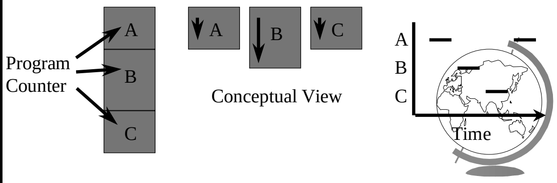
Operating Systems

Processes

(Ch 2.1)

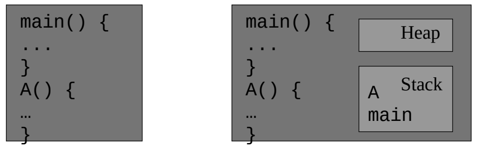
Processes

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



Processes

- "A program in execution"



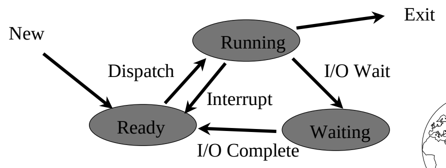
```
main() {
...
}
A() {
…
}
```

```
main() {
...
}
A() {
…
}
```

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

Process States

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



(Hey, you, show states in `top`!)

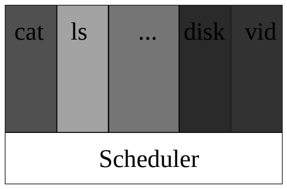
Design Technique: State Machines

- 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

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`")

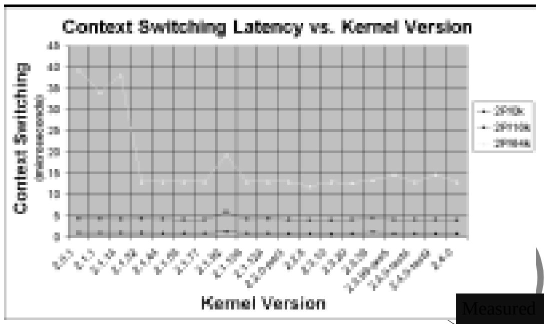
Interrupt Handling

- 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*

Linux Context Switch Times

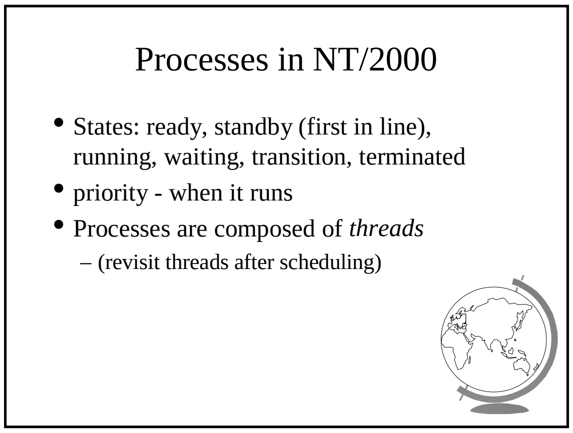


(http://math.nmu.edu/~benchmark/)

Measured with LMBench

Processes in Linux

- PCB is in `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



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)