KKK3412
Microprocessor

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Overview

- **Textbook:**

  Walter A. Triebel and Avtar Singh, "The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware and Applications, Prentice Hall.

- **Objectives:**

  The course will provide knowledge to build and program microprocessor-based 8088/86 systems.

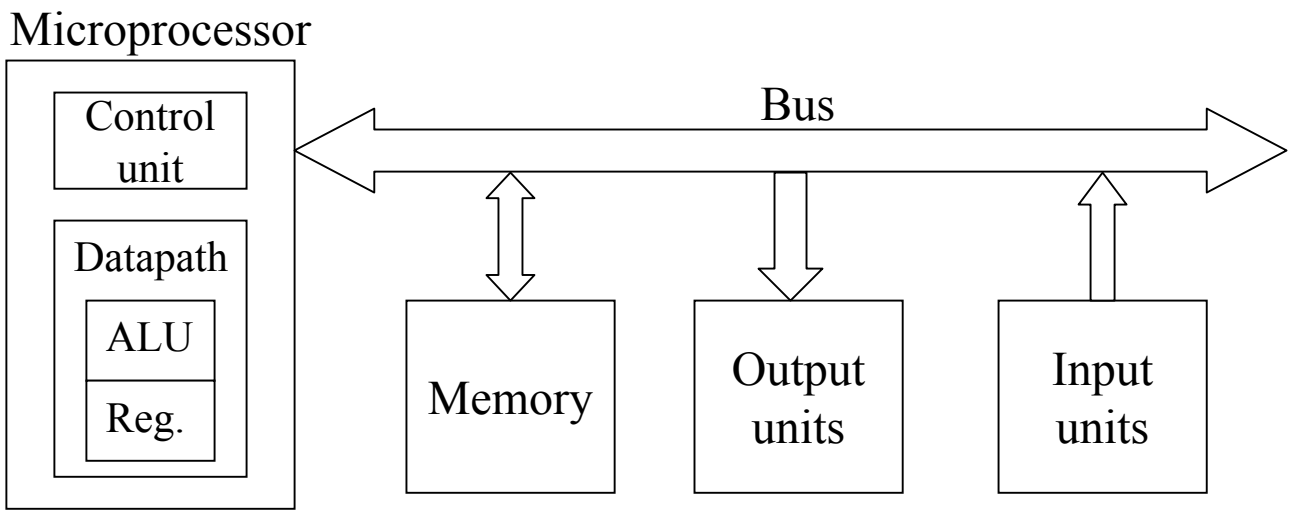
  - Microprocessor architecture
  - Architecture of microprocessor-based systems
  - Programming microprocessor-based systems
  - Future trends

- **Grading:**

  Lab report = 20%, Test = 40%, Final Exam = 40%

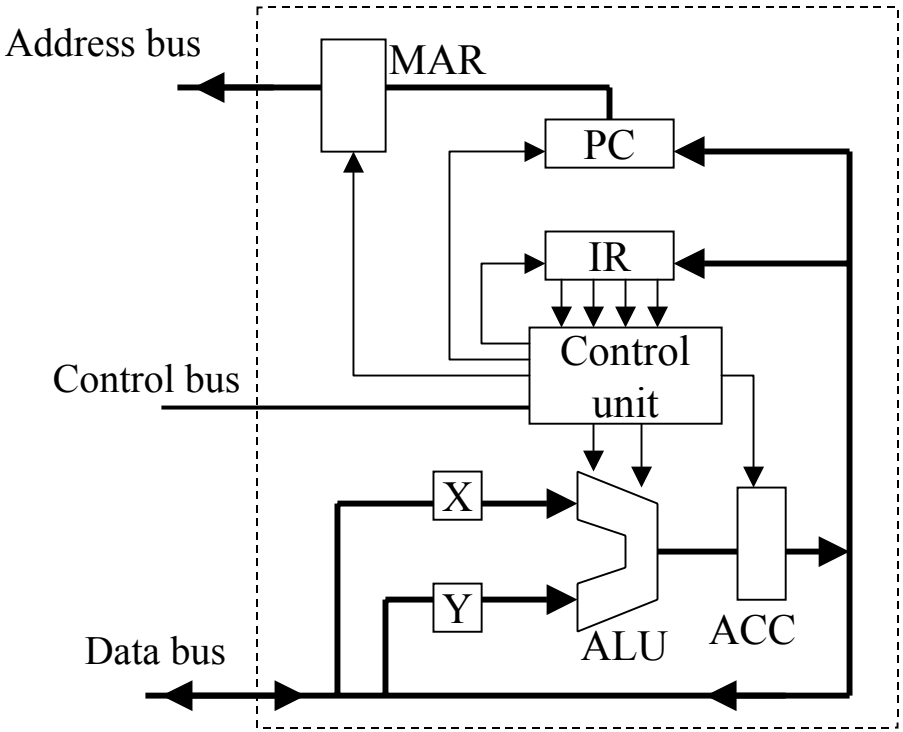
What are microprocessor-based systems?

