LECTURE 2

EET 2211

4TH SEMESTER – CSE & CSIT

CHAPTER 1, LECTURE 2

A BRIEF HISTORY OF COMPUTERS

- ✓ The computer generations are classified based on the fundamental hardware technology employed.

- ✓ Each new generation is characterized by greater processing performance, larger memory capacity, smaller size and lower cost than the previous one.

COMPUTER GENERATIONS

GENERATION	APPROXIMATE DATES	TECHNOLOGY	TYPICAL SPEED (operations per second)
1	1946-1957	Vacuum tubes	40,000
2	1957-1964	Transistors	2,00,000
3	1965-1971	Small and medium scale integration	10,00,000
4	1972-1977	Large scale integration	1,00,00,000
5	1978-1991	Very large scale integration	10,00,00,000
6	1991-	Ultra large scale integration	>10,00,00,000

FIRST GENERATION : VACUUM TUBES

- The first generation of computers used vacuum tubes for digital logic elements and memory.
- Famous first generation computer is known as IAS computer (is the basic prototype for all general-purpose computers).
- Basic design approach is the stored-program concept.
- The idea was proposed by von Neumann.
- It consists of (i) a main memory (which stores both data and instructions), (ii) an arithmetic and logic unit (ALU) (capable of operating on binary data), (iii) a control unit (which interprets the instructions in memory and causes them to be executed), and (iv) Input-Output (I/O) (equipment operated by the control unit).

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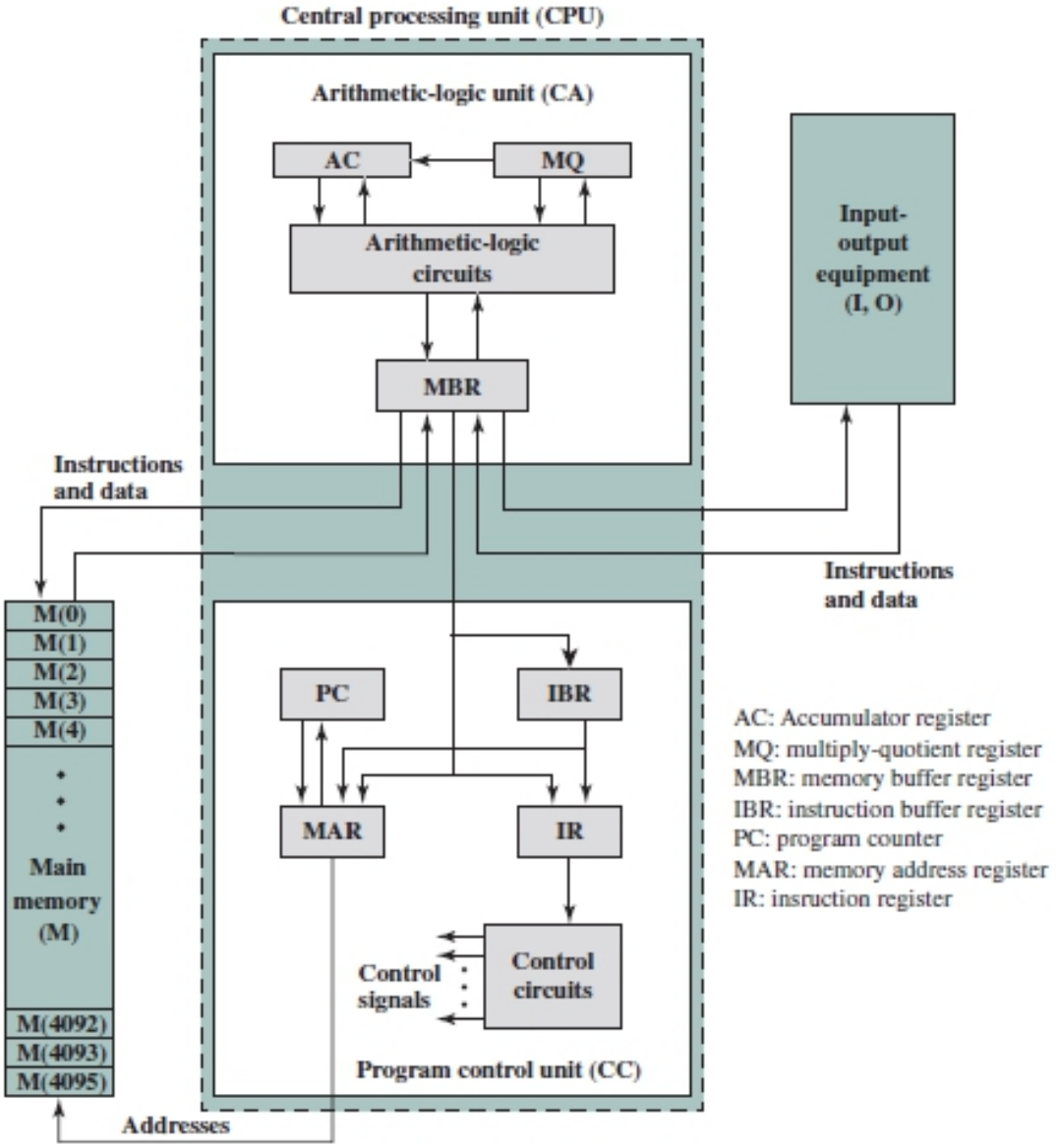

