CS 134: Operating Systems

Processes

2013-05-17

CS34

CS 134:
Operating Systems
Processes

Overview

Overview
Processes
Processes in Unix
Implementation
States
Threads
Concepts
Uses
Models
Design

Processes & Concurrency

What *is* a process?

What *is* concurrency?

Processes & Concurrency
What *is* a process?
What *is* concurrency?

User’s View of Processes

A fundamental OS abstraction

- But details vary from OS to OS:
  - Batch system—Jobs
  - Time-shared systems—User programs or tasks
- Common idea: Process = “A program in execution”
- Processes have a degree of independence from each other
  - Possibly only allowed communicate through designated mechanisms
  - One errant processes should not affect other unrelated ones

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Class Exercise

What makes up a process? (“A process has. . . ”)

- In general
- On a typical POSIX system

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Components of a Process (Unix)

- Execution state
  - Registers
  - Program counter
  - Program status word
  - Stack pointer
- Scheduling information
  - Process state
  - Priority
  - Class, etc.
- Memory
  - Text area
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Processes under UNIX

Processes:

- Create with `fork`
- Exit with `exit`
- Replace “process image” with `execve`

Multiple processes may be active at any one time (compare w/ uniprogrammed system)

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Class Question

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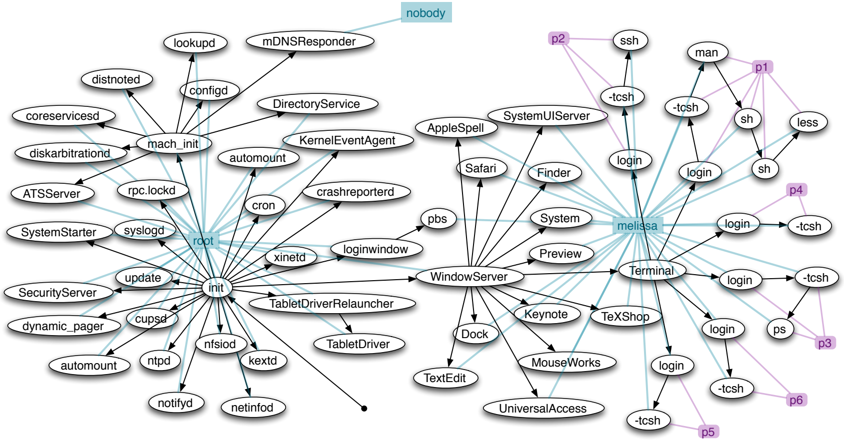
Processes under UNIX

The environment you interact with is made up of processes



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└Processes
  └Processes in Unix
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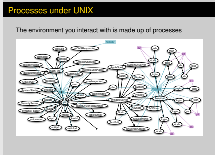

Process Implementation

How does the OS implement the process abstraction?

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Process Implementation (cont'd)

The OS needs to maintain a *process image* for each process:

- Process's address space, containing:
  - Program code
  - Program data
  - Processor stack
- Housekeeping information (*PCB*)
  - One of most important is *process state*

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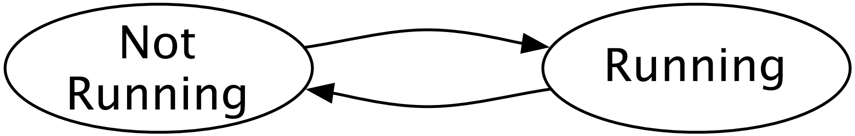
A Two-State Process Model

Simplest model for processes:



