WEEK02 – COMPUTER HARDWARE

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OUTLINE

- I. History of Personal Computer & Peripherals
- 2. Numeral Systems
- 3. Computer Hardware
 - I. CPU
 - 2. Power Case
 - 3. Memory
 - 4. Motherboard
 - 5. Peripherals

PERSONAL COMPUTER & PERIPHERALS

The Important Step in The World - Macintosh

Released in 1984, Macintosh series extended to 1991

CPU: Moto MC68000, CPU Speed: 8 MHz, Bus Speed: 8 MHz

Register Width: 32 bits, Data Bus Width: 16 bits, Address Bus Width 32 bits

Random Access Memory (RAM): 128 kB, Read Only Memory (ROM): 64 kB

Monitor: 9" build in, size: 512 X 342, color: 1 bit

Storage: 3.5" Floppy Drive with a size of 400 kB

Input/Output: Keyboard, Joystick/Mouse, Serial Port, Speaker, Audio Out

Operation System: Mac OS



Ref1: https://apple-history.com/128k

PERSONAL COMPUTER & PERIPHERALS

The Important Step in The World – IBM PC

1981 IBM PC 5150

CPU: Intel 8088, CPU Speed: 4.77 MHz

Register Width: 16 bits, Data Bus Width: 8 bit

RAM: 16-640 kB, ROM: 64 kB, Hard Disk: 20 MB

Monitor: 80 characters 25 lines

Storage: 5.25" Floppy Drive with a size of 160 kB Input/Output: Keyboard, RS232 Serial Port, Parallel Port, Speaker, 8-bit Slots

Operation System: PC DOS 1.0 – Windows + Intel = wintel Microsoft Basic ROM



Ref1: http://oldcomputers.net/ibm5150.html

PERSONAL COMPUTER & PERIPHERALS

The Important Step in Taiwan – ACER 710

1980 Micro-Professor (MPF) series 小教授家用電腦 1985 Multitech Accel 900, 6/10 MHz 80286 CPU 1987 ACER 710

CPU: Intel 8088, CPU Speed: 10 MHz

Register Width: 16 bits, Data Bus Width: 8 bit

RAM: 786 kB, ROM: 64 kB, Hard Disk: 20 MB

Monitor: 12" 80 characters 25 lines

Storage: 5.25" Floppy Drive with a size of 360 kB Input/Output: Keyboard, RS232 Serial Port, Parallel Port,

Speaker, 8-bit Slots Operation System: MS DOS 3.2



RefI: https://classictech.wordpress.com/computer-companies/acer-groupmultitech-electronics-inc-sunnyvale-calif/

NUMERAL SYSTEMS – BINARY, OCTAL, DECIMAL, HEXADECIMAL

After signals are digitalized (5/0V representing 1/o), the binary number system is used for the computer design.

The decimal number system gives a number abcd, where a, b, c, d are digital numbers from 0 to 9. $abcd = a \times 10^{3} + b \times 10^{2} + c \times 10^{1} + d \times 10^{0}$

In reverse direction, if you want to digitize a number N according to the decimal number system, you use division to find the digits:

Using the same way, we can find the number of a binary number 0110 0101 and find it back from a decimal number.

10

10

10

10

2 101 Ν 50 ... 1 2 $m_0 \dots d_0$ 25 ... 0 2 $m_1 \dots d_1$ 12 ... 1 2 6...0 2 $m_2 \dots d_2$ 3 ...0 2 $d_4 \dots d_3$ 1...1 2 $N = d_4 d_3 d_2 d_1 d_0$ N = 1100101

0110 0101 $= 2^{0} + 2^{2} + 2^{5} + 2^{6}$ = 101

NUMERAL SYSTEMS – BINARY, OCTAL, DECIMAL, HEXADECIMAL

Conversion between the binary, the octal, the decimal, and the hexadecimal number systems:

binary to decimal: $1111 = 2^4 - 1 = 15$ 8 1201 16 1201 150 ... 1 75 ... 1 8 16 digits of octal numbers: 0, 1, 2, 3, 4, 5, 6, 7 4...11 18...6 8 binary to octal numbers: 101 011 = 53 2...2 N = 4B1octal to decimal numbers: $53 = 5 \times 8^1 + 3 \times 8^0 = 43$ N = 2261digits of hexadecimal numbers: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F hexadecimal to decimal: $8FA0 = 8 \times 16^3 + 15 \times 16^2 + 10 \times 16 = 36768$ hexadecimal to binary: $8A0 = 1000 \ 1010 \ 0000$ hexadecimal to octal: 3F5 = 0.01111110101 = 0.01111110101 = 1.765

Arithmetic/Logic Unit (ALU)

CPU: The CPU is operated synchronously with the memory and the peripherals. They are clocked at the same rate, e.g. 5/8 MHz for 8088 CPU.

