Announcements

- Program #1
  - Is on the web
- Reading
  - Chapter 4
  - Chapter 6 (for Tuesday)

Process Control Block

- Stores all of the information about a process
- PCB contains
  - process state: new, ready, etc.
  - processor registers
  - Memory Management Information
    - page tables, and limit registers for segments
  - CPU scheduling information
    - process priority
    - pointers to process queues
  - Accounting information
    - time used (and limits)
    - files used
    - program owner
  - I/O status information
    - list of open files
    - pending I/O operations

Storing PCBs

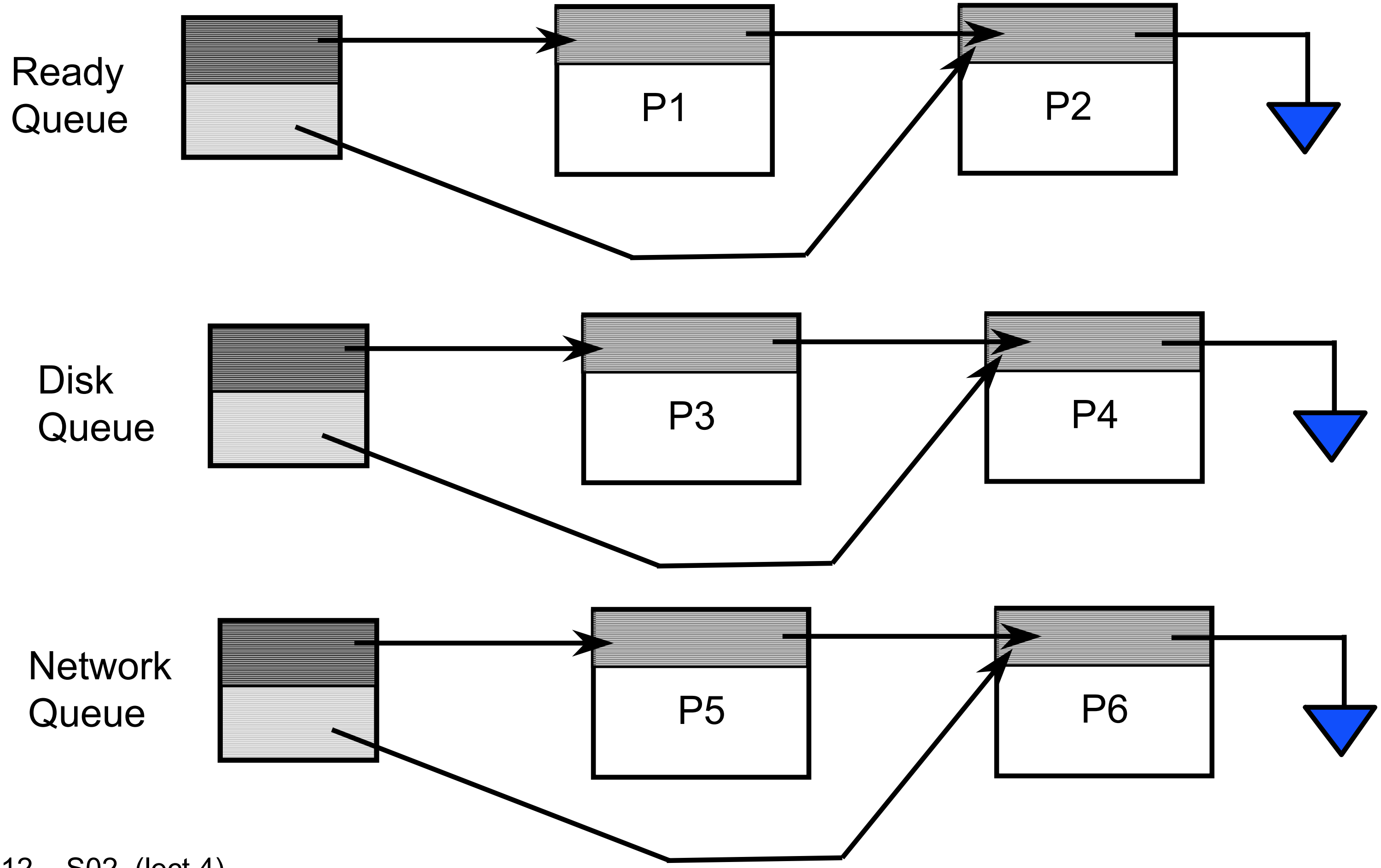
- Need to keep track of the different processes in the system
- Collection of PCBs is called a process table
- How to store the process table?
- First Option:

P1	P2	P2	P3	P4	P5
Ready	Waiting	New	Term	Waiting	Ready

- Problems with Option 1:
  - hard to find processes
  - how to fairly select a process

