



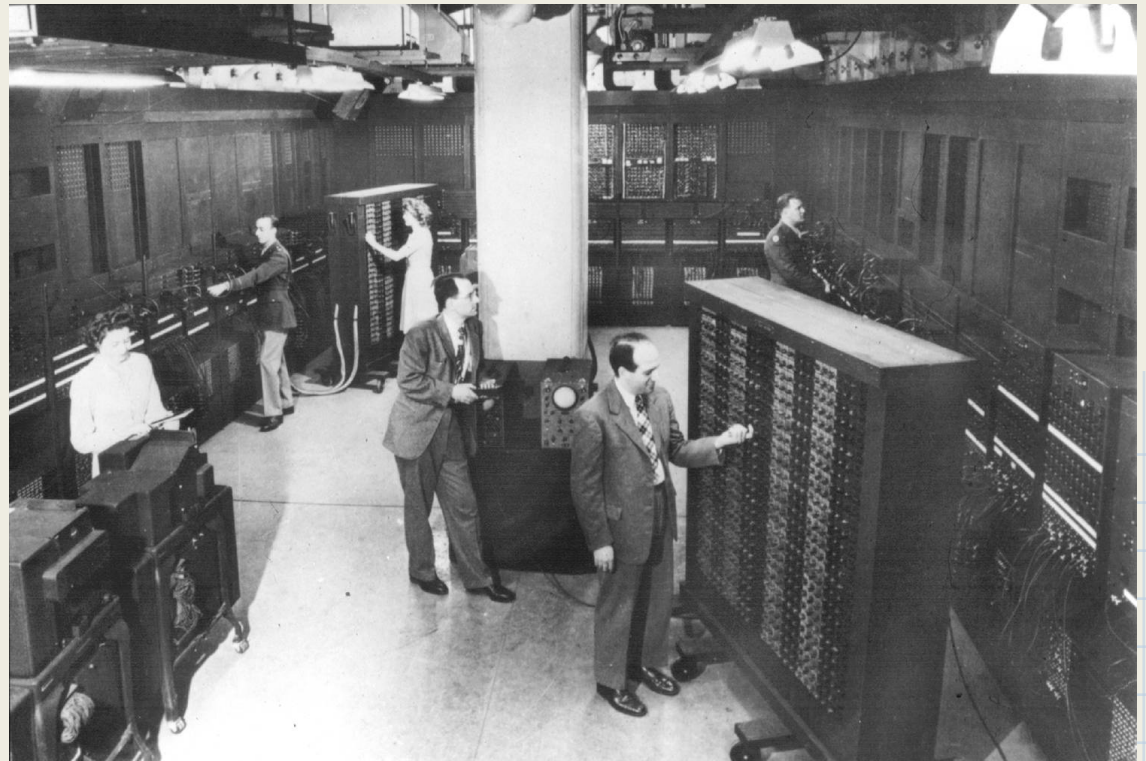
Computer architectures & the C programming language

Abstraction Layers

Application
Algorithm
Programming Language
Assembly Language
Operating System / Virtual Machine
Instruction Set Architecture
Microarchitecture
Digital Logic

