CS 3305B

Brief Intro to Threads

Lecture 6

Jan 25 2017

Introduction

- Multiple applications run concurrently!
- This means that there are multiple processes running on a computer

A "Single Threaded" Program

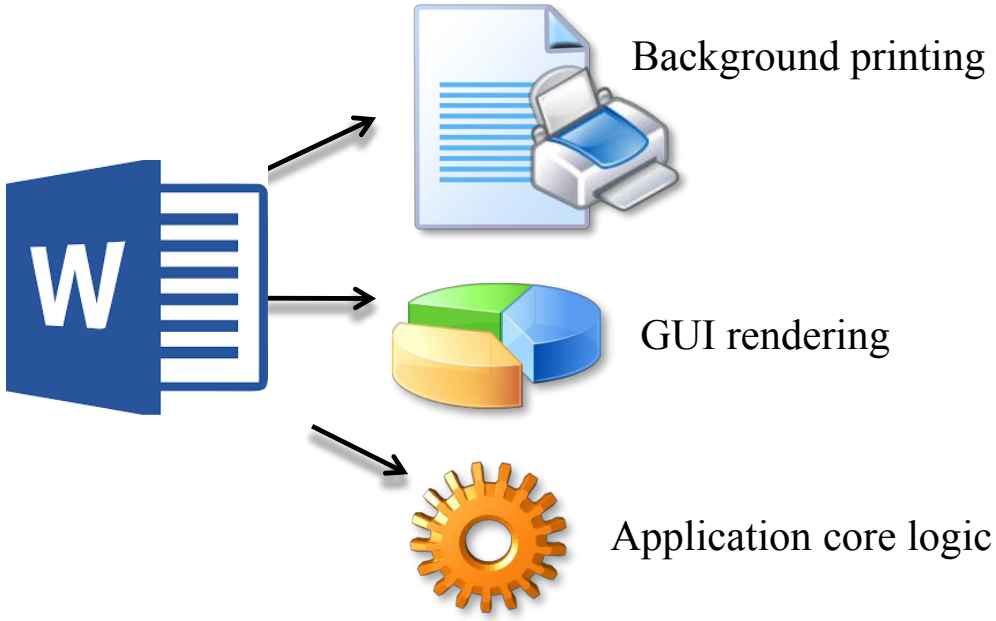
```
main()
{

  ......

{
```

Introduction

- Applications often need to perform many tasks at once

- This requires multiple threads of execution within a single process

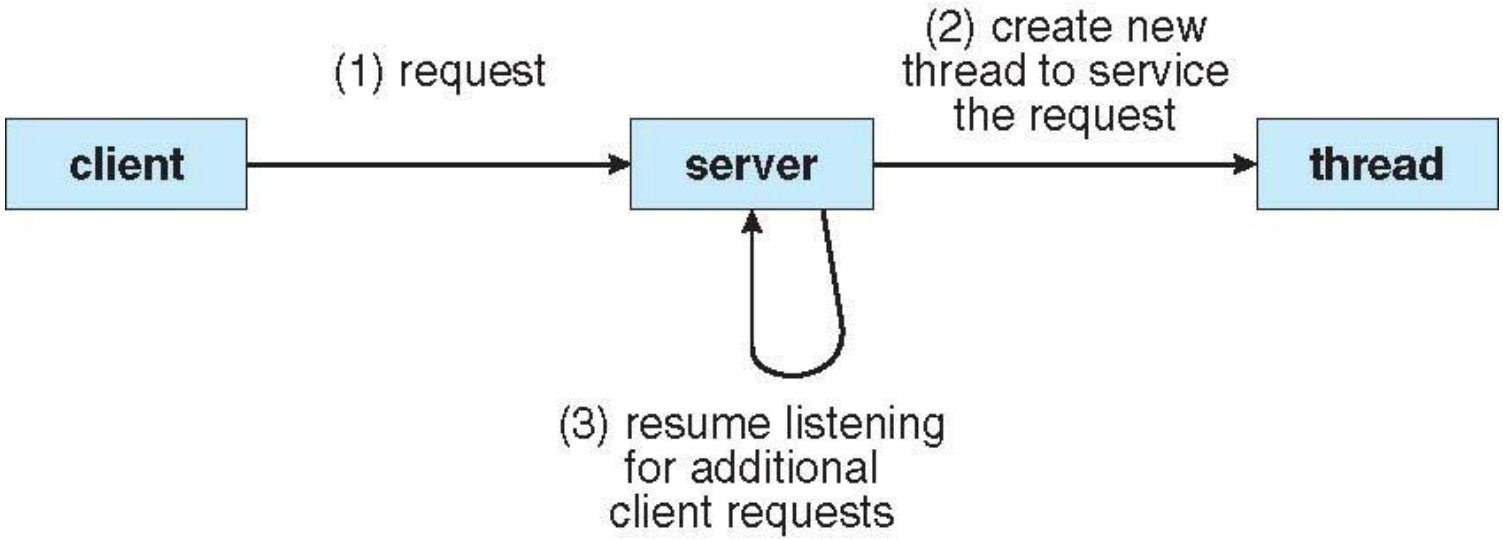
Example



- Example: Word processor
  - Tasks include:
    - Display graphics
    - Respond to keystrokes from the user
    - Perform spelling and grammar checking

