Announcements

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

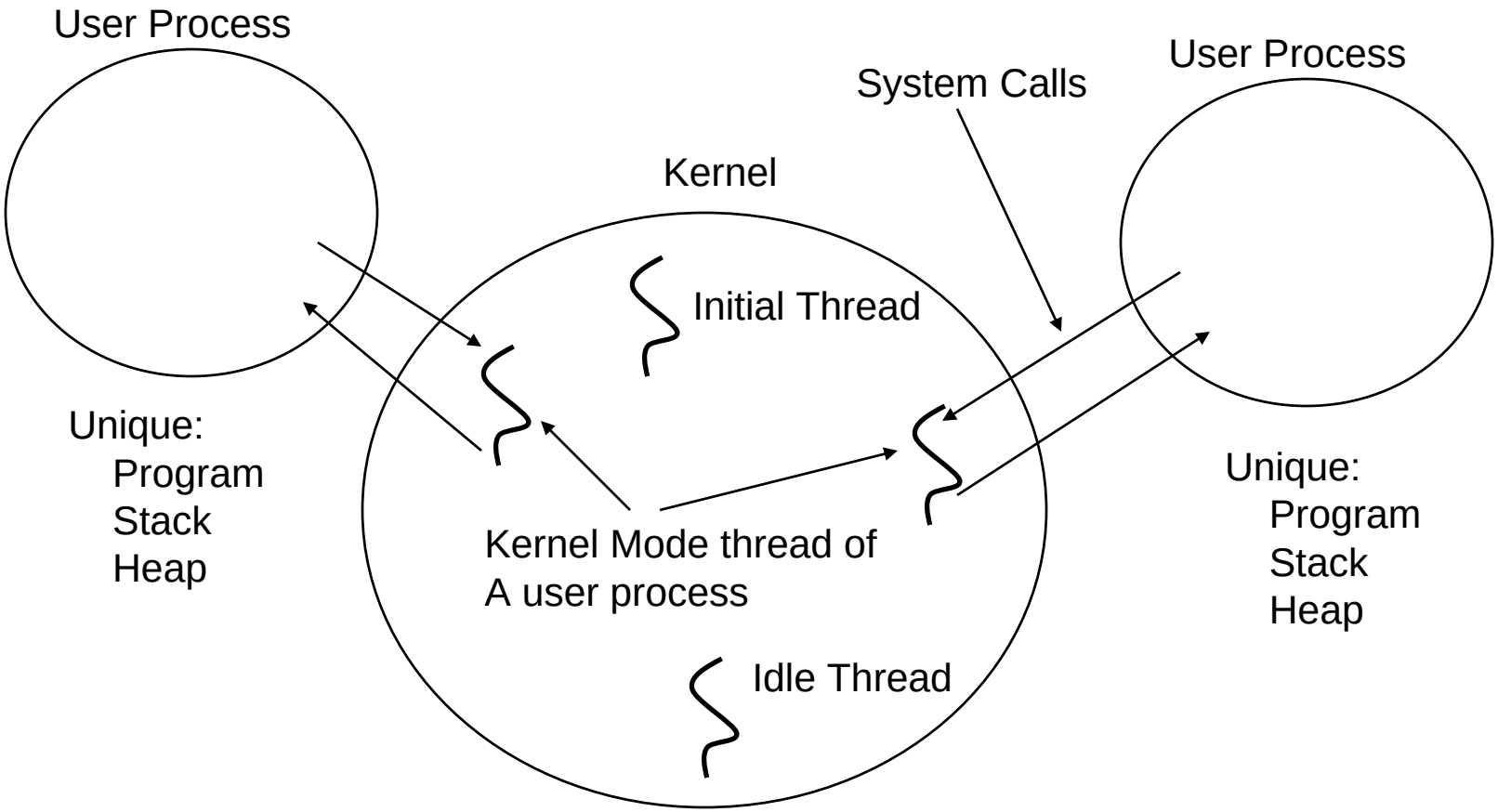
Process Termination

- 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

Relationship between Kernel mod and User Mode



Kernel Threads:

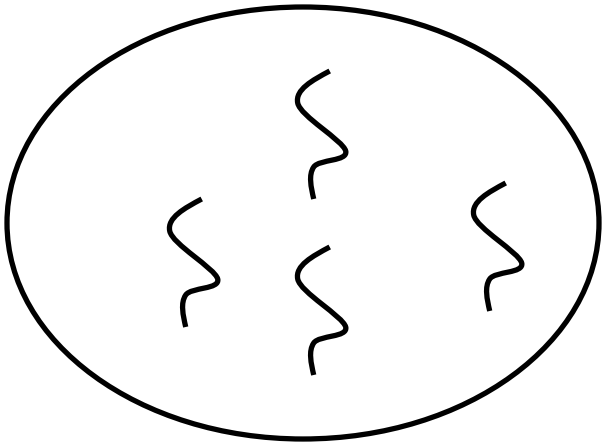
- Each has own stack (separate from user mode)
- Share heap with other kernel threads
- Run same program (kernel) as other kernel threads

Threads

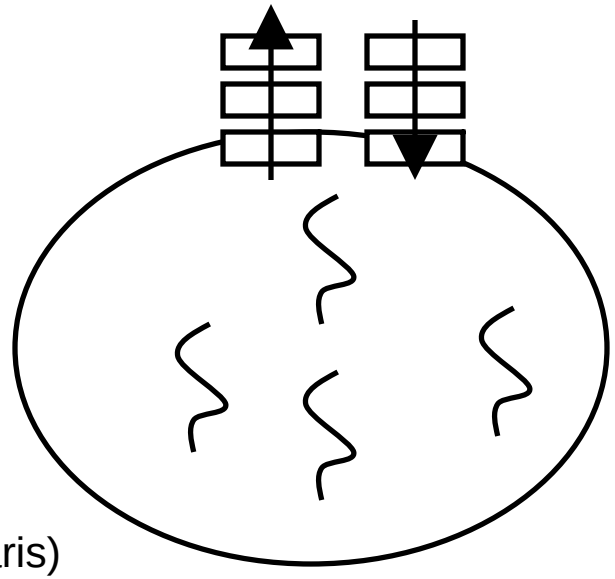
- processes can be a heavy (expensive) object
- threads are like processes but generally a collection of threads will share
  - memory (except stack)
  - open files (and buffered data)
  - signals
- can be user or system level
  - user level: kernel sees one process
    - + easy to implement by users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

Thread Implementation

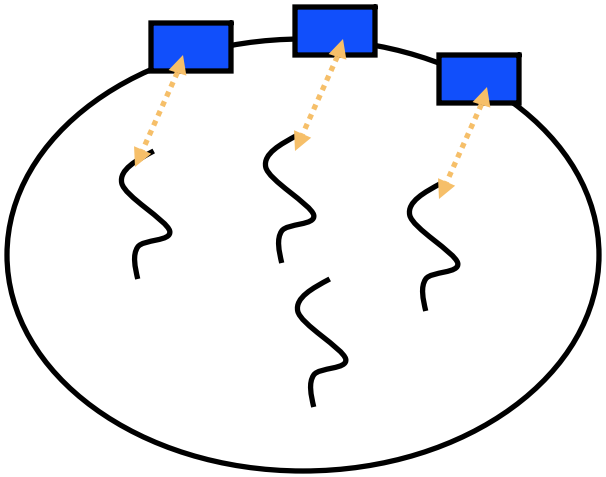
User Visible Threads



Async Kernel Calls (TruUnix 64)



Light Weigth Processes (Solaris)



Important Terms

- Threads
  - An execution context sharing an address space
- Kernel Threads
  - Threads running with kernel privileges
- User Threads
  - Threads running in user space
- Processes
  - An execution context with an address space
  - Visible to and scheduled by the kernel
- Light-Weight Processes
  - An execution context sharing an address space
  - Visible to and scheduled by the kernel

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

Selecting a process to run

- called scheduling
- can simply pick the first item in the queue
  - called round-robin scheduling
  - is round-robin scheduling fair?
- can use more complex schemes
  - we will study these in the future
- use alarm interrupts to switch between processes
  - when time is up, a process is put back on the end of the ready queue
  - frequency of these interrupts is an important parameter
    - typically 3-10ms on modern systems
    - need to balance overhead of switching vs. responsiveness