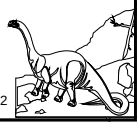
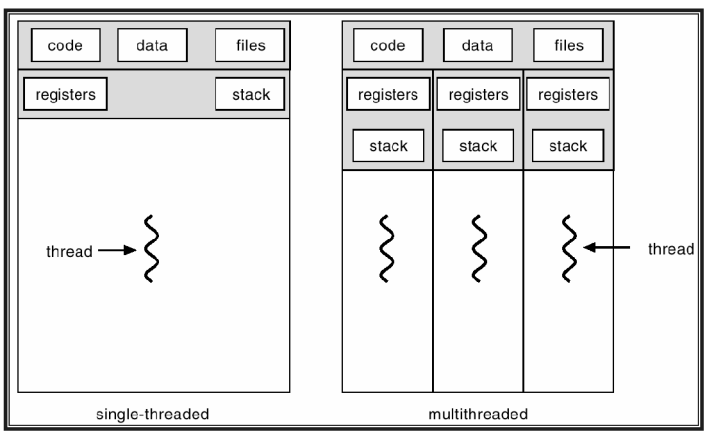
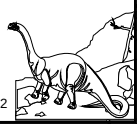
Chapter 5: Threads

- Overview
  Multithreading Models
  Threading Issues
  Pthreads
  Solaris 2 Threads
  Windows 2000 Threads
  Linux Threads
  Java Threads



Single and Multithreaded Processes





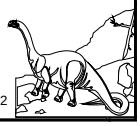
Benefits

- Responsiveness

  Resource Sharing

  Economy

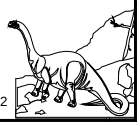
  Utilization of MP Architectures



User Threads

- Thread management done by user-level threads library

  Examples
  - POSIX *Pthreads*
  - Mach *C-threads*
  - Solaris *threads*



Kernel Threads

- Supported by the Kernel

  Examples
  - Windows 95/98/NT/2000
  - Solaris
  - Tru64 UNIX
  - BeOS
  - Linux

Multithreading Models

- Many-to-One

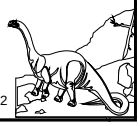
  One-to-One

  Many-to-Many

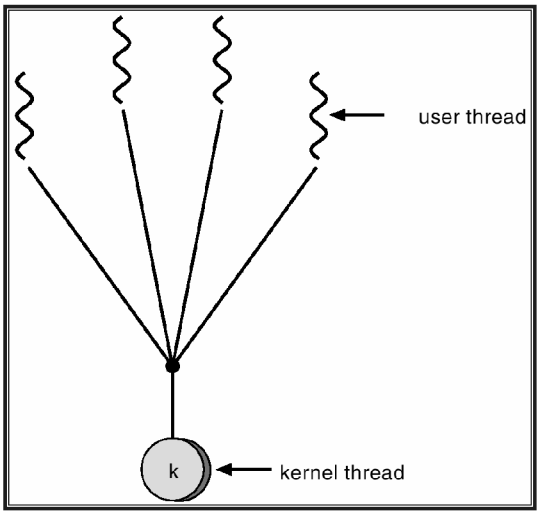
Many-to-One

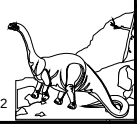
- Many user-level threads mapped to single kernel thread.

  Used on systems that do not support kernel threads.



Many-to-One Model

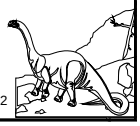




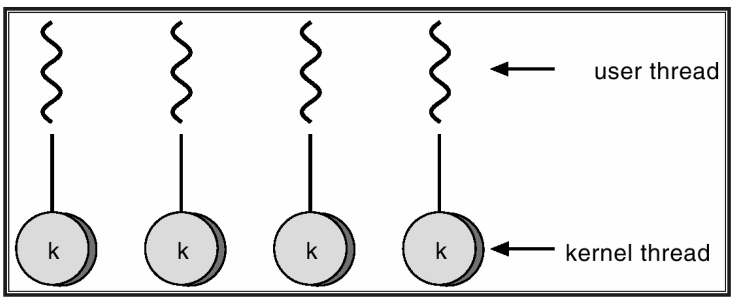
One-to-One

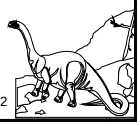
- Each user-level thread maps to kernel thread.