- Microprocessor-based systems are electrical systems consisting of microprocessors, memories, I/O units, and other peripherals.
  - Microprocessors are the brains of the systems
  - Microprocessors access memories and other units through buses
  - The operations of microprocessors are controlled by instructions stored in memories



What are microprocessors?

- A microprocessor is a processor (or Central Processing Unit, CPU) fabricated on a single integrated circuit.



A simple microprocessor architecture

Brief Historical Perspective on Computers

Pioneers - Blaise Pascal

1642

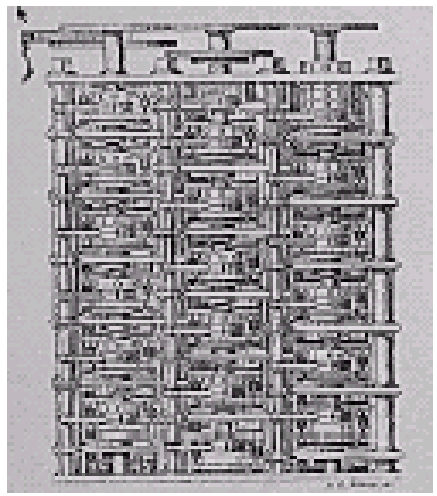
- French mathematician who invented the first operational calculating machine

Pioneers - Charles Babbage

1822

- British mathematician who invented the first device that might be considered as a computer in the modern sense of the word
  - Difference Engine (1822) - partially build
  - Analytical Engine (1830) - never build

- Difference Engine was eventually constructed from original drawings by a team at London's Science Museum
  - weight 3 tons, 10 feet wide, and 6.5 feet long
  - the device can perform calculations to 31 digits of accuracy



1938

- C. Shannon Master Thesis (*possibly the most important master's thesis of the twentieth century*) (1938)
  - demonstrated how Boolean algebra (concepts of TRUE and FALSE) can be used to represent the function of switches in electronic circuits

1945

- Mathematician who introduced basic elements of the stored-program computer
  - **A memory** containing both data and instructions
  - **A calculating unit** capable of performing both arithmetic and logical operations on the data
  - **A control unit**, which can interpret an instruction retrieved from the memory and select alternative courses of action based on the results of previous operations

