Amirkabir University of Technology
(Tehran Polytechnic)

Operating Systems

Processes-Part1

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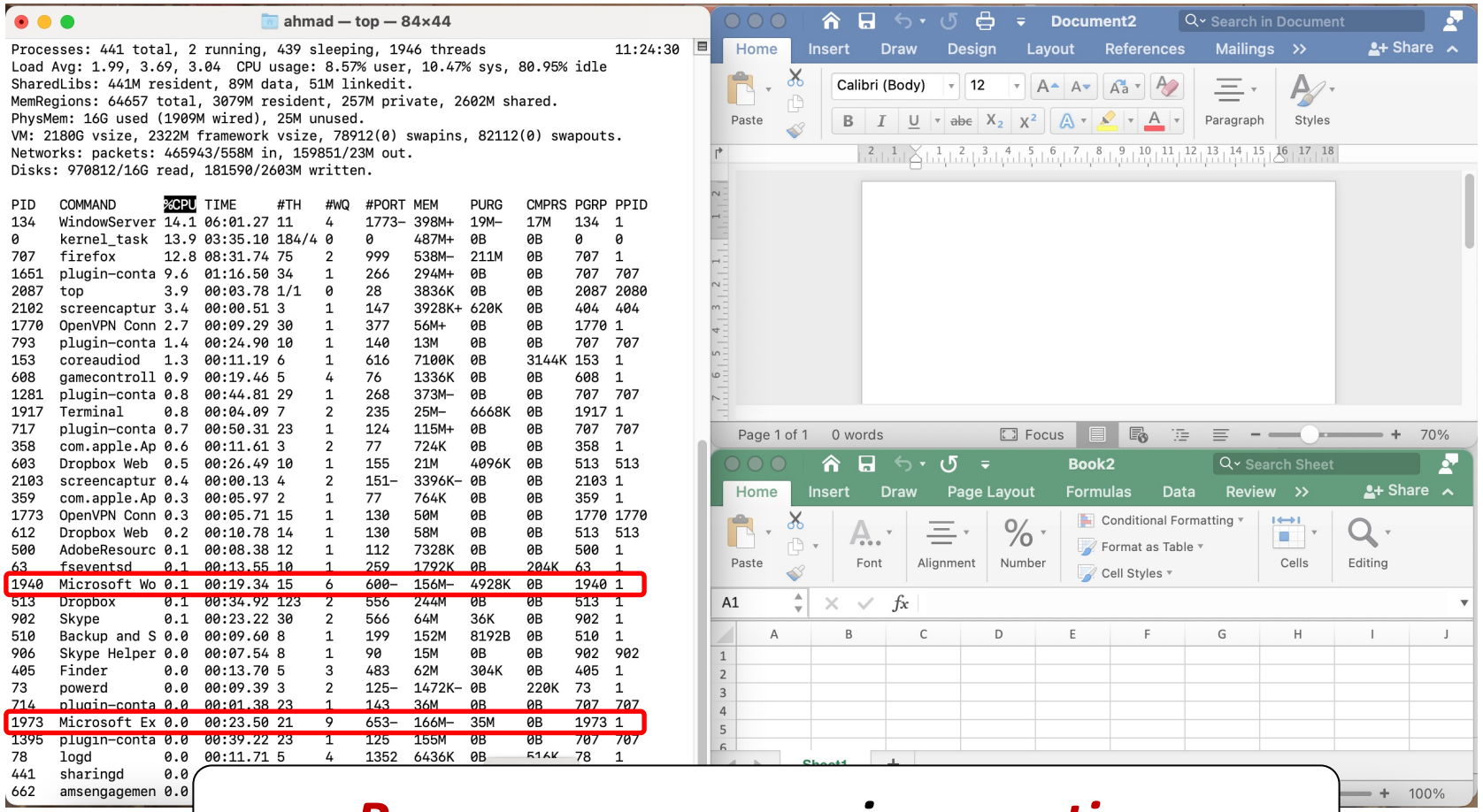
Process Concept

