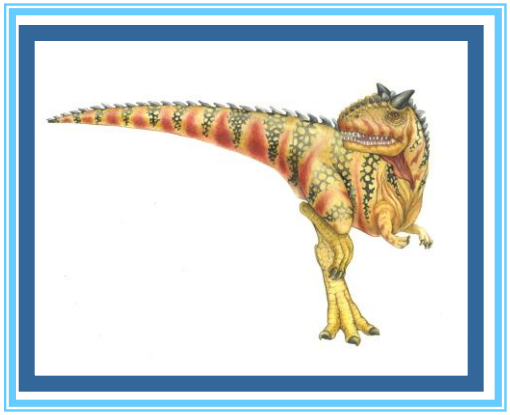
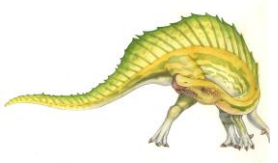
Chapter 4: Threads

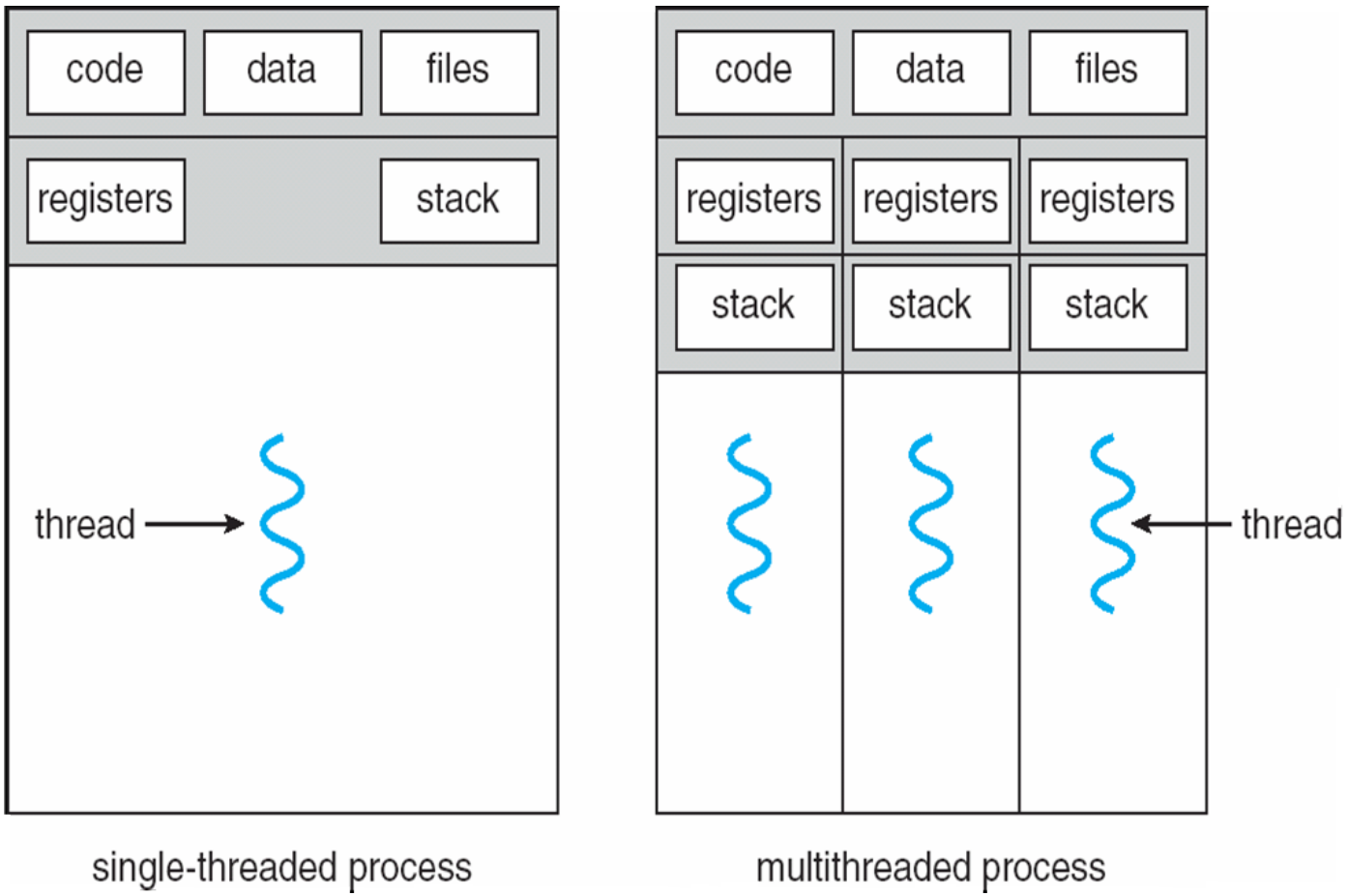


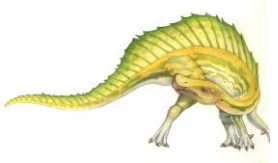
Chapter 4: Threads

- Overview
- Multithreading Models
- Thread Libraries
- Threading Issues
- Operating System Examples
- Linux Threads



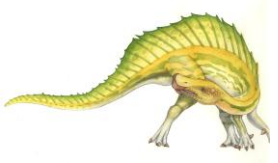