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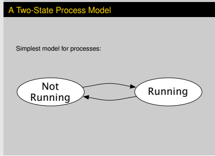
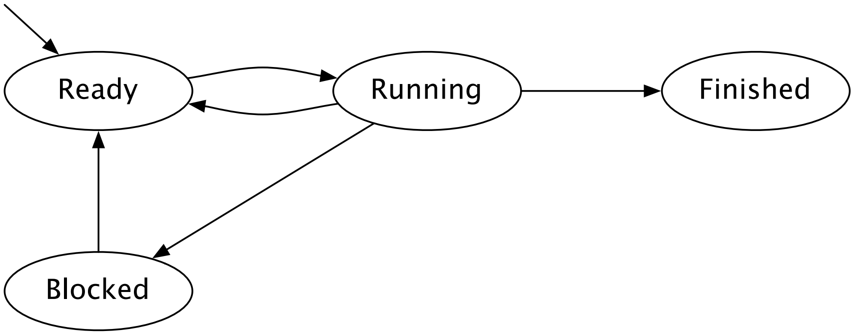
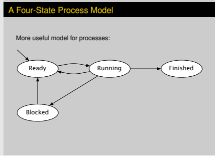
└─Processes
  └─States
    └─A Two-State Process Model



A Four-State Process Model

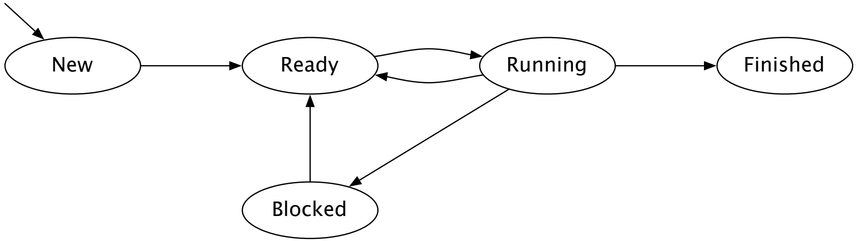
More useful model for processes:





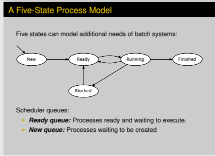
A Five-State Process Model

Five states can model additional needs of batch systems:



Scheduler queues:

- ***Ready queue:*** Processes ready and waiting to execute.
- ***New queue:*** Processes waiting to be created



Generalizing Processes

Simple view of process is

Address space

\+ Thread of execution

Does the mapping need to be one-to-one?

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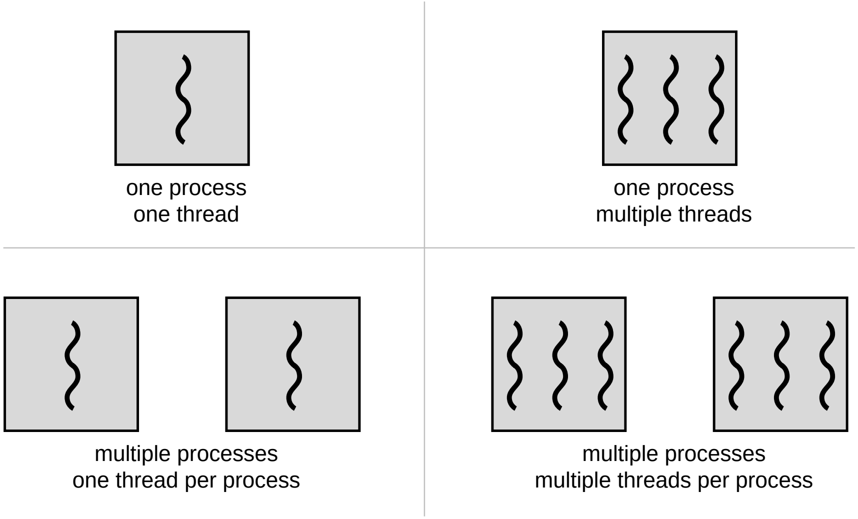
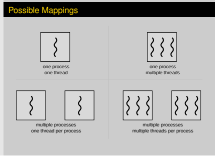
Possible Mappings





Threads

Motivation:

- Traditional processes: Virtual uniprocessor machine
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Uses of Threads