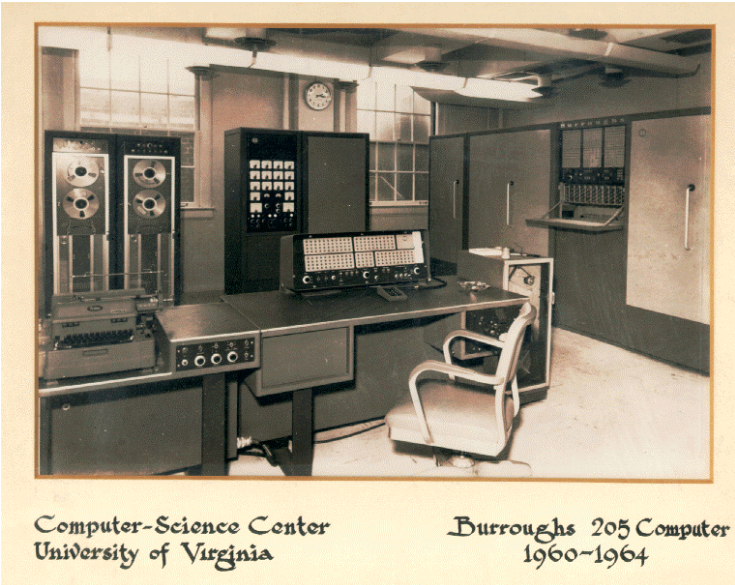
Evolution of Computers

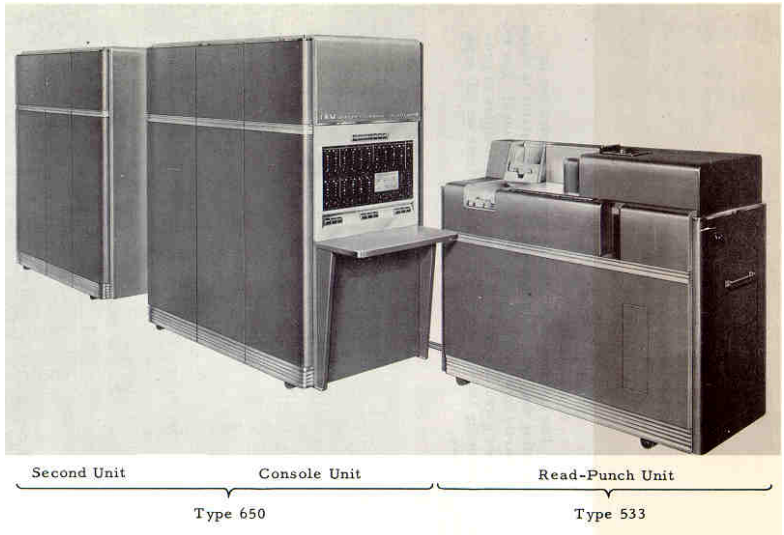
- First generation (1939-1954) - vacuum tube
- Second generation (1954-1959) - transistor
- Third generation (1959-1971) - IC
- Fourth generation (1971-present) - microprocessor

Http://history.acusd.edu/gen/recording/computer1.html

Evolution of Computers

- First generation (1939-1954) - vacuum tube



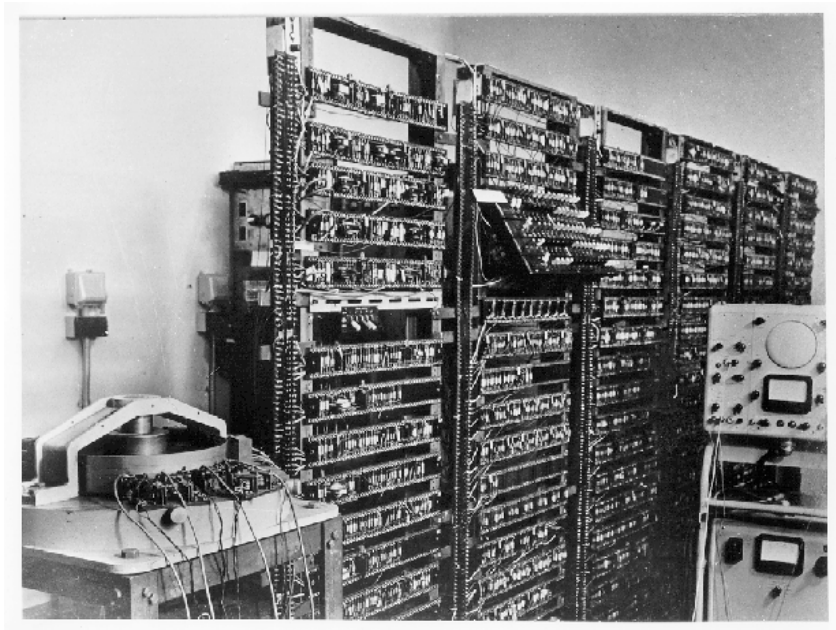


IBM 650, 1954

Http://history.acusd.edu/gen/recording/computer1.html
http://www.cs.virginia.edu/brochure/museum.html
http://www.columbia.edu/acis/history/650.html

Evolution of Computers

- Second generation (1954-1959) - transistor



Manchester University Experimental Transistor Computer

Http://history.acusd.edu/gen/recording/computer1.html
http://www.computer50.org/kgill/transistor/trans.html

