

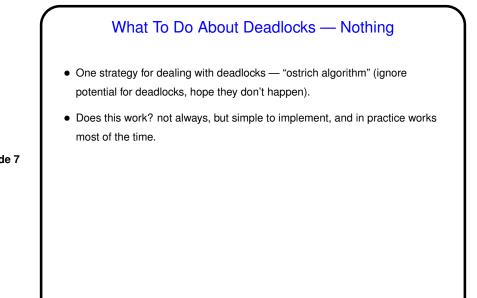
Slide 4

	Resources
Slide 5	 "Resource" is anything that should be used by only one process at a time — hardware device, piece of information (e.g., database record), etc. Can be unique (e.g, particular database record) or non-unique (e.g., one block of a fixed-size disk area such as swap space).
	 Preemptible versus non-preemptible — preemptible resources can be taken away from current owner without causing something to fail (e.g., memory); non-preemptible resources can't (e.g., hardware device).
	 Normal sequence for using a resource — request it, use it, release it. If not available when requested, block or busy-wait.
	Can easily implement this using semaphores, but then deadlock is possible if processes aren't disciplined.

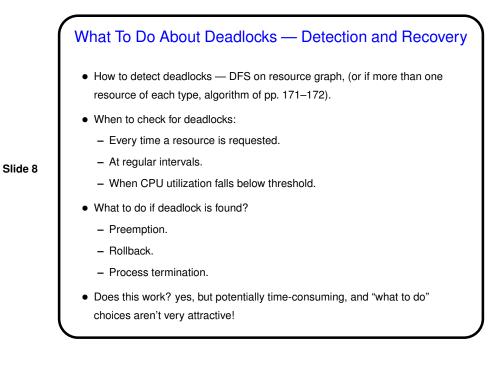
Deadlocks — Definitions and Conditions

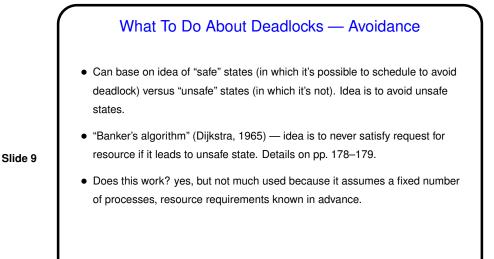
- Definition set of processes is "deadlocked" if each process in set is waiting for an event that only another process in set can cause.
- Necessary conditions:
 - Mutual exclusion resources can be used by at most one process at a time.
 - Hold and wait process holding one resource can request another.
 - No preemption resources cannot be taken away but must be released.
 - Circular wait circular chain of processes exists in which each process is waiting for resource held by next.
- Modeling deadlock "resource graphs" examples pp. 165-166.

Slide 6



Slide 7





What To Do About Deadlocks - Prevention • Idea here is to make it impossible to satisfy one of the four conditions for deadlock. • Mutual exclusion - don't allow more than one process to use a resource. E.g., define a printer-spool process to manage printer. Solves immediate problem but may produce others. Slide 10 • Hold and wait - require processes to request all resources at the same time and either get them all or wait. Works but may not be possible or efficient. • No preemption — allow preemption. Not usually possible/desirable. • Circular wait — impose strictly increasing ordering on resources, and insist that all processes request resources "in order". Works, but finding an ordering may be difficult.