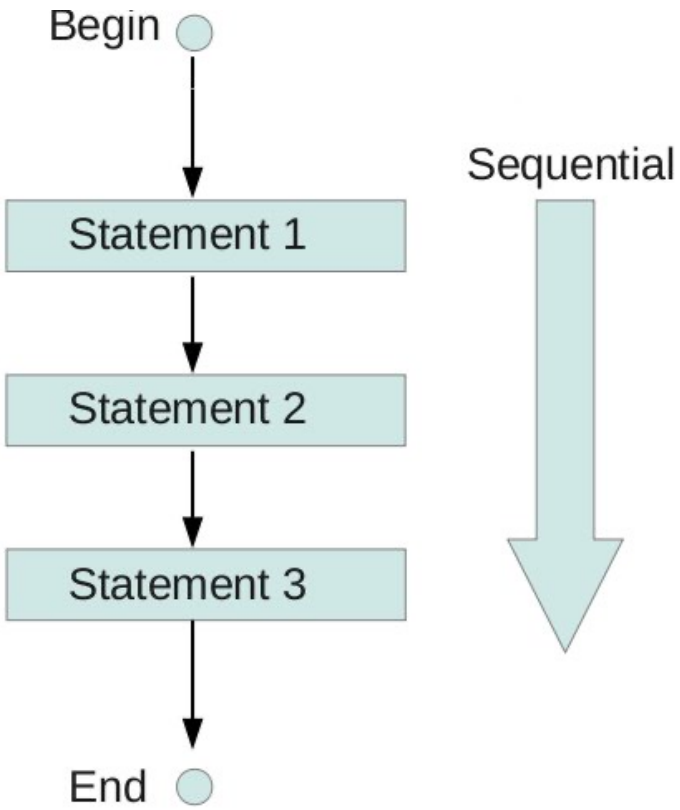
- An OS executes a variety of programs that run as a ***process***.



Process*, a program in *execution

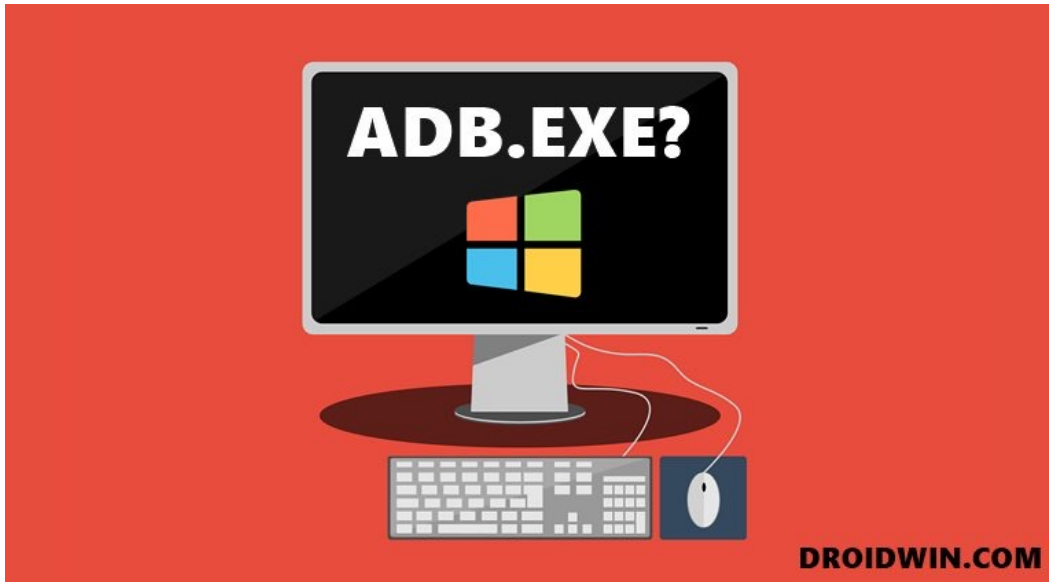
Process Concept (cont.)

- Process execution must progress in ***sequential fashion***.
  - ***No parallel execution*** of instructions of a single process.