Queues of Processes

- Store processes in queues based on state



forking a new process

- create a PCB for the new process
  - copy most entries from the parent
  - clear accounting fields
  - buffered pending I/O
  - allocate a pid (process id for the new process)
- allocate memory for it
  - could require copying all of the parents segments
  - however, text segment usually doesn’t change so that could be shared
  - might be able to use memory mapping hardware to help
    - will talk more about this in the memory management part of the class
- add it to the ready queue

Process Termination

- Process can terminate self
  - via the exit system call
- One process can terminate another process
  - use the kill system call
  - can any process kill any other process?
    - No, that would be bad.
    - Normally an ancestor can terminate a descendant
- OS kernel can terminate a process
  - exceeds resource limits
  - tries to perform an illegal operation
- What if a parent terminates before the child
  - called an orphan process
  - in UNIX becomes child of the root process
  - in VMS - causes all descendants to be killed

Termination (cont.) - UNIX example

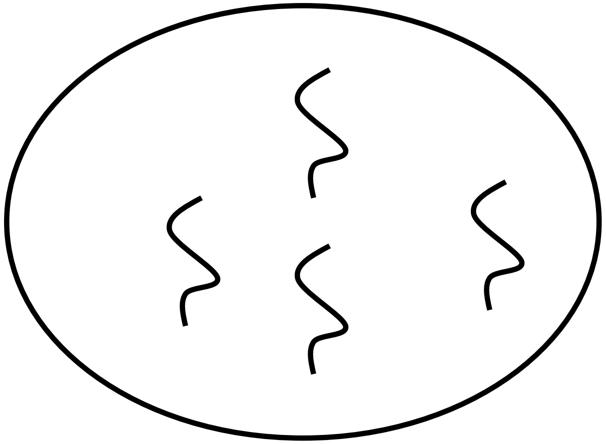
- Kernel
  - frees memory used by the process
  - moved process control block to the terminated queue
- Terminated process
  - signals parent of its death (SIGCHILD)
  - is called a zombie in UNIX
  - remains around waiting to be reclaimed
- parent process
  - wait system call retrieves info about the dead process
    - exit status
    - accounting information
  - signal handler is generally called the reaper
    - since its job is to collect the dead processes

Threads

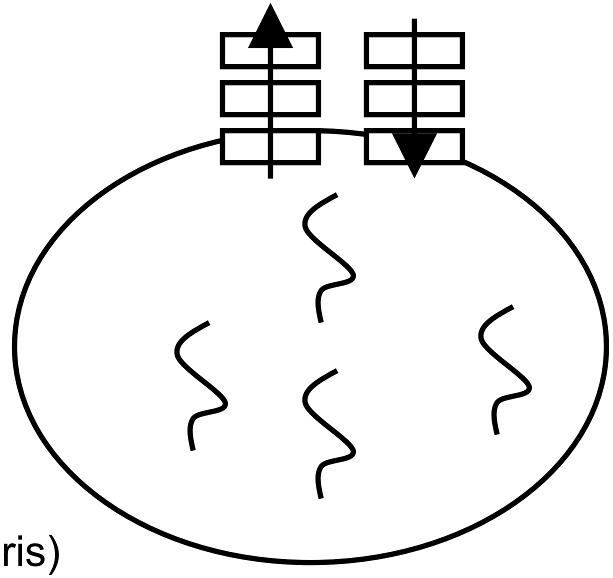
- processes can be a heavy (expensive) object
- threads are like processes but generally a collection of threads will share
  - memory (except stack)
  - open files (and buffered data)
  - signals
- can be user or system level
  - user level: kernel sees one process
    - + easy to implement by users
    - - I/O management is difficult
    - - in an multi-processor can’t get parallelism
  - system level: kernel schedules threads

Thread Implementation

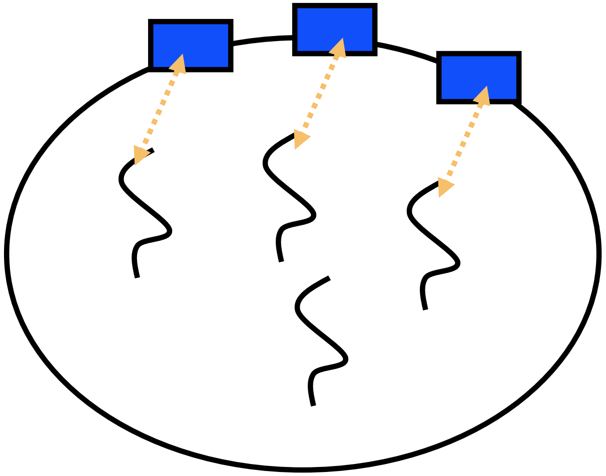
User Visible Threads



Async Kernel Calls (TruUnix 64)



Light Weigth Processes (Solaris)



Dispatcher

- The inner most part of the OS that runs processes
- Responsible for:
  - saving state into PCB when switching to a new process
  - selecting a process to run (from the ready queue)
  - loading state of another process
- Sometimes called the short term scheduler
  - but does more than schedule
- Switching between processes is called context switching
- One of the most time critical parts of the OS
- Almost never can be written completely in a high level language