Early Developments - 1940s

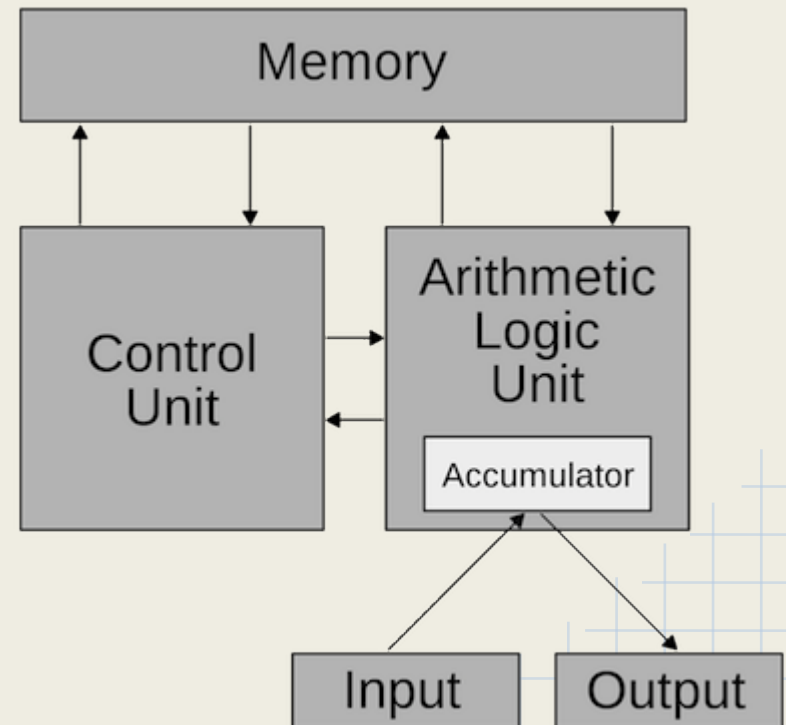
- Harvard Mark 1 - 1944
 - Mechanical with electro-magnetically controlled relays and gears
- ENIAC - 1946
 - Vacuum tubes



ENIAC. Source: http://www.fi.edu/learn/case-files/eckertmauchly/ENIAC_Image_2.jpg

