Threads Introduction

Thread: Introduction

- Each process has
  1. Own Address Space
  2. Single thread of control
- A process model has two concepts:
  1. Resource grouping
  2. Execution
- Sometimes it is useful to separate them

Unit of Resource Ownership

- A process has an
  - Address space
  - Open files
  - Child processes
  - Accounting information
  - Signal handlers
- If these are put together in a form of a process, can be managed more easily

Unit of Dispatching

- Path of execution
  - Program counter: which instruction is running
  - Registers:
    - holds current working variables
  - Stack:
    - Contains the execution history, with one entry for each procedure called but not yet returned
  - State
- Processes are used to group resources together
- Threads are the entities scheduled for execution on the CPU
- Threads are also called ***lightweight*** process

Its better to distinguish between the two concepts

Heavy weight process

Address space/Global Variables
Open files
Child processes
Accounting info
Signal handlers
Program counter
Registers
Stack
State

In case of multiple thr... per process

Light weight processes

Split

Unit of Resource

Address space/Global Variables
Open files
Child processes
Accounting Info
Signal Handlers

Unit of Dispatch

Program Counter
Reg...
Stac...
Stat...

Program Counter
Registers
S...
S...

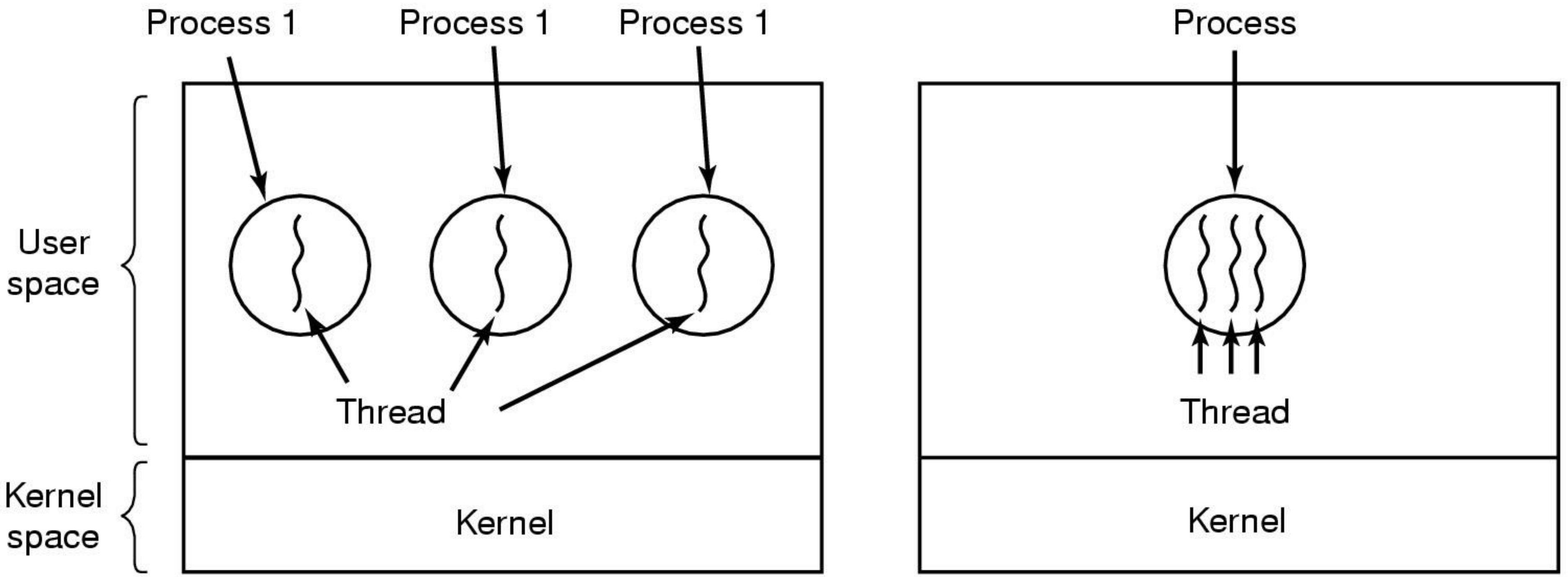
Program Counter
Registers
Stack
State

Share

Threads

- Allow multiple execution paths in the same process environment
- Threads share address space, open files etc
- But have own set of Program counter, Stack etc
- The first thread starts execution with
  - `int main(int argc, char *argv[])`
- The threads appear to the Scheduling part of an OS just like any other process

