Background

To understand parallel systems we must first understand serial systems

The von Neumann architecture
The classic Neumann architecture consists of main memory, a CPU (core/processor), and an interconnection (most notably bus)

Main Memory: Main memory consists of a collection of locations, each of which is capable of storing both instructions and data.

- Every location has an address and the location's contents.
- The address is used to access the location
- the contents of the location is the instruction or data stored in the location

CPU: divided into a control unit and a data path

- Control unit is responsible for deciding which instructions to run
- Datapath is responsible for actually executing the instructions
- Data in CPU is stored in a super fast storage place called registers
    - Has a special register called program counter that tells the cpu which instruction is next

Interconnection: How Instructions and data are transferred b/w main memory and CPU

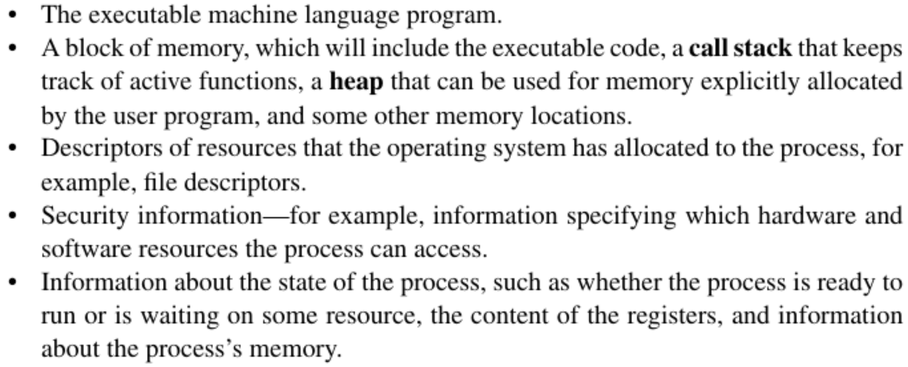
- Most notable hardware is called a bus, which is a set of parallel wires.

The Von Nuemann bottleneck: The separation of memory and CPU

- Since the interconnect determines the rate at which data and instructions are transmitted/can be accessed
- The vast quantity of data is isolated from the CPU
- A CPU is capable of executing instructions more than a hundred times faster than fetching items from main memory

Processes, Multitasking, and threads

- A operating system (OS) is a piece of software whose purpose is to manage hardware and software resources on a computer
    - It determines which programs can run and when they can run
    - It controls allocation of memory to those programs
    - Controls access to outside devices such as network card or hard disks
- Process: an instance of a computer program that is being executed
    - When a user runs a program the OS creates a process
    - A process consists of…



- The executable machine language program.
- A block of memory, which will include the executable code, a **call stack** that keeps track of active functions, a **heap** that can be used for memory explicitly allocated by the user program, and some other memory locations.
- Descriptors of resources that the operating system has allocated to the process, for example, file descriptors.
- Security information—for example, information specifying which hardware and software resources the process can access.
- Information about the state of the process, such as whether the process is ready to run or is waiting on some resource, the content of the registers, and information about the process's memory.

- Most operating systems are multitasking: OS provides support for simultaneous execution of multiple programs.
    - Even systems with one core can do this due to time slice: each process runs for a small interval of time (typically a few milliseconds).
    - If a process is waiting for a resource or needs to wait for a resource it will block: meaning that the process will stop executing and another process can run.
    - Threading: provides a mechanism for programmers to divide their program into independent tasks, so that when one thread is blocked the other can run.
        - Much faster to switch b/w threads than processes since they are lightweight