

Microprocessors, Lecture 1

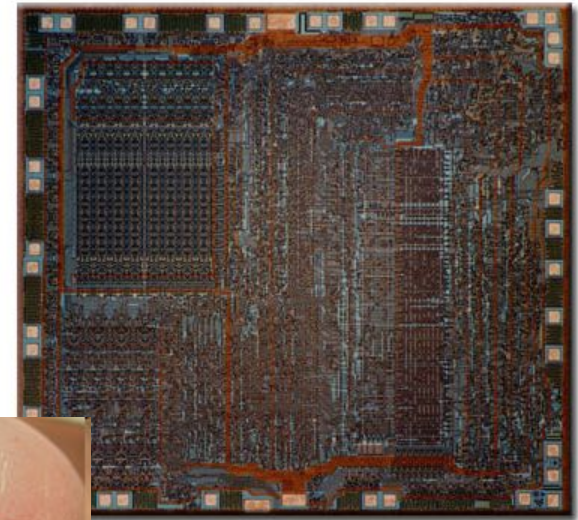
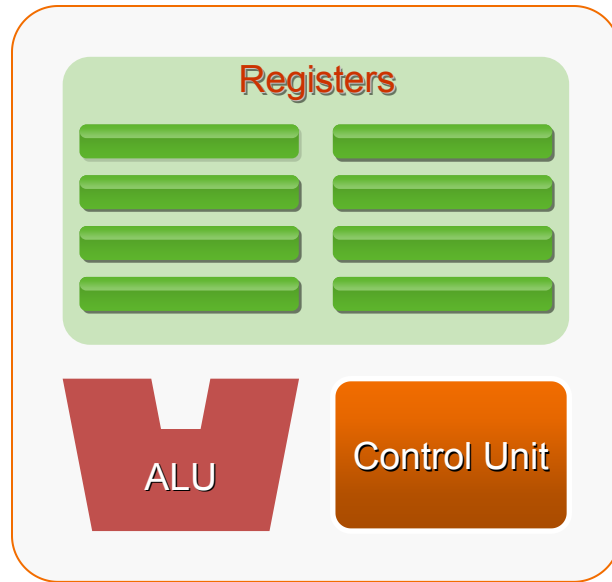
Introduction