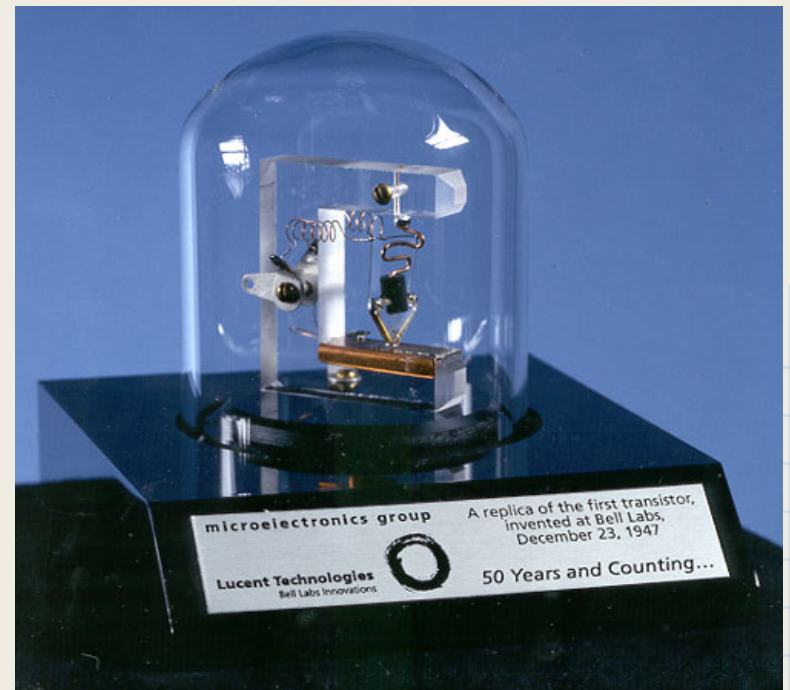
Von Neumann Architecture - 1952

- General purpose machine
- Bus interconnection
- Flexible



Transistors - 1950s / 1960s

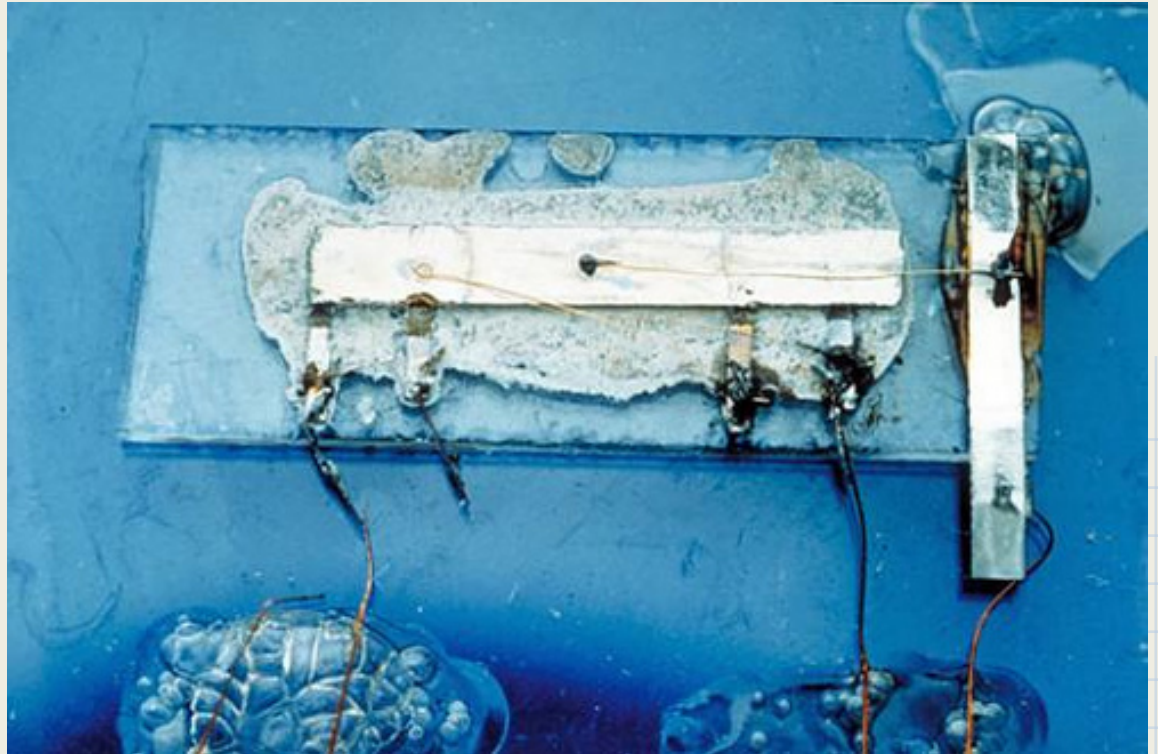
- Cheaper
 - \$120.000 (PDP1) vs \$2M (IBM 7090)
- Faster
 - Clock: 100ns (CDC 6600) vs 2usec (IBM 7090)
- Vacuum tubes obsolete



Replica of first Transistor. Source: <http://www.flickr.com/photos/revolweb/3984348493/>

Integrated Circuits - 1960s

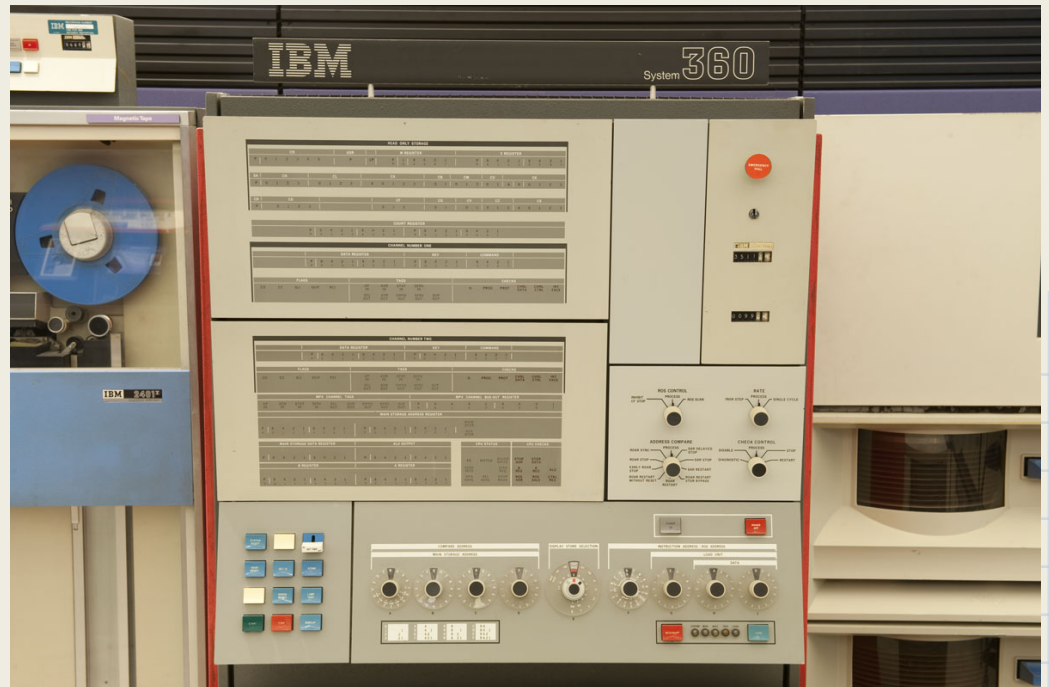
- Jack Kilby and Robert Noyce
 - Germanium based
 - Silicon based



