Computer Architecture

Prabhas Chongstitvatana
Department of Computer Engineering
Chulalongkorn University

http://www.cp.eng.chula.ac.th/faculty/pjw

Outline

- What is computer architecture
  - Types of computer
  - Structure and organization
  - Computer architecture concerns function
- Why is it interesting
  - Understand why computer is as it is today
  - where the performance came from

Outline

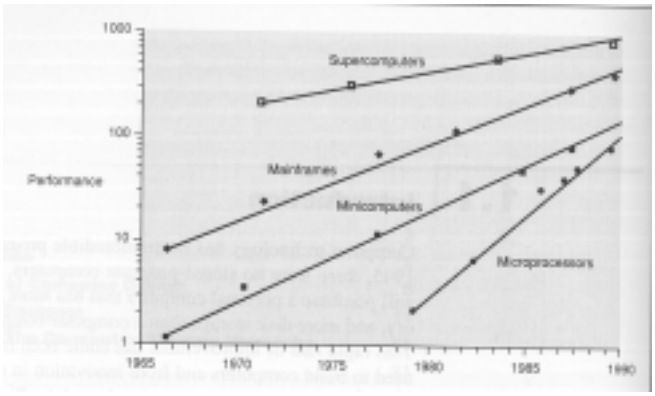
- Why is it useful to know computer architecture
  - understand computer products, its limitation and future trend

Types of computer

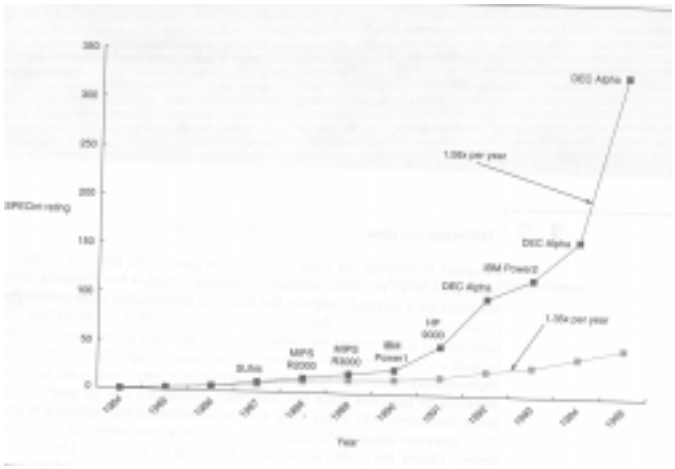
Define by performance and technology

- Supercomputer
- Mainframe
- Minicomputer
- Microcomputer
- Workstation
- PC

Types of computers

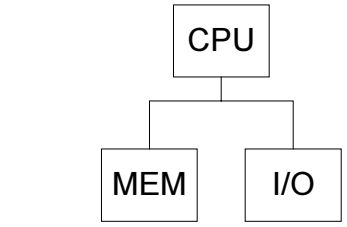


Microprocessor



What is computer function

- Perform operations on data
- Operations are directed by computer instructions (or Programs)
- Assembly language



DATA
PROGRAM

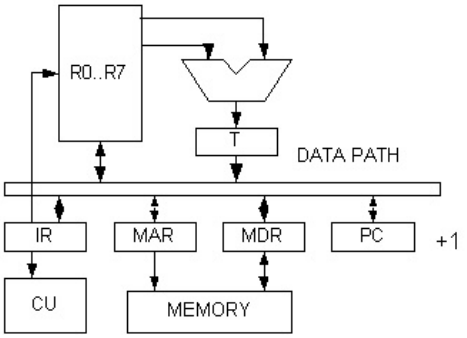
Assembly Language

Instruction Set is the function of a computer as seen by a programmer.

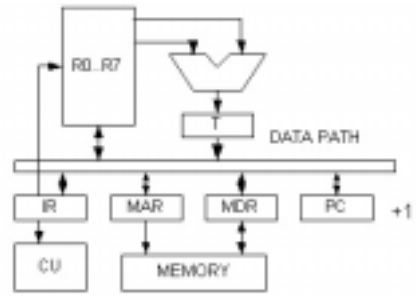
```
for (i=1; i<=1000; i++)
    x[i] = x[i] + s;

loop: LD F0,0(R1)        ; F0=array element
    ADDD F4,F0,F2        ; add scalar in F2
    SD 0(R1),F4          ; store result
    SUBI R1,R1,#8        ; decrement pointer
    BNEZ  R1,loop        ; branch R1 != zero
```

