HNDIT1032 Computer and Network Systems

Week 1- Introduction to Computer

Course Aims

- To develop the fundamental skills required in installation, configuration, maintenance, troubleshooting and management of computers and communication between computers

Course Details

Course Code	HNDIT1032
Course Title	Computer and Network System
Semester	1
Course Status	Compulsory, GPA
Number of Credits	3
Hours	Lecture= 30 Hours Practical=30 Hours
Mode of Delivery	Lectures, Discussion, Presentation, Assignment, Practical, blended learning, Demonstrations, LMS

Assessment Summary

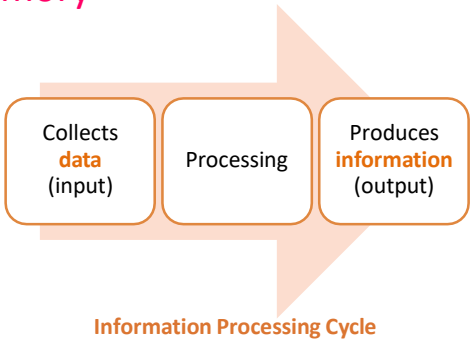
Assessment Method	Weightage
On-line quizzes and tutorials	20%
Assignments	20%
Final Examination	60%
Total	100%

Learning Outcomes(LO)

- After successful completion of this course the student should be able to:
  - LO1: describe how information and data are represented inside a computer system
  - LO2: assemble, disassemble and troubleshoot hardware related errors on a PC
  - LO3: install various operating systems, configure, maintain and troubleshoot.
  - LO4: identify the benefits of a networked environment and work in a networked environment

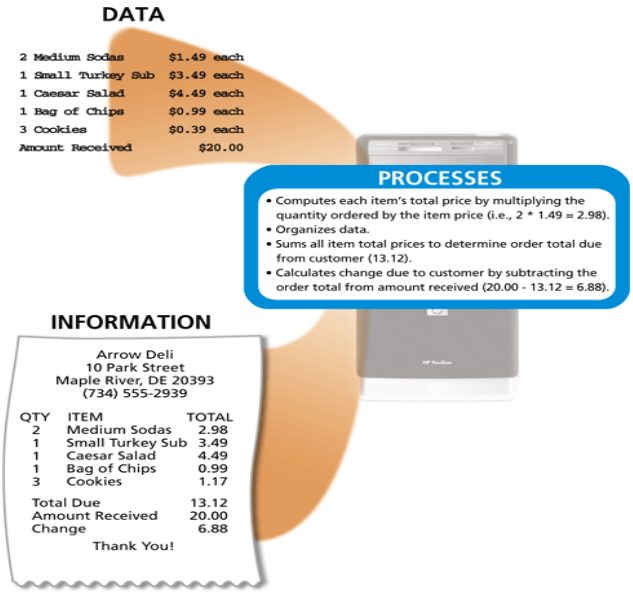
What is a computer ?

- A **computer** is an electronic device, operating under the control of instructions stored in its own memory



Information Processing Cycle

Data and Information…



Data and Information

- Data :
  - collected row facts
  - Cannot be used for decision making

  Ex: Student Name, Exam marks, exam status

UNDERSTANDING ids difficult
may or may not be meaningfull

- Information:
  - Processed data
  - Can be used to decision making

  Ex: - Students name in alphabetical order.
  - Students who have passed the exam.

understand is easy
always meaningfull

Data in Computing System

- Usually the computing systems are complex devices, dealing with a vast array of information categories
- The computing systems store, present, and help us modify:
  - Text
  - Audio
  - Images and graphics
  - Video

Forms of Data Representation

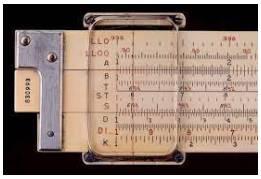
- The data can be represented in one or two ways
  1. Analog → is a continuous representation
  2. Digital → is a discrete representation

History of Computers

- Calculating Machines
- Napier's Bones
- Slide Rule
- Pascal's Adding and Subtraction Machine
- Leibniz's Multiplication and Dividing Machine
- Punch Card System

History of Computers…

ABACUS

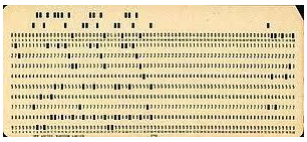


Slide Rule

Leibniz's Machine

Napier's Bones

Pascal's Machine



Punch Card System

Generations of Computers

- First Generation (Vacuum Tubes)
- Second Generation(Transistors)
- Third Generation(Integrated Circuit)
- Fourth Generation(Microprocessors)
- Fifth Generation(Artificial Intelligence)

First Generation(1940 to 1956) Using Vacuum Tubes

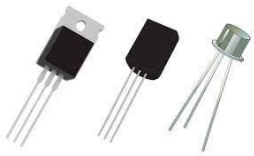
- Hardware Technology – The first generation of computers used vacuum tubes for circuitry and magnetic drums for memory.
- Software Technology- The instructions were written in machine language.
- Computing Characteristics - The computation time was in milliseconds.
- Physical Appearance- These computers were enormous in size and required a large room for installation.
- Application- Scientific application
- Example- Universal Automatic Computer (UNIVAC), Electronic Numerical Integrator And Calculator (ENIAC)

First Generation(1940 to 1956) Using Vacuum Tubes…

Second Generation(1956 to 1963) Using Transistors

- Hardware Technology- Transistors, used magnetic tapes and magnetic disks for secondary storage.
- Software Technology – Assembly language
- Computing Characteristics- computation time was in microseconds.
- Physical Appearance-The size of the computer was also reduced.
- Application- commercial production of these computers was very high
- Examples PDP-8, IBM 1401 and CDC 1604.

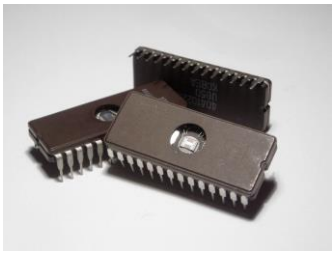
Second Generation(1956 to 1963) Using Transistors…



Third Generation (1964 to 1971) Using Integrated Circuits

- Hardware Technology -Integrated Circuit (IC) chips. multiple transistors are placed on a silicon chip.
- Software Technology- High-level languages
- Computing Characteristics-computation time was in nanoseconds
- Physical Appearance-The size of these computers was quite small
- Application-Computers became accessible to mass audience.
- Examples IBM 370, PDP 11.

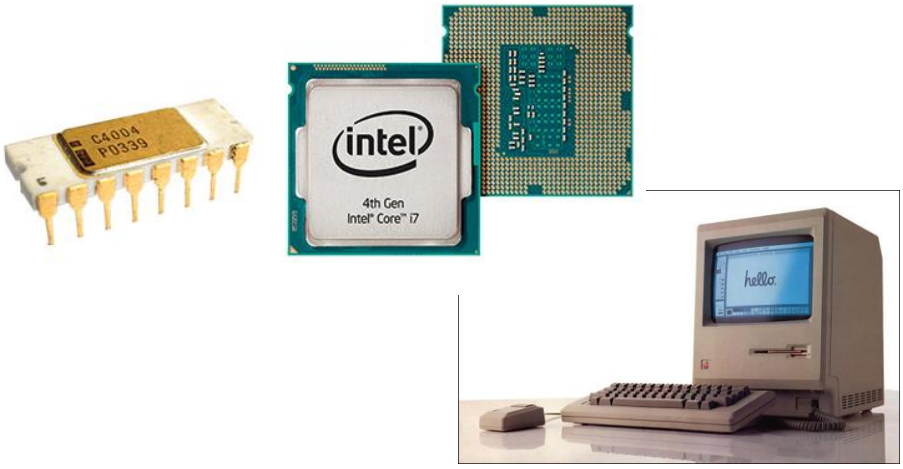
Third Generation (1964 to 1971) Using Integrated Circuits…



Fourth Generation(1971 to present) Using Microprocessors

- Hardware Technology -Microprocessor is a chip containing millions of transistors and components.
- Software MS- DOS and GUI based MS Windows
- Computing Characteristics- computation time is in picosecond
- Physical Appearance - smaller than the computers of the previous generation
- Application – Commercial purpose and personal computers
- Examples- IBM, Apple Macintosh

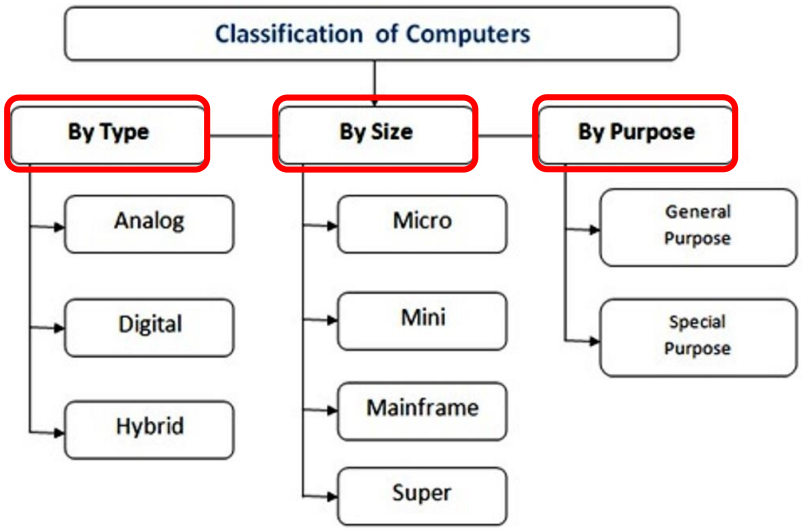
Fourth Generation(1971 to present) Using Microprocessors…



Fifth Generation(Present and Next) Using Artificial Intelligence

- Super Large Scale Integration
- Parallel processing
- Artificial Intelligence
- Natural Language Processing
- Speech Recognition
- virtual reality generation
- Satellite links
- Robotics

Classification of Computers



Microcomputers

- Microcomputers are
  - Small
  - Low-cost
  - Stand-alone machines
  - CPU, I/O devices, storage unit and OS
  - Example-

Minicomputer

- Multi-user systems.
- High processing speed
- High storage
- Real-time applications in industries, research centers, etc.
- PDP 11, IBM (8000 series)

Mainframe Computers

- Multi-user, multi-programming and high performance computers.
- very high speed, very large storage capacity
- Large and powerful systems generally used in centralized databases.
- Examples -CDC 6600 and IBM ES000 series.

Supercomputers

- Fastest and the most expensive machines.
- The speed measured in FLOPS (Floating point Operations Per Second).
- Trillions of calculations per second.
- Interconnecting thousands of processors that can work in parallel.
- Example- IBM Roadrunner, IBM Blue Gene, PARAM

Applications of computer

- Home
- Education
- Science
- Industry
- Entertainment
- Banking
- Government

Applications of computer…

- At Home
  - Mostly to check mails
  - Small documentation
  - Gaming
  - Music and Video
  - To solve homework
  - Photo Printouts using Good Printers
  - Work from Home concept

Applications of computer…

- In Education
  - Schools to Universities
  - To Educate necessary skills demanded by Industries
  - To give a demo or training
  - Server the purpose of Teaching Aids
  - To convey messages using Internet

Applications of computer…

- In Science
  - To analyze large data acquired over a period of time
  - To do complex floating point arithmetic
  - Image Processing
  - Research

Applications of computer…

- In Industry
  - To develop software, mostly to automate the manual work
  - To provide necessary solution to clients' needs
  - Software is developed for the needs of networking, banking, business, retail etc

Applications of computer…

- Entertainment
  - Music Industry
  - Games
  - Movies – to watch and create – 200 Linux Machines in parallel to create visualization in Titanic, the movie
  - IIIly Cartoons, special effects
  - Nowadays to promote theirs productions

Applications of computer…

- Banking
  - To store, access and modify huge amounts of data
  - Online business called e-business is becoming popular with a small amount of limitations
  - Paying bills become easy and time saving
  - online promotions

Applications of computer…

- Government
  - "Biometrics Attendance Monitoring"
  - Weather Forecasting and military applications
  - E- governance
  - Online payment of taxes, Insurances
  - Send Messages to virtually unreachable places at present
  - Wireless communication

Block Diagram of computer

- The computer system hardware comprises of three main components
  - **Input/output (I/O) Unit,**
  - **Central Processing Unit (CPU),**
  - **Memory Unit.**

Input/output Unit

- The user interacts with the computer via the I/O unit.
- The Input unit converts the data that it accepts from the user, into a form that is understandable by the computer.
- Output unit provides the output in a form that is understandable by the user
- Input devices like keyboard, trackball and mouse
- output devices are monitor and printer.

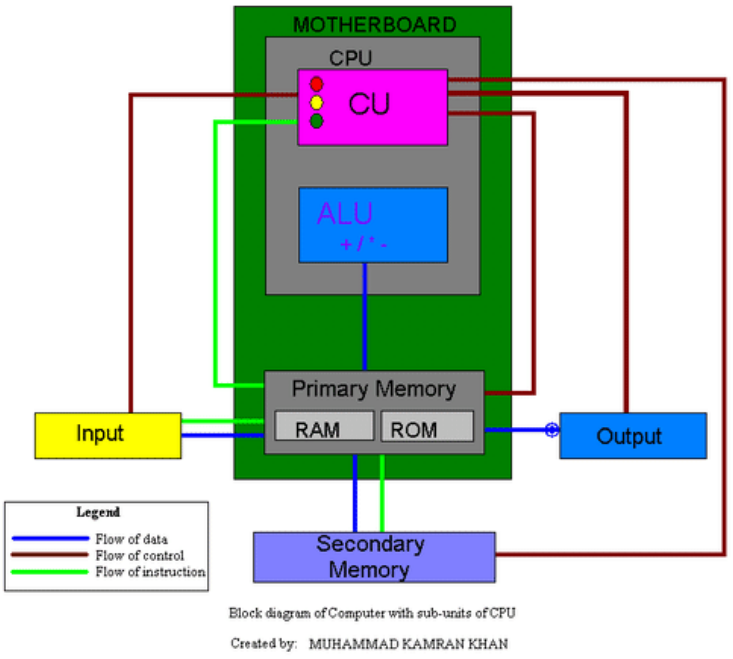
Central Processing Unit

- CPU controls, coordinates and supervises the operations of the computer.
- CPU consists of **Arithmetic Logic Unit (ALU)** and **Control Unit (CU).**
- **ALU-performs all the arithmetic and logic operations on the input data.**
- CU controls -checks the sequence of execution of instructions, and, controls and coordinates the overall functioning of the units of computers
- CPU also has a set of **registers** for temporary storage of data, instructions, addresses

Memory Unit

- Stores the data, instructions, intermediate results and outputs, temporarily, during the processing of data.
- The input data that is to be processed is brought into the main memory before processing.
- The output is stored in memory before being transferred to the output device.
- Main memory is primary memory of computers
- secondary memory - The data, the programs and the output are stored permanently in the storage unit of the computer.
- Magnetic disks, optical disks and magnetic tapes are examples of secondary memory

Block Diagram



Block diagram of Computer with sub-units of CPU

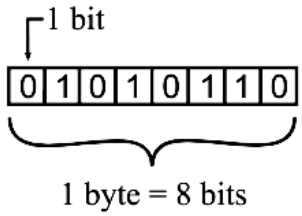
Created by: MUHAMMAD KAMRAN KHAN

HNDIT1032 Computer and Network Systems

Week 2-Data Representation in Computers

Digital Data

- Most computers are Digital
- Understands only two discrete values
  - 0 (Off)
  - 1 (On)
- Each on or off value is called a **bit** (binary digit)



How Computers Represent Data?

- A computer is an **electronic device**
- Electronic devices process data by manipulating electricity.

Presence of electricity (1)

Absence of electricity (0)

1011

Data Units use in a Computer

- A ***bit*** is the most basic unit of information in a computer.
  - It is a state of "on" or "off" in a digital circuit.
  - Sometimes they represent **high** or **low** voltage

- A ***byte*** is a group of eight (08) bits. It is the smallest possible *addressable* unit of computer storage.

Data Units use in a Computer…

- A ***word*** is a contiguous group of bytes.
  - Words can be any number of bits or bytes.
  - Word sizes of 16, 32, or 64 bits are most common.