First integrated circuit. Source: <http://0.tqn.com/d/inventors/1/0/t/C/1/intergratedcircuit.jpg>

Instruction Set Architecture

- IBM 360 - 1965
 - Clear distinction architecture/implementation
 - Same architecture with different hardware
 - Compatibility
 - CISC architecture

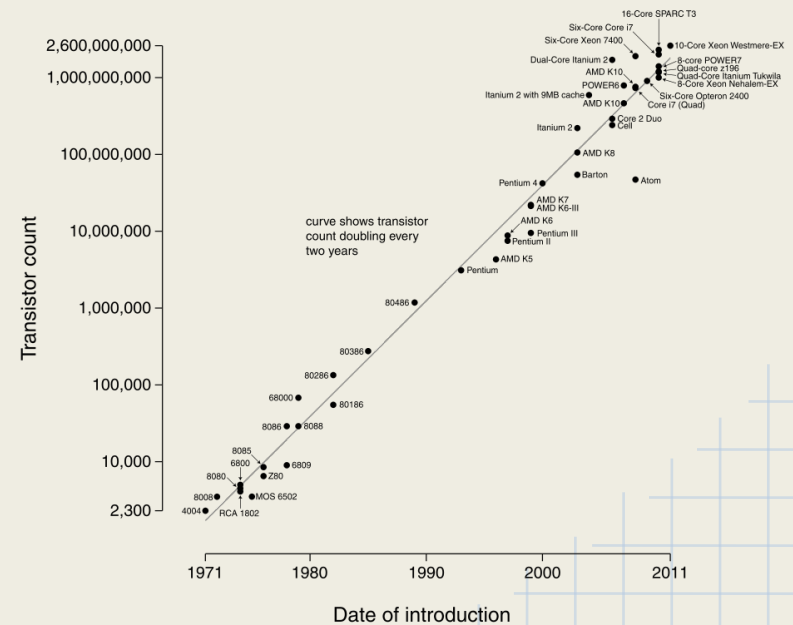


IBM 360. Source: http://dl.maximumpc.com/galleries/25oldpcs/ibm360_closeup1_full.jpg

Microprocessors - 1970s

- Rapid progress in size and speed
 - Moore's law
 - Twice the amount of chips on the same area
- Intel i432
 - First 32 bit processor

Microprocessor Transistor Counts 1971-2011 & Moore's Law



Moore's law. Source: <http://en.wikipedia.org/w/index.php?title=File:Transistor Count and Moore%27s Law - 2011.svg&page=1>

