Computer Organization

Organization means how various parts of a system interact

Computer
- input devices ⊂ from humans directly, from keyboard/mouse, from other computer
- memory devices
- ALU
- CU
- output devices

Types of computer ⊂ desktop comp., servers., embedded devices } w.r.t cost & performance

desktop

→ for individual purpose
→ have mouse, keyboard.
→ low cost

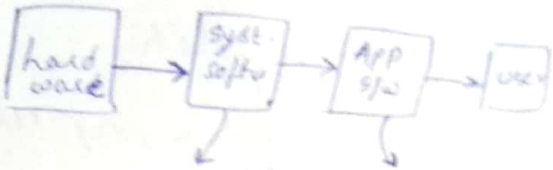
Server.

→ has higher storage & computing mechanism
→ for office, web, file storage
→ costly
→ scientific purposes eg: weather forecasting

Embedded devices

A computational device is placed in another device

eg. washing m/c, car, phone...



compiler
assembler
O.S

O.S

→ control I/O devices
→ protects info (security)
→ memory management

In m/c level lang, to perform a task, 1's & 0's are provided where top part is reserved for what op. is to be performed.

eg: a+b ⇒ 1011011101100010 ← assembler

in assembly lang. add a, b

eg: a+b×c eg. mult t, b, c
add t, , a
} in assembly level

∴ use higher level → compiler / interpreter

compiler: whole pgm is recompiled

interpreter: evaluated lines r alone recompiled

I/O devices

Mouse:

→ Doug Engelbart invented @ 1967 → CUI (command user interface)

→ 1973 – GUI

Mouse
- light source → lights the surface
- camera → capture 3400 - 10000 pics
- processor → process the image to find speed and direction

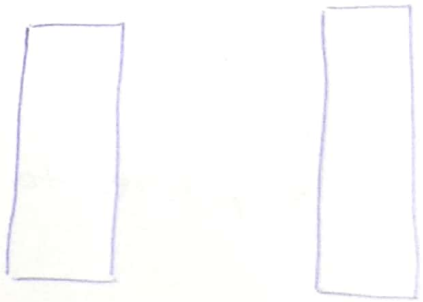
Monitor: Use LED now, used LCD – tube, before cathode ray tube

source is diff

→ polarised glasses

→ gives power to bend light using crystals to give image

→ associated with each pixel, there are active matrix to control its intensity



each pixel has 3 colours R, G, B

∴ 3 active matrix for a pixel.

→ each colour has 8 bits and is stored in bitmap matrix

→ each pixel has array of bits called bitmap

Motherboard

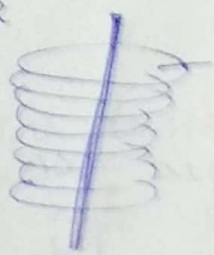
→ RAM, processor, registers, SMPS

→ 2 memory
- cache — in processor (faster than RAM) (SRAM)
- RAM (d-RAM) have to refresh freq

→ right side — drivers

→ left side — connectors to hard drives

harddisk



platters magnetically coated

to write or read, there are arms & guide powers to write

Flash-memory

→ Semi-conductor memory

→ faster

→ prone to damage than harddisk (limit to erase)

→ DVD — digital versatile disk

→ CD

→ to write 0, a pit is created

so while reading, we illuminate CD, & reflected light → 1 & scattered → 0

→ DVD

Increased bit & capacity by using light

Blu-ray disk

Networking technology

communicate among computers

→ LAN
→ WAN
→ MAN

→ large computer size due to vacuum tube 1951
→ In 1965, transistors technology
→ In 1975, ICs
→ In 1995 VLSI
→ In 2000 ultra LSI circuitry

How to find execution time if no. of instruct is given?

No. of clockcycle = total no. of instruction * Avg no. of clk cycle for 1 instruct (CPI) clk cycle per inst

since clk cycle is not same ∀ instruction

∴ CPU execution time = no. of clk cycle × clk period

Q] If we have 2 implementations of same architecture, comp. A has clk cycle of 250ps & CPI of 2.0 for some prgm. Comp. B has clk cycle 500ps & CPI of 1.2 for same prgm. which comp. faster for this prgm and by how much?