Various reasons why people use threads

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- Speeding execution
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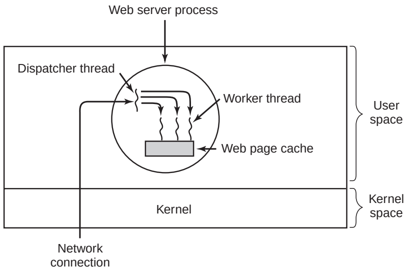
Uses of Threads—Example




```
/* Dispatcher Thread */
for ( ; ; ) {
  url = get_next_request();
  handoff_work(url);
}
```

```
/* Worker Thread */ \\
for ( ; ; ) {
  url = wait_for_work();
  page = look_in_cache(url);
  if (page == NULL)
    page = generate_page(url);
  send_page(page);
}
```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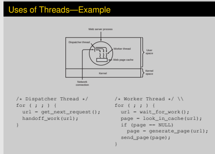

Class Exercise

Can an application implement threads without built-in thread support in the OS?

If so, what *does* it need from the from the OS to support threads?

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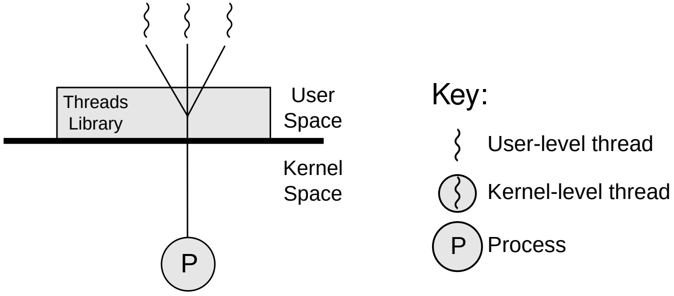
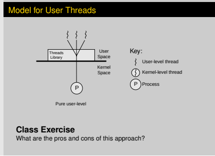
Model for User Threads



Pure user-level

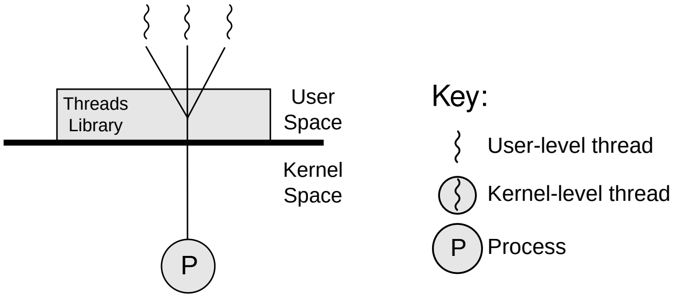
Class Exercise

What are the pros and cons of this approach?



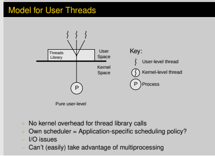
So, maybe we should put the threads in the kernel?

Model for User Threads



Pure user-level

- \+ No kernel overhead for thread library calls
- \+ Own scheduler = Application-specific scheduling policy?
- – I/O issues
- – Can't (easily) take advantage of multiprocessing



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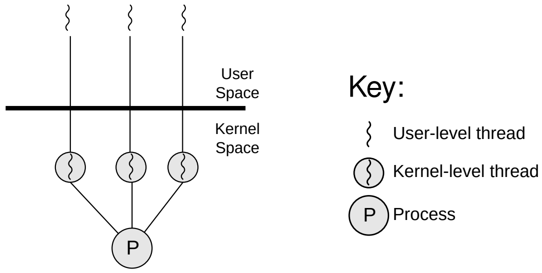
Model for Kernel-Level Threads



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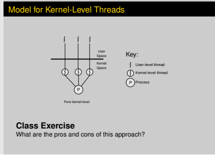
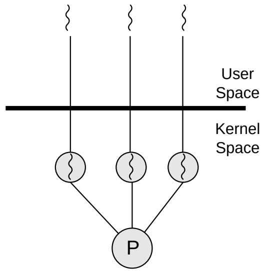


Model for Kernel-Level Threads



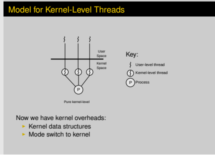
Pure kernel-level

Key:

