CSCI 460— Operating Systems

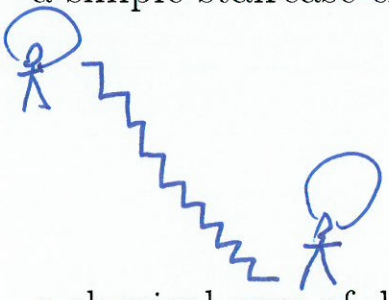
Lecture 7

Process Management—Deadlock and Starvation

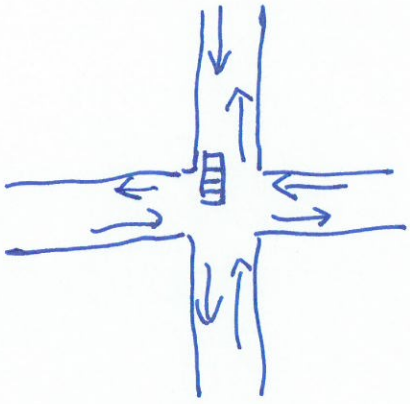
Textbook: Operating Systems
by William Stallings

1. Deadlock Concepts

- Deadlock — a simple staircase example.

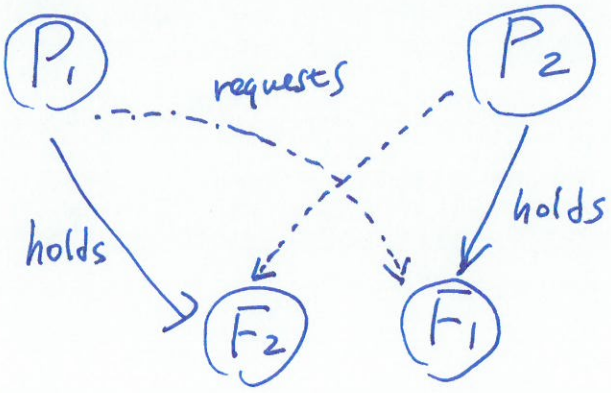


- Deadlock — a classical case of deadlock.

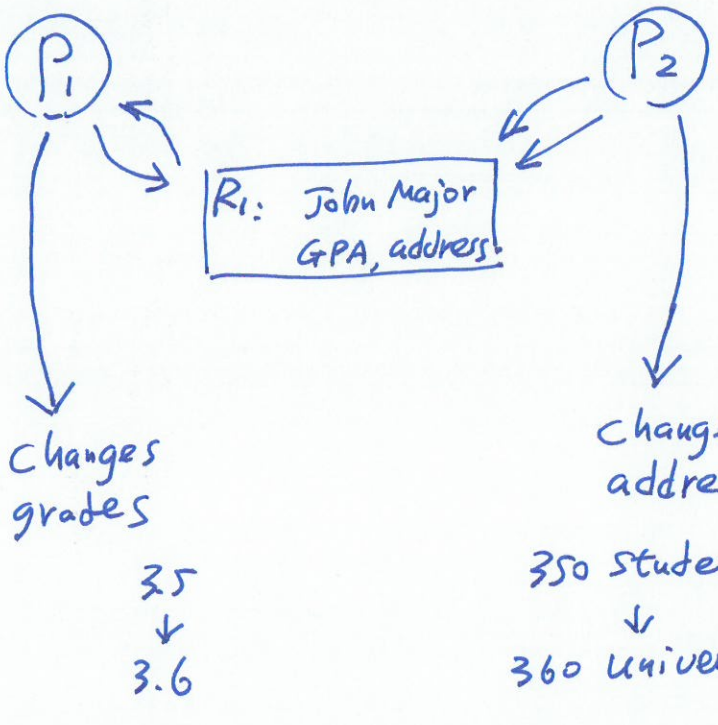


2. Seven Examples of Deadlock in CS

- Deadlocks on file requests

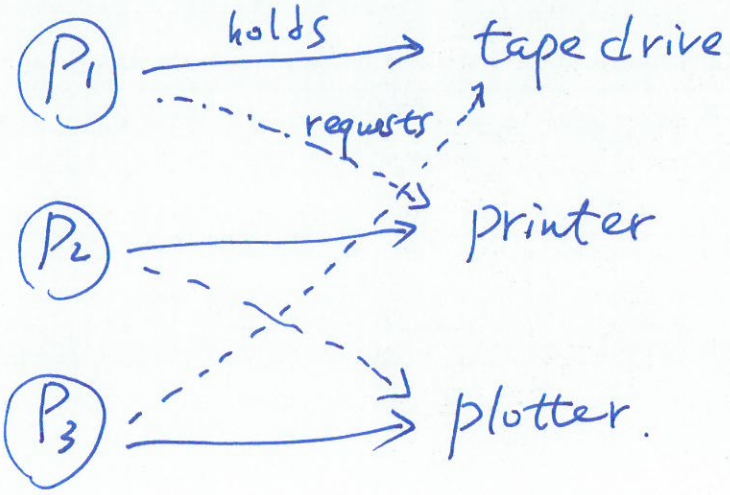


- Deadlocks in databases



- 2-people editing the same file (old project).