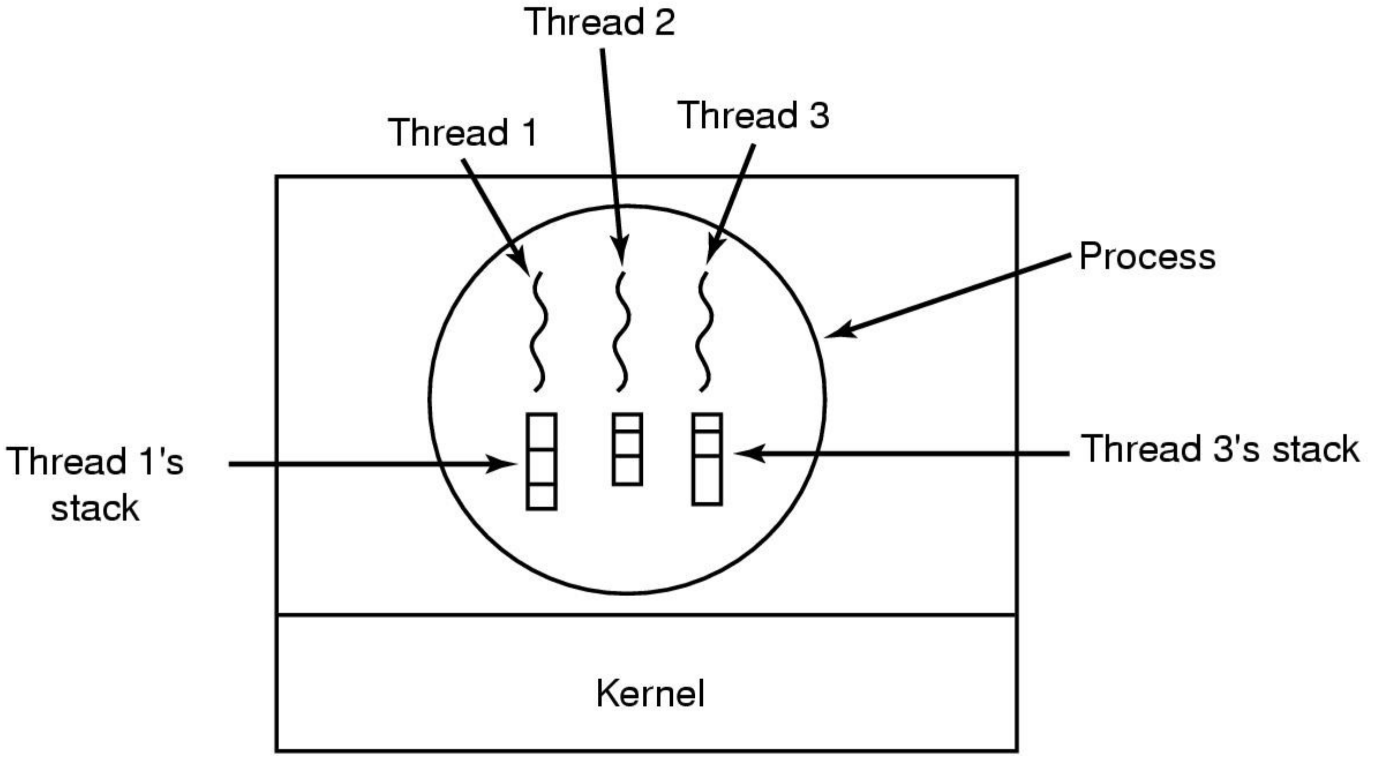
Process Vs. Threads



(a) Three threads, each running in a separate address space

(b) Three threads, sharing the same address space

The Thread Model

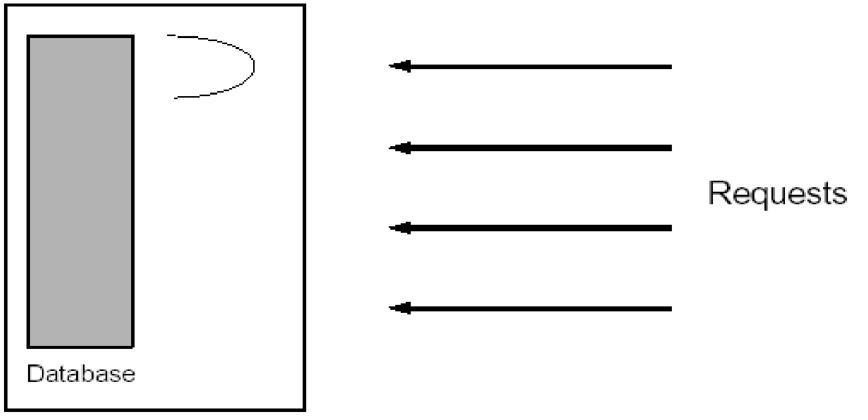


Each thread has its own stack

Thread Usage

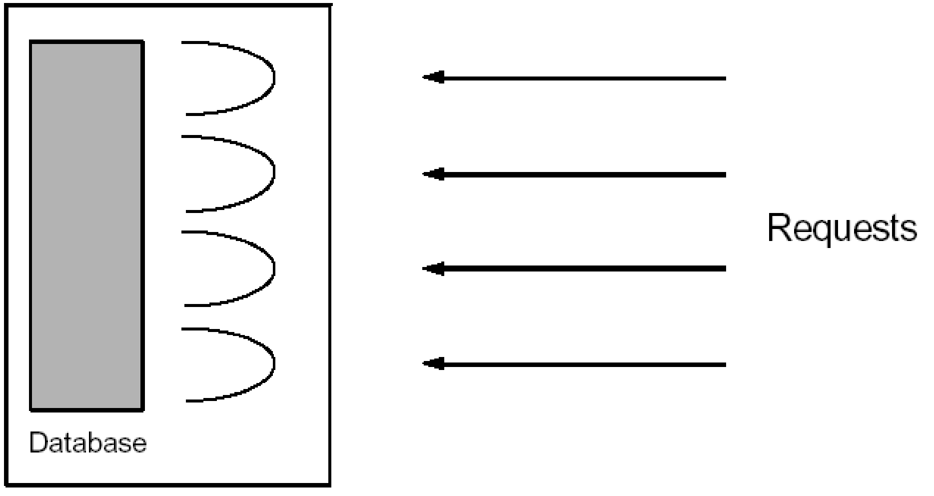
- Less time to create a new thread than a process
  - the newly created thread uses the current process address space
  - no resources attached to them
- Less time to terminate a thread than a process.
- Less time to switch between two threads within the same process, because the newly created thread uses the current process address space.
- Less communication overheads
  - threads share everything: address space, in particular. So, data produced by one thread is immediately available to all the other threads
- Performance gain
  - Substantial Computing and Substantial Input/Output
- Useful on systems with multiple processors