  Examples
  - Windows 95/98/NT/2000
  - OS/2



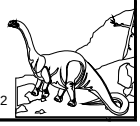
One-to-one Model

- 

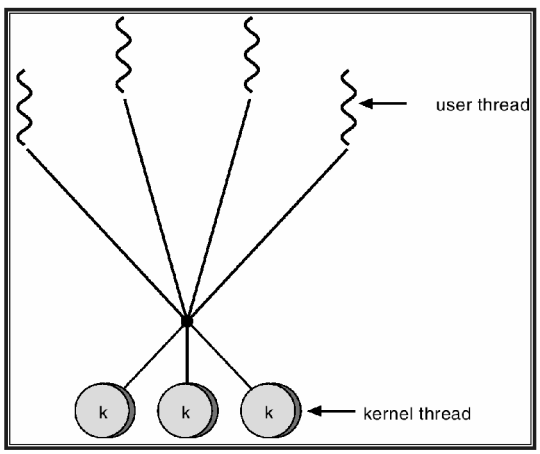


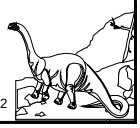
Many-to-Many Model

- Allows many user level threads to be mapped to many kernel threads.
- Allows the operating system to create a sufficient number of kernel threads.
- Solaris 2
- Windows NT/2000 with the *ThreadFiber* package



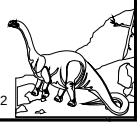
Many-to-Many Model





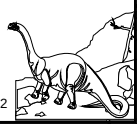
Threading Issues

- Semantics of fork() and exec() system calls.
  Thread cancellation.
  Signal handling
  Thread pools
  Thread specific data

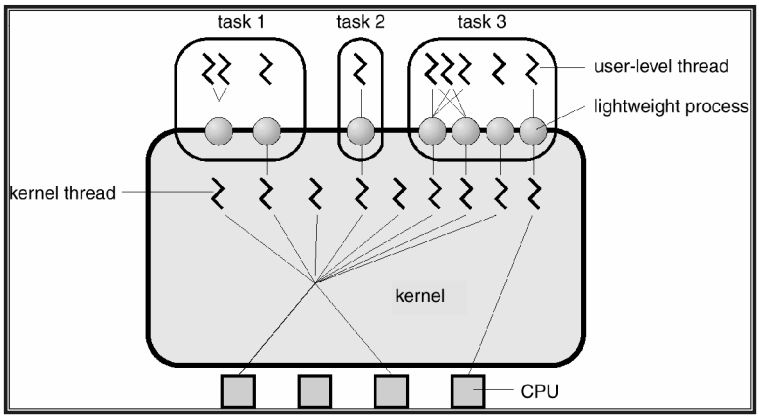


Pthreads

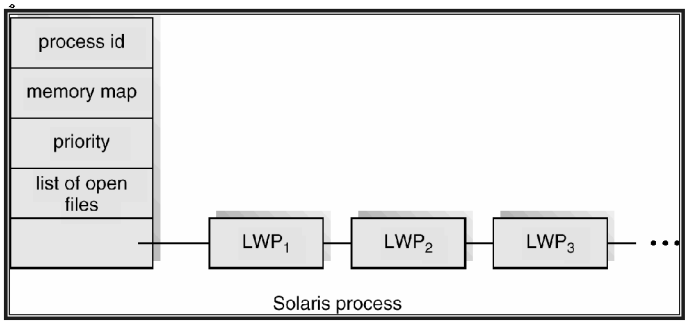
- a POSIX standard (IEEE 1003.1c) API for thread creation and synchronization.
  API specifies behavior of the thread library, implementation is up to development of the library.
  Common in UNIX operating systems.



Solaris 2 Threads



Solaris Process



Windows 2000 Threads

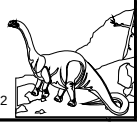
- Implements the one-to-one mapping.
  Each thread contains
  - a thread id
  - register set
  - separate user and kernel stacks
  - private data storage area

Linux Threads

- Linux refers to them as *tasks* rather than *threads*.
  Thread creation is done through clone() system call.
  Clone() allows a child task to share the address space of the parent task (process)

Java Threads

- Java threads may be created by:
  - Extending Thread class
  - Implementing the Runnable interface
- Java threads are managed by the JVM.



Java Thread States