Example

- Example: Web server
  - It is desirable to service requests concurrently



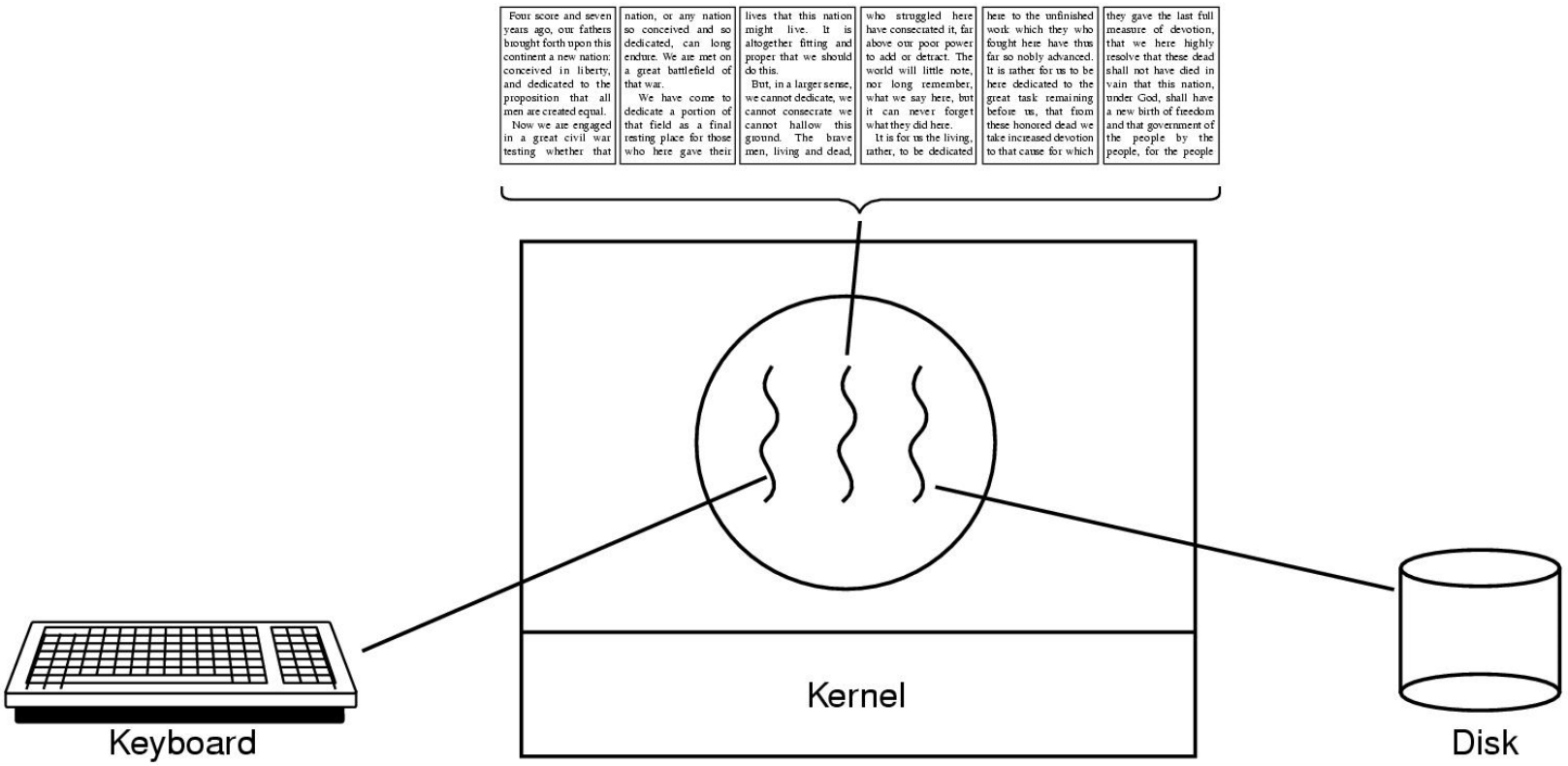
Introduction

- Earlier we discussed the use of forking to create a process
- For example we could
  - Word processor example: fork a process for each task
  - Web server example: fork a process for each request
- Not very efficient since a fork copies everything