Evolution of Computers

- Third generation (1959-1971) - IC

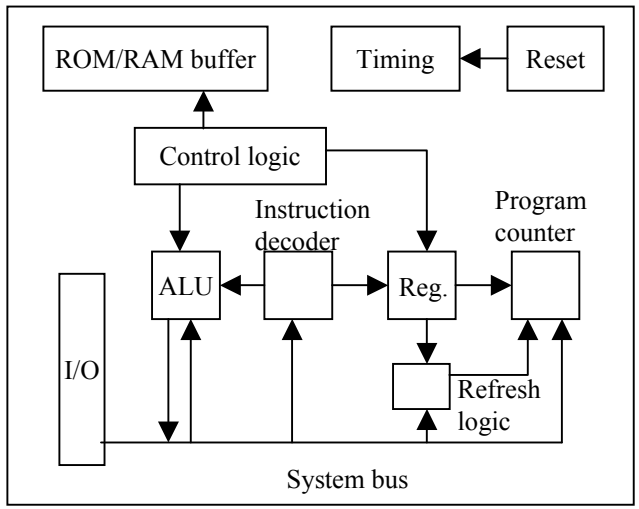
PDP-8, Digital Equipment Corporation

— Thanks to the use of ICs, the DEC PDP-8 is the least expensive general purpose small computer in 1960s

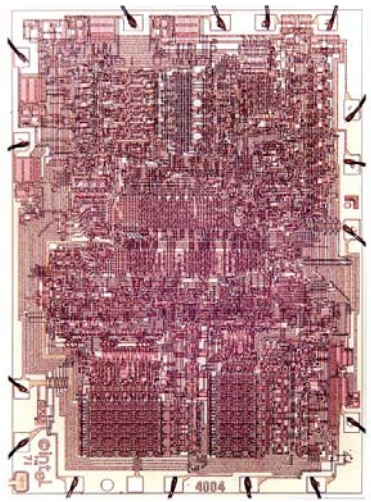
Http://history.acusd.edu/gen/recording/computer1.html
http://www.piercefuller.com/collect/pdp8.html

Evolution of Computers

- Fourth generation (1971-present) - microprocessor
  - In 1971, Intel developed 4-bit 4004 chip for calculator applications.



Block diagram of Intel 4004



4004 chip layout

http://www.intel.com

A good review article: The History of The Microprocessor, Bell Labs Technical Journal, Autumn, 1997

First Electronic Computers

1940's – 1950's

- Vacuum tubes & mechanical relays: UNIVAC, ENIAC
- 30 tons
- 150 Kwatts
- 80 bytes of memory
- Key problem was reliability
  - about 50 tubes had to be replaced per day

1940's – 1950's

ILLIAC

- built at the University of Illinois was the first computer owned by an academic department
- The String Quartet #4 "*the Illiac Suite*" - first music composed by a computer (1957)

The First Transistor

1948

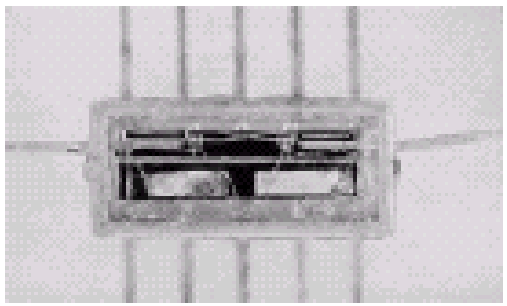
- William Shockley, Walter Brattain, and Jhon Bardeen succeeded in creating the *first point-contact germanium transistor* on the 23rd December 1947
  - they took a break for Christmas before publishing the achievement that is why the reference books state that the first transistor was created 1948

- Bipolar junction transistor (Shockley) - 1950
- Field effect transistor (MOS FET) - 1962

The First Integrated Circuit

1958

- Jack Kilby (Texas Instruments) in 1958 succeeded in fabricating multiple components on a single piece of semiconductors
  - a phase shift oscillator
- 1961 Fairchild and Texas Instruments fabricate first commercial integrated circuit comprising simple logic functions
  - two logic gates (four bipolar transistors and four resistors)