Single and Multithreaded Processes



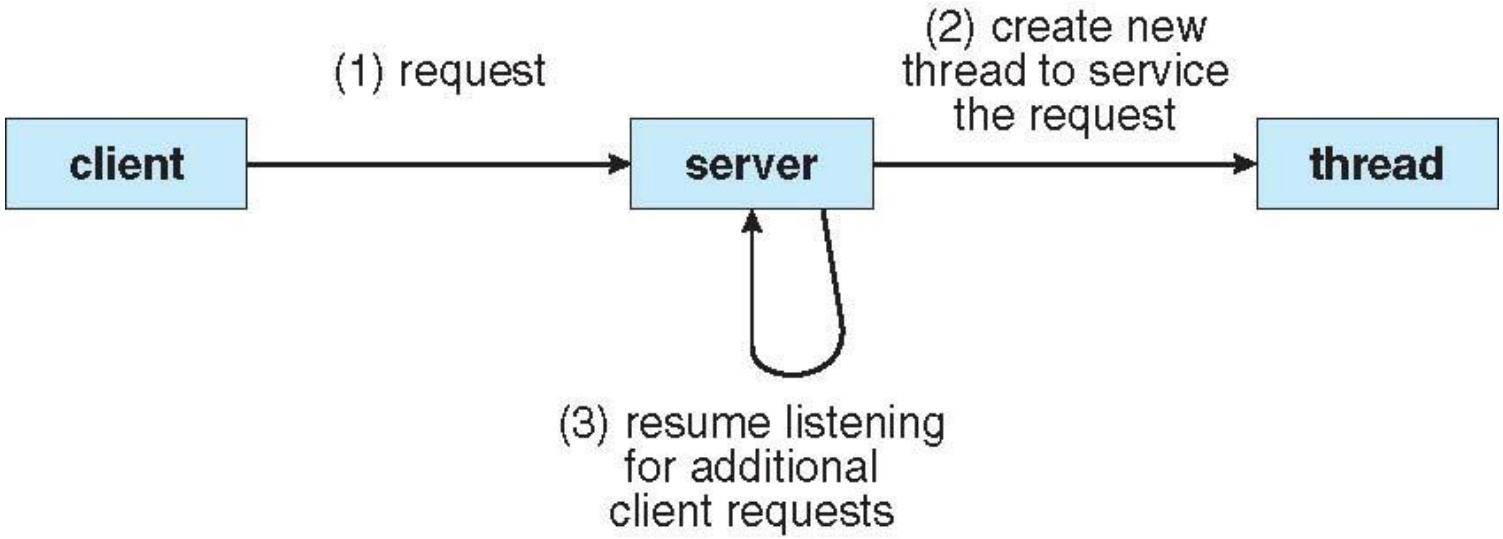


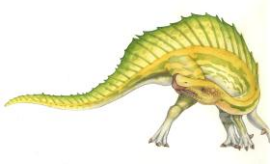
Multithread Programming

- Benefits
  - Responsiveness
  - Resource Sharing
  - Economy
  - Scalability
- challenges include
  - Dividing activities
  - Balance
  - Data splitting
  - Data dependency
  - Testing and debugging

