

Computer Architecture

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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

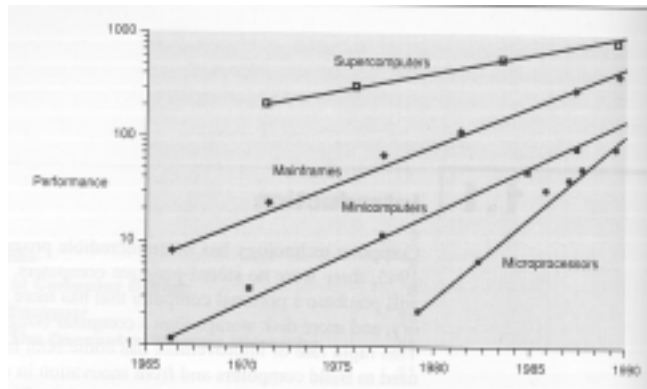
- Why is it useful to know computer architecture
 - understand computer products, its limitation and future trend

Types of computer

Define by performance and technology

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

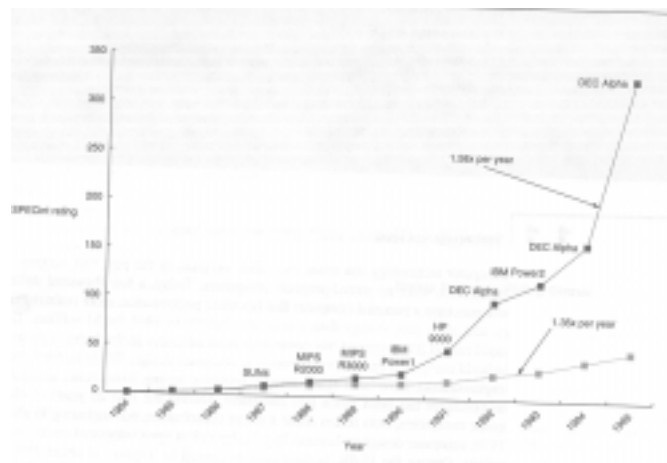
Types of computers



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5

Microprocessor

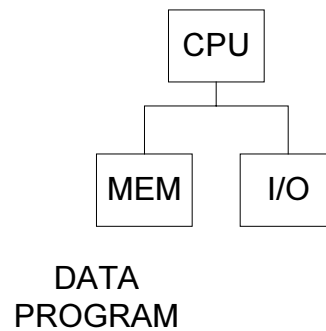


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6

What is computer function

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



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7

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;
```

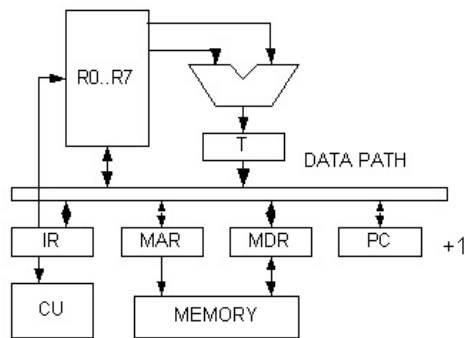
```
loop: LD F0,0(R1)      ; F0=array element  
      ADDD F4,F0,F2    ; add scalar in F2  
      SD 0(R1),F4     ; store result  
      SUBI R1,R1,#8   ; decrement pointer  
      BNEZ R1,loop    ; branch R1 != zero
```

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8

Structure and Organization

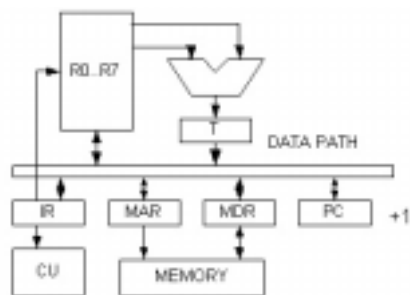
- Functional units
- Interconnection
- Resources



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9

How a processor work



$$A = B + C$$

Instruction Execution

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

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10

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 ^{rate}	SPECfp ^{rate}	IntRate Benchmark	JCOMP [®] Index 2.0
233 (T)	512	9.28	7.4	364.13	267
266 (T)	512	10.7	8.17	412.31	303
300 (T)	512	11.9	8.82	459.08	332
333 (T)	512	13.0	9.55	488.79	366
368 (T)	512	13.9	11.20	534.61	386
400 (T)	512	15.8	12.80	601.10	440
450 (T)	512	17.2	12.96	638.41	483

The Pentium II processor may contain design defects or errors known as errata. Current data sheet errata are available upon request.

NOTE:

Units: MHz and MB/sec.

Source for performance data: Pentium® Processor Performance Book, August 1996 (44396-000).
System configuration: Intel® Pentium® II 486/500, 33.3MHz based multi-board, 32 MB DRAM, 1.0M cache, 512KB/512 MB cache, 1MB cache, 10MB cache, 10MB cache, 10MB cache, 10MB cache.
IntRate: Windows NT 4.0, all others based on Windows 95.
Cache and DRAM are trademarks of Intel Corporation. Int, Pentium, and JCOMP are registered trademarks of Intel Corporation.

How to improve performance

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

Overlap of Operations : Pipeline

F D X M W

Non pipe

F D X M W

F D X M W

F D X M W

Pipe 5 stages

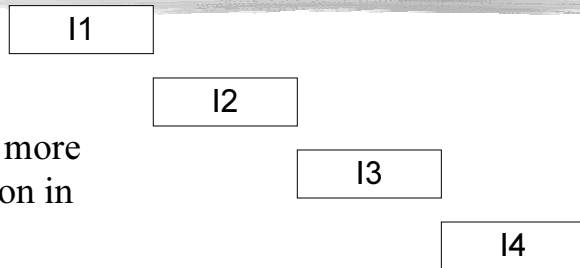
F D X M W

F D X M W

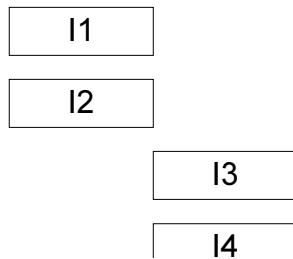
Speed up = pipeline depth

Multiple Functional Units

SuperScalar : do more than one instruction in a cycle



2 instructions at once



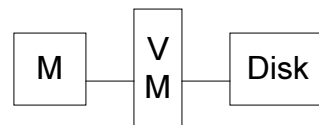
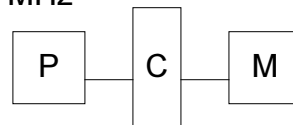
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15

Faster Memory

- Cache for faster memory
- Virtual memory for larger memory

100 MHz 100 ns = 10 MHz



10 MHz 10 ms = 100 Hz

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16

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