- A group of four (04) bits is called a ***nibble***.
  - Bytes, therefore, consist of two nibbles: a "high-order nibble," and a "low-order" nibble

5

Data Units use in a Computer…

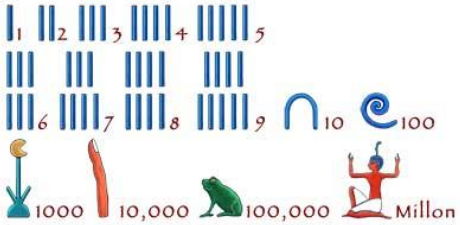
- **Bit**: It is the smallest unit of information used in a computer system. It can either have the value 0 or 1. Derived from the words *binary digit*.
- **Nibble**: It is a combination of 4 bits.
- **Byte**: It is a combination of 8 bits.
- **Word**: It is a combination of 16 bits.
- **Double word**: It is a combination of 32 bits.
- **Kilobyte (KB)**: It is used to represent the 1024 bytes of information.
- **Megabyte (MB)**: It is used to represent the 1024 KBs of information.
- **Gigabyte (GB)**: It is used to represent the 1024 MBs of information.

Types of Data Representations

- Character Representation
  - A, a, ?, @
- Number Representation
  - 1, 235, -10, 0

Number systems

- Positional Number System / Weighted Number System
- Non positional number system / non Weighted Number System



The Non-weighted/ Non Positional Numbers

- The non-weighted numbers are **not positional weighted** .
- That are not assigned with any weight to each digit position.
- position *independent*
- Ex-
  - Roman number system
    - ❖Roman numerals symbols with different values: I (1), V (5), X (10), C (50), M (100)
    - ❖Examples: I, II, III, IV, VI, VI, VII, VIII, IX
  - Egyptian number system

Weighted Numbers/ Positional Number

- The weighted numbers are those that obey the **position weighting principle**
- which states that the **position of each number represent a specific weight**.
- Numeric values are represented by a *sequence* of digit symbols. Each digit position has a value called a weight associated with it
- Ex:
  - decimal numbers
  - Binary numbers
  - Octal numbers
  - Hexadecimal numbers

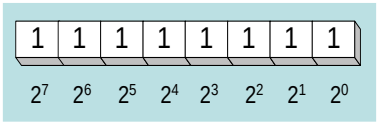
Number systems

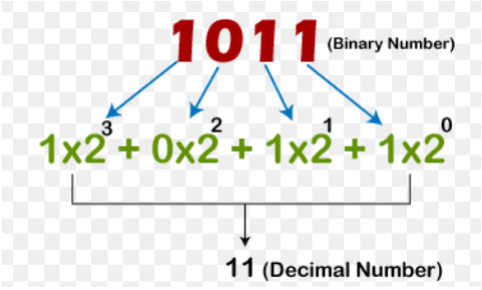
- In computers, all numbers, letters, pictures, sounds are represented as numbers.
- There're different number systems

Numbering System		
System	Base	Digits
Binary	2	0, 1
Octal	8	0,1,2,3,4,5,6,7
Decimal	10	0,1,2,3,4,5,6,7,8,9
Hexadecimal	16	0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

Binary Number System

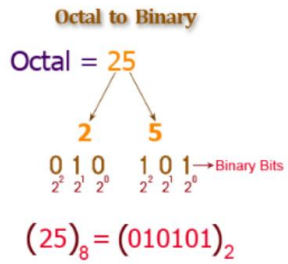
- Each digit (bit) is either **1 or 0**
- Each bit represents a power of 2
- Every binary number is a sum of powers of 2





Octal Number System

- Contains eight digits (0, 1, 2, 3, 4, 5, 6, 7)
- The base is 8
- Each digit in an octal number represents a specific power of its base (8).
- The three binary digits can be represented with a single octal digit.



Decimal Number System

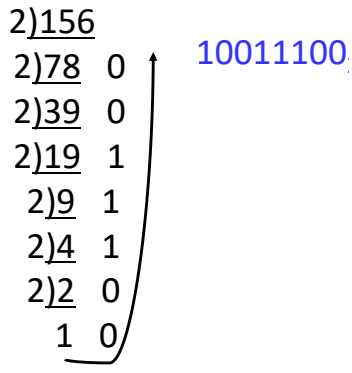
- Contains digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9)
- The base is 10.
- Each digit in decimal number represents a specific power of the base (10) of the number system.
- Widely used in our day to day life.

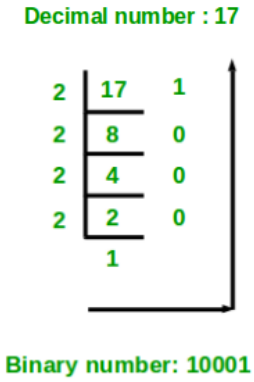
Hexadecimal Number System

- Contains 16 digits (0 to 9 and A to F)
- The base is 16.
- The A to F alphabets represent 10 to 15 decimal numbers.
- Each digit in a hexadecimal number represents a specific power of base (16) of the number system.
- Also known as alphanumeric number system

Converting Decimal to Binary

- $156_{10} = 10011100_2$



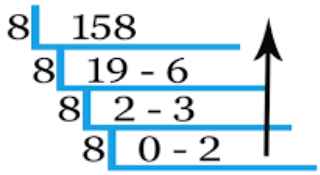


Converting Decimal to Octal

- $156_{10} = 234_8$

8)156
8)19 4
2 3

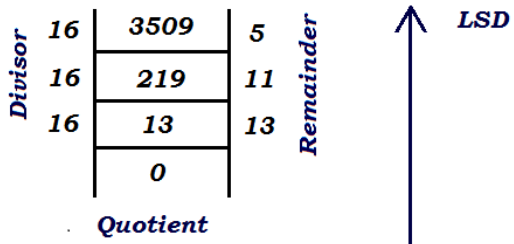
234_8



$(158)_{10} = (236)_8$

Converting Decimal to Hexadecimal

Find the Hex equivalent for the Decimal 3509



MSD - most significant digit
LSD - least significant digit

MSD

For Hex value 13 = D, 11 = B & 5 = 5
Therefore, the equivalent Hex number for decimal 3509 is DB5

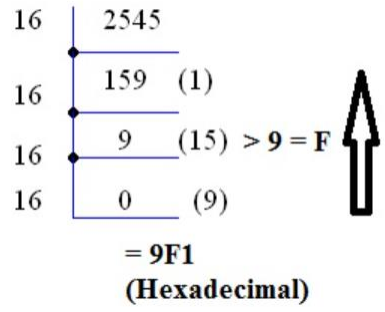
Converting Decimal to Hexadecimal…

- 156_{10}

  $156_{10} = 9C_{16}$

  16)156
  9 C

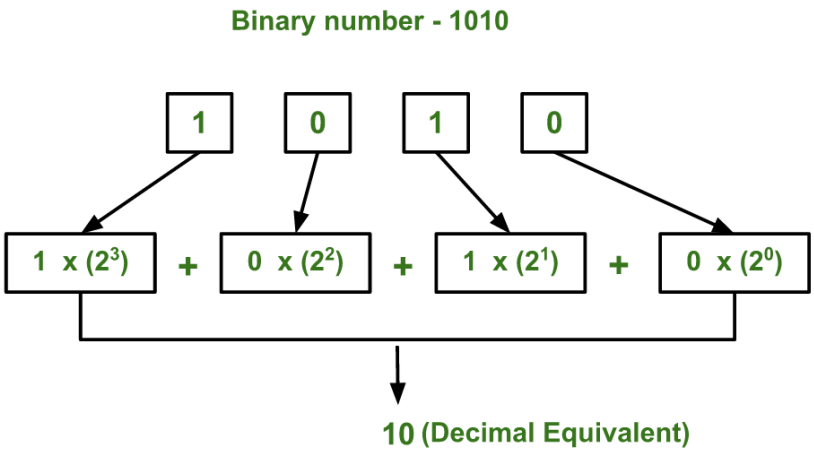
- 2545_{10}



Converting Binary to Decimal

Binary number - 1010

Converting Binary to Decimal



Converting Binary to Decimal…

Power of 2	Calculation	Value
2^0		1
2^1	2	2
2^2	2 * 2	4
2^3	2 * 2 * 2	8
2^4	2 * 2 * 2 * 2	16
2^5	2 * 2 * 2 * 2 * 2	32
2^6	2 * 2 * 2 * 2 * 2 *2	64
2^7	2 * 2 * 2 * 2 * 2 *2 * 2	128

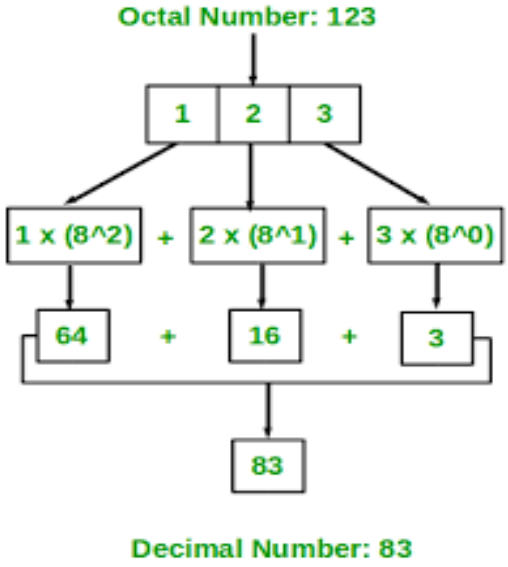
Example:

11001= $1\times 2^4 + 1\times 2^3 + 0\times 2^2 + 0\times 2^1 + 1\times 2^0$

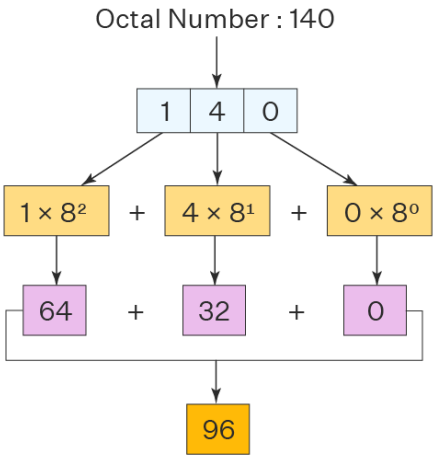
= 16 + 8 + 0 + 0 + 1

= 25

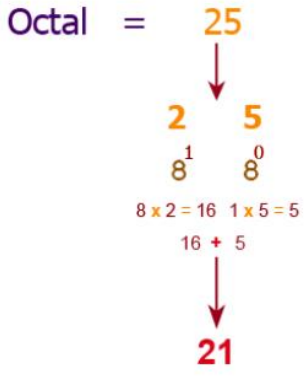
Converting Octal to Decimal



Converting Octal to Decimal…



$(140)_8 = (96)_{10}$



$(25)_8 = (21)_{10}$

Converting Octal to Decimal…

325_8

$= 3 \times 8^2 + 2 \times 8^1 + 5 \times 8^0$

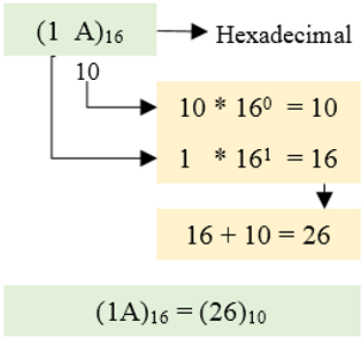
$= 3 \times 64 + 2 \times 8 + 5 \times 1$

$= 192 + 16 + 5$

$= 213_{10}$

Converting Hexadecimal to Decimal

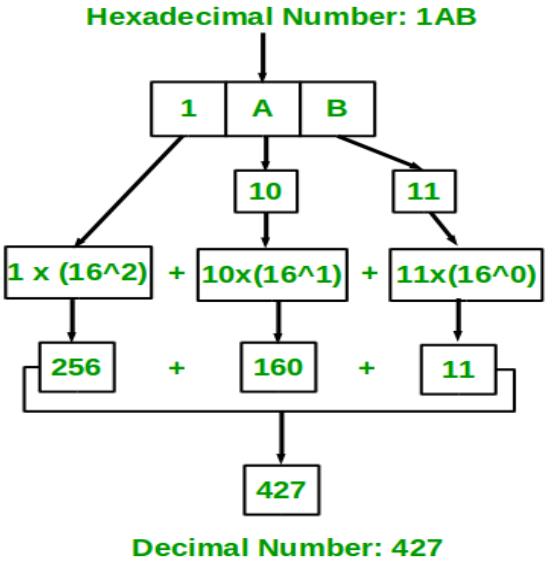
Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15



5 B C

$(5BC)_{16} = (1468)_{10}$

Converting Hexadecimal to Decimal…



Converting Hexadecimal to Decimal…

Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

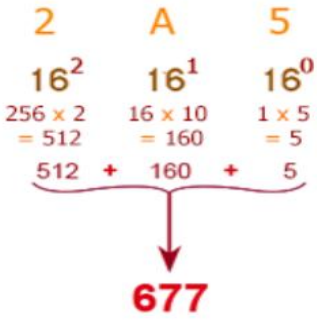
Example:
2 A 5

2 A 5

Converting Hexadecimal to Decimal…

Hexadecimal	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Example:
2 A 5



$(2A5)_{16} = (677)_{10}$

Converting Hexadecimal to Decimal…

$(2056)_{16}$

$= 2 \times 16^3 + 0 \times 16^2 + 5 \times 16^1 + 6 \times 16^0$

$= 2 \times 4096 + 0 + 80 + 6$

$= 8192 + 0 + 80 + 6$

$= (8278)_{10}$

Representing Octal number using Binary

Octal ⟶ Binary

Octal	Binary
0	000
1	001
2	010
3	011

Octal	Binary
4	100
5	101
6	110
7	111

Example

- **$(53)_8$ in Binary**
  - Binary equivalent of **5** is **$(101)_2$**.
  - Binary equivalent of **3** is **$(011)_2$**.

$(53)_8$

(101)(011)

$(101011)_2$

Representing Hexadecimal Number Using Binary

Hexadecimal ⟶ **Binary**

Hex	Binary
0	0000
1	0001
2	0010
3	0011

Hex	Binary
4	0100
5	0101
6	0110
7	0111

Hex	Binary
8	1000
9	1001
A	1010
B	1011

Hex	Binary
C	1100
D	1101
E	1110
F	1111

Example

- **$(F3)_{16}$ in Binary**
  - Binary equivalent of **F** is **$(1111)_2$**.
  - Binary equivalent of **3** is **$(0011)_2$**.

$(F3)_{16}$

(1111)(0011)

$(11110011)_2$

Octal ⟶ Hexadecimal

Converting Octal to Hexadecimal

Ex : **Convert 752_8 to hex**

First **convert the octal to binary:**

$111\ 101\ 010_2$

$0001\ 1110\ 1010$ re-group by 4 bits (add leading zeros)

Then **convert the binary to hex:**

1 14 10

1 E A

So $752_8 = 1EA_{16}$

Hexadecimal ⟶ Octal

Converting Hexadecimal to Octal

Ex : **Convert $E8A_{16}$ to octal**

First **convert the hex to binary:**

$1110\ 1000\ 1010_2$

$111\ 010\ 001\ 010$ and re-group by 3 bits (starting on the right)

Then **convert the binary to octal:**

7 2 1 2

So $E8A_{16} = 7212_8$

Character Representation

- Any text-based data is stored by the computer in the form of bits(a series of 1s and 0s)
- The combinations of 0s and 1s used to represent data are defined by patterns called **coding schemes**
  - BCD
  - ASCII
  - Extended ASCII
  - EBCDIC
  - Unicode

BCD (Binary Coded Decimal)

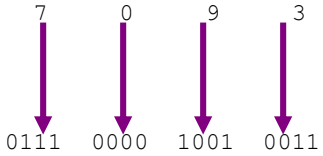
- Each digit in a decimal base 10 number is represented as a group of four binary digits, or bits.
-
- Any base 10 number or digit can be represented in binary notation using binary-coded decimal.