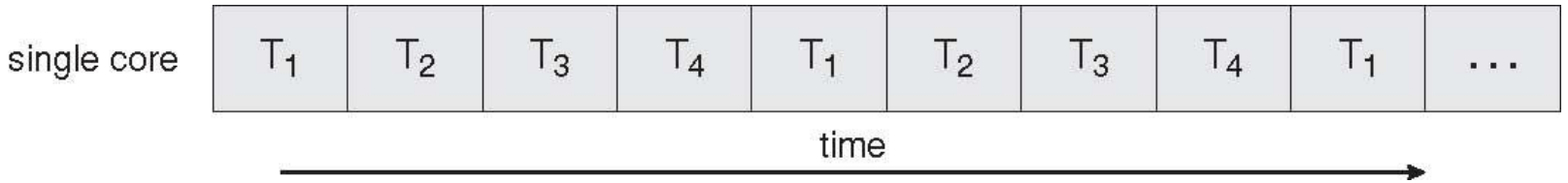


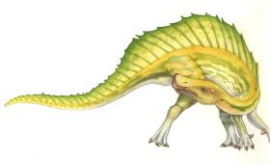
Multithreaded Server Architecture



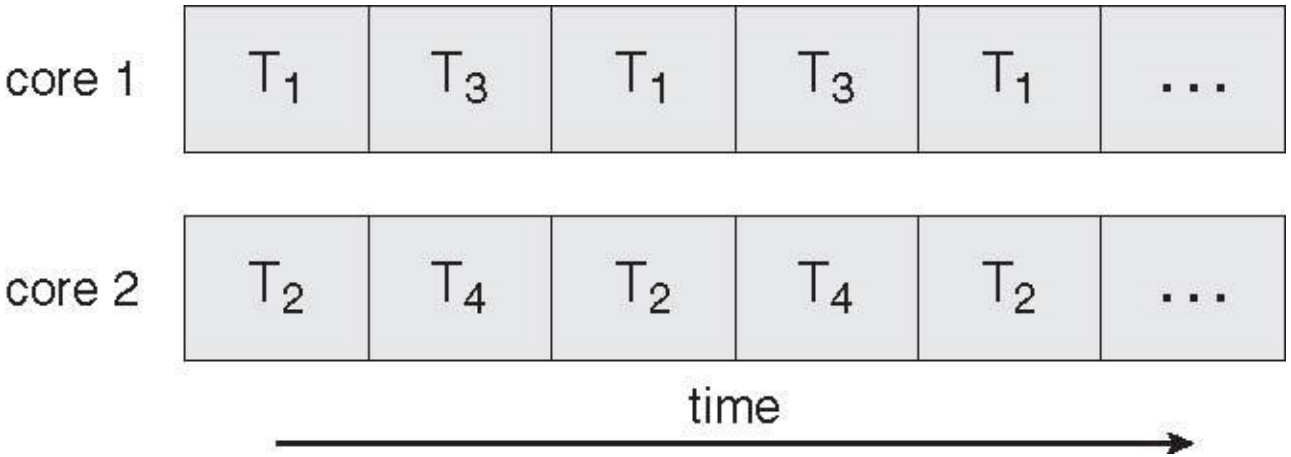


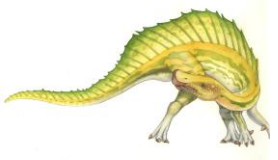
Concurrent Execution on a Single-core System





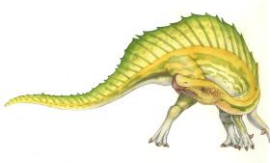
Parallel Execution on a Multicore System