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Basic definitions

- Microprocessor
 - Functionality of a CPU on a single chip



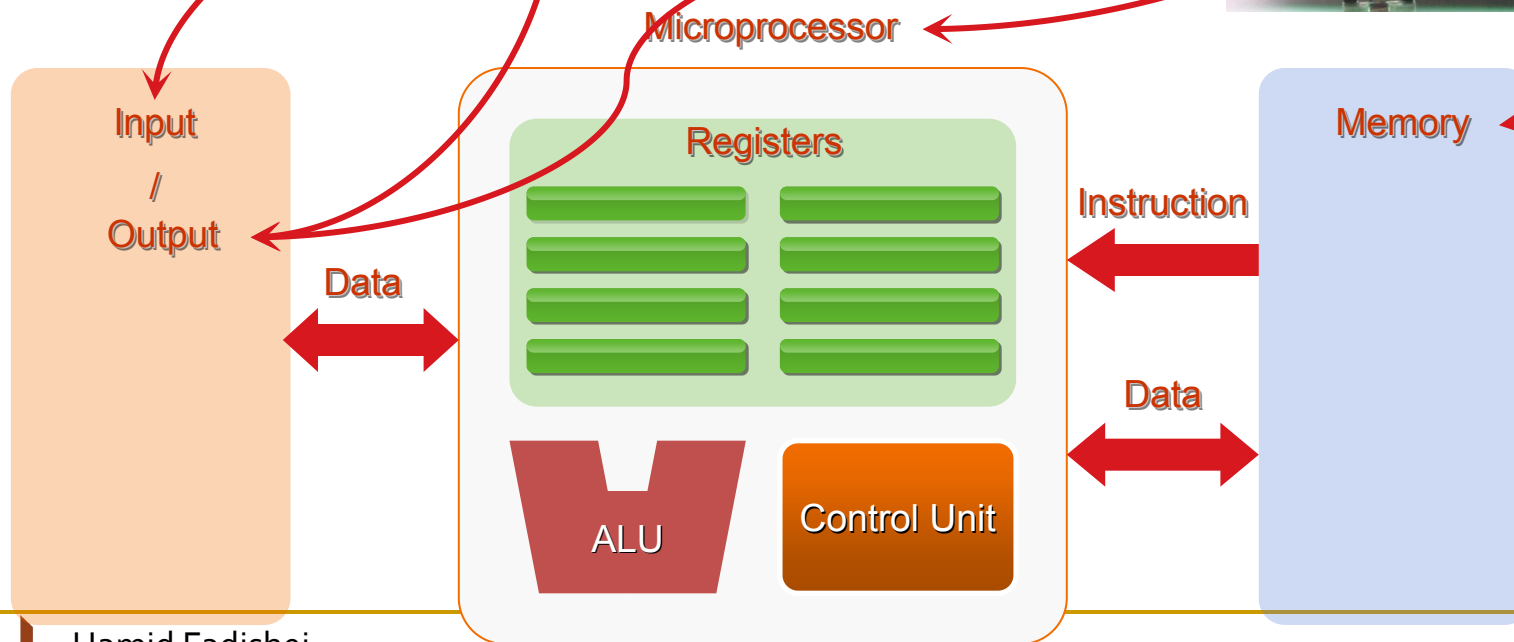
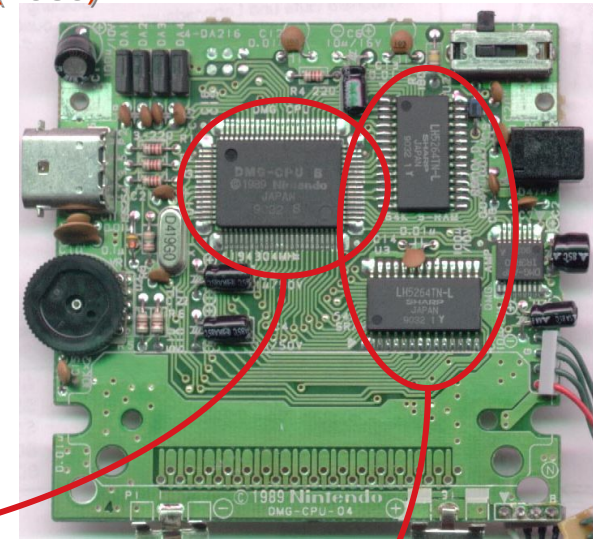
Zilog Z80 μ P
(1976)

Basic definitions

- Microprocessor system
 - Microprocessor
 - Memory
 - Input/Output
- Interconnection
 - Address, Data, and Control buses



Nintendo Gameboy (1989)