Digit	BCD
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
Zones	
1111	Unsigned
1100	Positive
1101	Negative

FIGURE 2.5 **Binary-Coded Decimal**

Example

- 7093_{10} = ? (in BCD)



1. Convert (123)10 in BCD

From the truth table above,

1 -> 0001

2 -> 0010

3 -> 0011

thus, BCD becomes -> 0001 0010 0011

2. Convert (324)10 in BCD

(324)10 -> 0011 0010 0100 (BCD)

Again from the truth table above,

3 -> 0011

2 -> 0010

4 -> 0100

thus, BCD becomes -> 0011 0010 0100

ASCII (American Standard Code for Information Exchange)

- Uses 7 bits and can represent 2^7 =128 characters
- Starts from *(ANSI) AMERICAN NATIONAL STANDARD INSTITUTE*
- It contains the numbers from 0-9, the upper and lower case English letters from A to Z, and some special characters.
- Assigns standard numeric values to letters, numerals, punctuation marks, and other characters used in computers.
- The character sets used in modern computers, in HTML, and on the Internet, are all based on ASCII.
- Every character is a unique ASCII code.
- The ASCII code for an uppercase A is 1000001.

ASCII Character Set

Low Order Bits		High Order Bits 0000 0	0001 1	0010 2	0011 3	0100 4	0101 5	0110 6	0111 7
0000	0	NUL	DLE	Space	0	@	P	`	p
0001	1	SOH	DC1	!	1	A	Q	a	q
0010	2	STX	DC2	"	2	B	R	b	r
0011	3	ETX	DC3	#	3	C	S	c	s
0100	4	EOT	DC4	$	4	D	T	d	t
0101	5	ENQ	NAK	%	5	E	U	e	u
0110	6	ACK	SYN	&	6	F	V	f	v
0111	7	BEL	ETB	'	7	G	W	g	w
1000	8	BS	CAN	(	8	H	X	h	x
1001	9	HT	EM	)	9	I	Y	i	y
1010	A	LF	SUB	*	:	J	Z	j	z
1011	B	VT	ESC	+	;	K	[	k	{
1100	C	FF	FS	,	<	L	\	l	|
1101	D	CR	GS	-	=	M	]	m	}
1110	E	SO	RS	.	>	N	^	n	~
1111	F	SI	US	/	?	O	_	o	DEL

“Hello, world” Example

		Binary		Hexadecimal		Decimal
H	=	01001000	=	48	=	72
e	=	01100101	=	65	=	101
l	=	01101100	=	6C	=	108
l	=	01101100	=	6C	=	108
o	=	01101111	=	6F	=	111
,	=	00101100	=	2C	=	44
	=	00100000	=	20	=	32
w	=	01110111	=	77	=	119
o	=	01100111	=	67	=	103
r	=	01110010	=	72	=	114
l	=	01101100	=	6C	=	108
d	=	01100100	=	64	=	100

Extended ASCII

- Uses 8 bits and can represent 2^8 =256 characters
- Extended version of ASCII
- Uses 8 bits for each character
- Introduced by IBM in 1981 for use in its first PC
- Extended ASCII represents the uppercase letter A as 01000001.
- Does not include enough code combinations to support all written languages.

EBCDIC (Extended Binary Coded Decimal Interchange Code)

- Extended BCD Interchange Code (pronounced *ebb'-se-dick*)
- 8-bit code
- Developed by IBM
- Rarely used today
- IBM mainframes only

Unicode

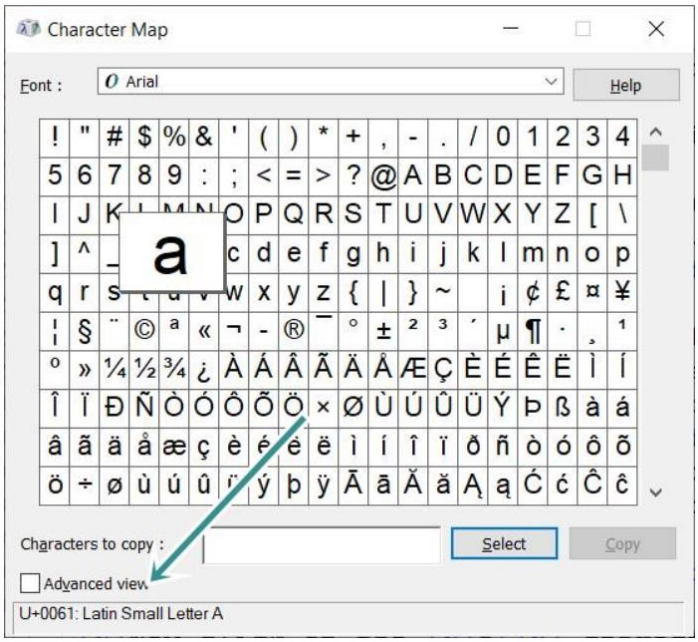
- Unicode is a Universal Encoding System (UES)
- Uses sixteen bits and provides codes or 65,000 characters.
- Can support all the written languages
- Most common character-encoding system on the World Wide Web
- Unicode assigns code to every character
- The code is an integer value.

Unicode uses two encoding forms: **8-bit and 16-bit**, based on the data type of the data that is being that is being encoded. The default encoding form is 16-bit, where each character is 16 bits (2 bytes)

Example

- You can refer character map to see all the code for characters.
- For example the code point of **a** (Latin small letter) is **0061** or **U+0061**.

Example:



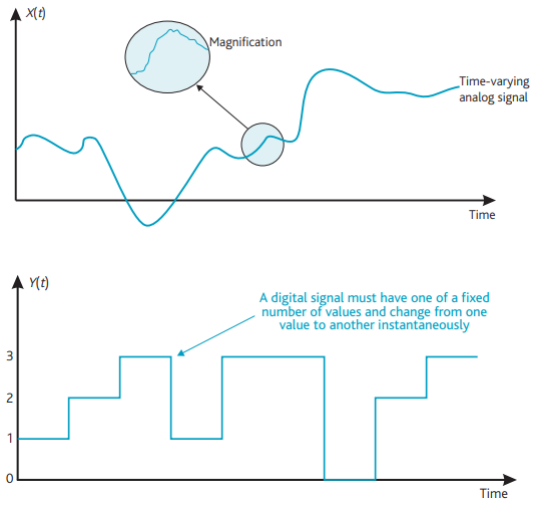
HNDIT1032 Computer and Network Systems

Week 03- Basic Logic Gates & Boolean Algebra

Analog & Digital System

- Analog variable can have any value between its maximum and minimum limits.
- Information inside a computer is represented in digital form.
- A digital variable is discrete in both value and in time.

Analog & Digital System



Logic Values

- Every logic input or output must assume one of two discrete states. You cannot have a state that is neither 1 nor 0.
- Each logic input or output can exist in only one state at any one time.
- Each logic state has an inverse or complement that is the opposite of its current state.

Binary Variables

- Recall that the two binary values have different names:
  - True/False
  - On/Off
  - Yes/No
  - 1/0
- We use 1 and 0 to denote the two values.
- Variable identifier examples:
  - A, B, y, z, or X1 for now
  - RESET, START_IT, or ADD1 later

Binary Logic and Gates

- Digital circuits are hardware components (based on transistors) that manipulate binary information
- We model the transistor-based electronic circuits as logic gates.
  - Designer can ignore the internal electronics of a gate

Basic Logic Gates

- The three basic logical operations are:
  - AND
  - OR
  - NOT
- AND is denoted by a dot (·).
- OR is denoted by a plus (+).
- NOT is denoted by an overbar (¯), a single quote mark (') after, or (~) before the variable.

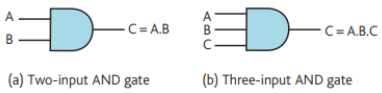
Truth Tables

- Truth table - a tabular listing of the values of a function for all possible combinations of values on its arguments

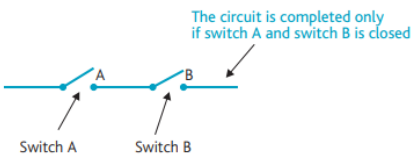
The AND Gate

- The AND gate is a circuit with two or more inputs and a single output.
- The output of an AND gate is true if and only if each of its inputs is also in a true state.
- Conversely, if one or more of the inputs to the AND gate is false, the output will also be false.

The AND Gate…



(a) Two-input AND gate (b) Three-input AND gate



Inputs		Output
A	B	F = A · B
0	0	0
0	1	0
1	0	0
1	1	1

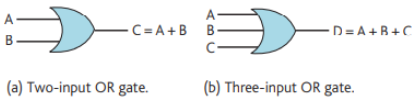
False because one or more inputs is false

True because both inputs are true

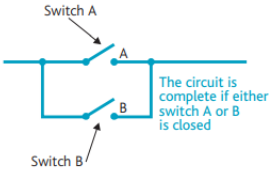
The OR Gate

- The output of an OR gate is true if any one (or more than one) of its inputs is true.
- The logical symbol for an OR operation is an addition sign, so that the logical operation A OR B is written as A +B.

The OR Gate…



(a) Two-input OR gate. (b) Three-input OR gate.



Inputs		Output
A	B	F=A+B
0	0	0
0	1	1
1	0	1
1	1	1

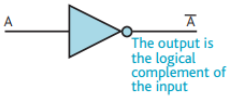
False because no input is true

True because at least one input is true

The Not Gate

- The NOT gate is also called an inverter or a complemented and is a two-terminal device with a single input and a single output.
- If the input of an inverter is X, its output is NOT X which is written X – or X’ .

The Not Gate

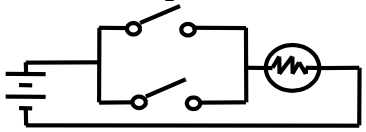


Input A	Output $F=\overline{A}$
0	1
1	0

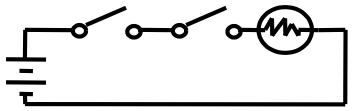
Logic Function Implementation

- Using Switches
- For inputs:
  - logic 1 is switch closed
  - logic 0 is switch open
- For outputs:
  - logic 1 is light on
  - logic 0 is light off.
- NOT uses a switch such
- that:
  - logic 1 is switch open
  - logic 0 is switch closed

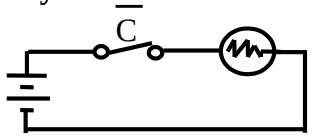
Switches in parallel => OR



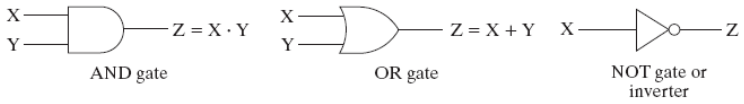
Switches in series => AND



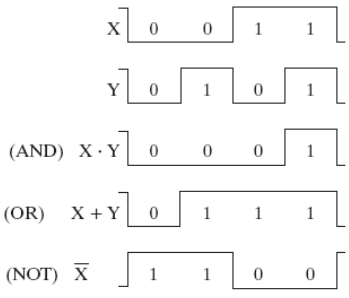
Normally-closed switch => NOT



Logic Gate Behavior



(a) Graphic symbols

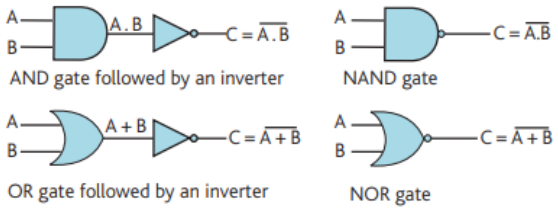


(b) Timing diagrams

The NAND & NOR Gates

- The two most widely used gates in real circuits are the NAND and NOR gates.
- These aren't fundamental gates because the NAND gate is derived from an AND gate followed by an inverter (Not AND).
- NOR gate is derived from an OR gate followed by an inverter (Not OR), respectively. T

The NAND & NOR Gates…



The NAND & NOR Gates…

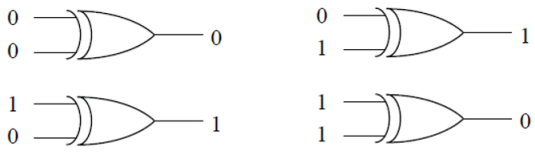
A	B	NAND $C = \overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

A	B	NOR $C = \overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

The XOR Gate

- An ***Exclusive-OR gate*** is sometimes called a parity checker.
- Parity checkers count the number of ones being input to a circuit and output a logic 1 or 0 based on whether the number of ones is odd or even.

The XOR Gate



All 06 Logic Gates

Inputs		Output					
A	B	AND $A \cdot B$	OR $A+B$	NAND $\overline{A.B}$	NOR $\overline{A + B}$	EOR $A \oplus B$	EXNOR $\overline{A \oplus B}$
0	0	0	0	1	1	0	1
0	1	0	1	1	0	1	0
1	0	0	1	1	0	1	0
1	1	1	1	0	0	0	1

Boolean Algebra, Law and Circuit simplification

Boolean Algebra

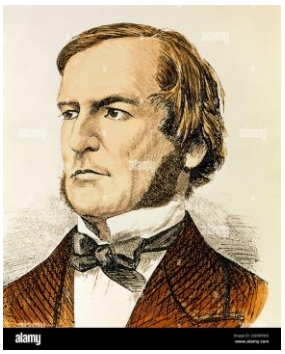
- Boolean expression: a expression formed by binary variables, for example,
- Boolean function: a binary variable identifying the function followed by an equal sign and a Boolean expression for example

$$L(D, X, A) = D\overline{X} + A$$

Introduction to Boolean Algebra

- We can write the Boolean equation $C = A \cdot B$ which uses variables A, B, and C and the AND operator.
- George Boole was an English mathematician (1815–1864) who developed a mathematical analysis of logic and published it in his book *An Investigation of the Laws* of Thought in 1854.

George Boole



Axioms and theorems of Boolean algebra

- An axiom or postulate is a fundamental rule that has to be taken for granted (i.e. the axioms of Boolean algebra define the framework of Boolean algebra from which everything else can be derived).
- Boolean variables obey the same commutative, distributive, and associative laws as the variables of conventional algebra.

Commutative, distributive, and associative laws of Boolean algebra

$A + B = B + A$ $A \cdot B = B \cdot A$	The AND and OR operators are **commutative** so that the order of the variables in a sum or product group does not matter.
$A \cdot (B \cdot C) = (A \cdot B) \cdot C$ $A + (B + C) = (A + B) + C$	The AND and OR operators are **associative** so that the order in which sub-expressions are evaluated does not matter.
$A \cdot (B + C) = A \cdot B + A \cdot C$ $A + B \cdot C = (A + B)(A + C)$	The AND operator behaves like multiplication and the OR operator like addition. The first **distributive** property states that in an expression containing both AND and OR operators the AND operator takes precedence over the OR. The second distributive law, $A + B \cdot C = (A + B)(A + C)$, is not valid in conventional algebra.

Basic Axioms of Boolean Algebra

NOT	AND	OR
$\overline{0} = 1$	$0 \cdot 0 = 0$	$0 + 0 = 0$
$\overline{1} = 0$	$0 \cdot 1 = 0$	$0 + 1 = 0$
	$1 \cdot 0 = 0$	$1 + 0 = 1$
	$1 \cdot 1 = 1$	$1 + 1 = 1$

Boolean operations on a constant and a variable

AND	OR	NOT
$0 \cdot X = 0$	$0 + X = X$	$\overline{\overline{X}} = X$
$1 \cdot X = X$	$1 + X = 1$	
$X \cdot X = X$	$X + X = X$	
$X \cdot \overline{X} = 0$	$X + \overline{X} = 1$	

DeMorgan's Theorem

- The purpose of DeMorgan's Theorem is to allow us to distribute an inverter from the output of an AND or OR gate to the gate's inputs.
- In doing so, an AND gate is switched to an OR gate and an OR gate is switched to an AND gate

DeMorgan's Theorem

$$\overline{A + B} = \overline{A} \cdot \overline{B} \qquad \overline{A} + \overline{B} = \overline{A \cdot B}$$

HNDIT1032 Computer and Network Systems

Week4- Karnaugh Maps

Introduction

- So far we can see that applying Boolean algebra can be awkward in order to simplify expressions.
- The Karnaugh map provides a simple and straight-forward method of minimizing Boolean expressions

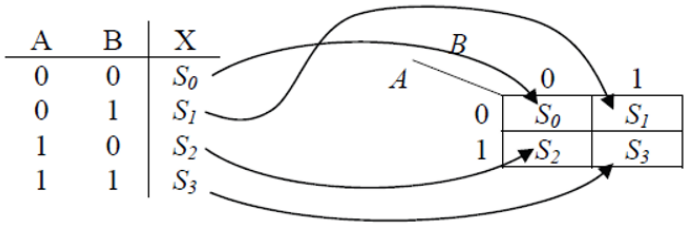
What is a Karnaugh map?