Fig.: IAS computer structure [Source: Computer Organization and Architecture by William Stallings]

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VON NEUMANN'S PROPOSAL

1) As the device is primarily a computer, it has to perform the elementary arithmetic operations.
2) The logical control of the device, i.e. the proper sequencing of operations can be most efficiently carried out by the central control unit.
3) Any device that is to carry out long and complicated sequences of operations must have a memory unit.
4) The device must have interconnections to transfer information from R (outside recording medium of the device) into specific parts C (CA+CC) and M (main memory), and form the specific part I (input).
5) The device must have interconnections to transfer from its specific parts C and M into R, and form the specific part O (output).

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- ✓ The memory of IAS consists of 4096 storage locations (words of 40 binary digits/bits each).
- ✓ It stores both data and instructions.
- ✓ Numbers are represented in binary form and instructions are in binary codes.
- ✓ Each number is represented by a sign bit and a 39-bit value.
- ✓ A word may alternatively contain 20-bit instructions.
- ✓ Each instruction consists of an 8-bit operation code/opcode (specifying the operation to be performed) and a 12-bit address designating one of the words in the memory (0-999).

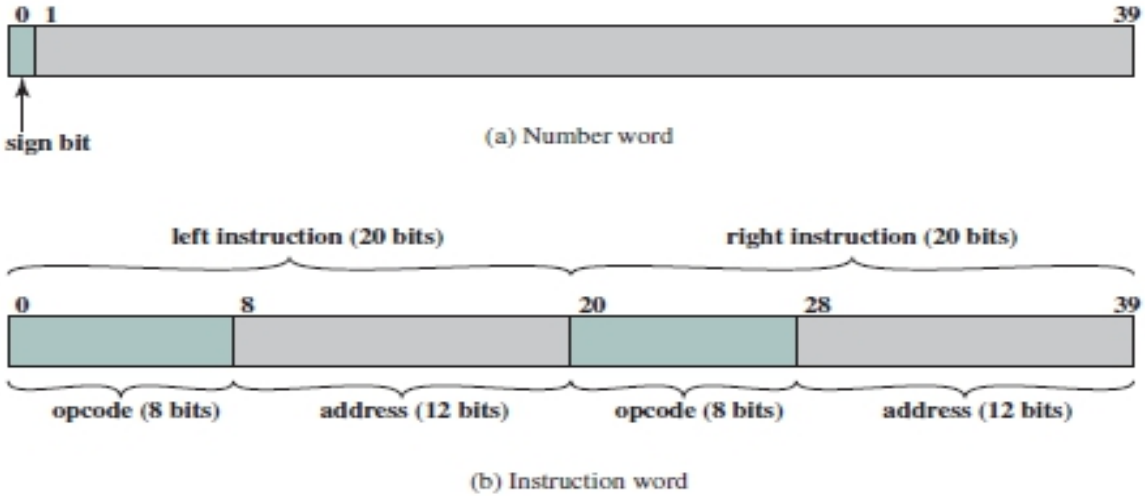

Fig.: IAS memory format [Source: Computer Organization and Architecture by William Stallings]