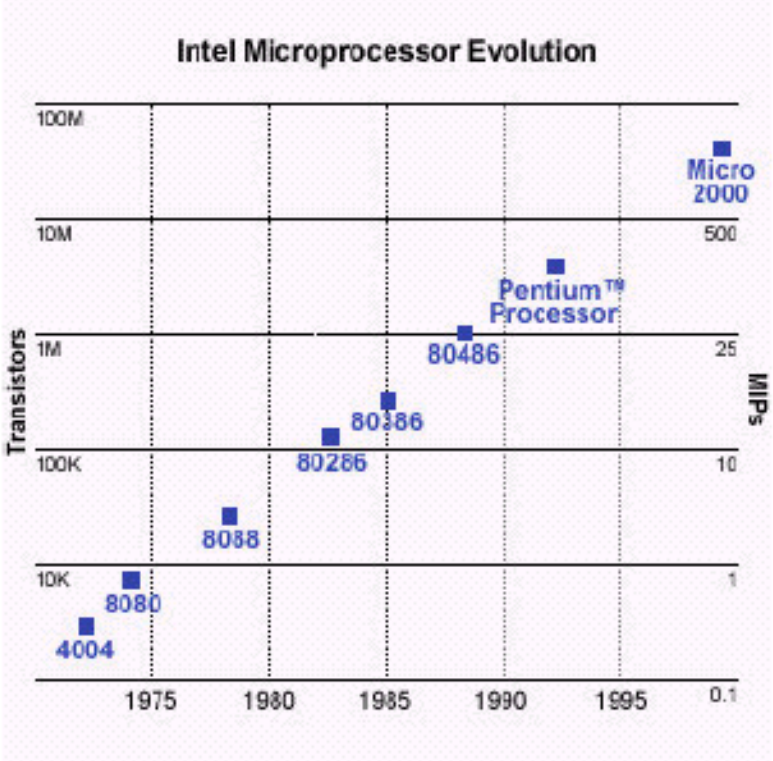


IBM Mainframes

Late 1960

- Powerful, centralized CPU's with terminals
- Age of the "big iron"

- **Moore's Law** (Gordon Moore, 1964) states that the number of transistors/chip doubles every two years.
- Exponential Growth!
- Has been true for 20 years, but growth has been closer to 2x every 18 months for last decade!



- *If we had similar progress in automotive technology, today you could buy a Lexus for about $2. It would travel at the speed of sound, and get about 600 Miles on a thimble of gas.* -Randall Tobias: Former Vice Chairman of AT&T.

Towards First Personal Computer

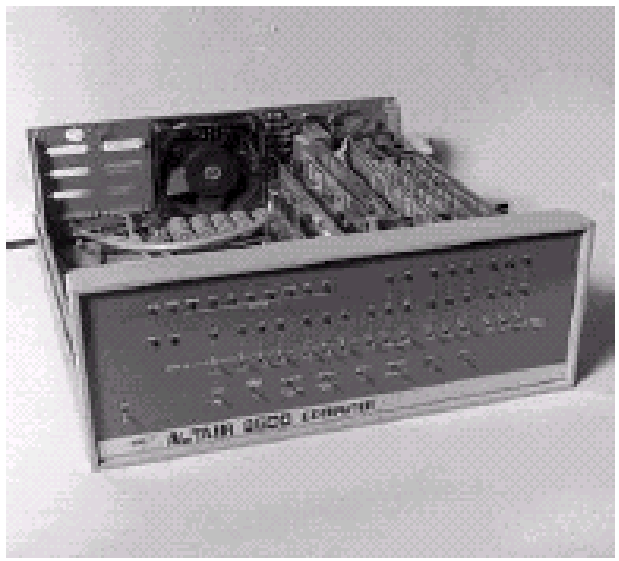
1974

- First general-purpose microprocessor, the 8080, introduced by Intel in 1974
  - 8-bit device, 4500 transistors, 200000 operations per second

Personal Computer

1974

- Altair 8800 (1974)
  - based on 8080 microprocessor,
  - affordable price of $375
  - no keyboard, no screen, no storage,
  - 4k memory, programmable by means of a switch panel



- Bill Gates and Paul Allen founded Microsoft (1975)
  - BASIC 2.0 on the Altair 8800
  - first high-level language available on a home computer

- S. Wozniak and S. Jobs create Apple
  - 16k ROM, 4k of RAM, a keyboard, and color display
- TRS-80 (Z80-based system) from Radio Shack - 1977
  - 4k ROM, 4k RAM, keyboard, and cassette type drive
- Personal Computer from IBM - 1981
  - 16-bit microprocessor 8088, ROM BASIC, cassette interface 360k floppy, DOS 1.0
  - price $1365