- A Karnaugh map provides a pictorial method of grouping together expressions with common factors and therefore eliminating unwanted variables.

Two Variable K Maps

- Two variable K Map is drawn for a boolean expression consisting of two variables.
- The number of cells present in two variable K Map = 2^2 = 4 cells.
- So, for a Boolean function consisting of two variables, we draw a 2 x 2 K Map.

Two Variable K Maps…



A	B	X
0	0	S_0
0	1	S_1
1	0	S_2
1	1	S_3

A \ B	0	1
0	S_0	S_1
1	S_2	S_3

Two Variable K Maps…

A	B	F
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table.

A \ B	0	1
0	0	1
1	1	1

F.

Three Variable K Maps

- Three variable K Map is drawn for a Boolean expression consisting of three variables.
- The number of cells present in three variable K Map = 2^3 = 8 cells.
- So, for a Boolean function consisting of three variables, we draw a 2 x 4 K Map.

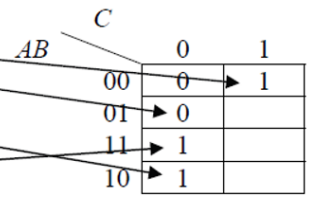
Three Variable K Maps…

A	B	C	Minterm
0	0	0	m_0
0	0	1	m_1
0	1	0	m_2
0	1	1	m_3
1	0	0	m_4
1	0	1	m_5
1	1	0	m_6
1	1	1	m_7

A \ BC	00	01	11	10
0	m0	m1	m3	m2
1	m4	m5	m7	m6

Three Variable K Maps…

A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

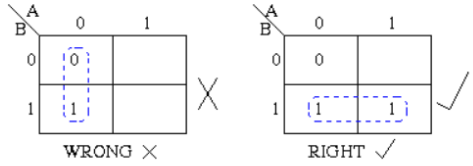


Karnaugh Maps - Rules of Simplification

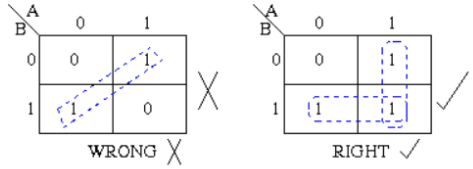
- No zeros allowed.
- No diagonals.
- Only power of 2 number of cells in each group.
- Groups should be as large as possible.
- Every one must be in at least one group.
- Overlapping allowed.
- Wrap around allowed.
- Fewest number of groups possible.

Karnaugh Maps - Rules of Simplification…

- **Groups may not include any cell containing a zero**

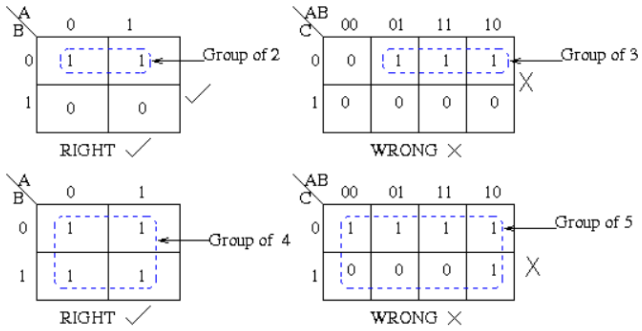


- **Groups may be horizontal or vertical, but not diagonal.**



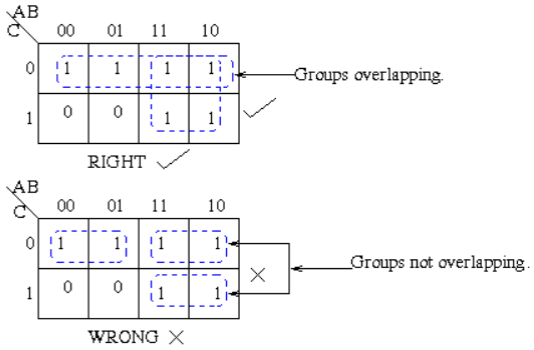
Karnaugh Maps - Rules of Simplification…

- **Groups must contain 1, 2, 4, 8, or in general 2^n cells.**
  That is if n = 1, a group will contain two 1's since $2^1 = 2$.
  If n = 2, a group will contain four 1's since $2^2 = 4$.



Karnaugh Maps - Rules of Simplification…

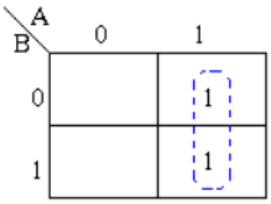
- **Groups may overlap.**



Consider the following map. The function plotted is: Z = f(A,B) = A + AB

Example 01

- $F(A,B) = A\bar{B} + AB$



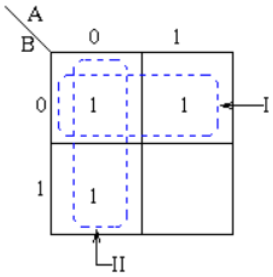
Example 01…

- The two adjacent 1's are grouped together. Through inspection it can be seen that variable B has its true and false form within the group.
- This eliminates variable B leaving only variable A which only has its true form. The minimized answer therefore is Z = A.

Example 02

- $F(A,B) = \bar{A}\bar{B} + A\bar{B} + \bar{A}B$

Example 02

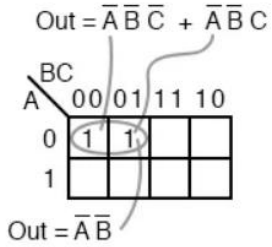


Example 03

- $F(A,B) = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C$

Example 03

- $F(A,B) = \bar{A}\bar{B} + A\bar{B} + \bar{A}B$

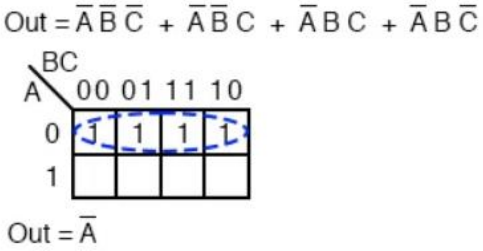


Example 04

- $F(A,B) = \bar{A}\bar{B}C + \bar{A}\bar{B}C + \bar{A}BC + \bar{A}B\bar{C}$

Example 04

- $F(A,B) = \bar{A}\bar{B}C + \bar{A}\bar{B}C + \bar{A}BC + \bar{A}B\bar{C}$

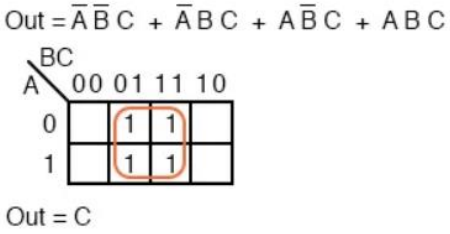


Example 05

- $F(A,B) = \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C + ABC$

Example 05

- $F(A,B) = \bar{A}\bar{B}C + \bar{A}\bar{B}C + \bar{A}BC + \bar{A}B\bar{C}$



Next Week Discussion

- How to draw circuits?

HNDIT1032 Computer and Network Systems

Week 05- Digital Circuits

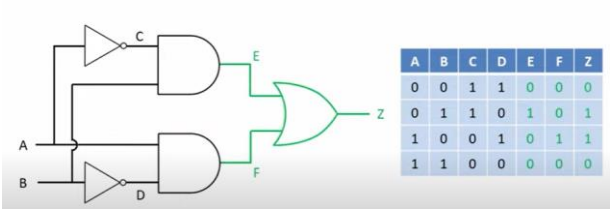
Introduction

- The digital computer consists of nothing more than the inter connection of three types of primitive elements called AND, OR, and NOT gates.

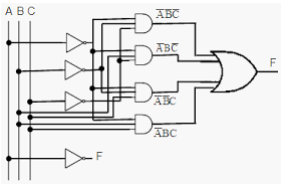
- Other gates called NAND, NOR, and EOR gates can be derived from these gates

Application of Gates

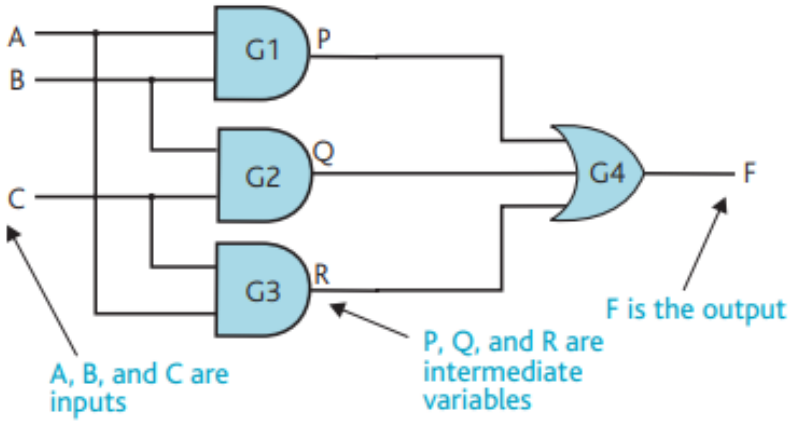
- Circuits are constructed by connecting gates together.
- The output from one gate can be connected (i.e. wired) to the input of one or more other gates.



A	B	C	D	E	F	Z
0	0	1	1	0	0	0
0	1	1	0	1	0	1
1	0	0	1	0	1	1
1	1	0	0	0	0	0



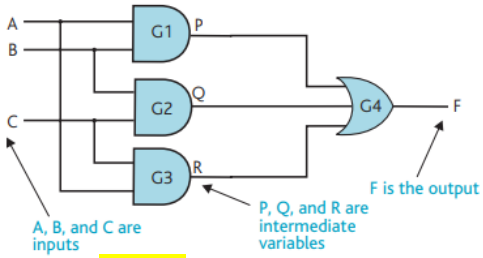
Example 01



Example 01…

- Consider the circuit of Fig. 2.13 that uses three two-input AND gates labeled G1, G2, and G3, and a three input OR gate labeled G4.
- This circuit has three inputs A, B, and C, and an output F.
- One approach is to create a truth table that tabulates the output F for all the eight possible combinations of the three inputs A, B, and C.

Example…

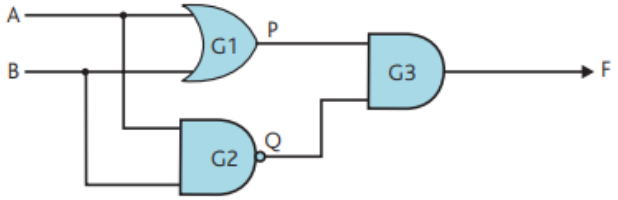


Circuit

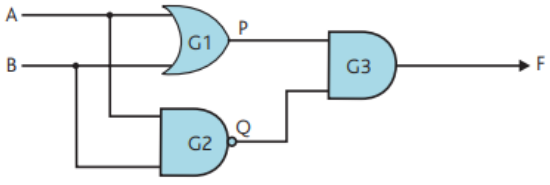
Truth table

Inputs			Intermediate values			Output
A	B	C	P = A·B	Q = B·C	R = A·C	F = P + Q + R
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	0
0	1	1	0	1	0	1
1	0	0	0	0	0	0
1	0	1	0	0	1	1
1	1	0	1	0	0	1
1	1	1	1	1	1	1

Example 02



Example 02…



$$F = P \cdot Q$$

$$P = A + B$$

$$Q = \overline{A \cdot B}$$

$$F = (A + B) \cdot \overline{A \cdot B}$$

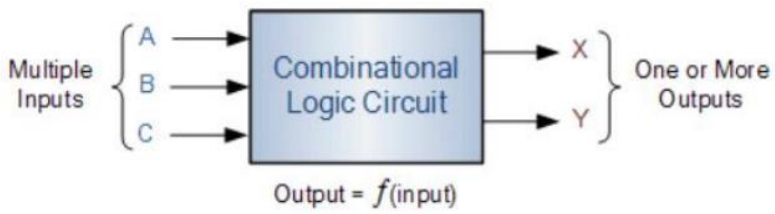
Inputs		Intermediate values		Output
A	B	$P = A + B$	$Q = \overline{A \cdot B}$	$F = P \cdot Q$
0	0	0	1	0
0	1	1	1	1
1	0	1	1	1
1	1	1	0	0

Types of Digital Logic Circuits

- Digital logic circuits can be classified into
  - Combinational
  - Sequential

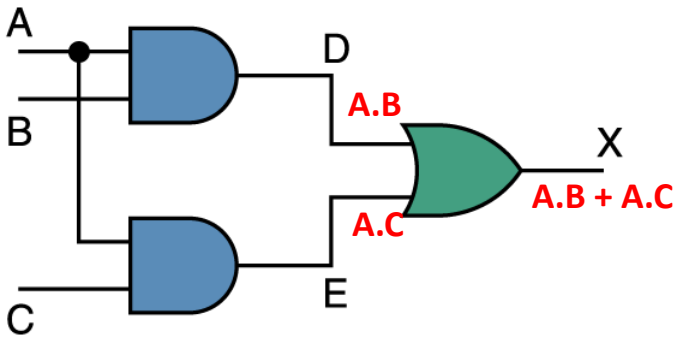
Combinational Circuits

- Theses circuits are made up from logic gates that are "combined" or connected together to produce more complicated switching circuits.



Combinational Circuits

- Gates are combined into circuits by using the output of one gate as the input for another



Combinational Circuits

A	B	C	D	E	X
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	0	0	0
1	0	1	0	1	1
1	1	0	1	0	1
1	1	1	1	1	1

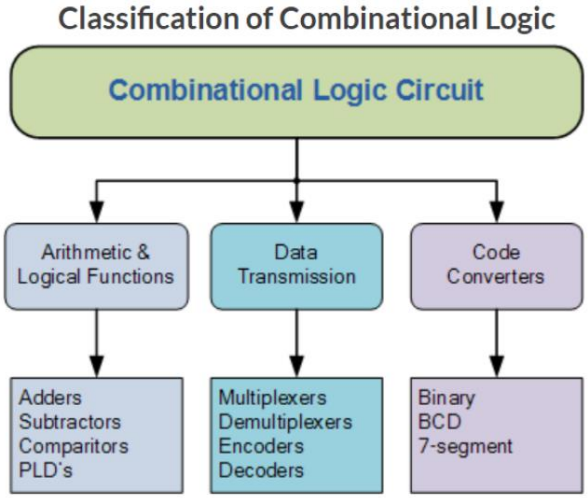
- Because there are three inputs to this circuit, eight rows are required to describe all possible input combinations
- This same circuit using Boolean algebra:

$$(AB + AC)$$

Combinational Circuits…

- Combinational logic circuits have no feedback, and any changes to the signals being applied to their inputs will immediately have an effect at the output.
- Common combinational circuits made up from individual logic gates that carry out a desired application include;
  - —Multiplexers,
  - —Demultiplexers,
  - —Encoders,
  - —Decoders,
  - —Full and Half Adders

Classification



Adders

- At the digital logic level, addition is performed in binary

- Addition operations are carried out by special circuits called, appropriately, **adders**

Half Adder

- Half adder is the simplest of all adder circuits.

- Half adder is a combinational arithmetic circuit that adds two numbers and produces a sum bit (s) and carry bit (c) both as output.

- The addition of 2 bits is done using a combination circuit called a Half adder.