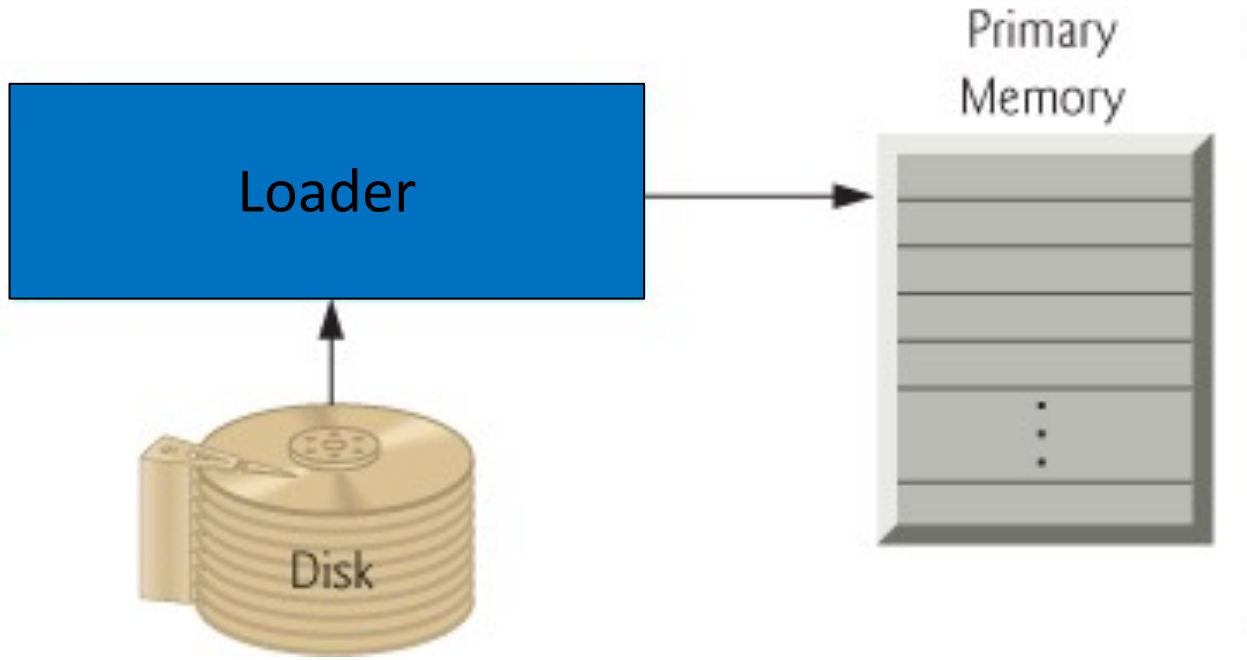
Process versus Program

- Program is **passive** entity stored on disk (***executable file***).



Process versus Program (cont.)

- ***Process** is active.*
  - ***Program becomes process*** when an executable file is loaded into memory.



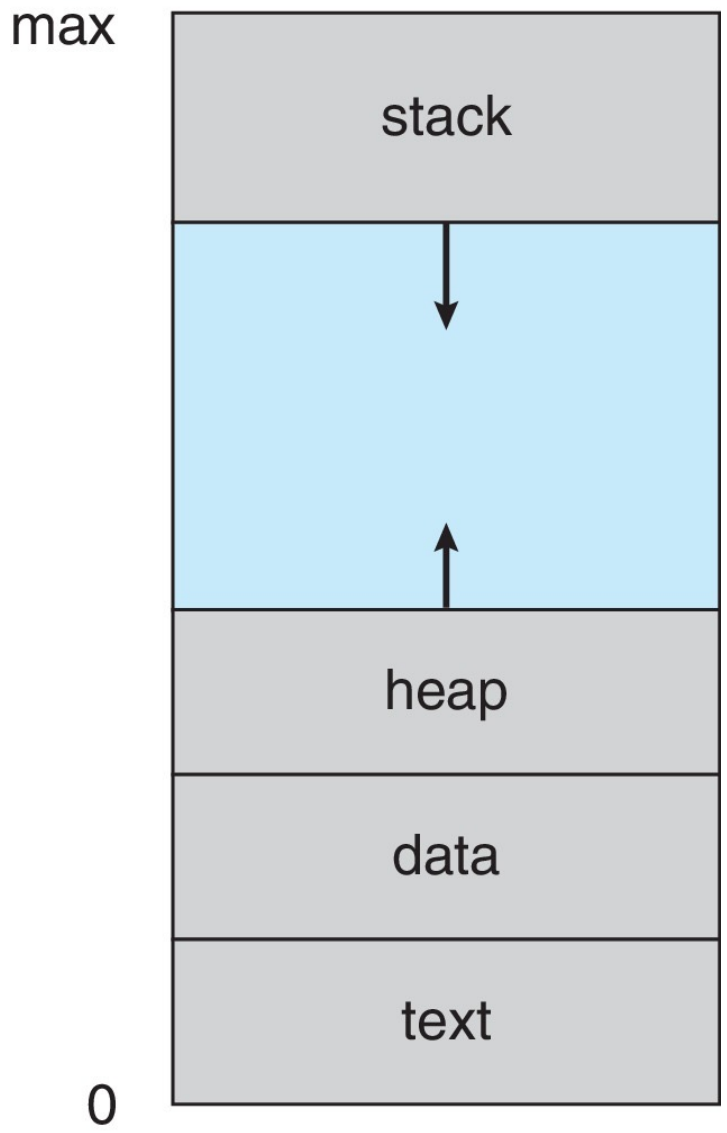
Process versus Program (cont.)

