Scheduling Algorithm and Analysis

RT Synchronization Protocol

(Module 35)

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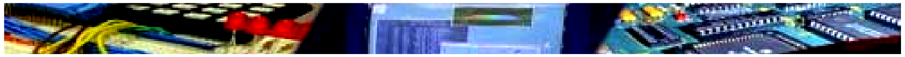
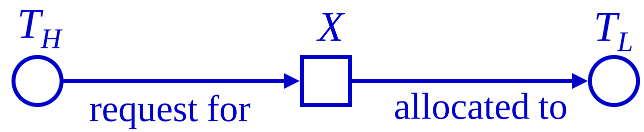
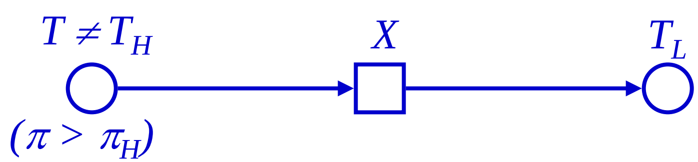


Blocking in PCP

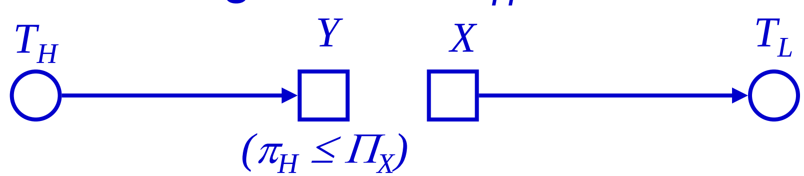
- **A task T_H can be blocked by a lower-priority task T_L in three ways:**
  - directly, i.e.

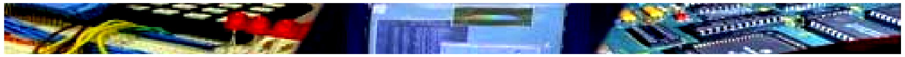


  - when T_L inherits a priority higher than the priority π_H of T_H.



  - When T_H requests a resource the priority ceiling of resources held by T_L is equal to or higher than π_H:



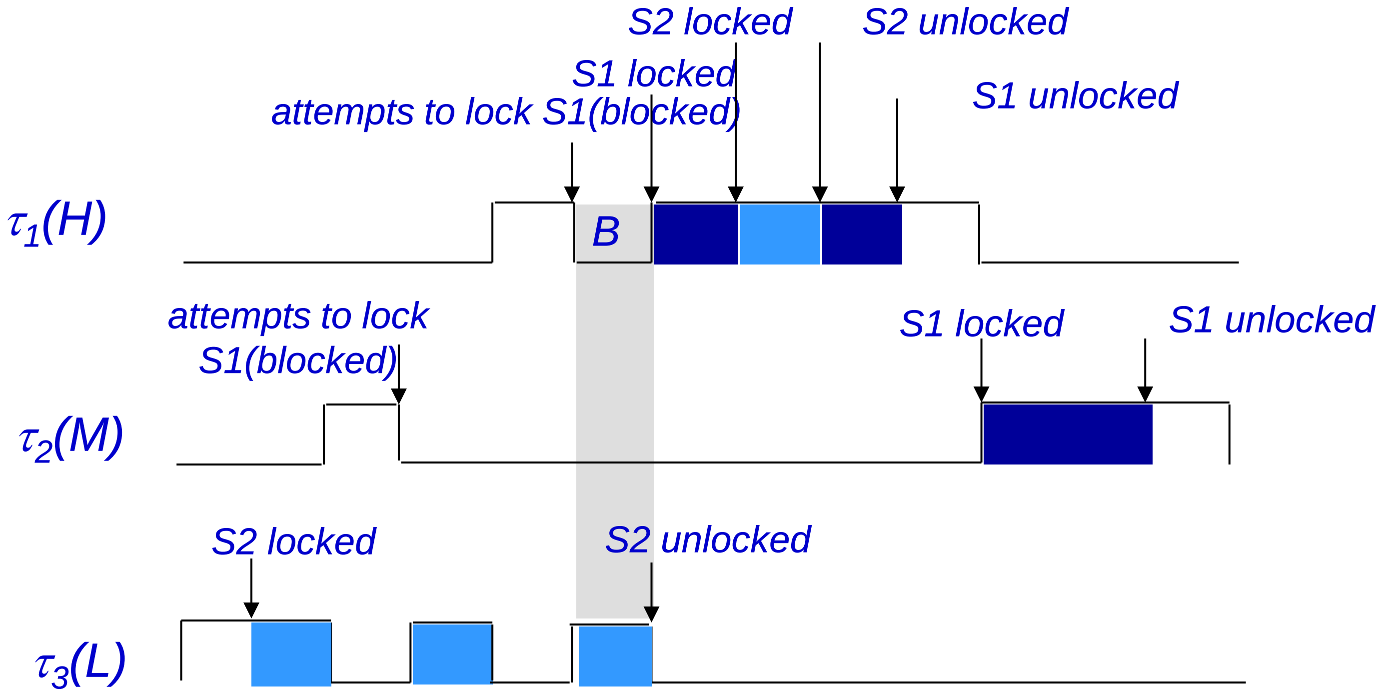


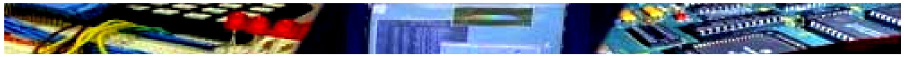
Blocked At Most Once (PCP)