Structure and Organization

- Functional units
- Interconnection
- Resources



How a processor work



A = B + C

Instruction Execution

- Fetch instruction
- Decode
- Execute
- Read/Write Memory
- Write Register

Performance

- How to measure performance
  - CPU time = Instruction count * CPI * clock cycle time
  - CPI Clock cycles per instruction
- Benchmark programs

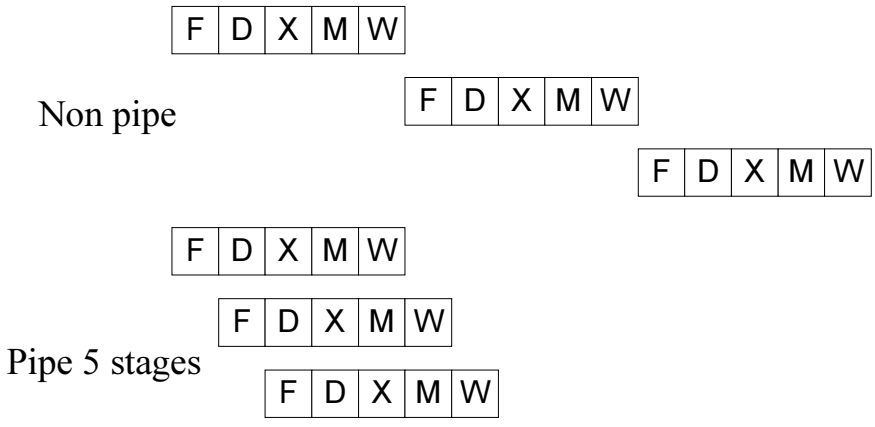
Performance report

Frequency (MHz)	Cache Size (K)	SPECint*95	SPECfp*95	IntelMedia Benchmark	ICOMP* index 2.0
233 (I)	512	9.38	7.4	364.13	267
266 (I)	512	10.7	8.17	412.31	303
300 (1)	512	11.9	8.82	459.08	332
333 (I)	512	13.0	9.55	498.79	366
350 (I)	512	13.9	11.20	534.61	386
400 (1)	512	15.8	12.40	601.10	440
450 (1)	512	17.2	12.90	658.41	483

How to improve performance

- Overlap of operations
- Multiple Functional units
- Technology : faster clock MHz
- Faster Memory

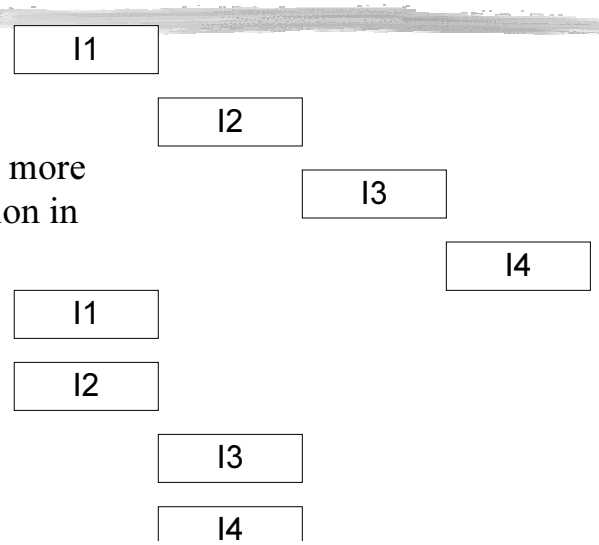
Overlap of Operations : Pipeline



Speed up = pipeline depth

Multiple Functional Units

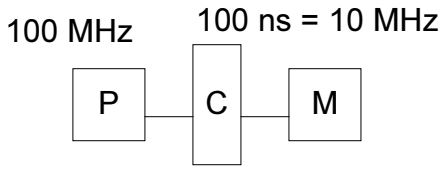
SuperScalar : do more than one instruction in a cycle

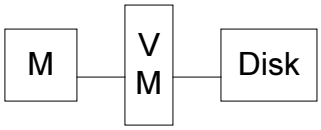


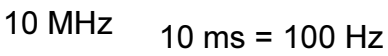
2 instructions at once

Faster Memory

- Cache for faster memory
- Virtual memory for larger memory







Parallel computers

- Multi processors
- Cluster
- Fault Tolerant

Future Trend

- More transistors : larger, faster processor
- More instruction issued per cycle
- Portable device : low power
- Change in work load