CS 4410
Operating Systems

Threads

Summer 2011

Cornell University

Today

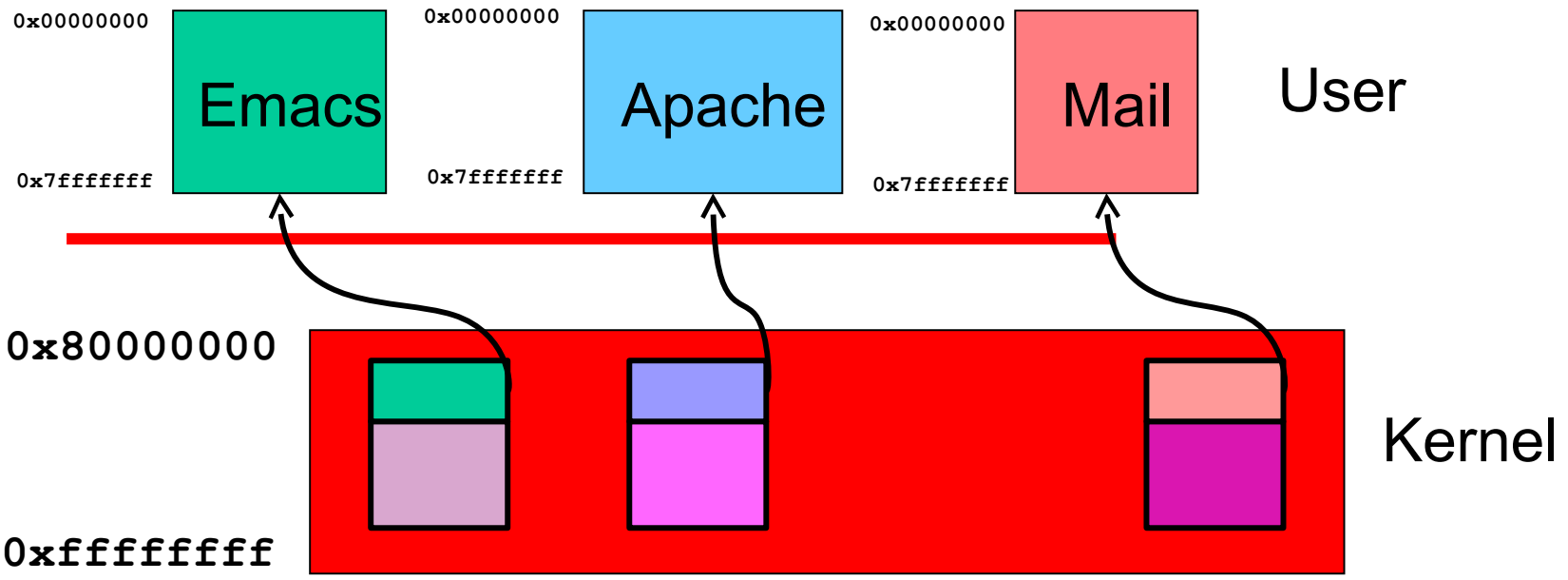
- What is the difference between thread and process? Why do we need threads?
- Processes and address spaces
- Difference between thread and process
- Thread
- Multi-threaded programming

Processes and Threads

- A **full process** includes numerous things:
  - an address space (defining all the code and data pages)
  - OS resources and accounting information
  - a “thread of control”, which defines where the process is currently executing (basically, the PC and registers)
- Creating a new process is **costly**, because of all of the structures (e.g., page tables) that must be allocated
- **Communicating** between processes is costly, because most communication goes through the OS

