SNS COLLEGE OF TECHNOLOGY

Coimbatore-35.

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COURSE NAME : OPERATING SYSTEMS

II YEAR/ IV SEMESTER

UNIT – II PROCESS SCHEDULING AND SYNCHRONIZATION

Topic: Deadlock avoidance

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Dead Lock Handling Methods
Dead lock Avoidance

- Requires that the system has some additional ***a priori*** information available
- Simplest and most useful model requires that each process declare the ***maximum number*** of resources of each type that it may need
- The deadlock-avoidance algorithm dynamically examines the resource-allocation state to ensure that there can never be a circular-wait condition
- Resource-allocation *state* is defined by the number of available and allocated resources, and the maximum demands of the processes

Dead Lock Handling Methods
Dead lock Avoidance-Safe State

When a process requests an available resource, system must decide if immediate allocation leaves the system in a safe state

System is in **safe state** if there exists a sequence $<P_1, P_2, \ldots, P_n>$ of ALL the processes in the systems such that for each P_i, the resources that P_i can still request can be satisfied by currently **available resources + resources** held by all the P_j, with $j < I$

That is:

If P_i resource needs are not immediately available, then P_i can wait until all P_j have finished

When P_j is finished, P_i can obtain needed resources, execute, return allocated resources, and terminate

When P_i terminates, P_{i+1} can obtain its needed resources, and so on

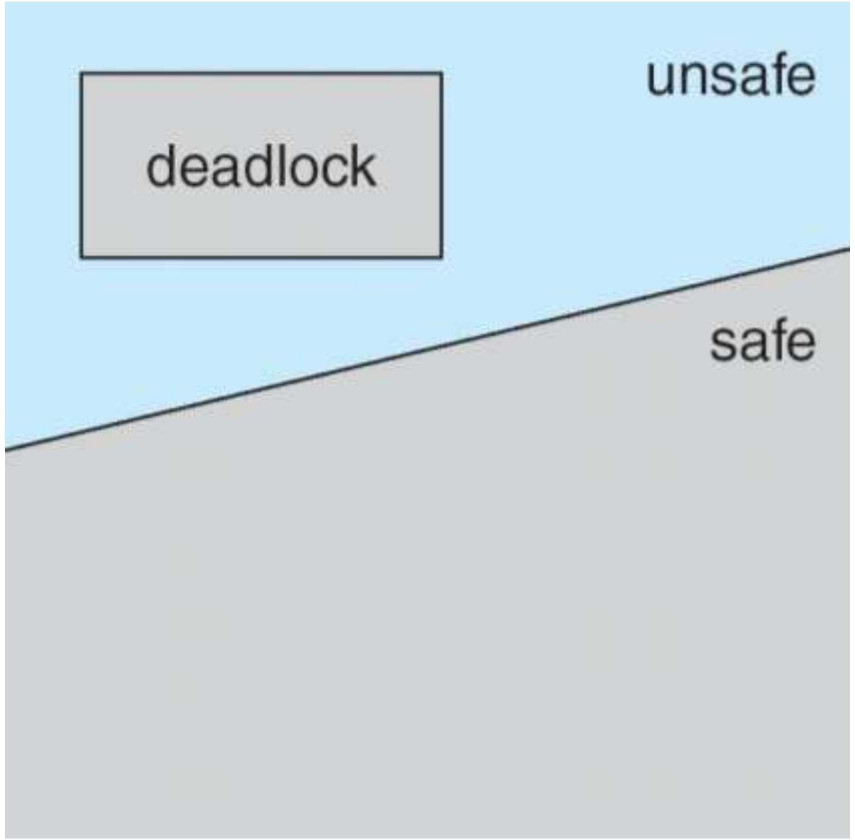
Dead Lock Handling Methods
Dead lock Avoidance-Safe State

Basic Facts

- If a system is in safe state ⇒ no deadlocks
- If a system is in unsafe state ⇒ possibility of deadlock
- **Avoidance ⇒ ensure that a system will never enter an unsafe state**.

Avoidance Algorithms

- **Single instance of a resource type**
  - Use a resource-allocation graph
- **Multiple instances of a resource type**
  - Use the banker's algorithm



Dead Lock Handling Methods

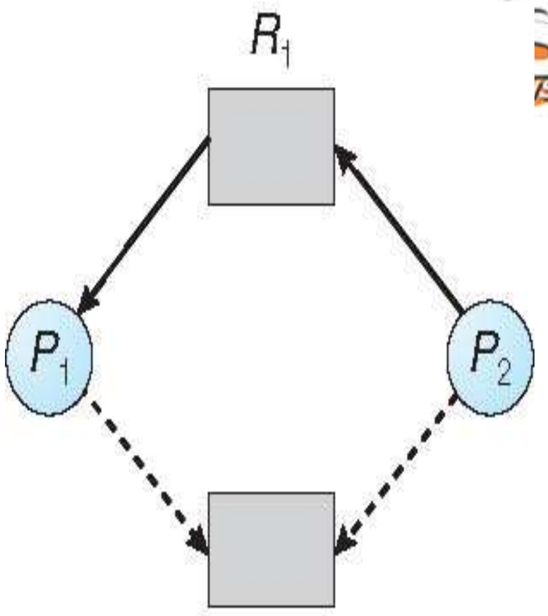
Claim edge $P_i \rightarrow R_j$ indicated that process P_j may request resource R_j; represented by a dashed line