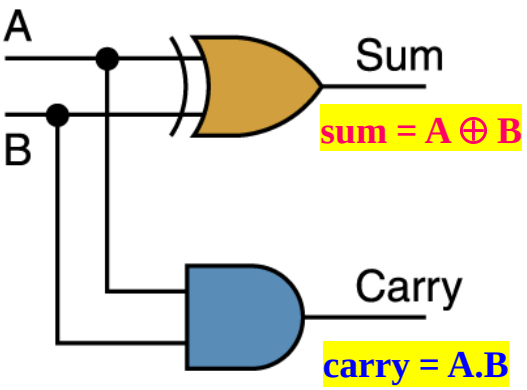
Half Adder cont…

- The result of adding two binary digits could produce a *carry value*
- Recall that 1 + 1 = 10 in base two
- A circuit that computes the sum of two bits and produces the correct carry bit is called a **half adder**

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$A \oplus B$ $A \cdot B$

Half Adder cont…

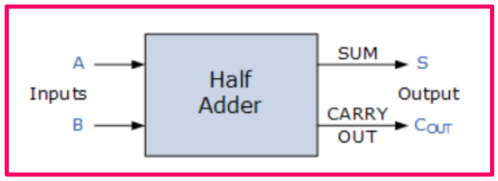


- Circuit diagram representing a **half adder**
- Two Boolean expressions:

$sum = A \oplus B$

$carry = AB$

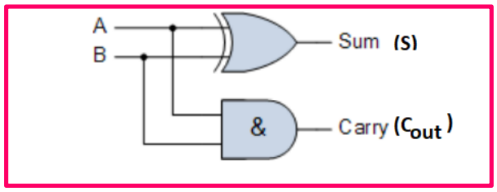
Half Adder…



$S = A'B + AB'$ → A XOR B → $A \oplus B$

$C_{out} = AB$

Input		Output	
A	B	S	C_{out}
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

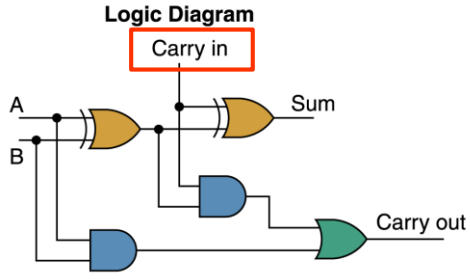


Full Adder

- Full Adder is the adder that adds three inputs and produces two outputs.
- The first two inputs are A and B and the third input is an input carry as C-IN.
- The output carry is designated as C-OUT and the normal output is designated as S which is SUM.

Full Adder cont…

- A circuit called a **full adder** takes the carry-in value into account

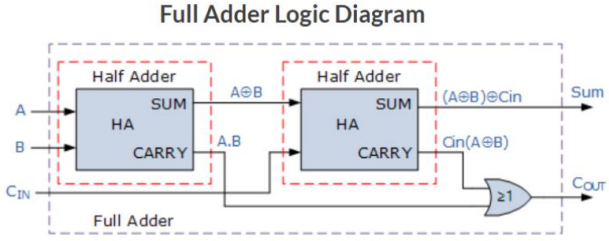


A full adder

Truth Table

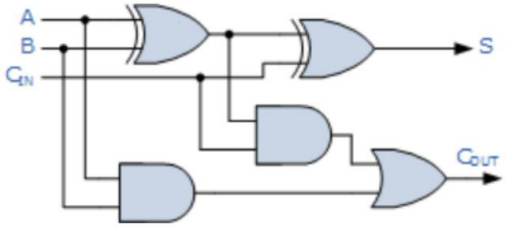
A	B	Carry-in	Sum	Carry-out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Full Adder

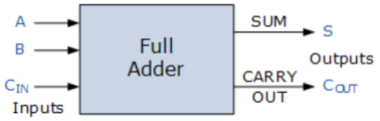


$S = A \oplus B \oplus C$

$C_{out} = A.B + C_{in}(A \oplus B)$



Full Adder



$S = A'B'C_{in} + A'BC'_{in} + AB'C'_{in} + ABC_{in}$

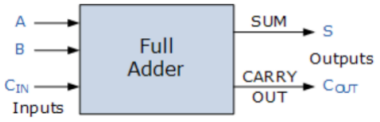
$C_{out} = A'BC_{in} + AB'C_{in} + ABC'_{in} + ABC_{in}$

$S = A \oplus B \oplus C$

$C_{out} = A.B + C_{in}(A \oplus B)$

Input			Output	
A	B	C_{in}	S	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Full Adder



$S = A'B'C_{in} + A'BC'_{in} + AB'C'_{in} + ABC_{in}$

$C_{out} = A'BC_{in} + AB'C_{in} + ABC'_{in} + ABC_{in}$

$S = A \oplus B \oplus C$

$C_{out} = A.B + C_{in}(A \oplus B)$

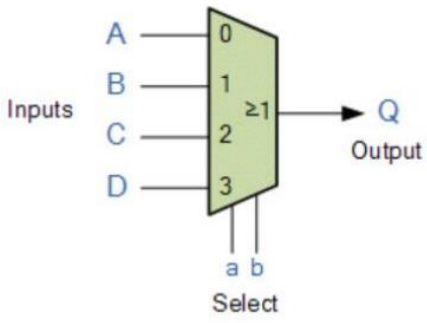
Input			Output	
A	B	C_{in}	S	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

A,B

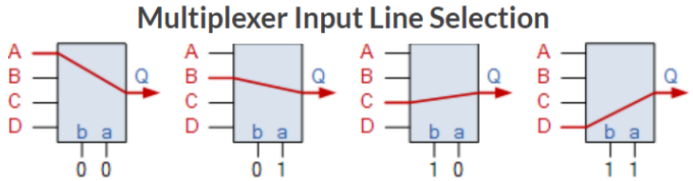
Multiplexer

- The multiplexer is a combinational logic circuit designed to switch one of several input lines to a single common output line.
- The multiplexer, shortened to “MUX” or “MPX”.
  - The output is equal to one of several input signals to the circuit
  - The multiplexer selects which input signal is used as an output signal based on the value represented by a few more input signals, called *select signals* or *select control lines*

Multiplexer



The multiplexer selects which input signal is used as an output signal based on the value represented by a few more input signals, called *select signals* or *select control lines*



Multiplexers

- **Multiplexer** is a combinational circuit that has maximum of 2^n data inputs, 'n' selection lines and single output line.
- One of these data inputs will be connected to the output based on the values of selection lines.
- Since there are 'n' selection lines, there will be 2^n possible combinations of zeros and ones. So, each combination will select only one data input. Multiplexer is also called as **Mux**.

4x1 Multiplexer

- 4x1 Multiplexer has four data inputs I_3, I_2, I_1 & I_0, two selection lines s_1 & s_0 and one output Y. The **block diagram** of 4x1 Multiplexer is shown in the following figure.

4x1 Multiplexer

- One of these 4 inputs will be connected to the output based on the combination of inputs present at these two selection lines. **Truth table** of 4x1 Multiplexer is shown below.

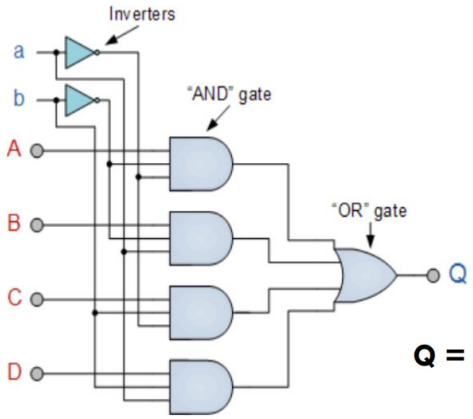
Selection Lines		Output
S_1	S_0	Y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

From Truth table, we can directly write the **Boolean function** for output, Y as :- $Y=S_1'S_0'I_0 + S_1'S_0I_1 + S_1S_0'I_2 + S_1S_0I_3$

4x1 Multiplexer

- We can implement this Boolean function using Inverters, AND gates & OR gate. The **circuit diagram** of 4x1 multiplexer is shown in the following figure.

4X1 Multiplexer

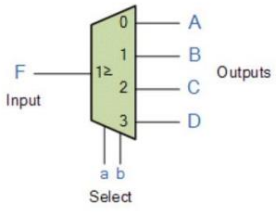


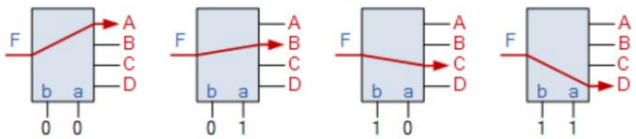
b	a	Q
0	0	A
0	1	B
1	0	C
1	1	D

Q = a'b'A + ab'B + a'bC + abD

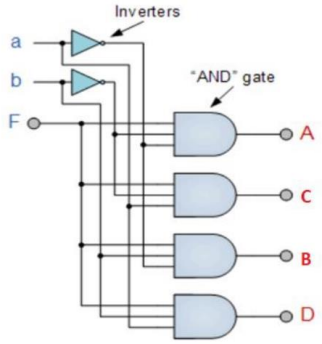
Demultiplexer

- The demultiplexer takes one single input data line and then switches it to any one of a number of individual output lines one at a time.





Demultiplexer

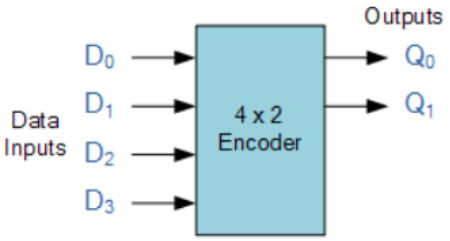


Output Select		Data Output Selected
a	b	
0	0	A
0	1	B
1	0	C
1	1	D

Encoder

- The Digital Encoder more commonly called a Binary Encoder takes ALL its data inputs one at a time and then converts them into a single encoded output.
- An "n-bit" binary encoder has 2^n input lines and n-bit output lines with common types that include
  - 4-to-2,
  - 8-to-3 and
  - 16-to-4 line

4-to-2 Bit Binary Encoder



Inputs				Outputs	
D_3	D_2	D_1	D_0	Q_1	Q_0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1
0	0	0	0	x	x

2^n inputs ⟹ n outputs

4 inputs ⟹ 2 outputs

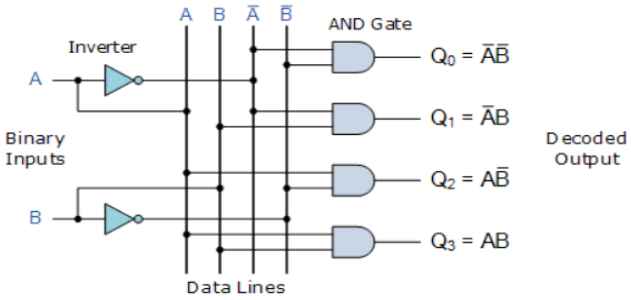
Decoder

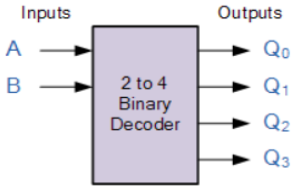
- The term "Decoder" means to translate or decode coded information from one format into another.
- Binary decoder transforms "n" binary input signals into an equivalent code using 2^n outputs.

n inputs ⟹ 2^n outputs

2 inputs ⟹ 4 outputs

2-to-4 Bit Binary Decoder



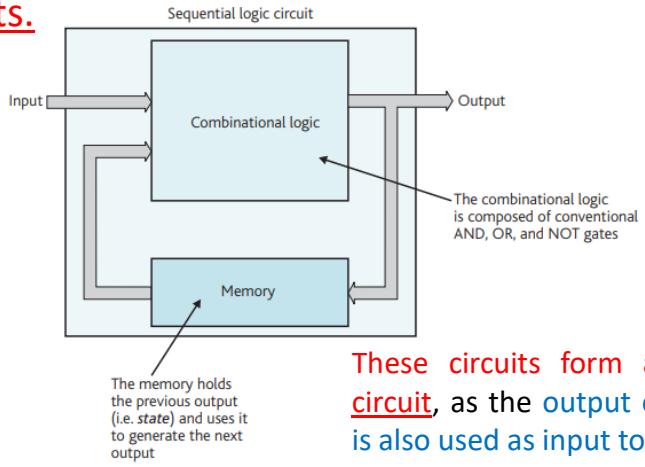


Truth Table

A	B	Q_0	Q_1	Q_2	Q_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Sequential Circuit

- The **output** of a sequential circuit depends not only on its current inputs, but also on its previous inputs.

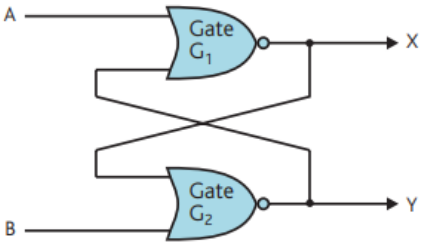


These circuits form a sequential circuit, as the output of the circuit is also used as input to the circuit.

Latch

- A latch is a 1-bit memory element.
- You can capture a single bit in a latch at one instant and then use it later;
- for example, when adding numbers you can
  - capture the carry-out in a latch and
  - use it as a carry-in in the next calculation

SR Flip-flop



A	B	$\overline{A + B}$
0	0	1
0	1	0
1	0	0
1	1	0

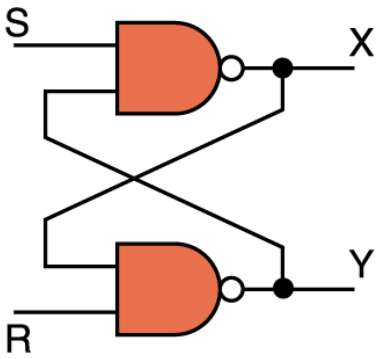
1. $X = \overline{A + Y}$
2. $Y = \overline{B + X}$

If we substitute the value for Y from equation (2) in equation (1), we get

3. $X = \overline{A + \overline{B + X}}$
   $= \overline{A} \cdot \overline{\overline{B + X}}$ — By de Morgan's theorem
   $= \overline{A} \cdot (B + X)$ — Two negations cancel
   $= \overline{A} \cdot B + \overline{A} \cdot X$ — Expand the expression

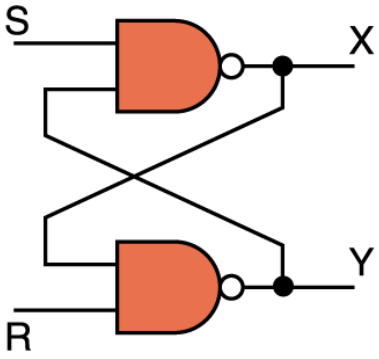
SR and RS flip-flops are same

Circuits as Memory



- An S-R latch stores a single binary digit (1 or 0)
- There are several ways an S-R latch circuit could be designed using various kinds of gates

Circuits as Memory



- The design of this circuit guarantees that the two outputs X and Y are always complements of each other
- The value of X at any point in time is considered to be the current state of the circuit
- Therefore, if X is 1, the circuit is storing a 1; if X is 0, the circuit is storing a 0

Other examples

- D flip-flop
- Clocked flip-flop
- Jk flip-flops

Sum of Product

- The *Sum of Product* (SOP) expression comes from the fact that two or more products (AND) are summed (OR) together.
- That is the outputs from two or more AND gates are connected to the input of an OR gate.
- So that they are effectively OR'ed together to create the final AND-OR logical output.

Example 01 SOP

$Q = A.B.\overline{C} + A.\overline{B}.C + \overline{A}.B.C$

Inputs			Output	Product
C	B	A	Q	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	1	$A.B.\overline{C}$
1	0	0	0	
1	0	1	1	$A.\overline{B}.C$
1	1	0	1	$\overline{A}.B.C$
1	1	1	0	

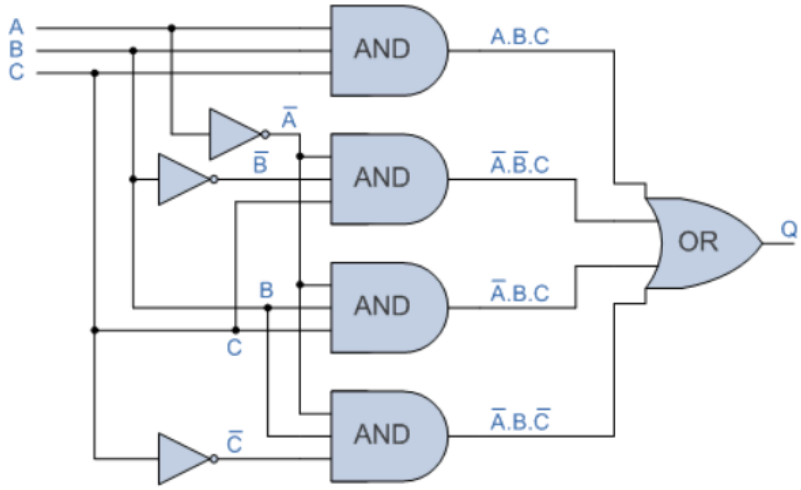
Example 02 SOP

$Q = A.B.C + \overline{A}.\overline{B}.C + \overline{A}.B.C + \overline{A}.B.\overline{C}$

Inputs			Output	Product
C	B	A	Q	
0	0	0	0	
0	0	1	0	
0	1	0	**1**	$\overline{A}.B.\overline{C}$
0	1	1	0	
1	0	0	**1**	$\overline{A}.\overline{B}.C$
1	0	1	0	
1	1	0	**1**	$\overline{A}.B.C$
1	1	1	**1**	$A.B.C$

Example 02 SOP

$Q = A.B.C + \overline{A}.\overline{B}.C + \overline{A}.B.C + \overline{A}.B.\overline{C}$



Product of Sum

- The *Product of Sum* (POS) expression comes from the fact that two or more sums (OR's) are added (AND'ed) together.
- That is the outputs from two or more OR gates are connected to the input of an AND gate.
- So that they are effectively AND'ed together to create the final (OR AND) output.