- Execution of program started via:
  - GUI mouse clicks
  - Command line entry of its name
  - Etc.
- One program can be several processes
  - How?
  - Consider multiple users executing the same program.

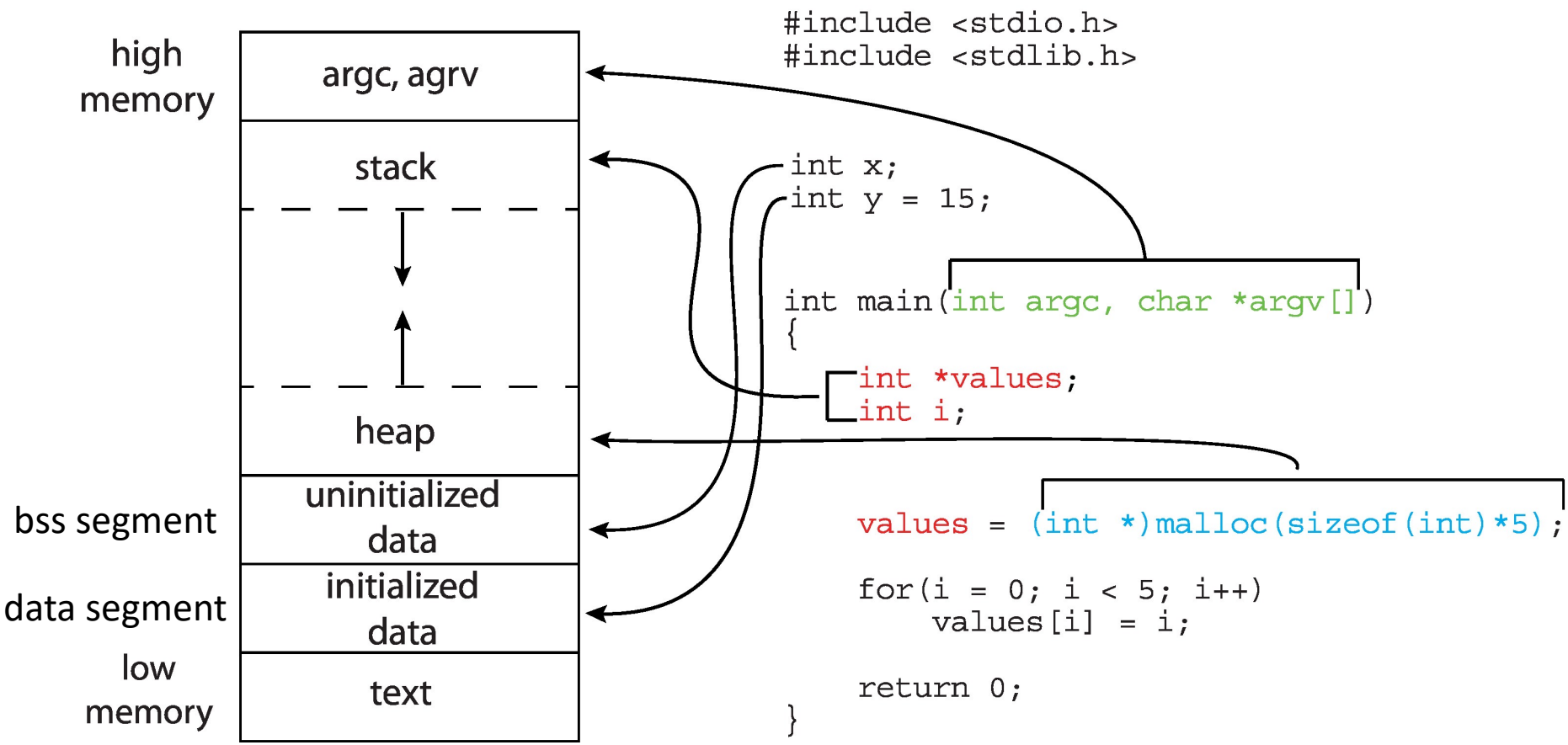
Multiple Parts of Process

- The program code, also called ***text section***
- Current activity including ***program counter***, processor registers
- ***Stack*** containing temporary data
  - Function parameters, return addresses, local variables
- ***Data section*** containing global variables
- ***Heap*** containing memory ***dynamically*** allocated during run time