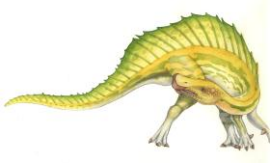
User Threads

- Thread management done by user-level threads library
- Three primary thread libraries:
  - POSIX Pthreads
  - Win32 threads
  - Java threads



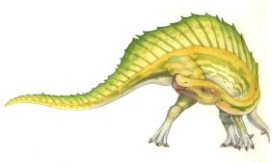
Thread Libraries

- Thread library provides programmer with API for creating and managing threads
- Two primary ways of implementing
  - Library entirely in user space
  - Kernel-level library supported by the OS



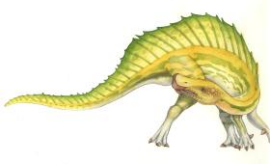
Pthreads

- May be provided either as user-level or kernel-level
- 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, Linux, Mac OS X)



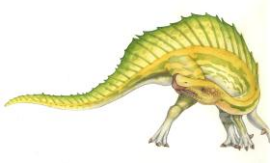
Java Threads

- Java threads are managed by the JVM
- Typically implemented using the threads model provided by underlying OS
- Java threads may be created by:
  - Extending Thread class
  - Implementing the Runnable interface



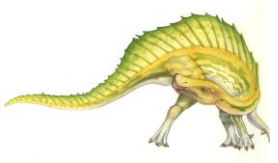
Threading Issues

- Semantics of **fork()** and **exec()** system calls
  - Does **fork()** duplicate only the calling thread or all threads?



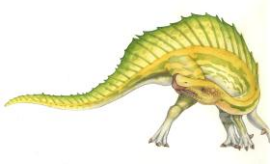
Thread Cancellation

- Terminating a thread before it has finished
- Two general approaches:
  - **Asynchronous cancellation** terminates the target thread immediately
  - **Deferred cancellation** allows the target thread to periodically check if it should be cancelled



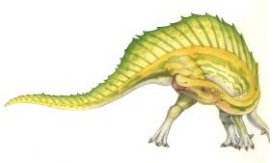
Signal Handling

- Signals are used in UNIX systems to notify a process that a particular event has occurred
- A signal handler is used to process signals
  1. Signal is generated by particular event
  2. Signal is delivered to a process
  3. Signal is handled
- Options:
  - Deliver the signal to the thread to which the signal applies
  - Deliver the signal to every thread in the process
  - Deliver the signal to certain threads in the process
  - Assign a specific threa to receive all signals for the process



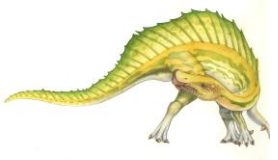
Thread Pools

- Create a number of threads in a pool where they await work
- Advantages:
  - Usually slightly faster to service a request with an existing thread than create a new thread
  - Allows the number of threads in the application(s) to be bound to the size of the pool



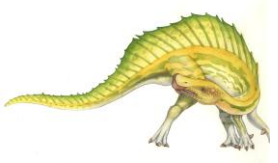
Linux Threads

flag	meaning
CLONE_FS	File-system information is shared.
CLONE_VM	The same memory space is shared.
CLONE_SIGHAND	Signal handlers are shared.
CLONE_FILES	The set of open files is shared.



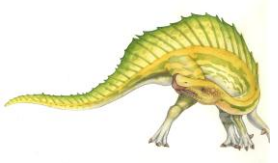
Linux Threads

- 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)



Linux Thread

- Thread operations include thread creation, termination, synchronization (joins, blocking), scheduling, data management and process interaction.
- A thread does not maintain a list of created threads, nor does it know the thread that created it.
- All threads within a process share the same address space. They share:
  - Process instructions, Most data
  - open files (descriptors)
  - signals and signal handlers
  - current working directory, User and group id
- Each thread has a unique:
  - Thread ID, set of registers, stack pointer
  - stack for local variables, return addresses
  - signal mask,priority, Return value: errno



End of Chapter 4