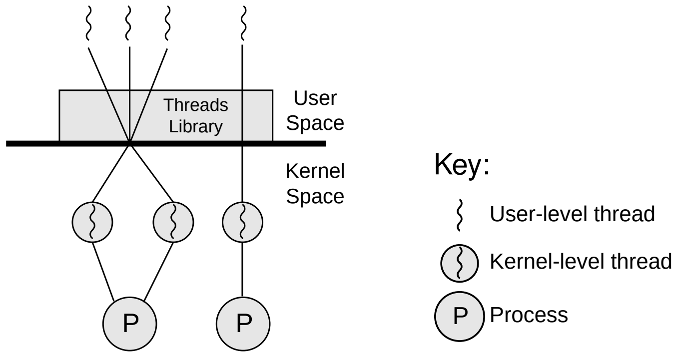
- User-level thread
- Kernel-level thread
- P Process

Now we have kernel overheads:

- Kernel data structures
- Mode switch to kernel



Hybrid Thread Schemes



Combined

Class Exercise

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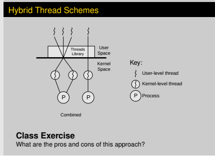
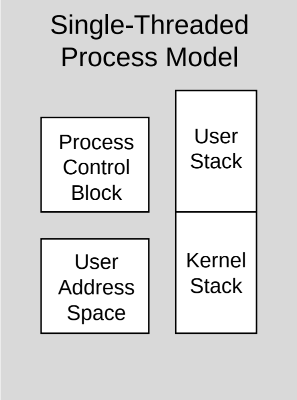


Traditional vs. Multithreaded Processes



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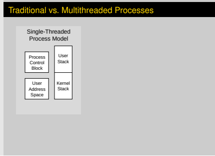

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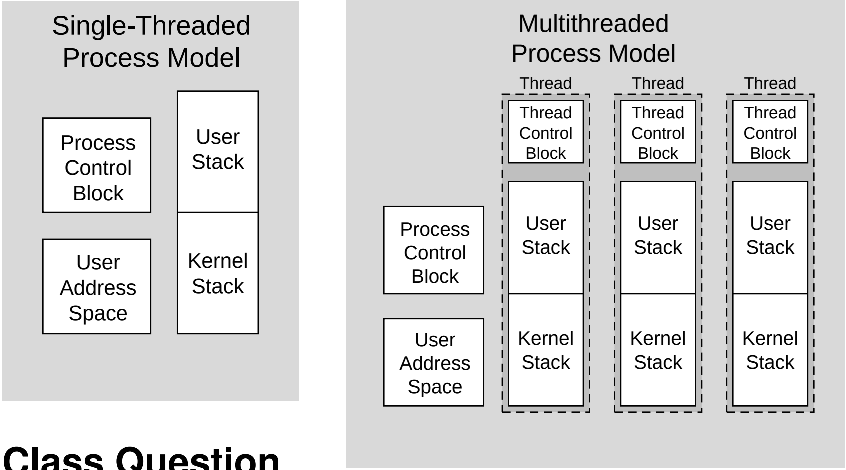

Class Question

But what's per-process and what's per-thread?

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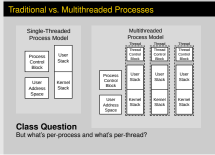

Per-Process vs. Per-Thread—*You* Decide. . .

- Execution state
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Per-Process vs. Per-Thread—You Decide. . .
Execution state: Registers, Program counter, Program status word, Stack pointer; Scheduling information: Process state, Priority, Class, etc.; Memory: Text area, Data area, Stack area; Security/Authentication Info: User ID, Group ID; I/O State: File descriptors, Working directory, Root directory; Event Notifications: Signals waiting, Signal mask, Time of next alarm; Other: Process ID, Parent process, Process group, Controlling terminal, Start time, CPU time, Children's CPU time