A: $E_1 = n \times 2.0 \times 250 = 500.0n$

$E_2 = n \times 1.2 \times 500 = 600n$

$E_1 > E_2 \Rightarrow$ 1 is faster

$\frac{E_1}{E_2} = \frac{5.0}{6}$ $\quad E_1 = \frac{8.33 E_2}{10}$

$\frac{P_1}{P_2} = \frac{E_2}{E_1} = 1.2$

$\therefore P_1 = 1.2 P_2$

Q} A compiler is made of 2 code sequence for a computer. The hardware designer have supplied the following facts:

instr. class	A	B	C
CPI	1	2	3

for a particular high level long seq the compiler designer is considering 2 code seq that seq following instruction count

code seq	A	B	C
1	2	1	2
2	4	1	1

(i) Which code seq executes the most instruction
(ii) Which will be faster?
(iii) What is the CPI for each seq?

A: (i) 2. (4+1+1)

(ii) $E_{1A} + E_{1B} + E_{1C} = (2\times1 + 1\times2 + 2\times3)n = 10n$

$E_{2A} + E_{2B} + E_{2C} = (4\times1 + 1\times2 + 1\times3)n = 9n$

$\therefore E_2 < E_1 \Rightarrow$ 2 is faster

(iii) $CPI_1 = \frac{10}{5} = 2$ (CPI = $\frac{\text{tot. no. of cycles}}{\text{no. of instr.}}$

$CPI_2 = \frac{9}{6} = \frac{3}{2} = 1.5$

Units

CPU execution time - sec/pgm

Instruction count = no. of inst/pgm

CPI = av. no. of clk cycle/ instr.

Clk cycle time = sec/clk cycle

⇒ Instruction count : dr

- prgming tool : dependent
- compiler : dependent
- algorithm : dependent
- instruction set architecture

⇒ CPI depends on

- algorithm
- prg. lang
- compiler.

⇒ Instruction set architecture affects:

→ clk cycle time (period)

→ CPI (complexity)

Computer arithmetic

Sign - magnitude

drawback :- 2 representation for 0

→ extra bit to represent sign if 2 no. are added.

2
1

ranges

sign- mag
1's comp
2's comp

$$-2^{+n-1}+1 \text{ to } 2^{n-1}-1$$

convert to 2's
⇒ write it +ve sign-mag form, if -ve take 2's comp. then MSB = 1

$$-2^{n-1} \text{ to } 2^{n-1}-1$$ (MSB = 1 ⇒ no is -ve

-3				-0
0	0	0	0	0
0	0	0	1	+1
0	0	1	0	+2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7

-ve

-3				
1	0	0	0	-8 →
1	0	0	1	-7 → -8+1
1	0	1	0	-6 → -8+2
1	0	1	1	-5
1	1	0	0	-4
1	1	0	1	-3
1	1	1	0	-2
1	1	1	1	-1

Sign extension :

Overflow

6+7 ⇒ 0110+
0111
1101

-ve not true ∴ overflow

6 - 7 ⇒ 0110
1001
1111 ⇒ -1

-6 - 7 →
1010+
1001
10011 ⇒ +ve 2 ; wrong

Multiplication (shift & add)

32 x 32

Multiplicant (64 bit) → shift left & add if 1 else shift left

Multiplier (32 bit) → shift right

product (64) → 32 + 32 = 64

ALU (64)

Eg: 2 x 3

Iteration	step	Mr multiplier	Mc multiplicant	P product
0		0011	00000010	00000000
1	P = P + Mc sll Mc srl Mr	0001	00000100	00000010
2	P = P + Mc sll Mc	0000	00001000	00000110

3rd Sll Mc 0000 00010000 00000110

Srl Mr

4th Sll Mc "

Srl Mr

Total no. of iteration = 32.

max no. of steps = 32 × 3 = 96.