Threads

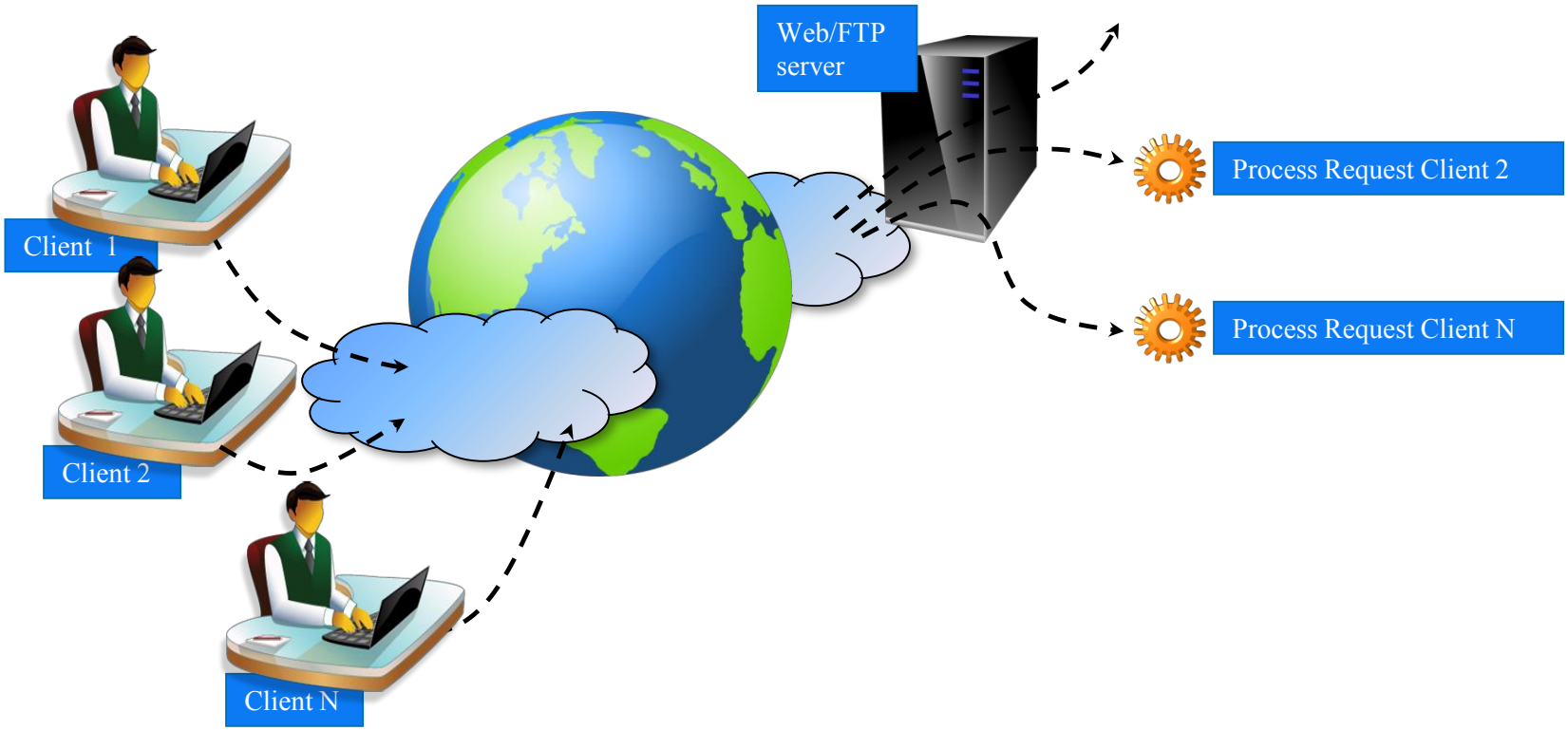
- A thread is a basic unit of CPU utilization
- Threads of a process share memory but can execute independently
- A traditional process can be viewed as a memory address space with a single thread

Thread Usage – Word Processor



A word processor program with three threads.

Thread Usage – Web Server



Why Not Fork?

- You certainly can fork a new process
- In fact, the first implementation of Apache web servers (Apache 1.0) forked N processes when the web server was started
  - "N" was defined in a configuration file
  - Each child process handled one connection at a time
- Problem: Process creation is time consuming and resource intensive
- Creating threads is not as expensive

Why Not Fork?