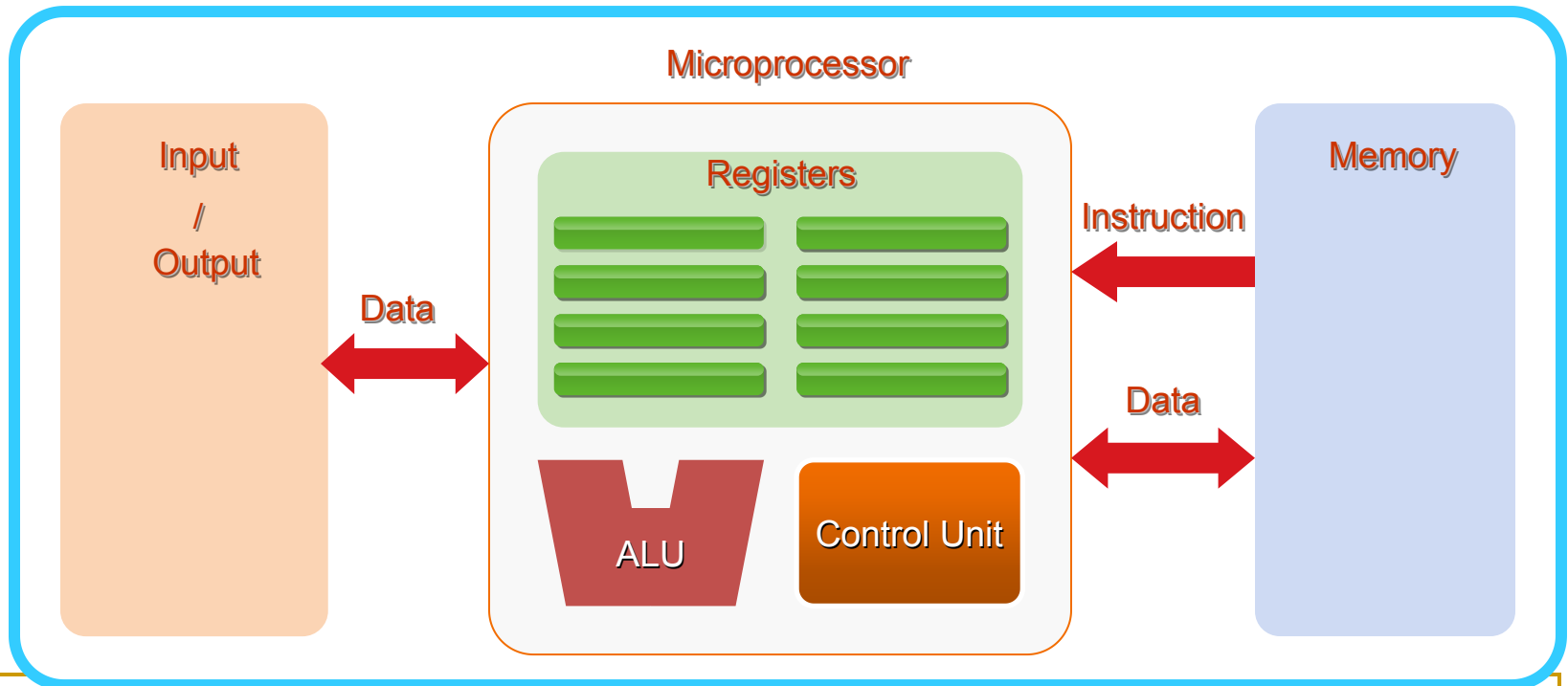
Basic definitions

■ Microcontroller

- A structure that integrates in a single chip...
 - a microprocessor
 - a certain amount of memory
 - a number of peripheral interfaces

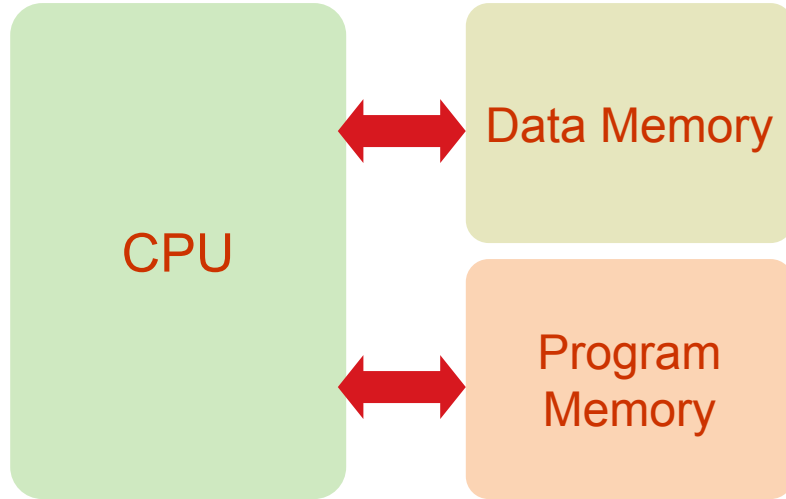


Microcontroller

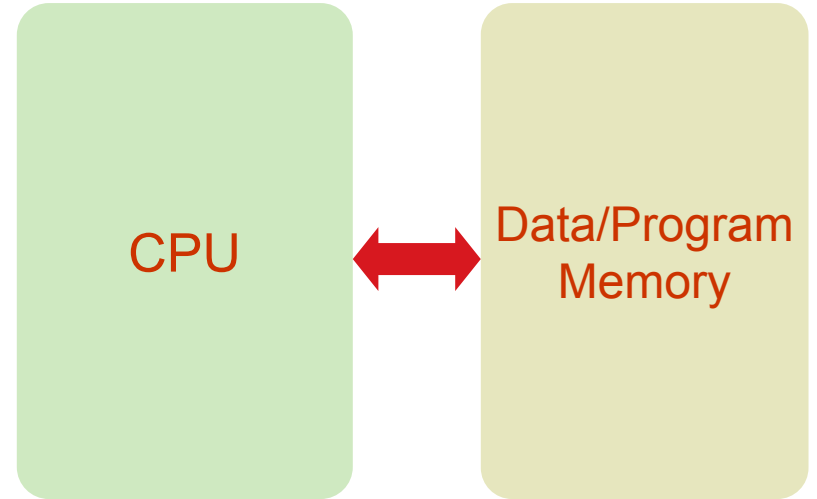


Microprocessor system architecture

- Von Neumann architecture
 - Single storage structure for both instructions and data
- Harvard architecture
 - Separate storage structures for instructions and data
- Modern processors may incorporate both aspects
 - Harvard model between CPU and cache
 - Von Neumann model between CPU and memory