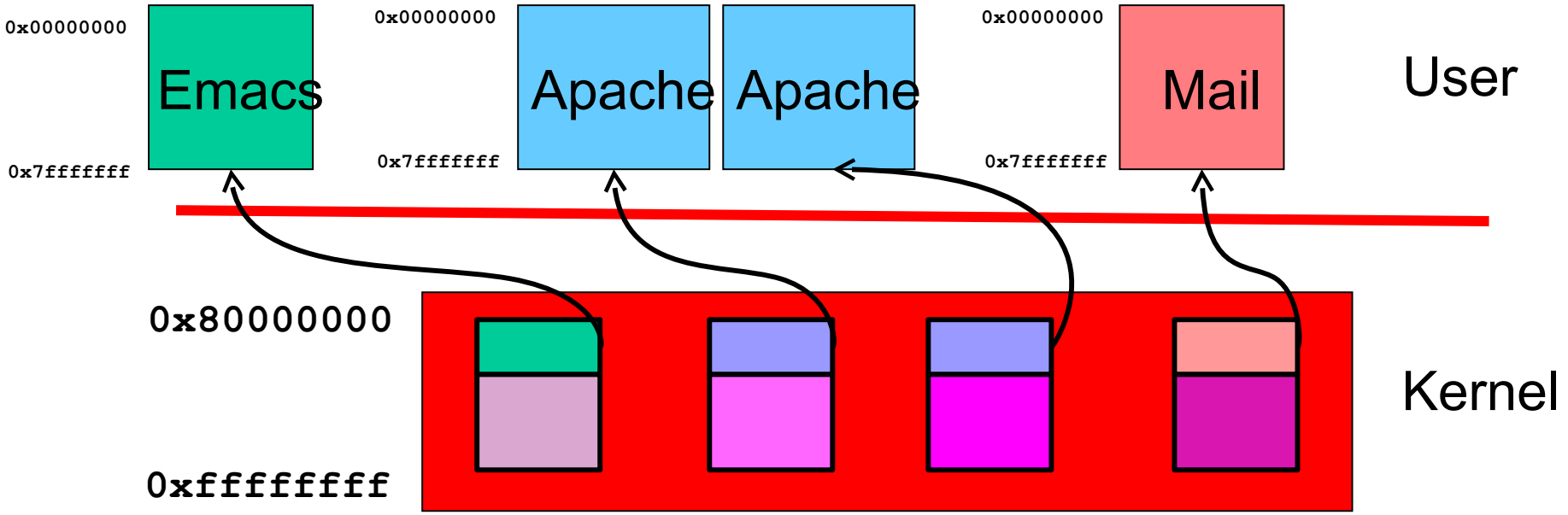
Processes and Address Spaces

- What happens when Apache wants to run multiple concurrent computations ?



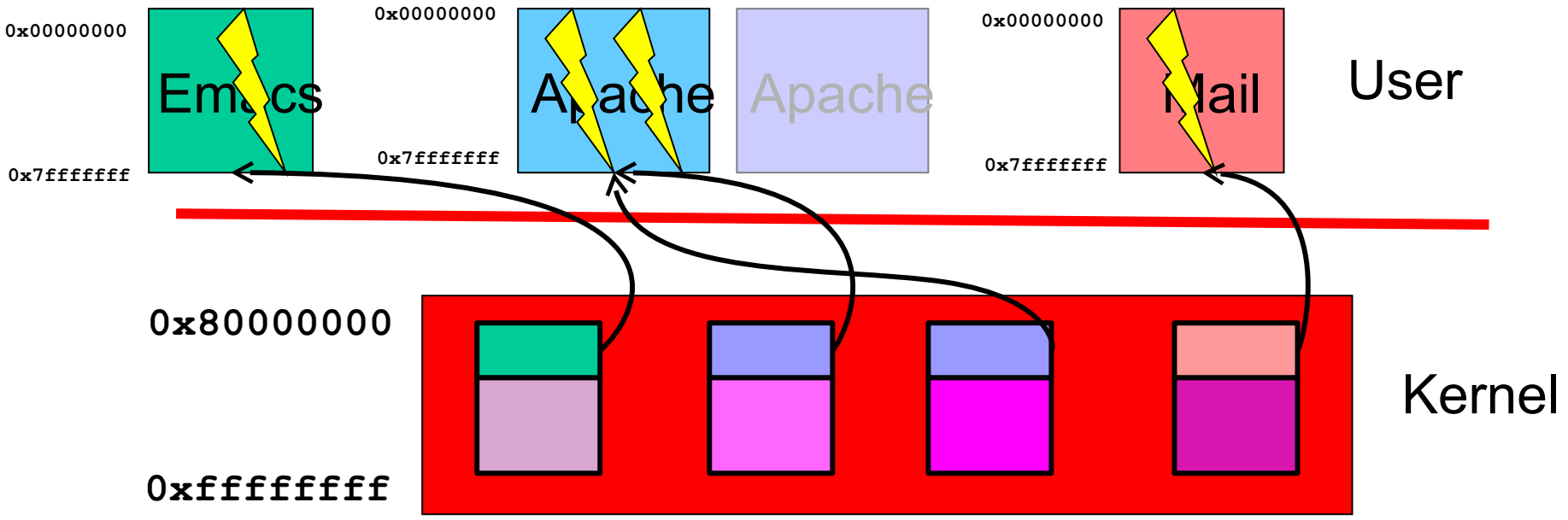
Processes and Address Spaces

- Two heavyweight address spaces for two concurrent computations ?