Process in Memory



Memory Layout of a C Program



Some Links

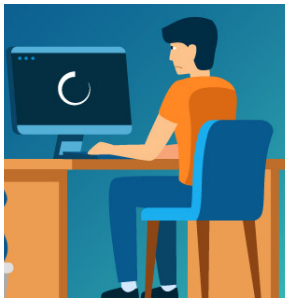
https://www.geeksforgeeks.org/memory-layout-of-c-program/

https://stackoverflow.com/questions/10315759/data-section-size-in-size-command-on-mac

Process State

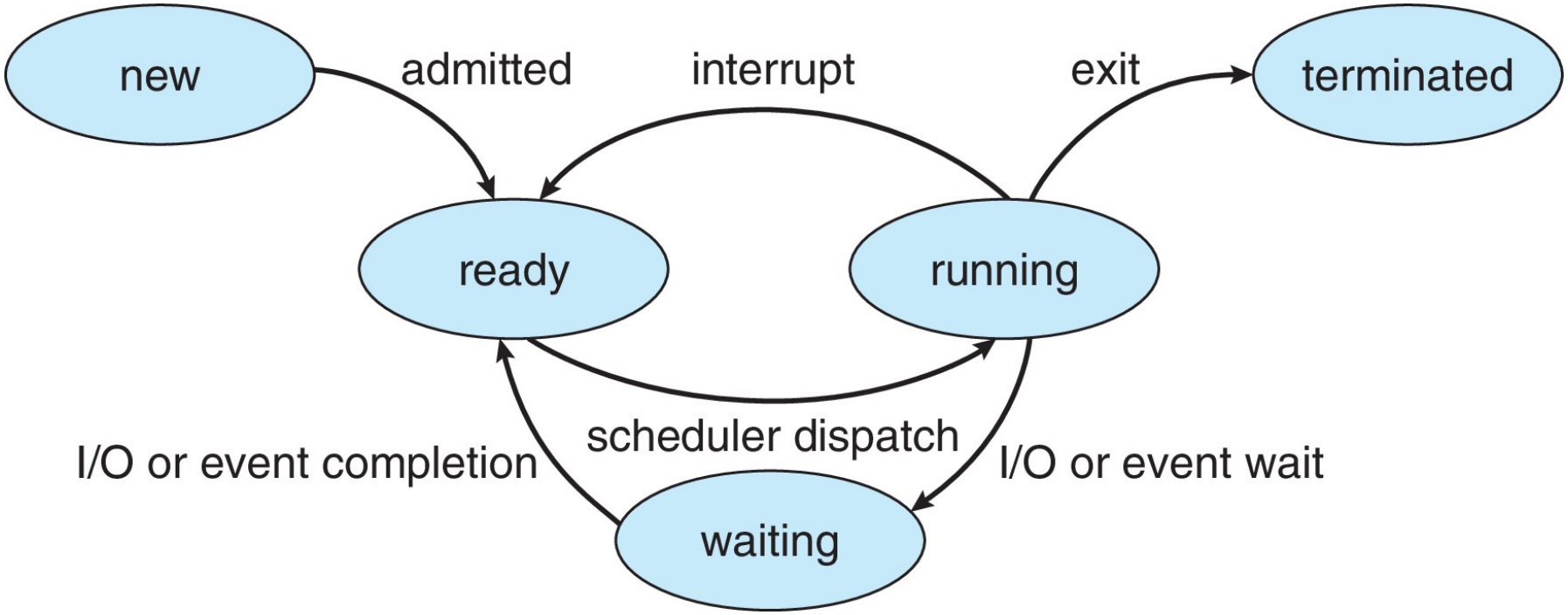
- As a process executes, it changes **state**

  - **New**: The process is being created
  - **Running**: Instructions are being executed



  - **Waiting**: The process is waiting for some event to occur
  - **Ready**: The process is waiting to be assigned to a processor
  - **Terminated**: The process has finished execution