Personal Computer - 1980s

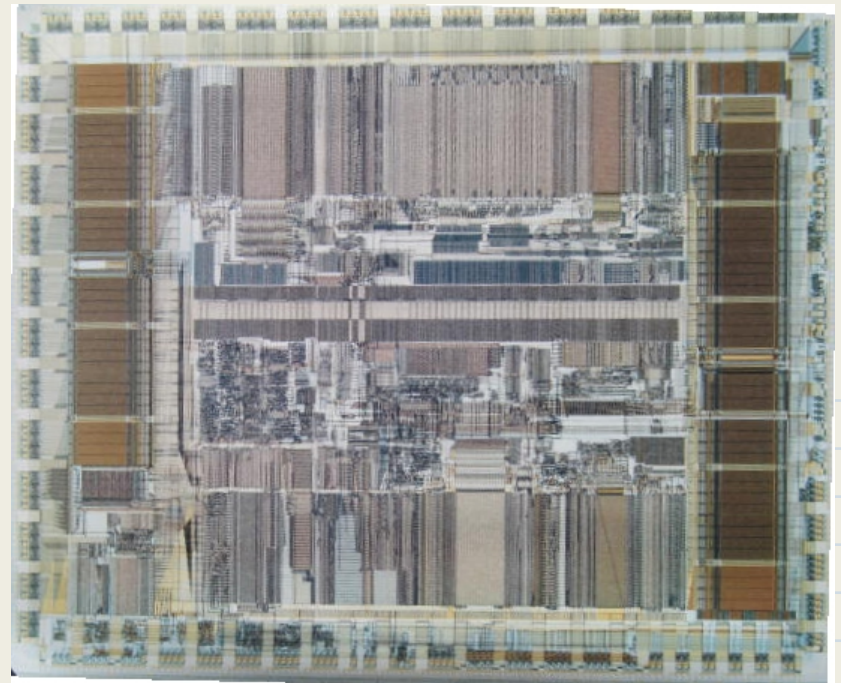
- Drop in price
 - Apple, Commodore
- RISC architecture
- Minicomputers replaced workstations
 - Distributed network and computing



Commodore 64. Source: <http://reprog.files.wordpress.com/2010/03/800px-commodore64.jpg>

Superscalar - 1990s

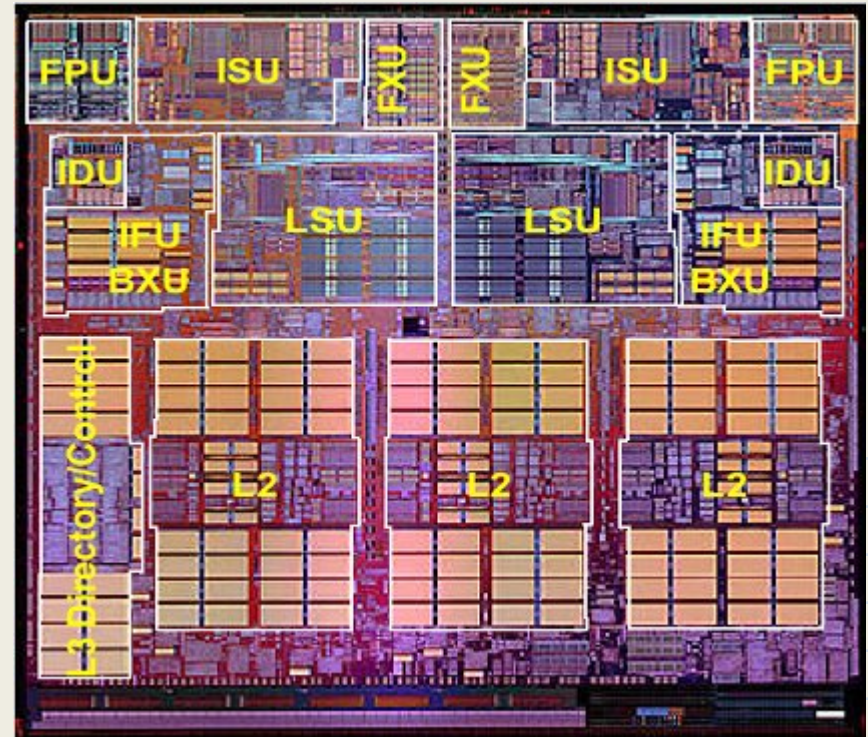
- IBM Power 1990: first superscalar advanced microprocessor
- DEC Alpha 1992: first 64 -bit (RISC)
 - Need larger memory addresses space



DEC Alpha. Source: http://en.wikipedia.org/wiki/File:Alpha_AXP_21064_diephoto1.jpg

Multicore - 2000s

- Clock frequency cannot be further increased
- Multicore processors



First Dual Core Processor: IBM Power 4. Source: http://www.fi.edu/learn/case-files/eckertmauchly/ENIAC_Image_2.jpg

C

- Dennis Ritchie, Bell Labs 1969 - 1973
- Developed as substitution of ASM (Assembly) for Unix
- Based on B programming language