Example 01 POS

$$Q = (A + B + C)(A + \overline{B} + C)(A + \overline{B} + \overline{C})$$

Inputs			Output	Product
C	B	A	Q	
0	0	0	0	$A+B+C$
0	0	1	1	
0	1	0	0	$A+\overline{B}+C$
0	1	1	1	
1	0	0	1	
1	0	1	1	
1	1	0	0	$A+\overline{B}+\overline{C}$
1	1	1	1	

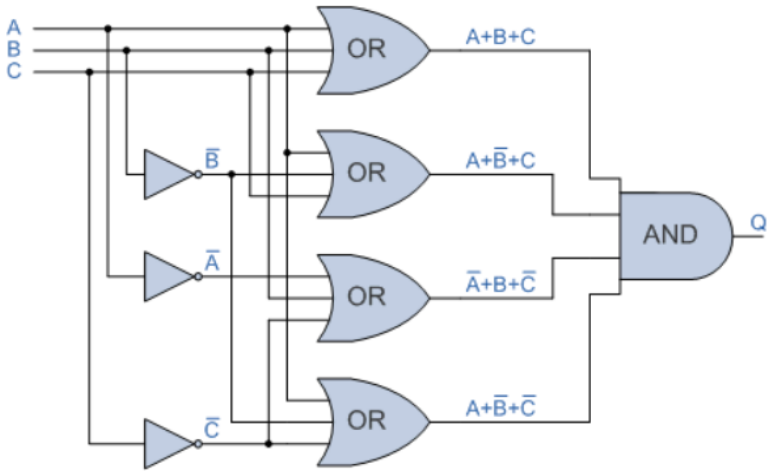
Example 02 POS

$$Q = (A + B + C)(A + \overline{B} + C)(\overline{A} + B + \overline{C})(A + \overline{B} + \overline{C})$$

Inputs			Output	Product
C	B	A	Q	
0	0	0	**0**	$A+B+C$
0	0	1	1	
0	1	0	**0**	$A+\overline{B}+C$
0	1	1	1	
1	0	0	1	
1	0	1	**0**	$\overline{A}+B+\overline{C}$
1	1	0	**0**	$A+\overline{B}+\overline{C}$
1	1	1	1	

Example 02 POS

$$Q = (A + B + C)(A + \overline{B} + C)(\overline{A} + B + \overline{C})(A + \overline{B} + \overline{C})$$



References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.
- https://www.electronics-tutorials.ws/logic

HNDIT1032 Computer and Network Systems

Week 06- Memory, Storage & CPU

Introduction

- From the moment you switch on a computer till you switch it off, computer uses its primary memory.
- When you request for the processing of data and instructions, the processor uses its registers, cache memory, primary memory and secondary memory.
- As a computer user, you need to be aware of the memory present in a computer.

Memory

What is memory?

- The computer's memory stores data, instructions required during the processing of data, and output results.
- Storage may be required for a limited period of time, instantly, or, for an extended period of time.
- Different types of memories, each having its own unique features, are available for use in a computer.

Memory Representation

1 bit = 0 or 1

1 Byte (B) = 8 bits

1 Kilobyte (KB) = 2^{10} = 1024 bytes

1 Megabyte (MB) = 2^{20} = 1024KB

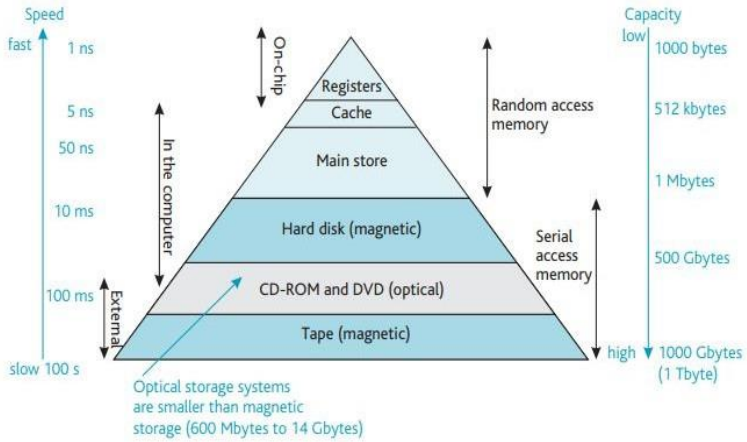
1 Gigabyte (GB) = 2^{30} = 1024 MB = 1024 *1024 KB

1 Terabyte (TB) = 2^{40}= 1024 GB = 1024 * 1024 *1024 KB

Memory Hierarchy

- The memory is characterized on the basis of two key factors—capacity and access time.
- Capacity is the amount of information (in bits) that a memory can store.
- Access time is the time interval between the read/ write request and the availability of data. The lesser the access time, the faster is the speed of memory.

Memory Hierarchy

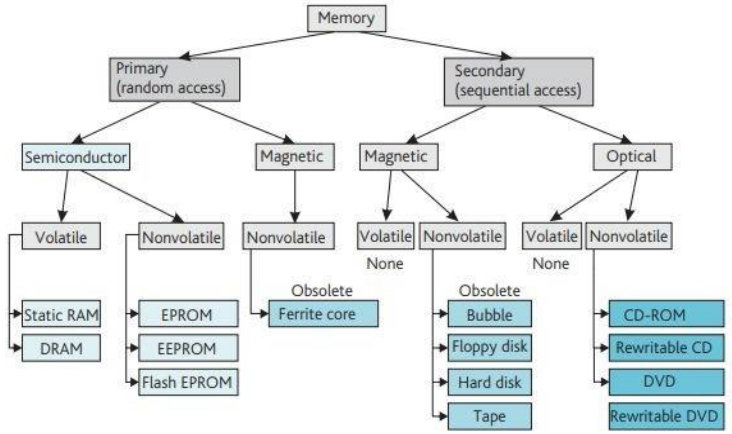


Classes of Memory

In general, referring to the computer memory

- Internal memory or primary
- Secondary memory

Classes of Memory



Primary Memory

- Primary memory is the main memory of computer.
- It is a chip mounted on the motherboard of computer.
- Primary memory is categorized into two main types-
  - Random Access Memory (RAM)
  - Read Only Memory (ROM)

Random Access Memory

- RAM is used to store data and instructions during the operation of computer.
- RAM loses information when the computer is powered off. It is a volatile memory.
- When the power is turned on, again, all files that are required by the CPU are loaded from the hard disk to RAM.

Random Access Memory

- RAM provides random access to the stored bytes, words, or larger data units.
- RAM can be read from and written to with the same speed.
- The **size of RAM** is measured in MB or GB.
- The performance of RAM is affected by— Access speed (how quickly information can be retrieved).
- The **speed of RAM** is expressed in nanoseconds.
- RAM affects the speed and power of a computer.

Types of RAM

There are two categories of RAM, depending on the technology used to construct RAM

(1) Dynamic RAM (DRAM),

(2) Static RAM (SRAM).

Dynamic RAM(DRAM)

- DRAM is the most common type of memory chip.
- DRAM is mostly used as main memory since it is small and cheap.
- It uses transistors and capacitors.
- DRAM must be refreshed continually to store information.
- Access speed of DRAM ranges from 50 to 150 ns.

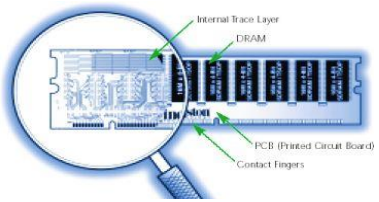
Static RAM(SRAM)

- SRAM chip is usually used in cache memory due to its high speed.
- SRAM uses multiple transistors (four to six), for each memory cell.
- It does not need constant refreshing and therefore is faster than DRAM.
- SRAM is more expensive than DRAM.
- The access speed of SRAM ranges from 2 - 10 nanosecond.

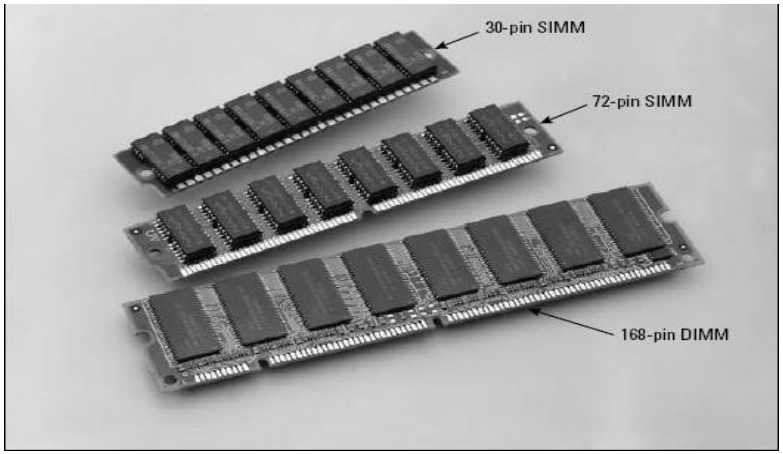
Memory Module

- The memory chips are available on a separate Printed Circuit Board (PCB) that is plugged into a special connect or on the motherboard.
- There are generally two types of

  RAM modules—Single Inline Memory Module (SIMM) and Dual Inline Memory Module (DIMM).



SIMM & DIMM



Read Only Memory(ROM)

- ROM is a non-volatile primary memory. It does not lose its content when the power is switched off.
- ROM comes programmed by the manufacturer.
- It stores standard processing programs that permanently reside in the computer.
- The ROM memory chip stores the Basic Input Output System (BIOS) & POST.

Types of ROM

- Programmable ROM (PROM)
- Erasable Programmable ROM (EPROM)
- Electrically Erasable Programmable ROM (EEPROM)
- Flash Memory is a kind of semiconductor based non-volatile, rewritable computer memory that can be electrically erased and reprogrammed

Storage

Secondary Memory

- In the previous section, we saw that RAM is expensive and has a limited storage capacity.
- Since it is a volatile memory, it cannot retain information after the computer is powered off.
- Thus, in addition to primary memory, an auxiliary or secondary memory is required by a computer.

Secondary Memory

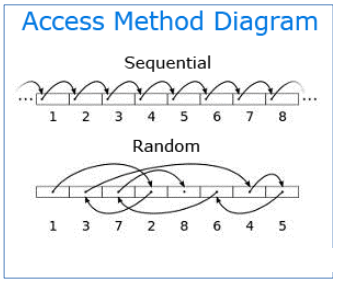
The information stored in storage devices can be accessed in two ways

1. Sequential access

2. Direct access

Sequential Access Devices

- Starting from the beginning, in order to locate a particular piece of data.
- Magnetic tape is an example of sequential access device.
- Sequential access devices are generally slow devices.



Sequential access memory is a storage system where **the data is stored and read in a fixed order**.

Direct Access Devices

- Direct access devices are the ones in which any piece of data can be retrieved in a non-sequential manner by locating it using the data's address.
- It accesses the data directly, from a desired location.
- Magnetic disks and optical disks are examples of direct access devices.

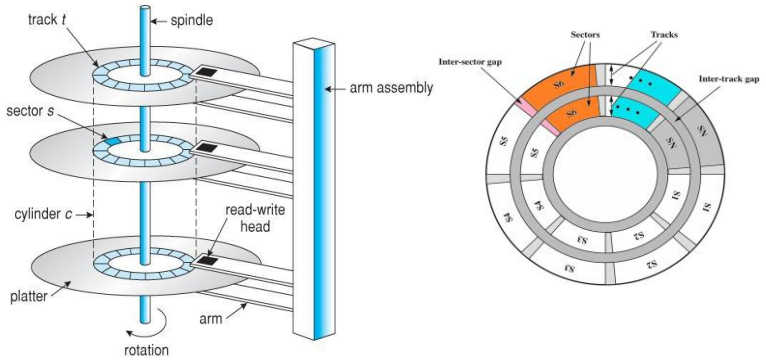
Magnetic Tape

- Sequential access device
- Inexpensive storage device
- Can store a large amount of data
- Easy to carry or transport
- Not suitable for random access data
- Slow access device
- Needs dust prevention, as dust can harm the tape
- Suitable for back-up storage or archiving

Magnetic Disk

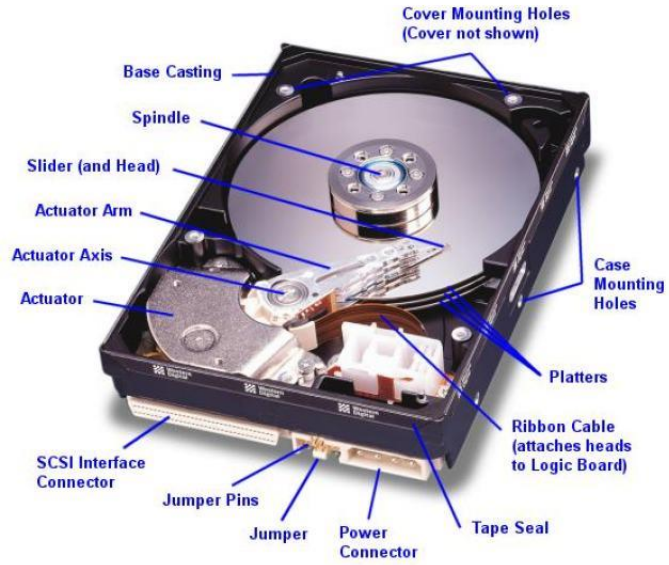
- Magnetic disk is a direct access secondary storage device.
- It is a thin plastic or metallic circular plate coated with magnetic oxide and encased in a protective cover.
- Data is stored on magnetic disks as magnetized spots.
- The presence of a magnetic spot represents the bit 1 and its absence represents the bit 0.

Magnetic Disk



Magnetic Disk

- The time taken to move the read/write head to the desired track is called the seek time.
- The time taken for desired sector of the track to come under read/write head is called the latency time.
- The rate at which data is written to disk or read from disk is called data transfer rate.



Floppy Disk

They are portable.

They are small and inexpensive.

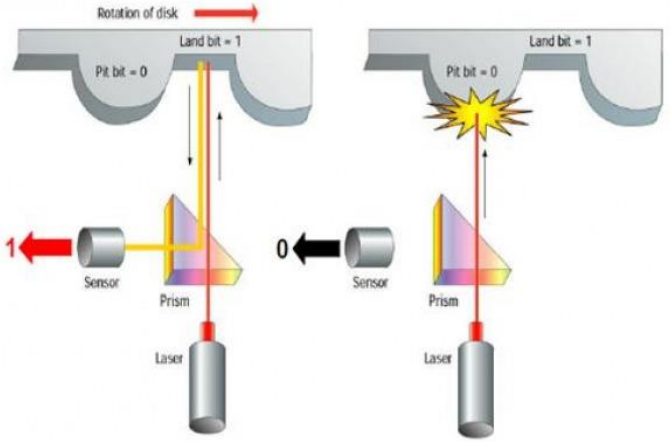
They come in two basic sizes—5-¼ inch and 3-½ inch.

