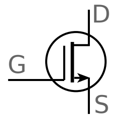
Lecture 1, Sep 8, 2022

- General purpose processors can be too slow for some applications because of overhead
  - Specialized hardware is used for e.g. WiFi
- Hardware is faster & more efficient
- Writing software involves many layers of abstraction
  - Code -> hardware adder -> logic gates -> transistor -> silicon
  - Makes it easier since it hides things we don't need to worry about
- Abstraction vs Complexity: need to manage complexity, find the right level of abstraction to succeed in labs



- Transistors: acting like a switch
  - When voltage on the gate is high, the drain and source are connected
  - Made of silicon chips, L is the length of the gate (current state of the art $L = 14\text{nm}$)
  - Transistors in chips are getting smaller and more powerful following Moore's Law

Why Build Hardware?

- Hardware is faster, but harder to produce and apply, and more expensive
- Why is hardware faster than software? Things get in the way with software:
  - Retrieval of instructions, operands, etc from memory
  - Write results back into memory
  - Keeps asking for the next computation
- Hardware is tailored to a specific purpose, so it doesn't have to ask what to do
- If not fast enough (throughput: things that can be done per unit time), just build more hardware!
- Hardware speed is bottlenecked by speed of electrical signal, wire resistance, capacitance, etc

When to Build Hardware?

- Software is easier to build, test, and manufacture
- Build hardware when software is simply too slow

Assembly Language

- High level languages are machine agnostic (doesn't care about the specific processor)
  - The compiler compiles this down to assembly
- Assembly language is a low level, machine specific language that is still human readable
- An assembler converts this to a native binary executable, which only runs on the specific architecture it was compiled/assembled for
- Assembly is typically only used in special circumstances:
  - Where high speed behaviour down to the instruction is needed
  - Where low level access to hardware is needed, e.g. device drivers
- ASM is a lot closer to hardware and is a stepping stone to learn computer architecture
- RISC-V: Reduced Instruction Set Computer, RISC-V is an open source ISA (instruction set architecture)