Assembly: Hello World

```
section      .text
    global _start                ;must be declared for
linker (ld)

_start:                                ;tell linker
entry point

    mov     edx,len              ;message length
    mov     ecx,msg              ;message to write
    mov     ebx,1                ;file descriptor (stdout)
    mov     eax,4                ;system call number (sys_write)
    int     0x80                 ;call kernel

    mov     eax,1                ;system call number (sys_exit)
    int     0x80                 ;call kernel

section      .data

msg    db      'Hello, world!',0xa    ;our dear string
len    equ     $ - msg                ;length of str
```

C: Hello World

```
#include<stdio.h>

main()
{
    printf("Hello World");
}
```

C Features

- High-Level Language with low-level tools
- Pointers Arithmetics
- Structures
- Functions
- I/O Library
- Math Library
- Macros System

C Missing Features

- Automatic Memory Management
- Object-Oriented Programming
- Functions and Operators Polymorphism
- Nested Functions
- Multitasking and Network (Third Party Libraries)

C System Types

- short int, long int (signed/unsigned)
- float, double
- struct, enum, union
- pointers to all data types

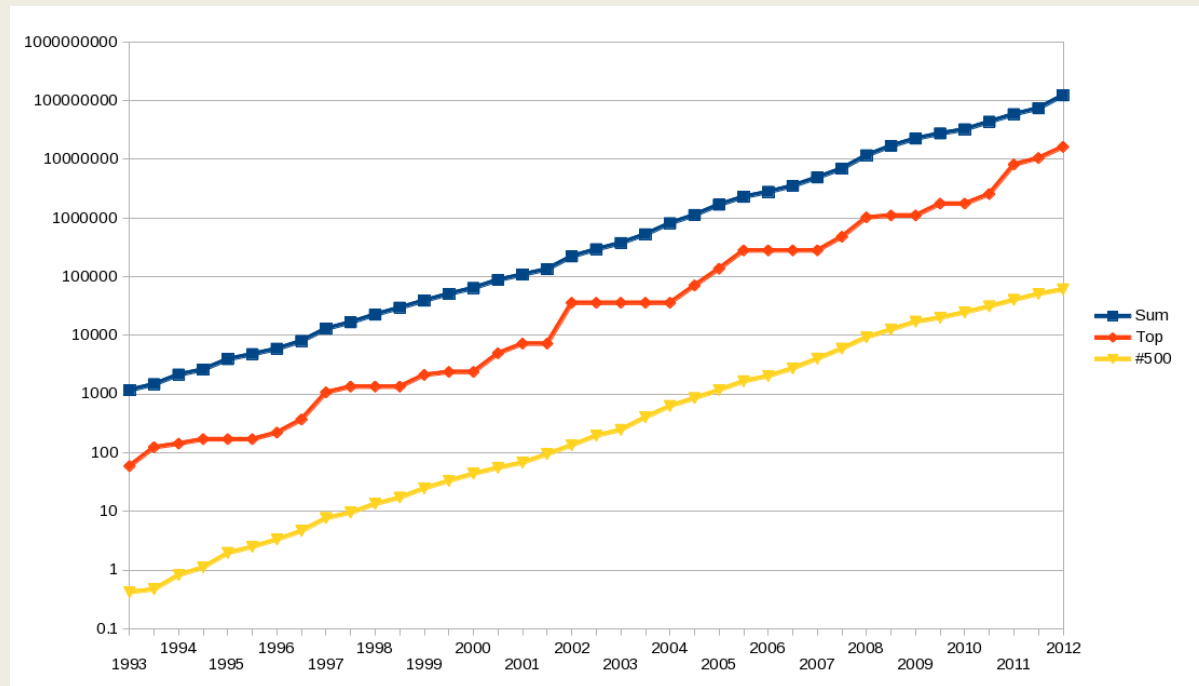


Thank you for your attention

Questions are welcome

Computing Power Evolution

- Evolution of SuperComputers
- Sum: total computing power available in the whole world
- Top: most powerful computer
- #500: 500th entry of the TOP500 list (<http://www.top500.org/>)



Computing Power Evolution. Source: <http://i.top500.org/overtime>