1. Single threaded database server



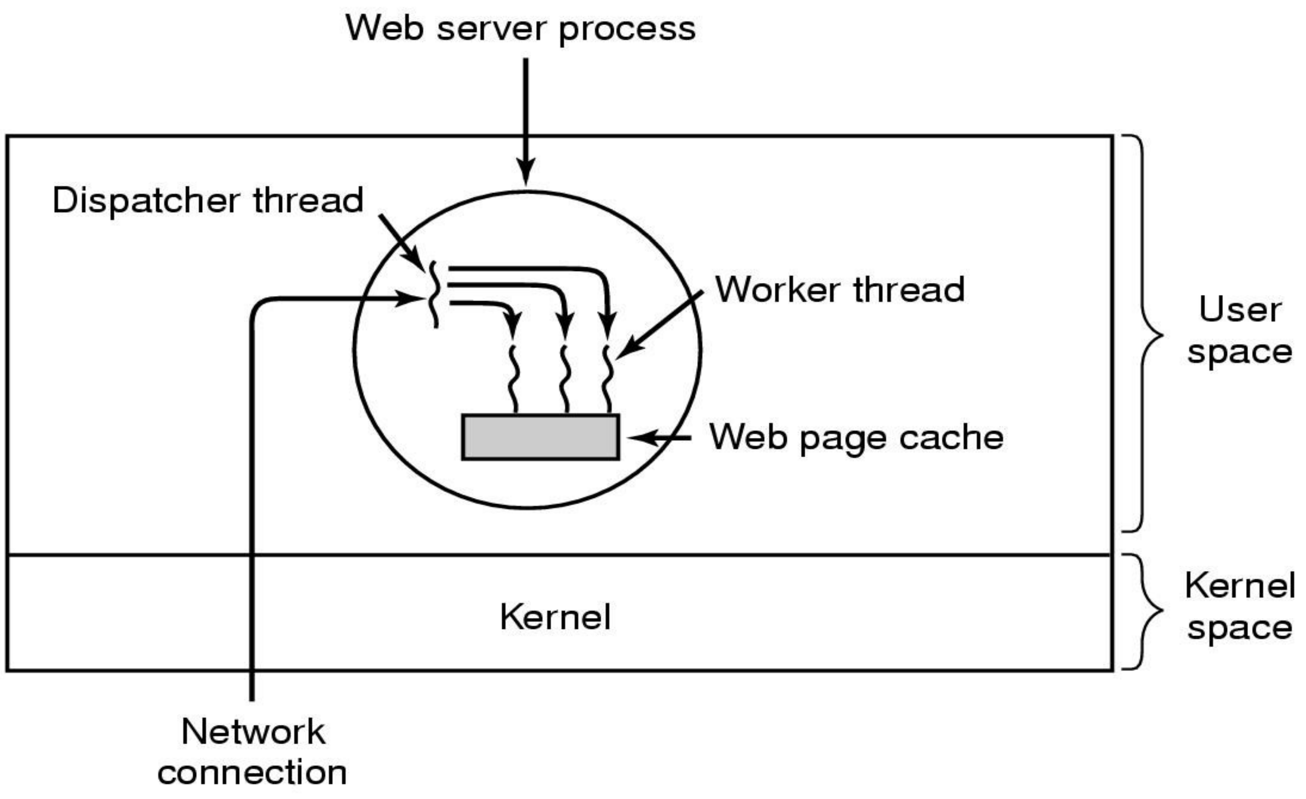
- Handles multiple clients
  - Either handle the requests sequentially
  - Or multiplex explicitly by creating multiple processes
- Problems
  - Unfair for quick requests, occurring behind lengthy request
  - Complex and error prone
  - Heavy IPC required

1. Multithreaded database server



- Assign a separate thread to each request
- As fair as in the multiplexed approach.
- The code is as simple as in the sequential approach, since the address space is shared - all variables are available
- Some synchronization of access to the database is required, this is not terribly complicated.