Harvard architecture



Von Neumann architecture



Instruction set architecture

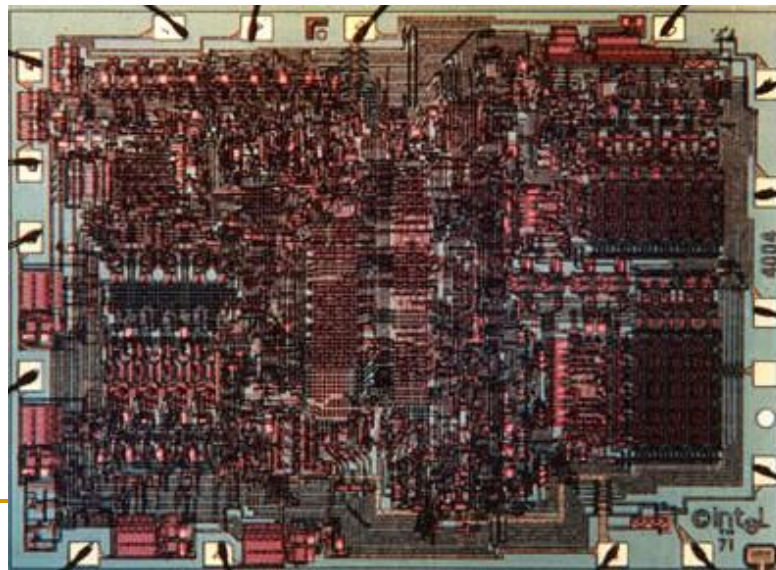
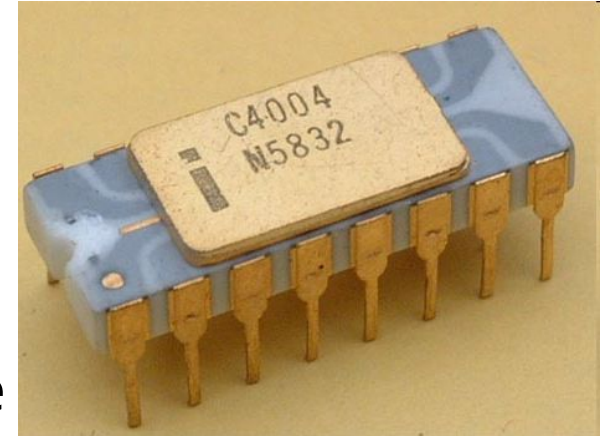
- CISC (Complex Instruction Set Computer)
 - ❑ Large amount of different and complex instructions
 - ❑ Rarely-used complex instruction
 - ❑ Difficult to pipeline
 - ❑ Easy to introduce bugs
 - ❑ Emphasis on hardware
 - ❑ Smaller machine code than RISC for the same operation
- RISC (Reduced Instruction Set Computer)
 - ❑ Simpler instructions sets that operate on registers
 - Makes higher clock frequencies possible
 - ❑ Constant instruction size
 - Makes pipelining easier
 - ❑ Easier design, less time-to-market
 - ❑ Emphasis on software (compiler)



History of microprocessors

■ Intel 4004

- ❑ Known as the first microprocessor
- ❑ 1971 - 1981
- ❑ Clock speed of 92KHz
- ❑ 2,300 transistors
- ❑ Now is considered a collectible antique
 - The gold white model is sold around US\$1000 on eBay



History of microprocessors

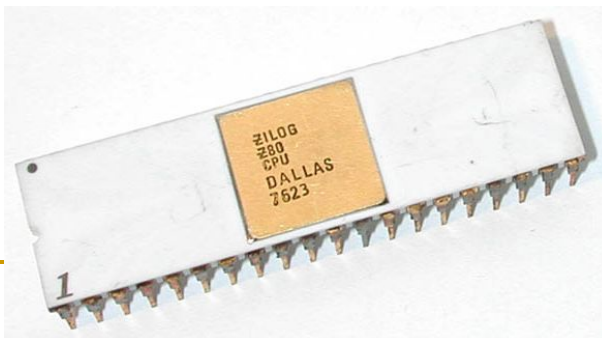
- Intel 8008
 - ❑ Released in 1972
 - ❑ 8-bit version of 4004
- Intel 8080
 - ❑ Enhanced features compared to 8008
 - ❑ Most notably, wider 16-bit address bus
 - ❑ The first truly usable microprocessor
 - ❑ Released in 1974
 - ❑ Running at 2 MHz
- Motorola 6800
 - ❑ Released in 1975
 - ❑ Maybe the first microprocessor with an index register
 - ❑ 6502 Variation used in famous Commodore 64