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Instruction Type	Opcode	Symbolic Representation	Description
Data transfer	00001010	LOAD MQ	Transfer contents of register MQ to the accumulator AC
	00001001	LOAD MQ,M(X)	Transfer contents of memory location X to MQ
	00100001	STOR M(X)	Transfer contents of accumulator to memory location X
	00000001	LOAD M(X)	Transfer M(X) to the accumulator
	00000010	LOAD –M(X)	Transfer –M(X) to the accumulator
	00000011	LOAD |M(X)|	Transfer absolute value of M(X) to the accumulator
	00000100	LOAD –|M(X)|	Transfer –|M(X)| to the accumulator
Unconditional branch	00001101	JUMP M(X,0:19)	Take next instruction from left half of M(X)
	00001110	JUMP M(X,20:39)	Take next instruction from right half of M(X)
Conditional branch	00001111	JUMP + M(X,0:19)	If number in the accumulator is nonnegative, take next instruction from left half of M(X)
	00010000	JUMP + M(X,20:39)	If number in the accumulator is nonnegative, take next instruction from right half of M(X)
Arithmetic	00000101	ADD M(X)	Add M(X) to AC; put the result in AC
	00000111	ADD |M(X)|	Add |M(X)| to AC; put the result in AC
	00000110	SUB M(X)	Subtract M(X) from AC; put the result in AC
	00001000	SUB |M(X)|	Subtract |M(X)| from AC; put the remainder in AC
	00001011	MUL M(X)	Multiply M(X) by MQ; put most significant bits of result in AC, put least significant bits in MQ
	00001100	DIV M(X)	Divide AC by M(X); put the quotient in MQ and the remainder in AC
	00010100	LSH	Multiply accumulator by 2; that is, shift left one bit position
	00010101	RSH	Divide accumulator by 2; that is, shift right one position
Address modify	00010010	STOR M(X,8:19)	Replace left address field at M(X) by 12 rightmost bits of AC
	00010011	STOR M(X,28:39)	Replace right address field at M(X) by 12 rightmost bits of AC

Table: IAS instruction set [Source: Computer Organization and Architecture by William Stallings]

SECOND GENERATION : TRANSISTORS

- ✓ Vacuum tubes were replaced by transistors.
- ✓ Transistor is a solid-state device made form silicon; smaller, cheaper and generates less heat than vacuum tubes.
- ✓ Complex arithmetic & logic units, control units, high level programming language, and the provision of system software were introduced.
- ✓ E.g. IBM 7094 where data channels or independent I/O modules were used with their own processor and instruction sets.
- ✓ Multiplexers were used which are the central termination point for data channels, CPU and memory.

THIRD GENERATION : INTEGRATED CIRCUITS

- ✓ The integrated circuits consists of discrete components like transistors, resistors, capacitors etc.
- ✓ Two fundamental components that are required are gates and memory cells.
- ✓ Gates control the data flow.
- ✓ Memory cells store 1 bit data.
- ✓ Governed by Moore's Law which states that the number of transistors doubles in every 18 months.