- 1983 IBM XT gets hard disk (10Mb hard disk costs $3000)
- 1985 Intel Introduces 80386
  - first 32-bit 80x86 family
- 1986 Compaq introduces first 80386-based system
- 1989 Intel introduces 80486, includes math co-processor
- 1992 Intel Pentium (64-bit) memory bus,
  - AMD, Cyrix 486 compatible processors
- 1999 AMD Athlon (650 MHz)
  - Cyrix M II - 300MHz to MII -433MHz

1997

Single Instruction Multiple Data (SIMD), Multimedia Extensions / Matrix Math Extensions (MMX)

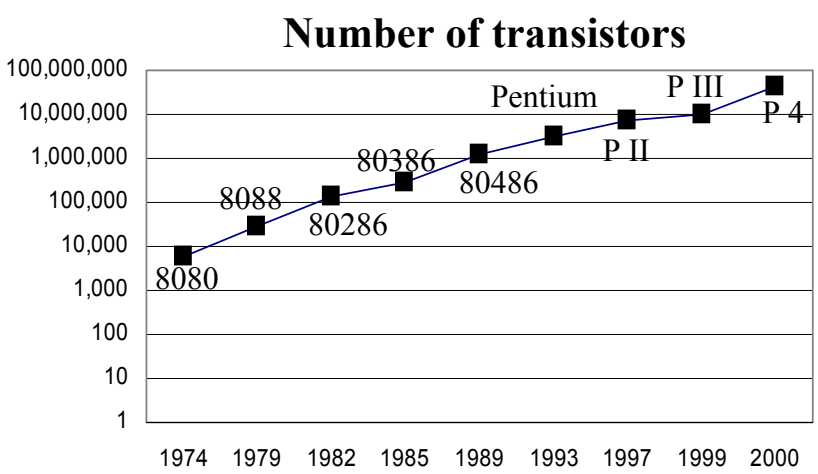
- AMD, K6
- Intel Pentium II
- Cyrix/IBM M2 (6x86 MX)

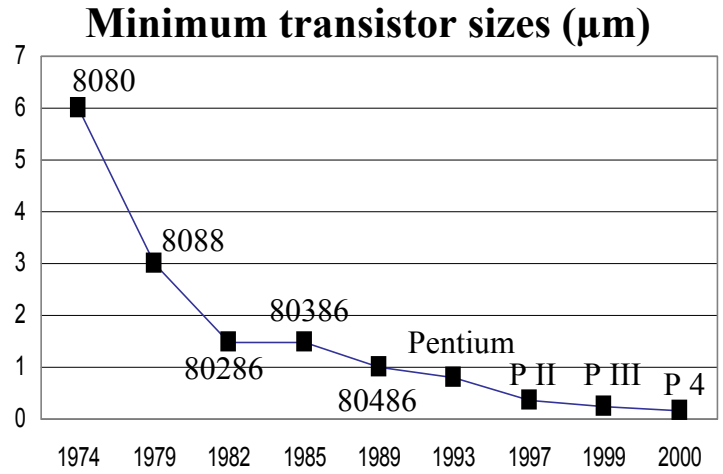
1998 - .....

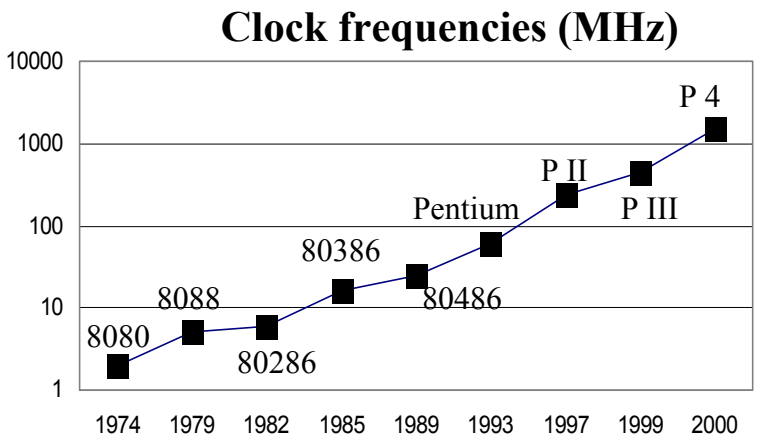
- Low-power portable computing
- Single Instruction Multiple Data (SIMD) for floating point ops (AMD K6-2)
- Integrated CPU/Video/Audio (Cyrix/NSM MediaGX)