- Deadlocks in device allocation



- Deadlocks in multiple device allocation

ignored

- Deadlocks in spooling

ignored

- Deadlocks in disk sharing

ignored

- Deadlocks in a network

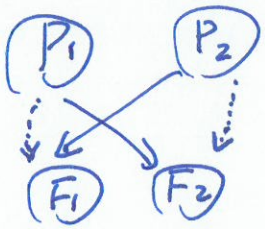
see the scanned handout

3. Conditions for Deadlock

- Mutual exclusion

if it is much wider, there won't be a deadlock

- Resource holding

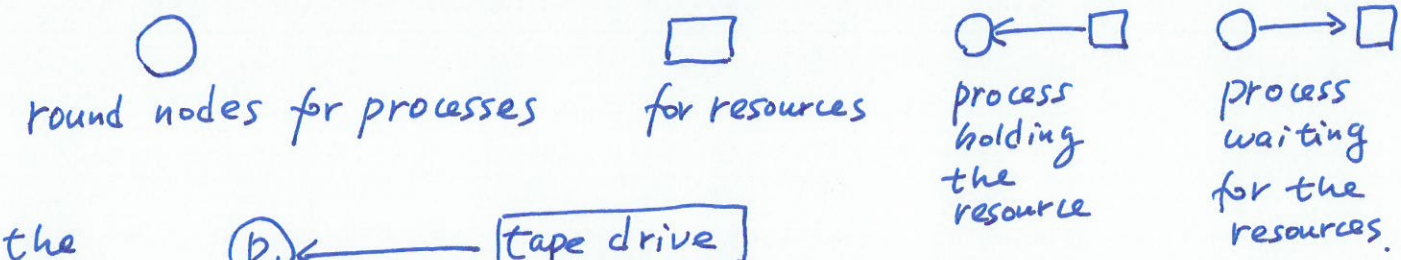


- No preemption

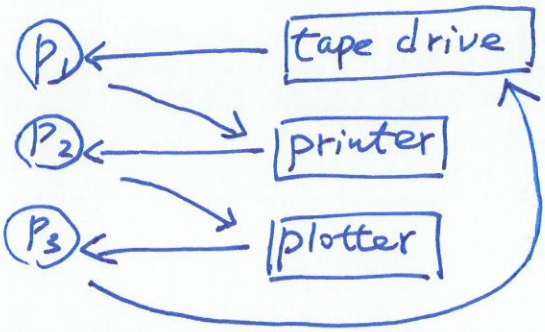
- Circular waiting

4. Modeling Deadlocks

- Directed Graph method (Holt,1972)



For the device example:

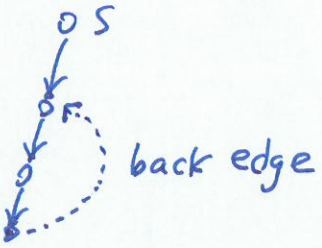


- A system is deadlocked iff there is a directed cycle.

- Detecting cycles in a dynamic graph is not easy.

Q: In a large directed graph, how do you determine there is a cycle?

A: When running DFS, there is a cycle iff we encounter a back edge.



5. Handling Deadlocks

- Prevention (prevent 1 of the 4 conditions from happening)

– Mutual exclusion. Ex. a unit of CPU time can't be shared.

– Resource holding. Ex. Try to satisfy a job's request completely.

– No preemption. Ex. Allow OS to deallocate resources from jobs.

– Circular waiting. Ex. Try to force the graph to be without cycles, e.g., numbering the same resources as #1, #2, #3, ...

- Avoidance (Banker's Algorithm)
  - 1. No customer will be granted a loan exceeding the bank's total capital.
  - 2. A customer will be given a maximum credit limit.
  - 3. No customer will be allowed to borrow over the limit.
  - 4. Sum of all loans $\leq$ bank's total capital.

Ex.

Job #	Devices allocated	Max limit	(Remaining)
1	0 2	4	4 2
2	2 3	5	3 2
3	4 4	8	4 4

system has 10 devices

10-(0+2+4)=4 system has 4 left

Safe state ↳ there is one way out.

system has only 10-(2+3+4) = 1 left, unsafe state