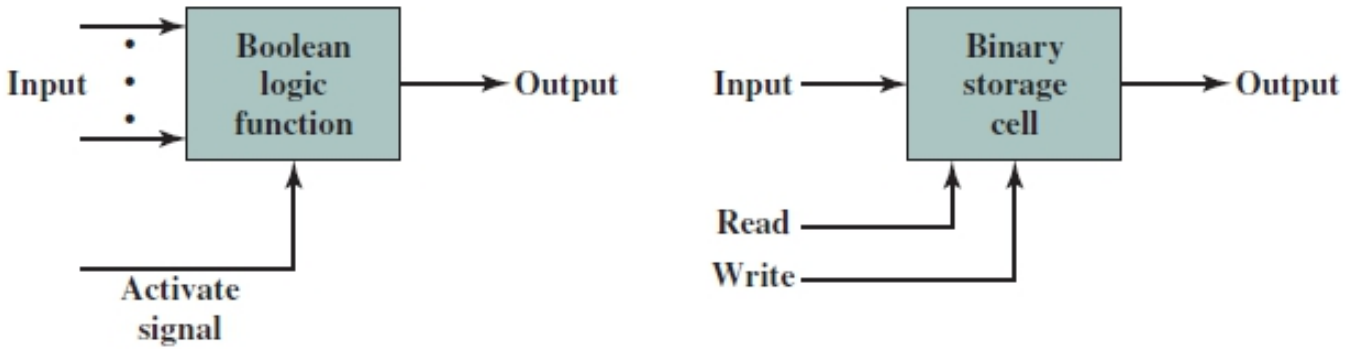

Fig.: Fundamental computer elements [Source: Computer Organization and Architecture by William Stallings]

LATER GENERATIONS

Two important developments of later generations are:

1. **SEMICONDUCTOR MEMORY** : First application of integrated circuit is processor. It is faster, smaller in size, memory cost decreased with corresponding increase in physical memory density.

2. **MICROPROCESSORS** : It started in 1971 with the development of first chip 4004 to contain all the components of a CPU on a single chip.

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(a) 1970s Processors

	4004	8008	8080	8086	8088
Introduced	1971	1972	1974	1978	1979
Clock speeds	108 kHz	108 kHz	2 MHz	5 MHz, 8 MHz, 10 MHz	5 MHz, 8 MHz
Bus width	4 bits	8 bits	8 bits	16 bits	8 bits
Number of transistors	2,300	3,500	6,000	29,000	29,000
Feature size (μm)	10	8	6	3	6
Addressable memory	640 bytes	16 KB	64 KB	1 MB	1 MB

(b) 1980s Processors

	80286	386TM DX	386TM SX	486TM DX CPU
Introduced	1982	1985	1988	1989
Clock speeds	6–12.5 MHz	16–33 MHz	16–33 MHz	25–50 MHz
Bus width	16 bits	32 bits	16 bits	32 bits
Number of transistors	134,000	275,000	275,000	1.2 million
Feature size (μm)	1.5	1	1	0.8–1
Addressable memory	16 MB	4 GB	16 MB	4 GB
Virtual memory	1 GB	64 TB	64 TB	64 TB
Cache	–	–	–	8 kB

Table: Evolution of Intel Microprocessors [Source: Computer Organization and Architecture by William Stallings]

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(c) 1990s Processors

	486TM SX	Pentium	Pentium Pro	Pentium II
Introduced	1991	1993	1995	1997
Clock speeds	16–33 MHz	60–166 MHz,	150–200 MHz	200–300 MHz
Bus width	32 bits	32 bits	64 bits	64 bits
Number of transistors	1.185 million	3.1 million	5.5 million	7.5 million
Feature size (μm)	1	0.8	0.6	0.35
Addressable memory	4 GB	4 GB	64 GB	64 GB
Virtual memory	64 TB	64 TB	64 TB	64 TB
Cache	8 kB	8 kB	512 kB L1 and 1 MB L2	512 kB L2

(d) Recent Processors

	Pentium III	Pentium 4	Core 2 Duo	Core i7 EE 4960X
Introduced	1999	2000	2006	2013
Clock speeds	450–660 MHz	1.3–1.8 GHz	1.06–1.2 GHz	4 GHz
Bus width	64 bits	64 bits	64 bits	64 bits
Number of transistors	9.5 million	42 million	167 million	1.86 billion
Feature size (nm)	250	180	65	22
Addressable memory	64 GB	64 GB	64 GB	64 GB
Virtual memory	64 TB	64 TB	64 TB	64 TB
Cache	512 kB L2	256 kB L2	2 MB L2	1.5 MB L2/15 MB L3
Number of cores	1	1	2	6

Table: Evolution of Intel Microprocessors [Source: Computer Organization and Architecture by William Stallings]

THANK YOU