The 5-¼ inch disk came around 1987. It can store 360 KB to 1.2 MB of data

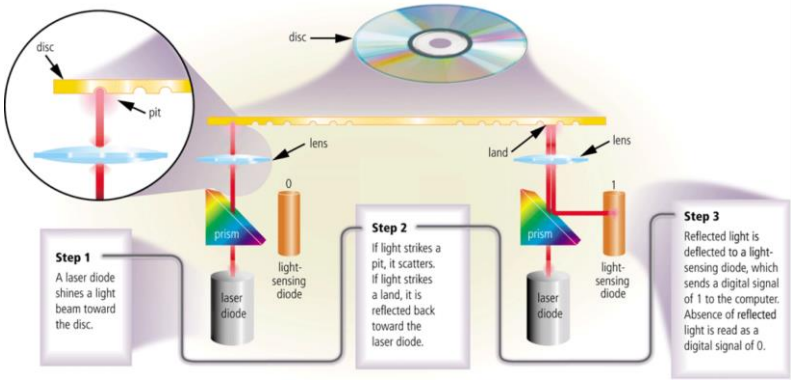
Optical Disk

- Optical disk is a flat and circular disk which is coated with reflective plastic material that can be altered by laser light.
- Optical disk does not use magnetism.
- The bits 1 and 0 are stored as spots that are relatively bright and light.
- CD ROM, DVD

Optical Disk



Optical Disk



CD ROM

- A CD-ROM drive reads data from the compact disk.
- Data is stored as pits(depressions) and lands (flat area) on CD-ROM disk.
- When the laser light is focused on the disk, the pits scatter the light (interpreted as 0) and the lands reflect the light to a sensor (interpreted as 1) .

DVD ROM

- It is a high-density medium with increased track and bit density.
- DVD-ROM uses both sides of the disk and special data compression technologies.
- The tracks for storing data are extremely small. A full-length movie can be stored on a single disk.
- Each side of DVD-ROM can store 4.7 GB of data, so a single DVD can store 9.4 GBof data.

DVD ROM

Capacity:

- 4.7 GB (single-sided, single-layer – common)
- 8.5 GB (single-sided, double-layer)
- 9.4 GB (double-sided, single-layer)
- 17.08 GB (double-sided, double-layer)

DVD-ROM can be **recordable and rewritable** both.

Central Processing Unit(CPU)

CPU

- Central Processing Unit (CPU) or the processor is also often called the brain of computer.
- CPU consists of Arithmetic Logic Unit (ALU) and Control Unit (CU).
- Also has a set of registers which are temporary storage areas for holding data, and instructions

CPU

- CPU executes the stored program instructions,
  - i.e. instructions and data are stored in memory before execution.
- For processing, CPU gets data and instructions from the memory.
- The CPU is fabricated as a single Integrated Circuit (IC) chip, and is also known as the microprocessor.

Arithmetic Logic Unit

- ALU consists of two units—arithmetic unit and logic unit.
- Some of the arithmetic operations supported by the arithmetic unit are—addition, subtraction, multiplication and division.
- Logic unit performs comparisons of numbers, letters and special characters.
- Logic operations include testing for greater than, less than or equal to condition (>, <, =, >=, <=, etc)

Registers

- ALU performs arithmetic and logic operations, and uses registers to hold the data that is being processed.
- Registers are high-speed storage areas within the CPU, but have the least storage capacity.
- Registers store data, instructions, addresses and intermediate results of processing.

Registers

- Accumulator (ACC) stores the result of arithmetic and logic operations.
- Instruction Register (IR) contains the current instruction most recently fetched.
- Program Counter (PC) contains the address of next instruction to be processed.
- Memory Address Register (MAR) contains the address of next location in the memory to be accessed.
- Memory Buffer Register (MBR) temporarily stores data from memory or the data to be sent to memory.
- Data Register (DR) stores the operands and any other data.

Control Unit

- CU coordinates the input and output devices of a computer.
- It directs the computer to carry out stored program instructions by communicating with the ALU and the registers.
- CU tells when to fetch the data and instructions, what to do, where to store the results, the sequencing of events during processing etc.

References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.
- https://www.electronics-tutorials.ws/logic

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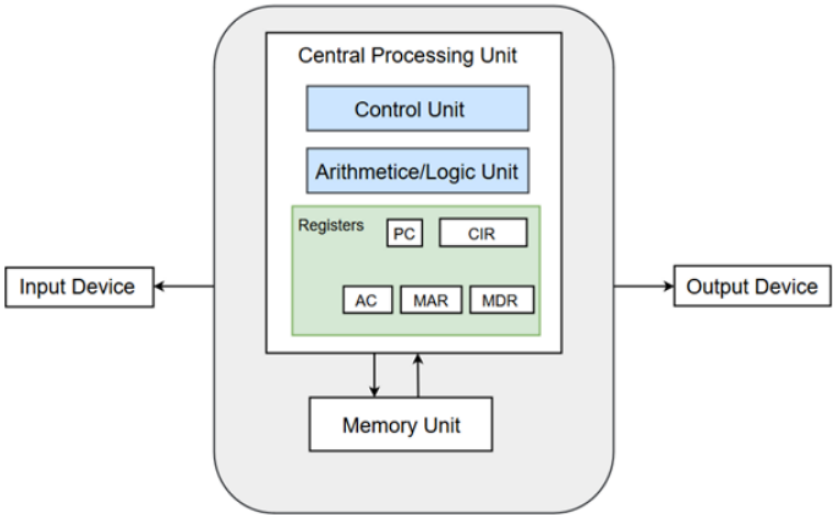
Week 07- Registers & Instructions

Von Neumann Model

- Von-Neumann proposed his computer architecture design in 1945 which was later known as Von-Neumann Architecture.

- It consisted of a
  - ✓ Control Unit,
  - ✓ Arithmetic & Logical Memory Unit (ALU),
  - ✓ Registers and
  - ✓ Inputs/Outputs.

Von Neumann Model



Components of CPU

- ALU
- Control Unit
- Registers

Registers

- Registers are high-speed storage areas within the CPU, but have the least storage capacity.
- Registers store data, instructions, addresses and intermediate results of processing.
- Registers are often referred to as the CPU's working memory.

Registers

- The data and instructions that require processing must be brought in the registers of CPU before they can be processed.
- For example, if two numbers are to be added, both numbers are brought in the registers, added and the result is also placed in a register.
- Registers are used for different purposes, with each register serving a specific purpose.

Registers inside the CPU

Registers	Description
MAR (Memory Address Register)	This register holds the memory location of the data that needs to be accessed.
MDR (Memory Data Register)	This register holds the data that is being transferred to or from memory.
AC (Accumulator)	This register holds the intermediate arithmetic and logic results.
PC (Program Counter)	This register contains the address of the next instruction to be executed.
CIR (Current Instruction Register)	This register contains the current instruction during processing.

Size of the Registers

- The size of register, also called word size, indicates the amount of data with which the computer can work at any given time.
- The bigger the size, the more quickly it can process data.
- The size of a register may be 8, 16, 32 or 64 bits.
- For example, a 32–bit CPU is one in which each register is 32 bits wide and its CPU can manipulate 32 bits of data at a time.
- Nowadays, PCs have 32–bit or 64–bit registers.

Stored Program Concept

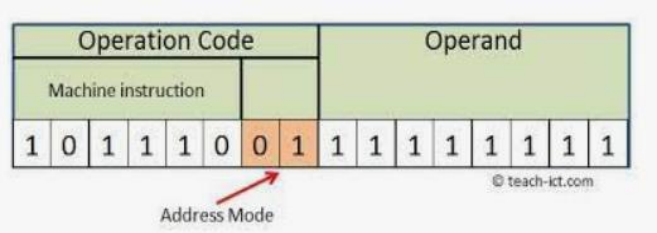
- The program and the data, on which the program operates, are stored in main memory, waiting to be processed by the processor.
- This is also called the stored program concept.
- Instructions are key concept.

What are Instructions?

- A computer program is a set of instructions that describe the steps to be performed for carrying out a computational task.
- An instruction is designed to perform a task and is an elementary operation that the processor can accomplish.

Structure of Instructions

- An instruction is divided into groups called fields.
- The common fields of an instruction are
  - Operation code
  - Operand code



Opcode & Operands

- The operation code represents action that the processor must execute.
- It tells the processor what basic operations to perform.
- The operand code defines the parameters of the action and depends on the operation.

Example

Opcode	Operand
MOV	C, A
ADD	B
MVI	A, 32H
MVI	B, F2H

Example: MVI E, ABH — **ABH** will be moved or copied to the register **E**.

MOV eax, ebx — copy the value in **ebx** into **eax**

Example of instruction ADD

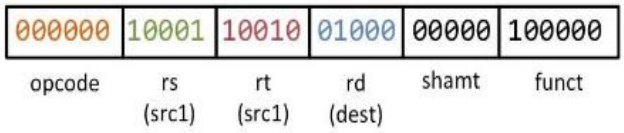
Machine Language

- Computers do not understand "add R8, R17, R18"
- Instructions are translated to machine language (1s and 0s)

Example:

```
add R8, R17, R18 →
00000010 00110010 01000000 00100000
```

MIPS instructions have logical fields:



Instruction Set

- A processor has a set of instructions that it understands, called as instruction set.
- An instruction set or an instruction set architecture(ISA) is a part of the computer architecture.
- It relates to
  - programming,
  - instructions,
  - registers,
  - addressing modes,
  - memory architecture, etc.

Instruction Set Architecture

- Critical Interface between hardware and software
- An ISA includes the following …
  - Instructions and Instruction Formats
  - Data Types, Encodings, and Representations
  - Programmable Storage: Registers and Memory
  - Addressing Modes: to address Instructions and Data
  - Handling Exceptional Conditions (like division by zero)

Examples	(Versions)	First Introduced in
Intel	(8086, 80386, Pentium, ...)	1978
MIPS	(MIPS I, II, III, IV, V)	1986
PowerPC	(601, 604, …)	1993

Microarchitecture

- Microarchitecture is the processor design technique used for implementing the Instruction Set.
- Computers having different microarchitecture can have a common Instruction Set.
- Pentium and Athlon CPU chips implement the x86 instruction set, but have different internal designs.

CISC vs RISC

On the basis of the instruction set, microprocessors are classified as—

- Reduced Instruction Set Computer (RISC)
- Complex Instruction Set Computer (CISC)-the x86 instruction set of the original Intel 8086

processor is of the CISC type. The PCs are based on the x86 instruction set.

CISC

- CISC has a large instruction set .
- Instructions are of variable lengths, using 8, 16 or 32 bits for storage.
- Need more transistors.
- AMD and Cyrix are based on CISC.

RISC

- RISC has simple, single-cycle instructions, which performs only basic instructions.
- RISC has fewer instructions and requires fewer transistors.
- The instruction size is fixed (32 bits).
- RISC processors can handle multiple instructions simultaneously.
- Apple Mac G3 and PowerPC are based on RISC.

Next week

Instruction fetch/execute life cycle

References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.

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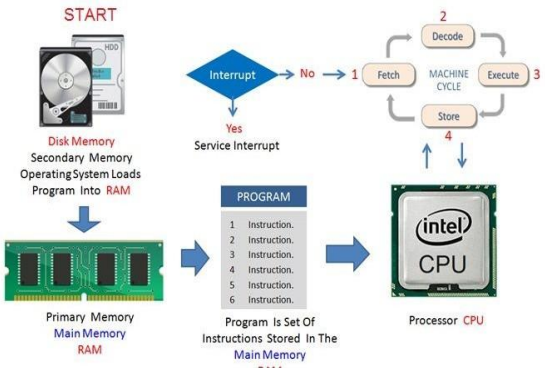
Week 08- Instruction
Life Cycle and System
Buses

Instruction Cycle

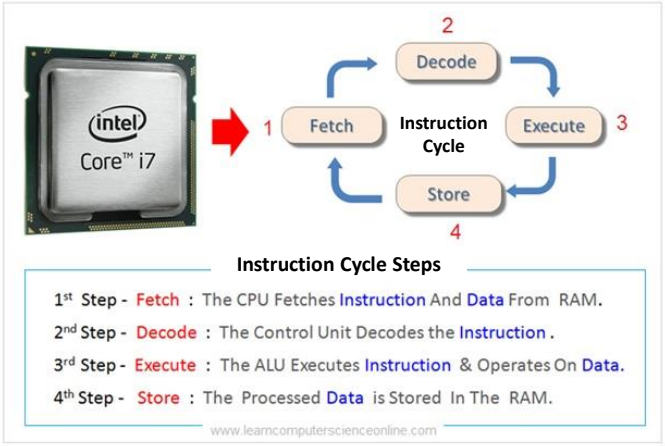
- The primary responsibility of a computer processor is to execute a sequential set of instructions that constitute a program.
- CPU executes each instruction in a series of steps, called instruction cycle.

Steps in Instruction Cycle

1. Fetching
2. Decoding
3. Executing
4. Storing

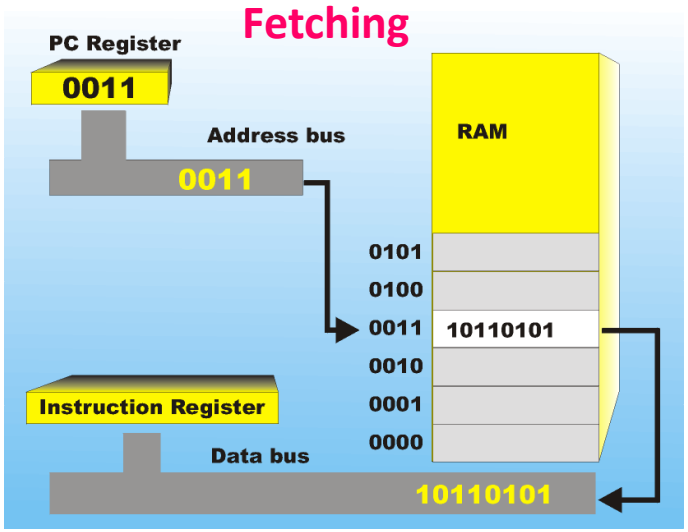


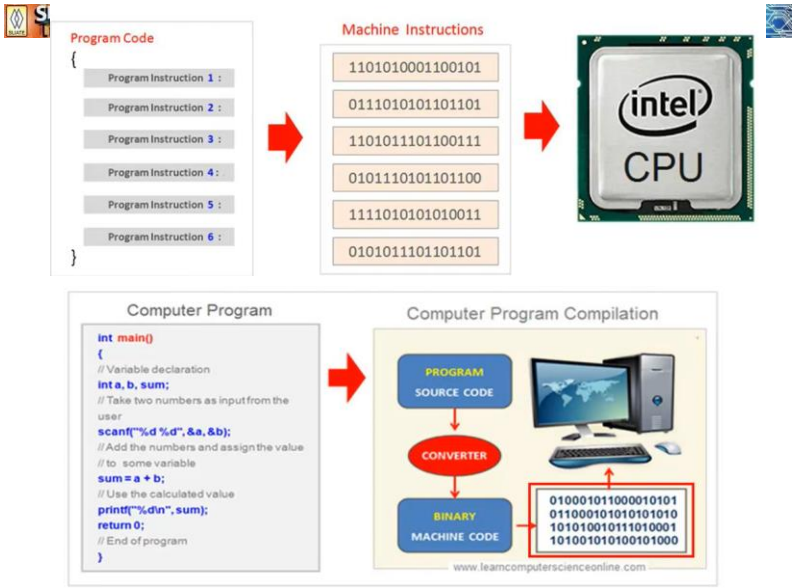
Steps in Instruction Cycle

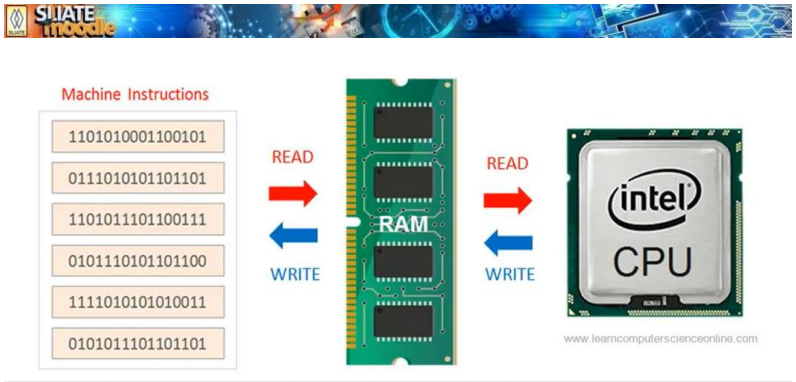


Fetching

- The processor fetches the instruction from the memory.
- The fetched instruction is placed in the Instruction Register (IR).
- Program Counter (PC) holds the address of next instruction to be fetched and is incremented after each fetch.