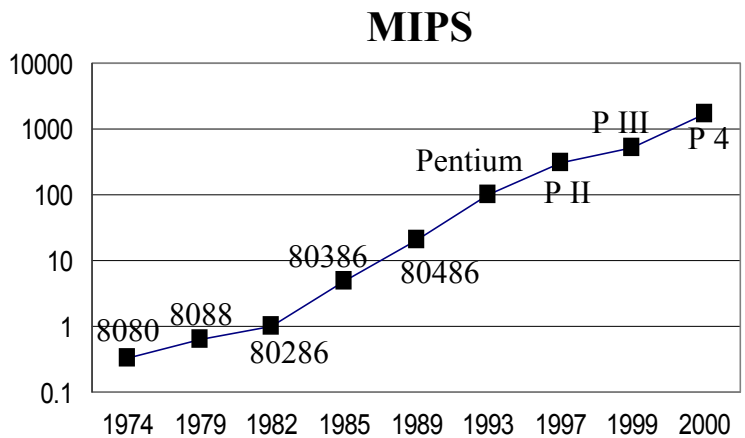
- Low-cost computing
  - 300 MHz MMX CPU + 3D: $125
  - 64 MB SDRAM: $75
  - 10 GB hard disk: $200

Evolution of Intel Microprocessors









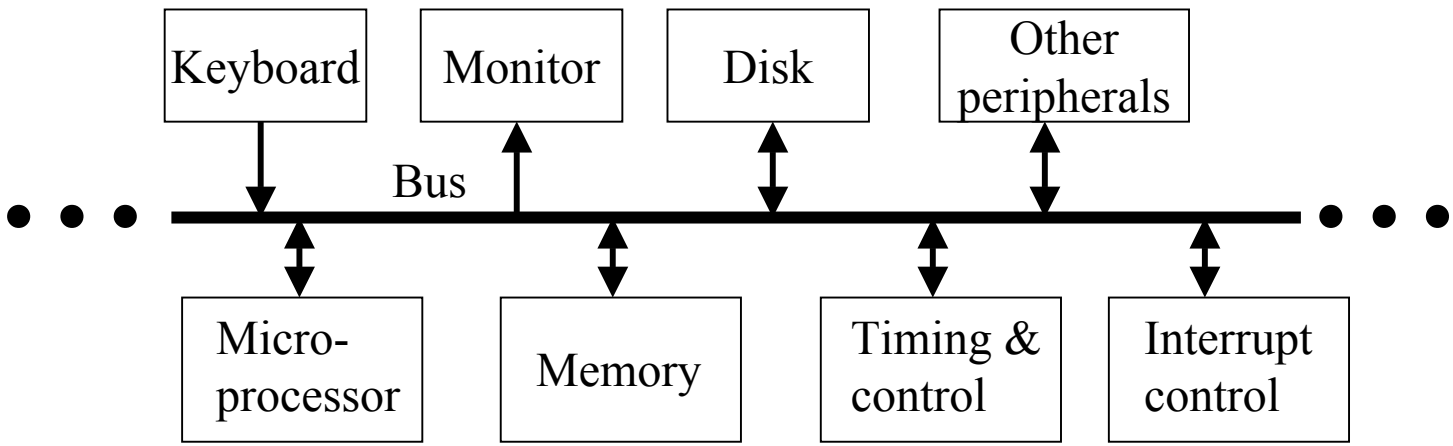
Other Commercial Microprocessors

- PowerPC (*IBM, Motorola*)
- Athlon, Dulon, Hammer (*AMD*)
- Crusoe (*Transmeta*)
- SPARC, UltraSPARC (*Sun Microsystems*)
- TI's TMS DSP chips (*Texas Instruments*)
- StarCore (*Motorola, Agere*)
- ARM cores (*Advanced RISC Machines*)
- MIPS cores (*MIPS Technologies*)
- ● ● ● ● ● ●