History of microprocessors

■ Zilog Z80

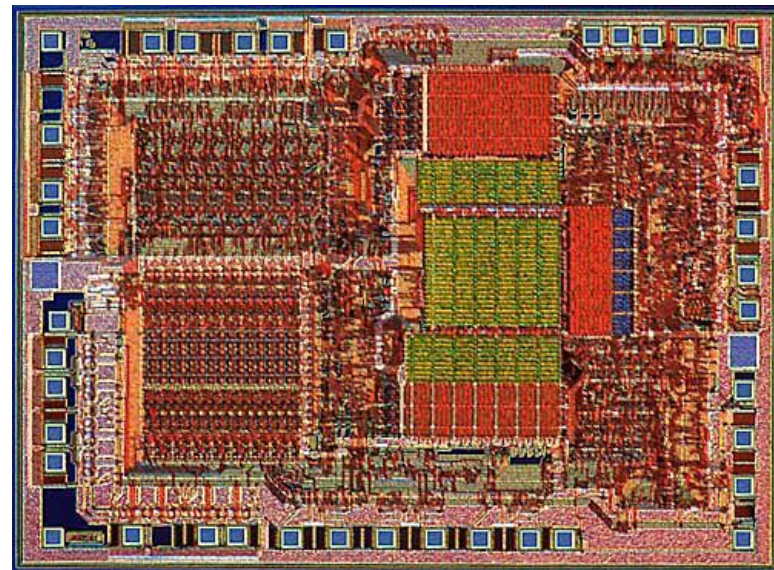
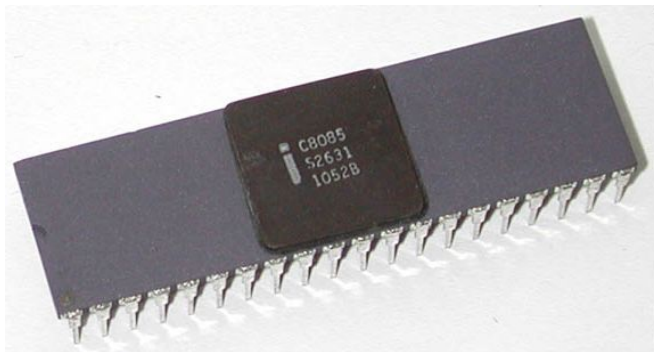
- ❑ Maybe the most popular microprocessor of all time
- ❑ Running at 2.5Mhz in the first NMOS version (up to 20Mhz for today CMOS version)
- ❑ Designed by Frederico Faggin after he left Intel
 - He was either the designer or design team leader for 4004, 8008, and 8080
- ❑ Released in July 1976
- ❑ Binary compatible with the 8080 with enhanced features
 - Dynamic RAM refresh signalling
 - Two switchable register sets



