Pintos and Project One

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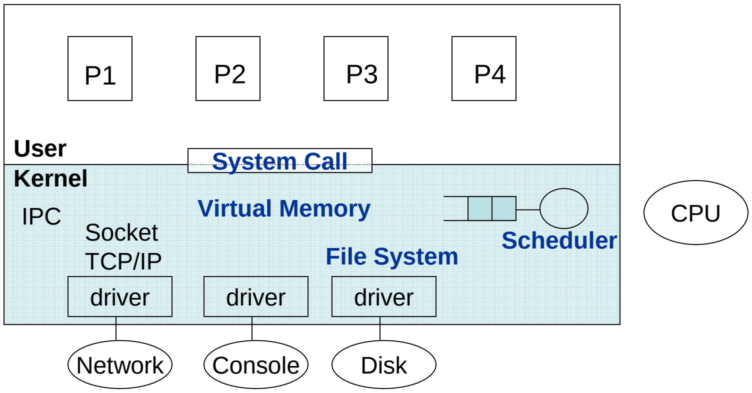
Overview

- Typical OS structure



P1
P2
P3
P4
User
System Call
Kernel
IPC
Socket
TCP/IP
Virtual Memory
File System
Scheduler
CPU
driver
driver
driver
Network
Console
Disk

Adopted from Lecture Notes L1 p.14

Getting Started

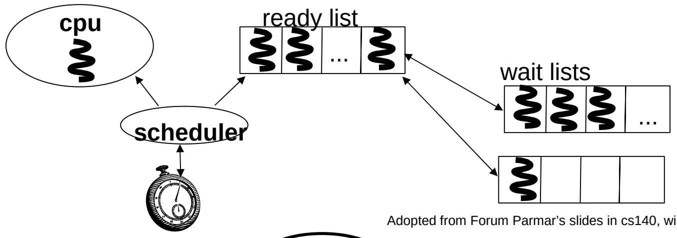
- Stanford computing facility
  - – UNIX Workstations: elaine, myth, vine, etc.

- Building and Running Pintos

```
> set path = ( /usr/class/cs140/`uname -m`/bin $path )
> zcat /usr/class/cs140/pintos/pintos.tar.gz | tar x
> cd pintos/src/threads/
> make
> pintos -v (--bochs)-- run alarm-multiple
```

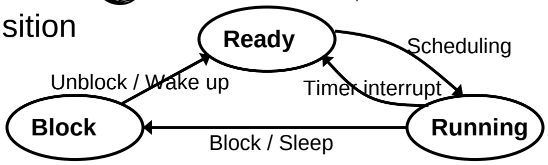
Project One: Threads

- What is a thread? pointer to instruction + state
- Threading System



Adopted from Forum Parmar's slides in cs140, winter 2007

- State Transition



Part I – Alarm Clock

- Already in Pintos: devices/timer.c
- Redo timer_sleep() to avoid busy waiting:

```
/* Suspends execution for approximately TICKS timer ticks. */
void timer_sleep (int64_t ticks){
  int64_t start = timer_ticks ();
  ASSERT (intr_get_level () = NTR_ON);

  while (timer_elapsed (start) < ticks)
    thread_yield ();
```

- Requirement:
  - No busy waiting
  - Also, reduce the time spent in timer interrupt handler

Part II – (a) Priority Scheduling

- Priority Scheduling
  - Thread L yields as H added to ready list
  - Thread H wakes up first when H and L both waiting for a lock, a sema, etc
- Starting Point
  - Read Section 2.1.1
  - Go over the Pintos source code
    - When does content switching happen in Pintos?
    - When does your scheduler need to take action? Point it out from the code.
- Have this part working before doing Part III

Part II – (b) Priority Donation

- Priority inversion problem
  - Consider the scenario:
    - L holds Lock K, running
    - H comes in, kicking out L (L still holds Lock K)
    - M comes in ready list
    - H waits for Lock K; M starts running
    - Now: M runs, then L, and then H
  - What should we do?
    - Priority Donation
    - Required for locks
      Optional for sema and conditional variable

Part III – Advanced Scheduler

- BCD Scheduler
  - Appendix B4.4 for multi-level feedback queue
  - Enabled when `thread_mlfqs == true`
  - Priority depends on:
    - niceness
    - recent_cpu
    - load_avg
- Fixed-Point Real Arithmetic

Grading

- 50% Design Document
  - Template, asking about:
    - Data structure
    - Algorithm
    - Synchronization
    - Rationale
  - Coding Standard
    - Comment your code!
- 50% Test suite
  - Run `make check` in build/
  - Test scripts in pintos/src/tests

Useful Tools

- cvs/svn
- cscope
- backtrace
- pintos-gdb
- Test cases
  - Run an individual test (e.g. alarm-multiple)

    `make build/tests/threads/alarm-multiple.result`, OR
    `pintos -v -- run alarm-multiple`
- Data structure
  - Provided in pintos/src/lib/kernel/
- Newsgroup

Some Advice

- Read the manual
- Start with Design Document
- Integrate early
- Spend lots of time reading the code
- Synchronization
  - Keep in mind: A thread can be interrupted by another thread