Diagram of Process State

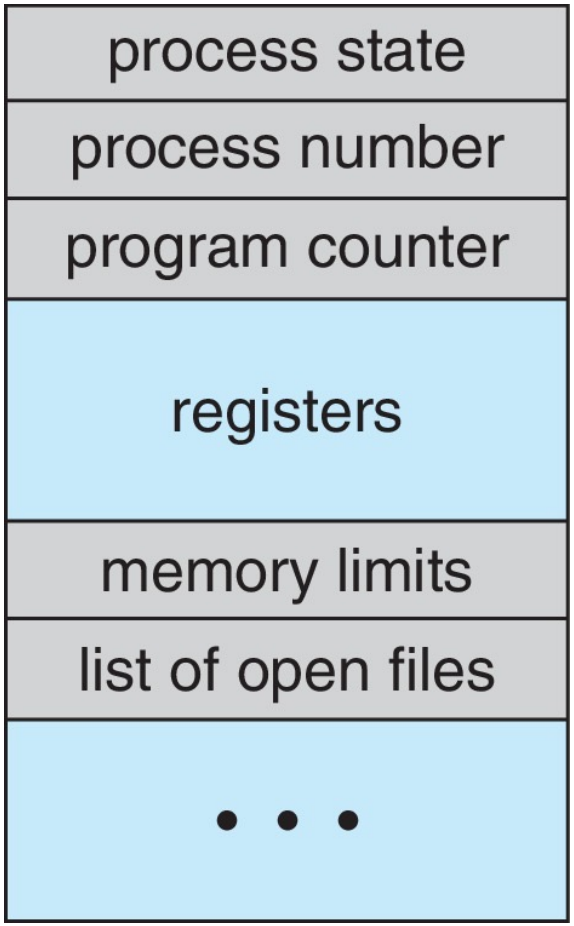


Process Control Block (PCB)

Information associated with each process

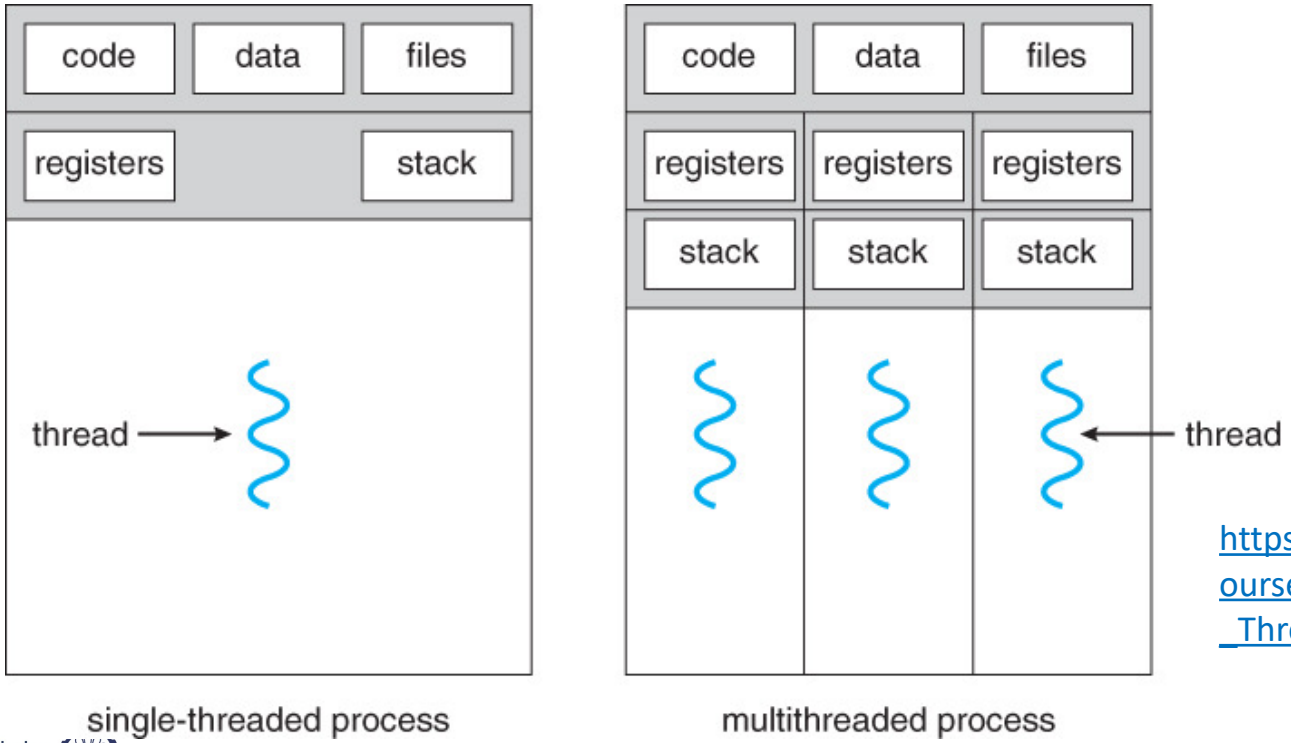
- Process state: running, waiting, etc.
- Program counter: location of instruction to next execute.
- CPU registers: contents of all process-centric registers.
- CPU scheduling information: priorities, scheduling queue pointers.
- Memory-management information: allocated memory
- Accounting information: CPU used, clock time elapsed since start, etc
- I/O status information: allocated I/O devices, list of open files.