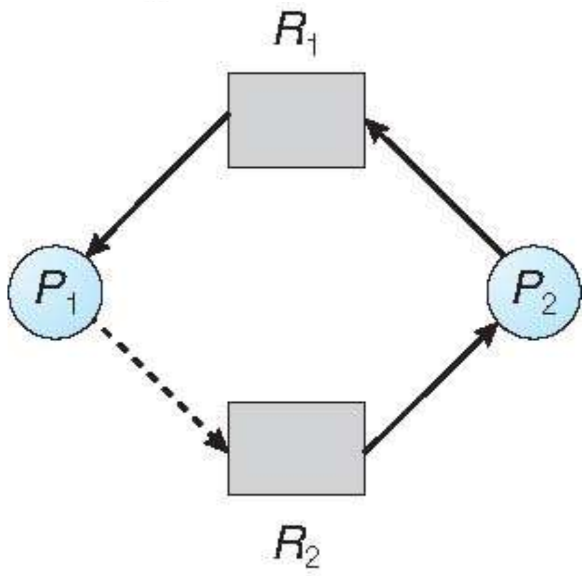
Claim edge converts to request edge when a process requests a resource

Request edge converted to an assignment edge when the resource is allocated to the process

When a resource is released by a process, assignment edge reconverts to a claim edge

Resources must be claimed *a priori* in the system





Dead Lock Handling Methods

Resource-allocation graph Algorithms

- Suppose that process P_i requests a resource R_j
- The request can be granted only if converting the request edge to an assignment edge does not result in the formation of a cycle in the resource allocation graph

Dead Lock Handling Methods
Avoidance Algorithms-Bankers Algorithm

Multiple instances

Each process must a priori claim maximum use

When a process requests a resource it may have to wait

When a process gets all its resources it must return them in a finite amount of time

Data Structures for the Banker's Algorithm

Let n = number of processes, and m = number of resources types.

- **Available**: Vector of length m. If available $[j] = k$, there are k instances of resource type R_j available
- **Max**: n x m matrix. If *Max* $[i,j] = k$, then process P_i may request at most k instances of resource type R_j
- **Allocation**: n x m matrix. If Allocation$[i,j] = k$ then P_i is currently allocated k instances of R_j
- **Need**: n x m matrix. If *Need*$[i,j] = k$, then P_i may need k more instances of R_j to complete its task

***Need* [*i,j*] = *Max*[*i,j*] – *Allocation* [*i,j*]**

Safety Algorithm

1. Let ***Work*** and ***Finish*** be vectors of length *m* and *n*, respectively. Initialize:

   Work = Available

   ***Finish* [*i*] = *false* for *i* = 0, 1, …, *n*- 1**

2. Find an ***i*** such that both:

   (a) ***Finish* [*i*] = *false***

   (b) $\boldsymbol{Need_i \leq Work}$

   If no such ***i*** exists, go to step 4

3. $\boldsymbol{Work = Work + Allocation_i}$
   Finish*[*i*] = *true
   go to step 2

4. If ***Finish* [*i*] == *true*** for all ***i***, then the system is in a safe state

Resource-Request Algorithm for Process P_i

$Request_i$ = request vector for process P_i. If $Request_i[j] = k$ then process P_i wants k instances of resource type R_j

1. If $Request_i \leq Need_i$ go to step 2. Otherwise, raise error condition, since process has exceeded its maximum claim
2. If $Request_i \leq Available$, go to step 3. Otherwise P_i must wait, since resources are not available
3. Pretend to allocate requested resources to P_i by modifying the state as follows:

$$Available = Available - Request_i;$$

$$Allocation_i = Allocation_i + Request_i;$$

$$Need_i = Need_i - Request_i;$$

- If safe $\Rightarrow$ the resources are allocated to P_i
- If unsafe $\Rightarrow$ P_i must wait, and the old resource-allocation state is restored

Example of Banker's Algorithm

- 5 processes P_0 through P_4;
  3 resource types:
  A (10 instances), *B* (5instances), and *C* (7 instances)
- Snapshot at time T_0:

	Allocation	Max	Available
	A B C	*A B C*	*A B C*
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

Example (Cont.)

- The content of the matrix ***Need*** is defined to be ***Max – Allocation***

	Need
	A B C
P_0	7 4 3
P_1	1 2 2
P_2	6 0 0
P_3	0 1 1
P_4	4 3 1

- The system is in a safe state since the sequence < P_1, P_3, P_4, P_2, P_0> satisfies safety criteria

Example: P_1 Request (1,0,2)

- Check that Request ≤ Available (that is, (1,0,2) ≤ (3,3,2) ⇒ true

	Allocation	*Need*	*Available*
	A B C	*A B C*	*A B C*
P_0	0 1 0	7 4 3	2 3 0
P_1	3 0 2	0 2 0	
P_2	3 0 2	6 0 0	
P_3	2 1 1	0 1 1	
P_4	0 0 2	4 3 1	

- Executing safety algorithm shows that sequence < P_1, P_3, P_4, P_0, P_2> satisfies safety requirement
- Can request for (3,3,0) by P_4 be granted?
- Can request for (0,2,0) by P_0 be granted?

References

1. Silberschatz, Galvin, and Gagne, “Operating System Concepts”, Ninth Edition, Wiley India Pvt Ltd, 2009.
2. Andrew S. Tanenbaum, “Modern Operating Systems”, Fourth Edition, Pearson Education, 2010.

Thank you