τ_1:{…P(S1)…P(S2)…V(S2)…V(S1)…}

τ_2:{…P(S1)…V(S1)…}

τ_3:{…P(S2)…V(S2)…}

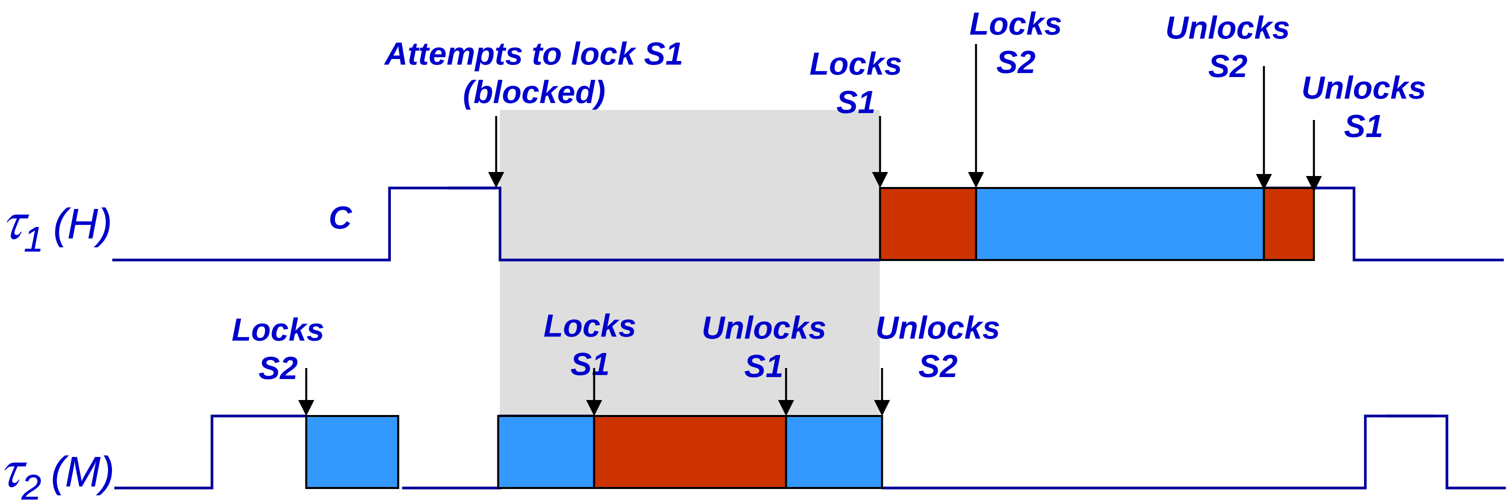


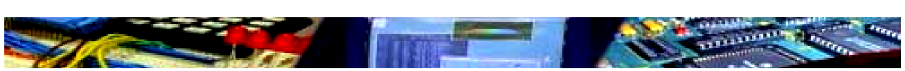


Deadlock Avoidance: Using PCP

τ_1 :{…P(S1)…P(S2)…V(S2)…V(S1)..}

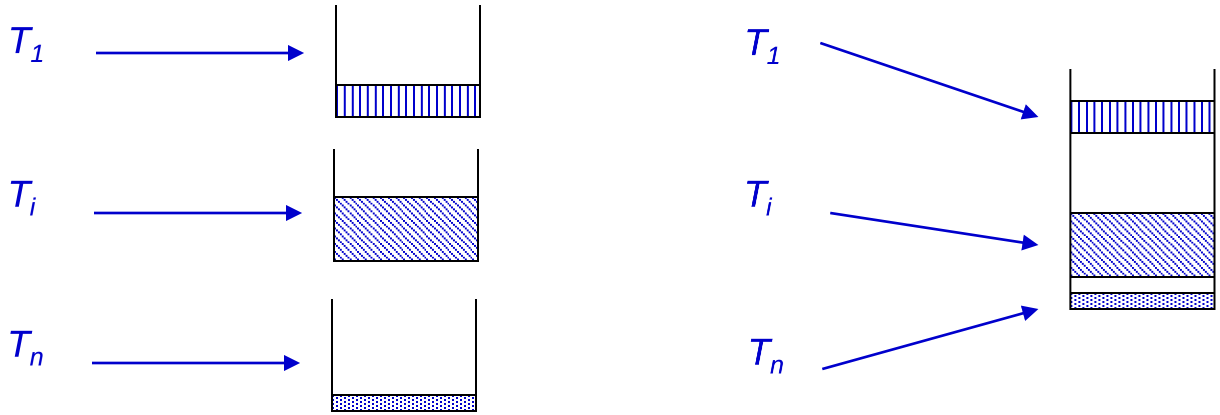
τ_2 :{…P(S2)…P(S1)…V(S1)…V(S2)..}





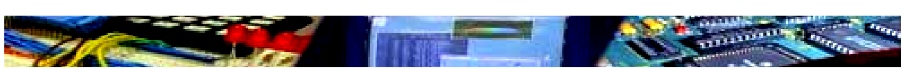
Stack Sharing

- **Sharing of the stack among tasks eliminates stack space fragmentation and so allows for memory savings:**



no stack sharing   *stack sharing*

- **However:**
  - Once job is preempted, it can only resume when it returns to be on top of stack.
  - Otherwise, it may cause a deadlock.
  - Stack becomes a resource that allows for "one-way preemption".



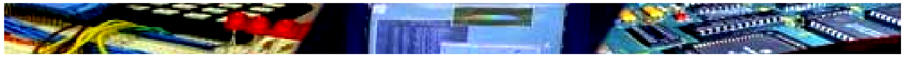
Stack-Based Priority Ceiling Protocol

- **<u>To avoid deadlocks</u>: Once execution begins, make sure that job is not blocked due to resource access**
  - allow preemption only if the priority is higher than the ceiling of the resources in use

- **Update Current Ceiling in the usual manner**
  - If no resource allocated, $\Pi_S(t) = \Omega$
- **Scheduling Rule:**
  - J_i released and blocked until $\pi_i(t) > \Pi_S(t)$
  - When not blocked jobs are scheduled in the usual manner.
- **Allocation Rule:**
  - Allocate when requested

Stack-Based PCP (cont)

- **The Stack-Based Priority-Ceiling Protocol is** deadlock-free**:**
  - When a job begins to execute, all the resources it will ever need are free.
  - Otherwise, $\Pi_S(t)$ would be higher or equal to the priority of the job.
  - Whenever a job is preempted, all the resources needed by the preempting job are free.
  - The preempting job can complete, and the preempted job can resume.
- **Worst-case blocking time of Stack-Based Protocol is the same as for Basic Priority Ceiling Protocol.**
- **Stack-Based Protocol smaller context-switch overhead**
  - 2 context switches since once execution starts, job cannot be blocked (may be preempted)
  - 4 context switches for PCP since a job may be blocked at most once



Supplementary Slides