Process Control Block (PCB) (cont.)



Threads

- So far, process has ***a single thread of execution***.
- Consider having ***multiple program counters*** per process.
  - Multiple locations can execute at once
    - Multiple threads of control -> **thread**

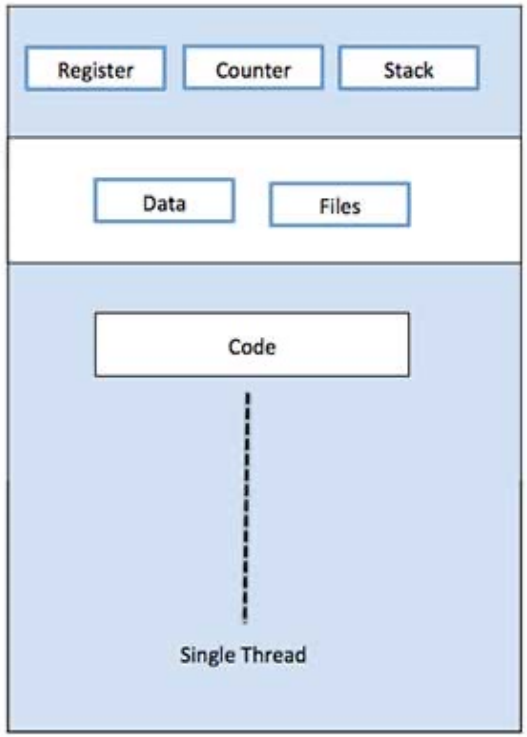


single-threaded process

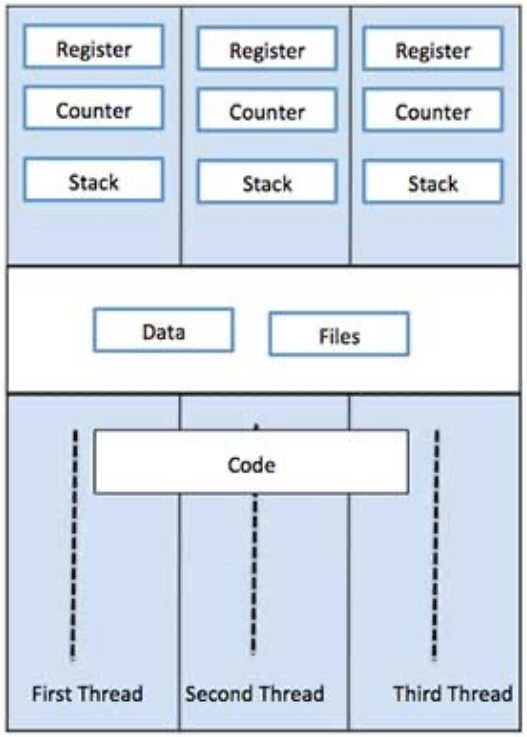
multithreaded process

https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/4_Threads.html

Threads



Single Process P with single thread



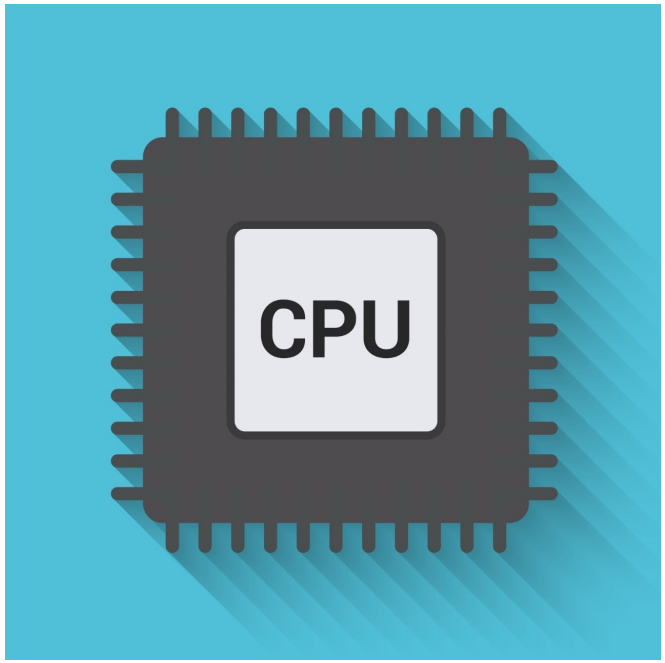
Single Process P with three threads

https://www.tutorialspoint.com/operating_system/os_multi_threading.htm

- Must then have ***storage for thread details***
  - Multiple program counters in PCB.
- Explore in detail in ***Chapter 4***.

