Hardware basics

CS 2XA3

Term I, 2018/19

Outline

Processors

- x86, x86-64, IA-64, Sparc, PowerPC, Alpha, . . .
- RISC (Reduced Instruction Set Computers) vs CISC (Complex . . .)
- We will study x86 architecture
  - 8088, 8086
  - 80286
  - 80386
  - 80486
  - Pentium
  - .....

see for instance Wikipedia at

`https://en.wikipedia.org/wiki/List_of_Intel_CPU_microarchitectures`

8086

- 16 bit registers
- **AX**, **BX**, **CX**, **DX** general purpose
- **AX = [AL|AH]** (*order due to NASM being little endian*), lower (**AL**) and upper (**AH**) parts; the same for **BX**, **CX**, **DX**
- **SI**, **DI** for pointers, can be used as general purpose
- **BP** base pointer
- **SP** stack pointer
- **CS** (code), **DS** (data), **SS** (stack), **ES** (extra) segment registers
- **IP** instruction pointer; address of next instruction to be executed
- **FLAGS** various flags

80386 +

- 32 bit registers
- **EAX**, **EBX**, **ECX**, **EDX** general purpose
  EAX = [AL|AH|-|-] (*order due to NASM being little endian*); the same for **EBX**, **ECX**, **EDX**
- **ESI**, **EDI** for pointers, can be used as general purpose
- **EBP** base pointer
- **ESP** stack pointer
- **CS** (code), **DS** (data), **SS** (stack), **ES** (extra) segment registers; still 16 bit !!
- **FS**, **GS** new, like **ES**
- **IP** instruction pointer; address of next instruction to be executed
- **FLAGS** various flags

Real mode (8086)

- Memory (addressable space) $\leq 2^{20}$ bytes = 1 MB
- Need 20 bits, but registers are 16 bits
- Address is a pair **selector:offset**, where **selector** is a segment register and **offset** a 16 bit address
- That is, 16 x (**selector**) + **offset**
- Disadvantages
  - A register can reference $2^{16} = 64$ KB
  - Segments are 64 KB; if $>$ 64 KB segment register must be changed
  - Address is not specified uniquely

16 Bit protected mode (80286)

- Selector value is an index into a descriptor table
- Segments are not at fixed positions, as in real mode
- Uses virtual memory: keep data and code in memory that programs are currently using
- Segments are moved between memory and disk as needed
- Segments still limited to 64K

32 Bit protected mode

- Offsets are 32-bits
- Segments are up to 4 GB
- Segments are divided into 4 KB pages
- Virtual memory works with the pages
- Windows, Linux, OSX all run in protected mode