Processes

- "A program in execution"
- Modern computers allow several at once
  - "pseudoparallelism"

A conceptual view of processes with a program counter and time.

Processes

- "A program in execution"
- "more" than a program: `ls`, `tcsh`
- "less" than a program: `gcc blah.c`
  - `cpp, cc1, cc2, ln ...`
- "A sequential stream of execution in its own address space"

Process States

- Consider:
  - `cat /etc/passwd | grep claypool`

A state machine diagram showing process states with transitions for New, Running, Ready, Dispatch, Interrupt, I/O Wait, I/O Complete, and Exit.

Design Technique: State Machines

- Process states
- Move from state to state based on events
  - Reactive system
- Can be mechanically converted into a program
- Other example:
  - string parsing, pre-processor

Unix Process Creation

- System call: `fork()`
  - creates (nearly) identical copy of process
  - return value different for child/parent
- System call: `exec()`
  - over-write with new process address space
- Shell
  - uses `fork()` and `exec()`
  - simple!
- (Hey, you, show demos!)
Process Scheduler

- All services are processes
- Small scheduler handles interrupts, stopping and starting processes

<table>
<thead>
<tr>
<th>cat</th>
<th>ls</th>
<th>...</th>
<th>disk</th>
<th>vid</th>
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Scheduler

Process Control Block

- Each process has a PCB
  - state
  - program counter
  - registers
  - memory management
  - ...
- OS keeps a table of PCB’s, one per process
- (Hey! Simple Operating System, "system.h")

Interrupt Handling

- Stores program counter (hardware)
- Loads new program counter (hardware)
  - jump to interrupt service procedure
- Save PCB information (assembly)
- Set up new stack (assembly)
- Set “waiting” process to “ready” (C)
- Scheduler (C)
  - Newly awakened process
    + Often called a context-switch
  - Previously running process

Context Switch

- Pure overhead
- So … fast, fast, fast
  - typically 1 to 1000 microseconds
- Sometimes special hardware to speed up
- Real-Time wants worse case
  - RT Linux worse case sub 20 microseconds
- How to decide when to switch contexts to another process is process scheduling

Processes in Linux

- PCB is `struct task_struct`
  - states: RUNNING, INTERRUPTIBLE, UNINTERRUPTIBLE
  - priority: when it runs
  - counter: how long it runs
- Environment inherited from parent
- NR_TASKS max, 2048
  - 1/2 is max per user

Linux Context Switch Times

(http://math.nmu.edu/~benchmark/)
Processes in NT/2000

- States: ready, standby (first in line), running, waiting, transition, terminated
- Priority - when it runs
- Processes are composed of threads
  – (revisit threads after scheduling)