Process Scheduling

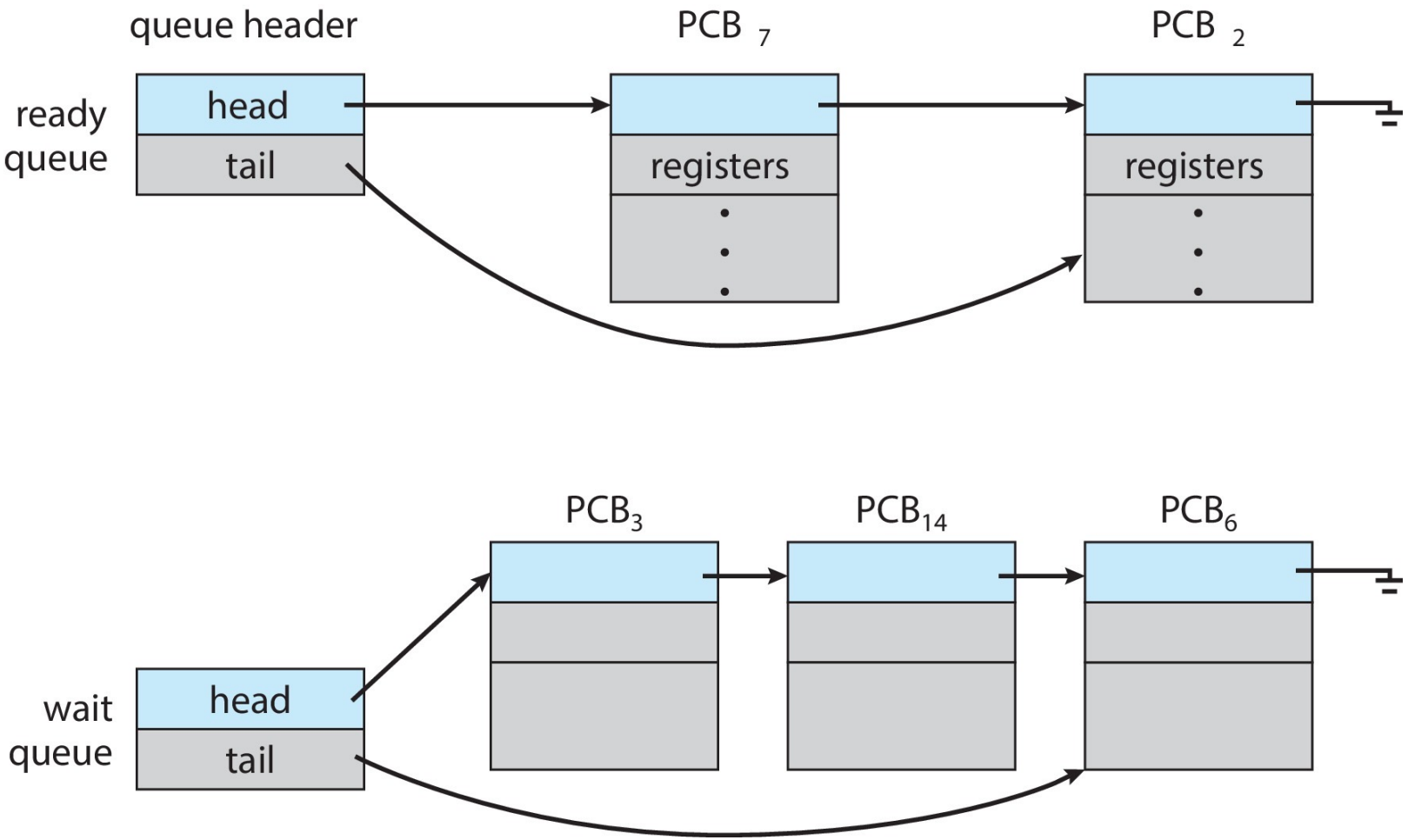
- ***Process scheduler*** selects among available processes for next execution on CPU core.
- **Goal: Maximize CPU use, quickly switch processes onto CPU core.**



Process Scheduling (cont.)

- Maintains ***scheduling queues*** of processes
  - **Ready queue**
    - Set of all processes residing in main memory, ready and waiting to execute.
  - **Wait queues**
    - Set of processes waiting for an event (i.e., I/O)
- Processes ***migrate*** among the various queues.

Ready and Wait Queues



Representation of Process Scheduling