History of microprocessors

■ Intel 8085

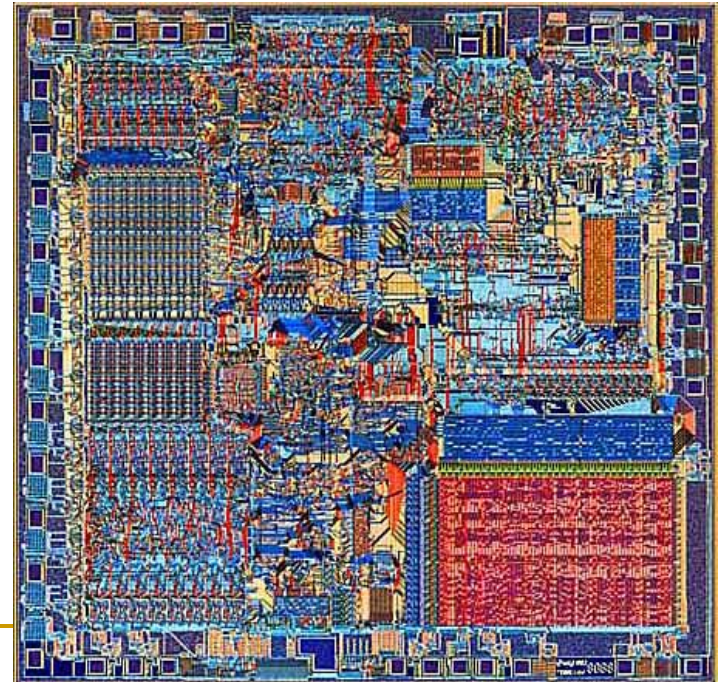
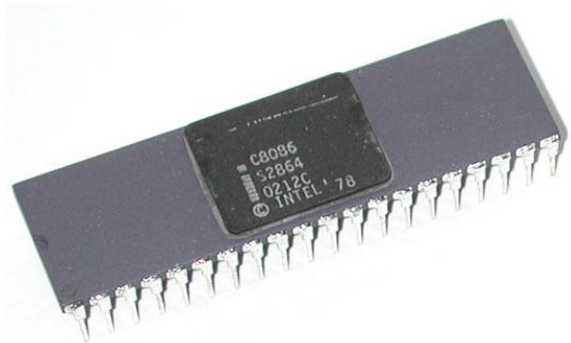
- ❑ binary compatible with the 8080, but required less supporting hardware
 - Only +5v power supply instead of +5, -5, and -12 (and hence 8085)
 - Clock-generator and bus-controller circuits on the chip
- ❑ Running at up to 6 Mhz
- ❑ 6,500 transistors
- ❑ Widely used for educational purposes at some universities
- ❑ Was not a great success



History of microprocessors

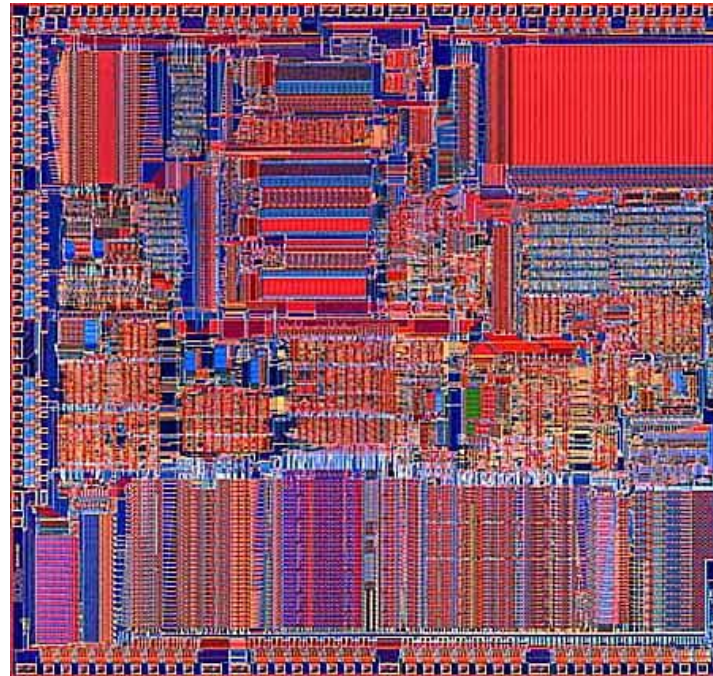
■ Intel 8086

- ❑ A 16-bit microprocessor
- ❑ Released in 1978
- ❑ Gave rise to the x86 architecture
- ❑ 5 to 10 Mhz clock speed
- ❑ 8088 (1979) used in the first IBM PCs
- ❑ 29,000 transistors



History of microprocessors

- Intel 80386 (i386)
 - 1985-2007
 - Running at 12 MHz to 40 MHz
 - 275,000 transistors



History of microprocessors

■ Trends

- ❑ Movement from 8-bit architectures to 16, 32, and 64-bit ones
- ❑ Movement towards RISC architectures (Mid-1980's)
 - ARM, SPARC, PowerPC, DEC Alpha
- ❑ Other enhancements
 - Better operating system support
 - ❑ Protected mode, Virtual memory
 - Instruction-level parallelism
 - Multicore architectures
 - Power/thermal optimizations



History of microprocessors

■ Intel Xeon E5

- ❑ 2012
- ❑ 8 cores
- ❑ 2,270,000,000 transistors
- ❑ 2.4GHz Clock

■ Oracle SPARC M7

- ❑ Coming soon
- ❑ More than 10,000,000,000 transistors
- ❑ 32 cores