Processes and Address Spaces

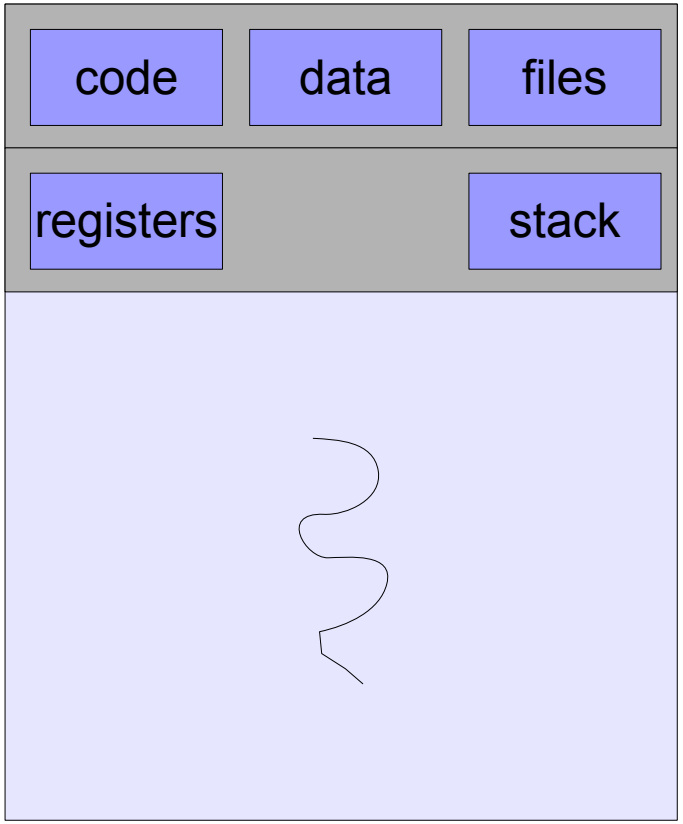
- We can eliminate duplicate address spaces and place concurrent computations in the same address space



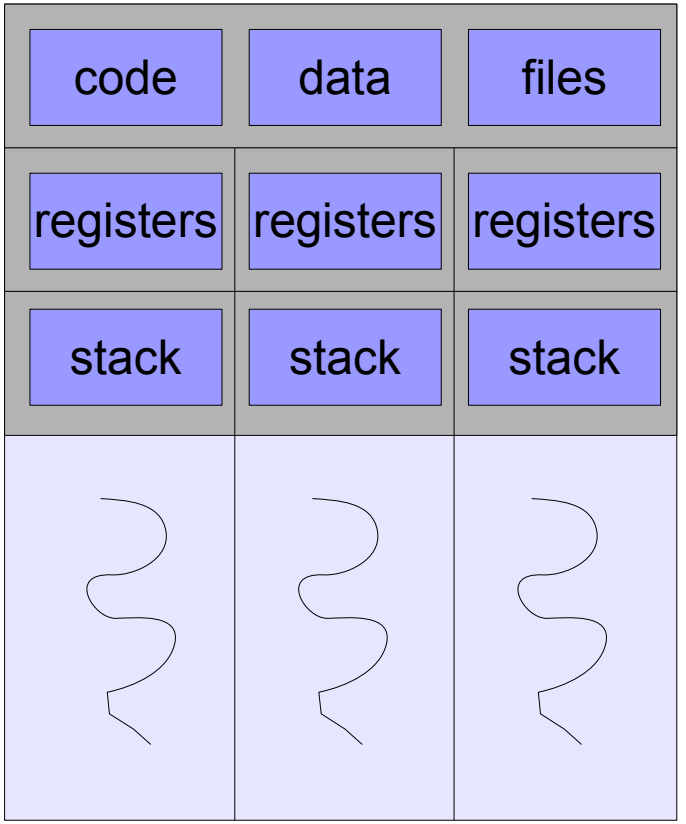
Threads and Processes

- Modern operating systems therefore support two entities:
  - the **process**, which defines the **address space** and general process attributes
  - the **thread**, which defines a **sequential execution stream** within a process
- **A thread is bound to a single process**. For each process, however, there may be many threads.
- Threads are the unit of scheduling; processes are *containers* in which threads execute.

Threads and Processes



single-threaded process



multi-threaded process

Thread

- Basic unit of CPU utilization.
- It comprises:
  - Thread ID
  - PC
  - Register set
  - SP
- It belongs to a process.
- It shares:
  - Code
  - Data
  - OS resources (files, etc)

  with the other threads of the same process.

Multi-threaded programming

- A programmer can create multiple threads to complete a task, to achieve:
  - Responsiveness
  - Resource sharing
  - Economy
  - Scalability
    - Multiprocessor architecture
    - Ex. Word count at many files

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