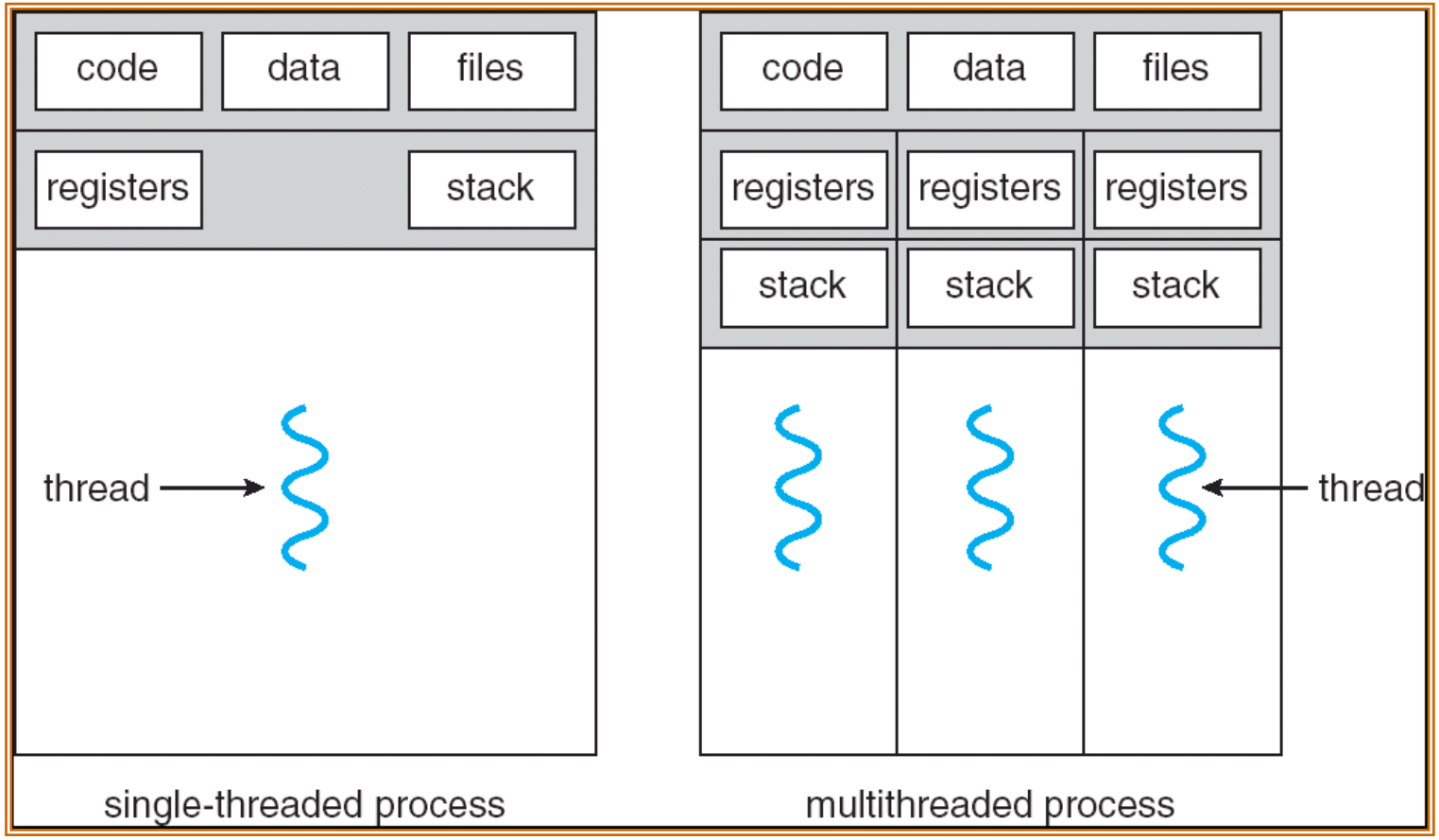
- Let's look at web servers
  - This allowed a child process to handle multiple connections at a time
  - Web servers have caches for read pages
  - Forking means that these caches cannot be shared
  - Using threads allows for these caches to be shared

Thread State

- Threads share
  - Process address space
    - Text
    - Data (global variables)
    - Heap (dynamically allocated data)
  - OS state
    - Open files, sockets, locks
- Threads have their own CPU context
  - Program counter(PC), Stack pointer (SP), register state, stack

Single and Multithreaded Processes

they share it



Benefits of Threads

- Responsiveness

they have their own cpu context

  - Overlap computation and blocking due to I/O on a single CPU
- Resource Sharing
  - Example: Word processor
    - The document is shared in memory.
    - Forking would require replication
- Allocating memory and resources for process creation is costly
- Context-switching is faster

Thread Libraries

- A thread library provides the programmer with an API for creating and managing threads
- Three main libraries:
  - POSIX Pthreads
  - Win32
  - Java

Problem

- Sharing global variables is dangerous - two threads may attempt to modify the same variable at the same time.
- Use support for mutual exclusion primitives that can be used to protect against this problem.
- The general idea is to lock something before accessing global variables and to unlock as soon as you are done.
- More on this topic later in the course

Summary

- Introduction to the concept of threads
- There will be more discussion