Applications of Microprocessor-Based Systems

- Computers

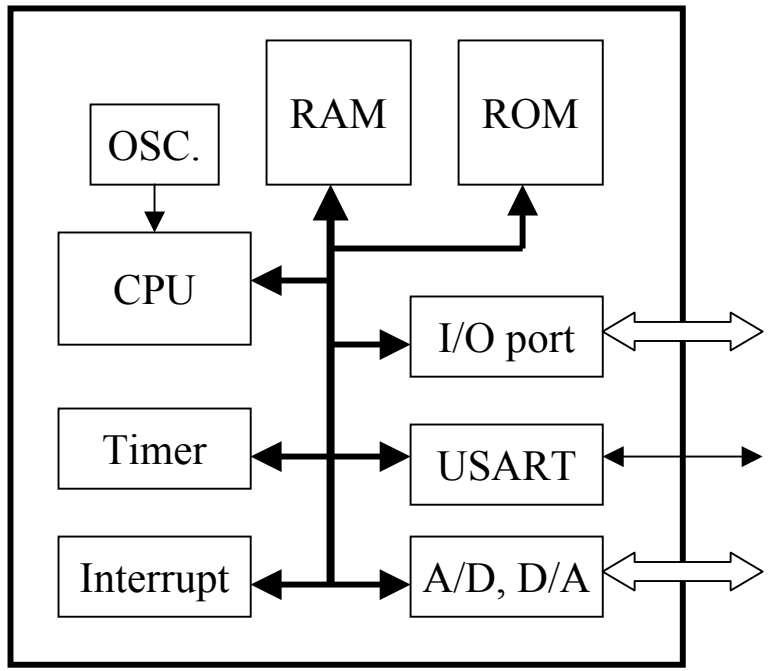
  — System performance is normally the most important design concern



Block diagram of a computer

Applications of Microprocessor-Based Systems

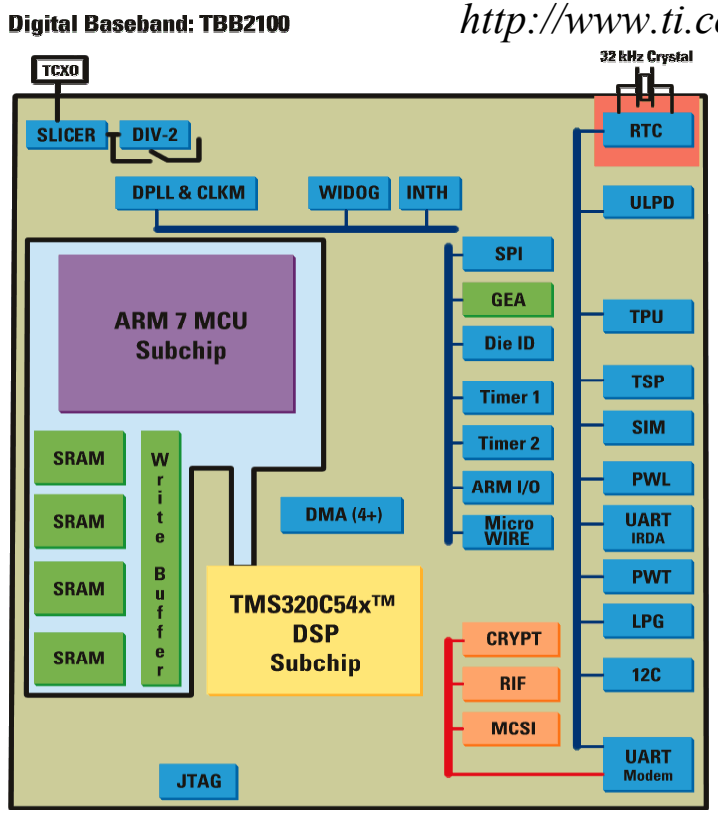
- Microcontrollers
  - A microcontroller is a simple computer implemented in a single VLSI chip.
  - In general, microcontrollers are cheap and have low performance
  - Microcontrollers are widely used in industrial control, automobile and home applications



Block diagram of a microcontroller

Applications of Microprocessor-Based Systems

- ASICs
  - Microprocessors are embedded into ASIC chips to implement complex functions
  - In general, it requires that the microprocessors have ***low power consumption*** and take ***small silicon area***



A TI baseband chip for cellular phone applications