e.g. A multithreaded web server

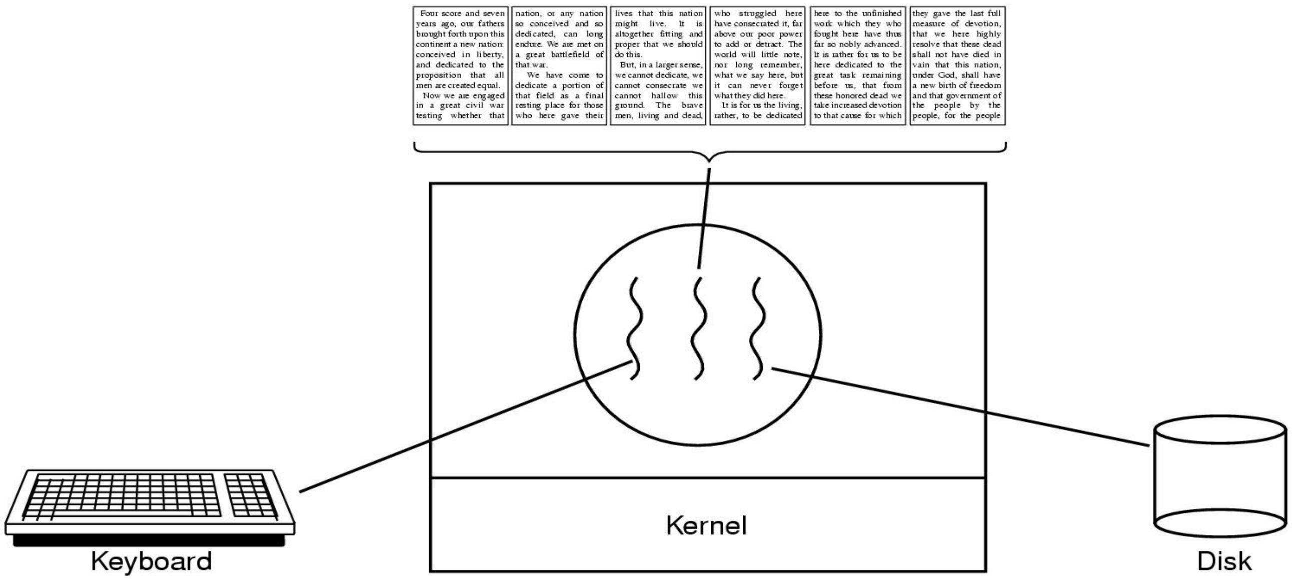


2. Background Processing

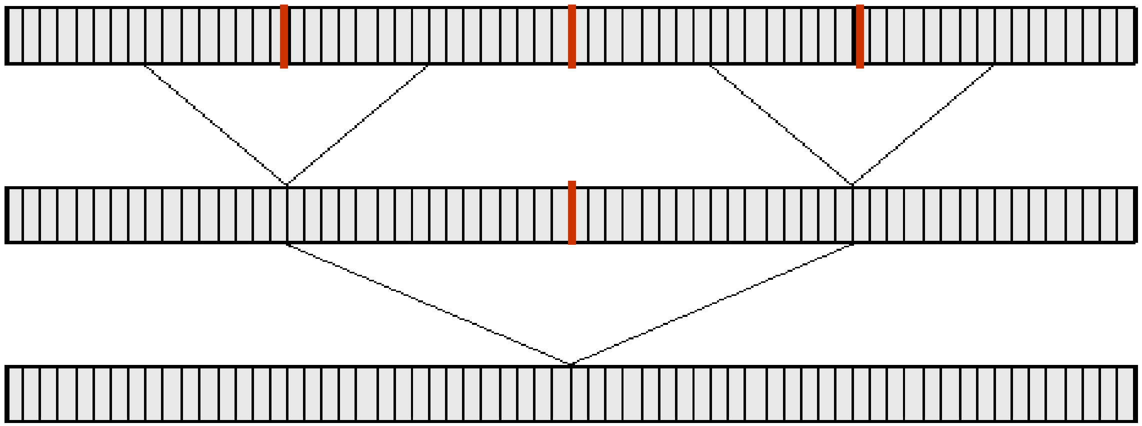
- Consider writing a GUI-based application that uses:
  - Mouse
  - Keyboard input
  - Handles various clock-based events

- In a single threaded application, if the application is busy with one activity, it cannot respond (quickly enough) to other events, such as mouse or keyboard input.
- Handling such concurrency is difficult and complex
- But simple in a multithreaded process

e.g. A word processor with 3 threads



3. Parallel Algorithms e.g. Mer



- Sort some data items on a shared-memory parallel computer.
- Our task is merely to implement a multithreaded sorting algorithm.
  - Divide the data into four pieces
  - Have each processor sort a different piece.
  - Two processors each merge two pieces
  - One processor merges the final two combined pieces.