of waiting processes must exist such that P_0 is waiting for a resource held by P_1 , P_1 is waiting for a resource held by P_2, \dots, P_{n-1} is waiting for a resource held by P_n , and P_n is waiting for a resource held by P_0 .