Vcc

Ò

GND

8-bit data bus interface

16-bit internal architecture

Direct addressing to memory

8-bit & 16-bit signed and unsigned arithmetic in binary or decimal including multiply and divide

CPU: input data from memory or disk, calculation, output data, interrupted processing

Refl: https://eater.net/8bit/



MIN

MODE

MAX MODE

Operation Time: Several Cycles of Clock Time, Unit: 0.2 μs for 8088 CPU Speed of 5 MHz



But The Operational Interrupt Speed for your program is still 1 kHz.

Another Simple CPU

Powered by USB, use FTDI Friend (a chip to convert USB signal to serial port) $Pin7, 20, 21: USBV_{CC}$ Pin8, 22: USB GND Pin3: USB RX Pin2: USB TX Pin9 & 10: Crystal Pin I: $5V \rightarrow 10k\Omega \rightarrow Pin1 \rightarrow$ Switch $\rightarrow GND$ $Pin 19: Pin 19 \rightarrow 220.0 \rightarrow$ $LED \rightarrow GND$



Refl: http://yehnan.blogspot.com/2013/09/arduino_9.html

Two Types of Commands Used in CPU Operation:

I. Reduced Instruction Set Computer (RISC, 精簡指令集)

Who uses it? Work Station, for example, SPARC (Oracle), Power PC (IBM), ARM CPU (for cell phone) What is its purpose? Short time for each operation.

2. Complex Instruction Set Computer (CISC, 複雜指令集)

Who uses it? CPU for personal computers (Intel, AMD, VIA)

What is its purpose? Long time for each operation while having more powerful functions like commands for multimedia, for power saving, ...

Refl: https://cs.stanford.edu/people/eroberts/courses/soco/projects/risc/risccisc/

RISC Commands: LOAD A, 2:3 LOAD B, 5:2 PROD A, B STORE 2:3, A CISC Commands: MULT 2:3, 5:2

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POWER

Signal: 0 or 5 V, Power: 0 or 5 V, 12 V

What's difference? The signal does not provide enough power. The current of the signal is small. It sometimes cannot drive the device, even a low-power consuming LED device.

- 4 pin peripheral power connector
- ATX 20 pin main power connector
- 4 pin ATX + 12V power connector

Sometimes, the signal line does not have a protecting resistor. In that case, you need to add a current limiting resistor when you use the signal to light up the LED.

Ref1: https://www.pcworld.com/article/2025425/how-to-pick-the-best-pc-power-supply.html Ref2: https://forum.digikey.com/t/common-computer-power-supply-connectors/328



MEMORY

Accelerate the operation speed. The program and data will be loaded into the memory before the commands in the program are executed.

For the 8088 CPU, the storage size is 8 bits (1 bytes) and the addressing capability is 2²⁰ (1 Mega Bytes). The memory are usually separated to several parts for data, coding, and stacking pages.

The memory used by CPU is named random access memory (RAM), a dynamic RAM.

Another type – static RAM

SRAM: on-chip, fast access, short time, DRAM: off-chip, long time

SRAM: small size, DRAM: large storage capacity

SRAM: expensive, DRAM: cheap

SRAM: complex, DRAM: simple design

Refl: https://medium.com/@winl0tricks/static-ram-vs-dynamic-ram-which-is-better-4d691c052781

					MIN MODE	(MAX MODE	
	GND		\sim	40] Vcc		
	A14			39	A15		
	A13	□ 3		38	A16/S3		
	A12			37	A17/S4		
	A11	5		36] A18/S5		
_	A10	6		35	A19/S6		
	A9			34	SSO	(HIGH)	
	A8	8 🗋		33] MN/MX		
	AD7	[9	8088 CPU	32	RD		
	AD6	[10		31] HOLD	(RQ/GTO)	
	AD5			30] HLDA	(RQ/GT1)	
	AD4	1 2		29] WŔ	(LOCK)	
	AD3	13		28] 10/M	(S2)	
	AD2	14		27	DT/R	(S1)	
	AD1	L 15		26	DEN	(SO)	
	AD0	16		25	ALE	(QS0)	
	NMI	17		24	INTA	(QS1)	
	INTR	[18		23	TEST		
	CLK	19		22	READY		
	GND	20		21	RESET		

RAM (Random Access Memory)

SRAM – Static RAM vs. DRAM – Dynamic RAM





MOTHERBOARD

Integrate CPU, Memory, Power, Expansion Slots like PCI Express, PCI, AGP (Accelerated Graphic Port for Video Cards)

I/O Port (Mouse, Keyboard, USB, Serial Port), S/PDIF(Sony and Phillips Digital Interconnect Format - SoundI/O), Bluetooth, Wi-Fi/RJ45

Northbridge: Communications between The CPU Interface, AGP, and The Memory

Southbridge: IC for The Hard Drive Controller, I/O Controller, and Integrated Hardware

Storage Units Like Hard Disk Drive (HDD), Floppy Disk Drive (FDD), Optical Disk Drive (ODD), CD-ROM, DVD, Blue-Ray DVD

Refl: https://www.computerhope.com/jargon/m/mothboar.htm



PERIPHERALS – STANDARD INPUT & OUTPUT

Display, Mouse, Keyboard, Sound I/O, CCD (Charge-coupled Device)

The screen size of the surface pro is $260 \times 175 \text{ mm}^2$. The screen resolution is 2736×1824 pixels. For a full color display, one pixel is represented by four bytes for red (R), green (G), blue (B), and alpha (A). The mapping of the screen requires 19 MBytes.

Bluetooth Mouse, Bluetooth Earphone

CCD Resolution 8 Mega Pixels

Integrated Sound Card – Realtek (瑞昱) High Definition Audio

Most hardware requires the software drivers for your operational system (OS).







PERIPHERALS – HARD DISK, CD, DVD

Secondary storage, permanent or long-time storage of data.

Magnetic domains read/write using the head made by magnetic tunneling junctions.

3D TLC NAND-based flash memory - a type of non-volatile memory that retains data when power is lost.



DVD Disk





PERIPHERALS – EXTERNAL PORTS



Ref1: http://www.expertreviews.co.uk/accessories/pc-monitors/1404476/hdmi-vs-displayport-vs-dvi-vs-vga-every-connection-explained Ref2: https://en.wikipedia.org/wiki/Parallel_port

PERIPHERALS – EXTERNAL PORTS

You can write software to control or to send data to the parallel port.

The data can be combined to form 16 bit resolution for output.

The 16 bit data can be send for digital-toanalog conversion for a 0-10V output.

The resolution of the output analog voltage is estimated by $\frac{20}{2^{16}} = 3.05 \times 10^{-4}$ V.

It's possible to reverse the data direction so you can read the analog voltage as a digital number.

The resolution depends on how many bits used in the AD/DA conversion.



PERIPHERALS – INTERNET

Ethernet is used in your everyday life. The data is predominantly transferred by cable (Ethernet cable connection) while the data transfer can be wireless for the end users (Wi-Fi-wireless fidelity, cellphone mobile data).

1962 The first commercial modem – the Bell 103 developed by AT&T, full-duplex transmission, speed of 300 bps (bits per second)

1991 The data transfer speed of the modem is increased up to 14.4 Kbps. (1990-1996 used in Taiwan -> BBS)

Sound of dial-up modem: https://www.youtube.com/watch?v=gsNaR6FRuO0

Ethernet is developed by the company – Xerox PARK between 1973 and 1974.

The development of Ethernet is inspired by ALOHANET. "In the late 1960s, Abramson and his team set out to connect computers across the University of Hawaii system using radio communications."

The speed of the first Ethernet – 10BASE5 is 2.94 Mbps. Now the speed is increased up to 400 Gbps.







EXERCISE

- I. Please use the components of a 9V battery, LM7805, SN74LS08 to demonstrate the results of $1 \cdot 1 = 1$ and $1 \cdot 0 = 0$.
- 2. Put decimal numbers of 13812, 217003, and 1996 into the three different for binary, the octal, and the hexadecimal forms.
- 3. What are their decimal forms of the hexadecimal numbers, 1204, F21, and 2AF?
- 4. What are all the possible data transfer speeds for the RS-232 serial port?
- 5. What are the differences between the parallel port and the RS-232 serial port?