Program Instruction - Memory Read OR Memory Write

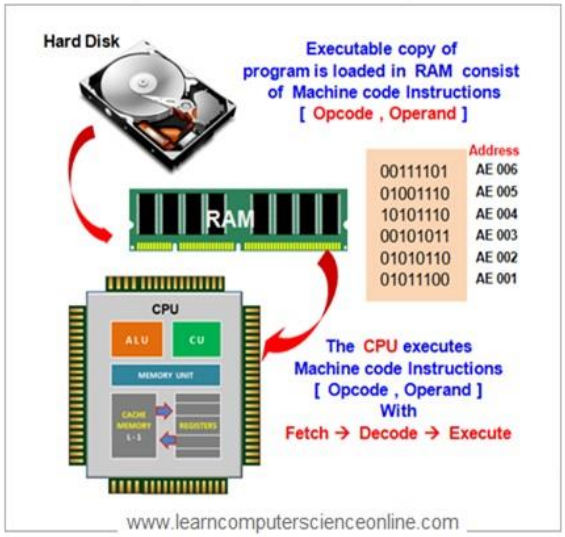
Input OR Output Operation
Arithmetic calculations OR
Logical Operations

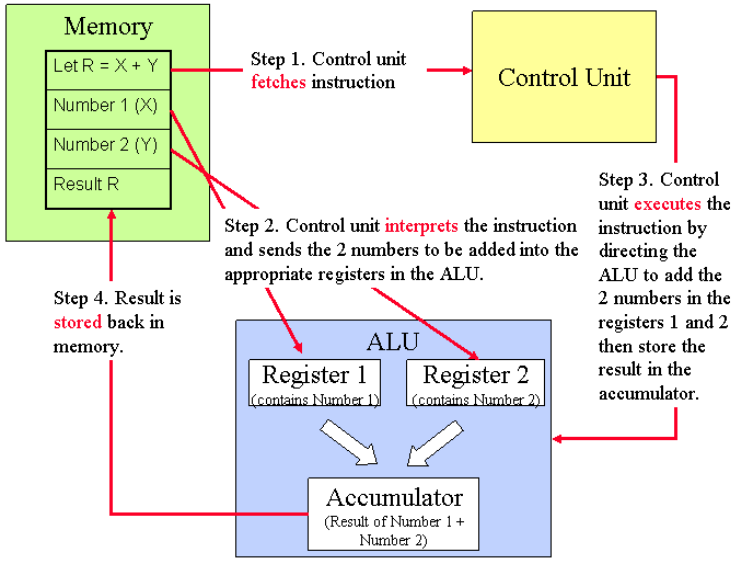
Decoding

- The instruction that is fetched is broken down into parts or decoded.
- The instruction is translated into commands so that they correspond to those in the CPU's instruction set.

Executing

- Executing the decoded instruction or the command is executed.
- CPU performs the operation implied by the program instruction.
- For example, if it is an ADD instruction, addition is performed.


Hard Disk
Executable copy of program is loaded in RAM consist of Machine code Instructions [Opcode , Operand]
Address
00111101 AE 006
01001110 AE 005
10101110 AE 004
00101011 AE 003
01010110 AE 002
01011100 AE 001
RAM
CPU
ALU
CU
MEMORY UNIT
CACHE MEMORY L-1
REGISTERS
The CPU executes Machine code Instructions [Opcode , Operand] With Fetch → Decode → Execute
www.learncomputerscienceonline.com


Memory
Let R = X + Y
Number 1 (X)
Number 2 (Y)
Result R
Step 1. Control unit fetches instruction
Control Unit
Step 2. Control unit interprets the instruction and sends the 2 numbers to be added into the appropriate registers in the ALU.
Step 3. Control unit executes the instruction by directing the ALU to add the 2 numbers in the registers 1 and 2 then store the result in the accumulator.
Step 4. Result is stored back in memory.
ALU
Register 1 (contains Number 1)
Register 2 (contains Number 2)
Accumulator (Result of Number 1 + Number 2)

Storing

- CPU writes back the results of execution, to the computer's memory.

Microprocessor

- A processor's instruction set is a determining factor in its architecture.
- Reduced Instruction Set Computer (RISC).
  - AMD and Cyrix are based on CISC.
- Complex Instruction Set Computer (CISC).
  - Apple Mac G3 and PowerPC are based on RISC.

System Buses

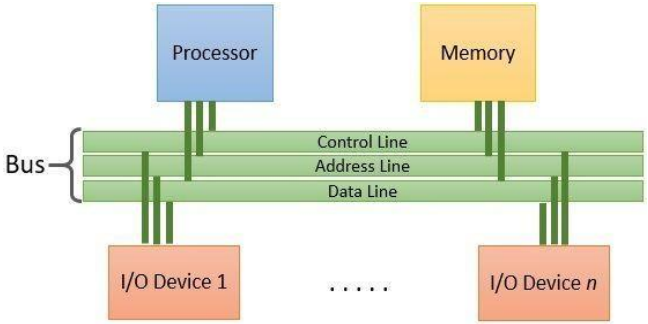
- Bus is a set of electronic signal pathways that allows information and signals to travel between components inside or outside of a computer.
- The different components of computer, i.e., CPU, I/O unit, and memory unit are connected with each other by a bus.

System Buses

- A bus is a set of wires used for interconnection, where each wire can carry one bit of data.
- A bus width is defined by the number of wires in the bus.
- A computer bus can be divided into two types — Internal Bus and External Bus.
- The Internal Bus connects components inside the motherboard like, CPU and system memory.
- It is also called the System Bus.

System Buses

- Data Bus
- Address Bus
- Control Bus



Data Bus

- Data Bus transfers data between the CPU and memory.
- The bus width of a data bus affects the speed of computer.
- The size of data bus defines the size of the processor.
- A processor can be 8, 16, 32 or 64-bit processor.
- An 8–bit processor has 8 wire data bus and carry 1 byte of data.

Address Bus

- Address Bus connects CPU and RAM with set of wires similar to data bus.
- The width of address bus determines the maximum number of memory locations the computer can address.

  The number of lines (wires) in the address bus determines the maximum amount of RAM that can be directly accessed by the CPU as each line carries one bit of the address.

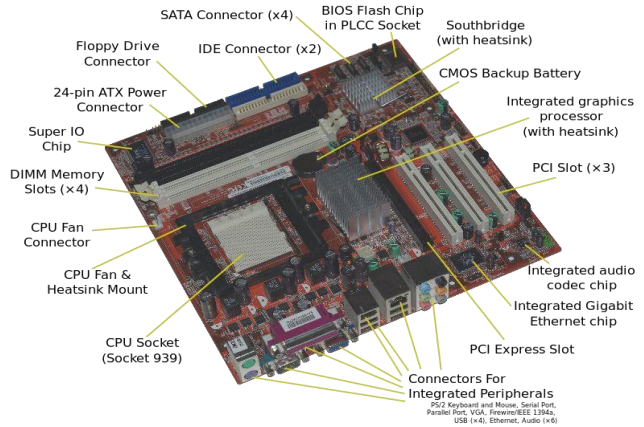
Control Bus

- Control Bus specifies whether data is to be read or written to the memory, etc.

Motherboard

- The computer is built up around a motherboard.
- It is a large Printed Circuit Board (PCB), having many chips, connectors and other electronics mounted on it.
- The motherboard is the hub, which is used to connect all the essential components of a computer.

The layout of Motherboard



Ports and Interfaces

- Serial Port— to connect old peripherals.
- Parallel Port— to connect old printers.
- USB Ports—to connect newer peripherals
- RJ45 connector (called LAN or Ethernet port)
- VGA connector for connecting a monitor.
- Audio plugs (line-in, line-out and microphone).
- PS/2 port to connect mouse and keyboard into PC.

Expansion Slots

- ISA (Industry Standard Architecture) slot—To connect modem and input devices.
- PCI (Peripheral Component InterConnect) slot—To connect audio, video and graphics.
- AGP (Accelerated Graphic Port) slot—A fast port for a graphics card.

BIOS (Basic Input/ Output System)

- BIOS it is the basic program used as an interface between the operating system and the motherboard.
- BIOS contain the instructions for the starting up of the computer.
- The BIOS runs when the computer is switched on.
- It performs a Power On Self Test (POST) that checks that the hardware is functioning properly and the hardware devices are present.

References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.

HNDIT1032 Computer and Network Systems

Week 09- Software & Operating System

Introduction

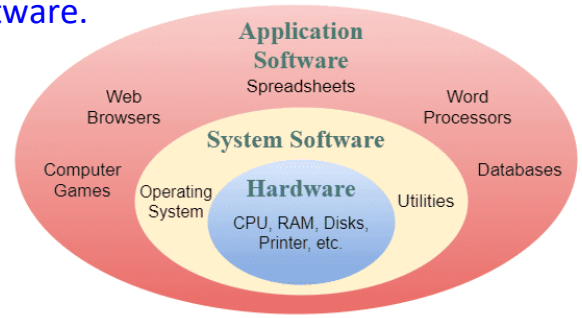
- The computer, as a machine, can do nothing for you without the software.
- Software is required for the functioning of computer.
- Software programs instruct computer about the actions to be performed, so as to get the desired output.

Software

- A computer system consists of hardware and software.
- Software is a set of programs that instructs the computer about the tasks to be performed.
- Software tells the computer how the tasks are to be performed; hardware carries out these tasks.

Types of Software

- Software can be broadly classified in two categories:
  - System Software.
  - Application Software.



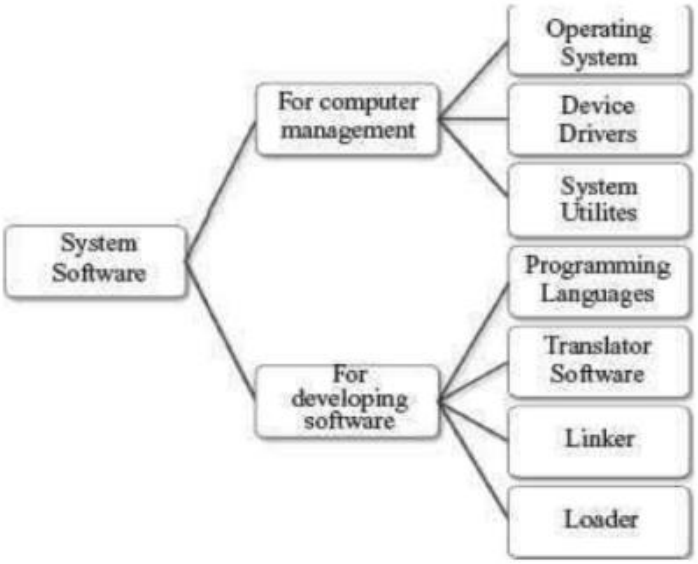
System Software

- The purposes of the system software are:
  - To provide basic functionality to computer,
  - To control computer hardware, and
  - To act as an interface between user, application software and computer hardware

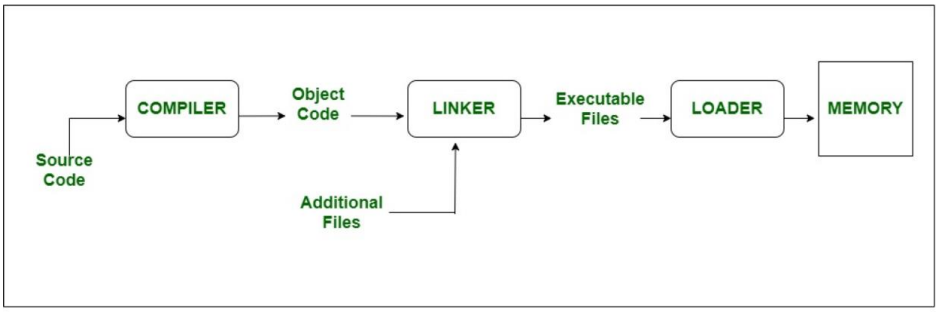
Categories of System Software

- On the basis of their functionality, system software may be broadly divided into two categories
  - Management and functionality of computer.
  - Development of application software

Categories of System Software



Linker and Loader Extra note



- **Linker:** A linker is special program that combines the object files, generated by compiler/assembler and other pieces of code to originate an executable file has .exe extension. In the object file, linker searches and append all libraries needed for execution of file.
- **Loader:** It is special program that takes input of executable files from linker, loads it to main memory, and prepares this code for execution by computer. Loader allocates memory space to program.

Application Software

- The software that a user uses for accomplishing a specific task is the application software.
- Application software may be a single program or a set of programs.
- A set of programs that are written for a specific purpose and provide the required functionality is called software package.

Examples of Application Software

- Word Processing Software
- Image Processing Software
- Accounting Software
- Spreadsheet Software
- Presentation Software
- CAD/CAM Software
- Web Browser Software

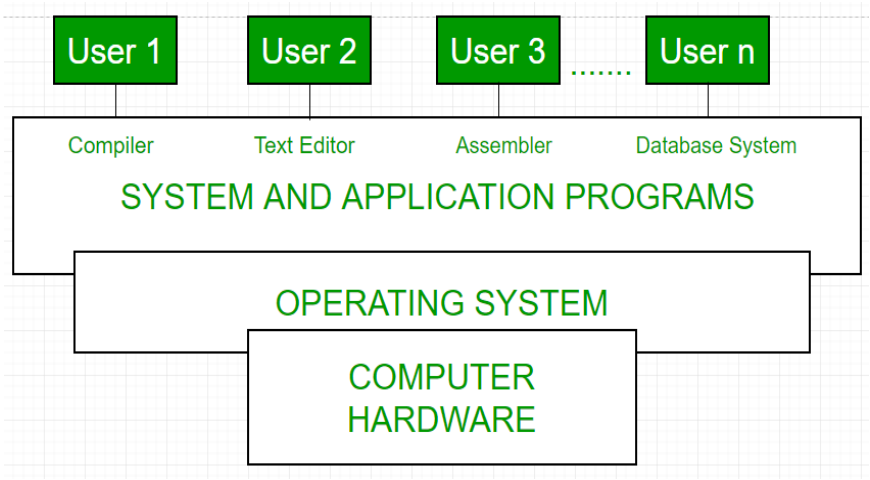
Software Market

- Retail Software
- OEM Software stands
- Demo Software
- Shareware
- Freeware
- Public Domain Software
- Open-Source Software

Operating System(OS)

- Any computer system you use has an operating system.
- The user interacts with the machine via the operating system.
- A software on the machine interacts with the hardware via the operating system.
- Operating system intermediates between the hardware and the user.

View of OS



Types of OS

- Single User and Single Task OS
- Single User and Multitasking OS
- Multiuser OS
- Multiprocessing OS
- Real Time OS
- Embedded OS

Single User Single Task

- This is for use by a single user for a standalone single computer for performing a single task.
- Operating system for Personal Computers (PC) are single user OS.
- For example, if the user is editing a document, then a document cannot be printed on the printer simultaneously.
- Example MS DOS

Single User Multitasking

- This is allows execution of more than one task or process concurrently.
- The processor switches rapidly between processes.
- For example, the user can listen to music on the computer while writing an article using a word processor software.
- Example Windows OS.

Multiuser OS

- This is used in computer networks that allow same data and applications to be accessed by multiple users at the same time.
- Linux, UNIX, and Windows are examples of multi user OS.

Multiprocessing OS

- This have two or more processors for a single running process.
- Processing takes place in parallel and is also called parallel processing.
- Since execution takes place in parallel, they are used for high speed execution, and to increase the power of computer.
- Linux, UNIX and Windows

Real Time OS

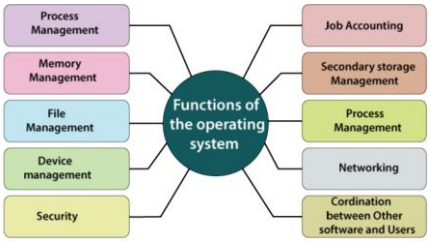
- Real time OS are designed to respond to an event within a predetermined time.
- These operating systems are used to control processes. Processing is done within a time constraint.
- They are used to respond to queries in areas like medical imaging system, industrial control systems, telephone switching equipment, flight control, and real-time simulations etc.

Embedded OS

- This is embedded in a device in the ROM.
- They are specific to a device and are less resource intensive.
- They are used in appliances like microwaves, washing machines, traffic control systems etc.

Functions of OS

1. Process Management
2. Memory Management
3. File Management
4. Device Management
5. Protection & Security
6. Communication
7. User Interface



Process Management

- A process is a program in a state of execution.
- A process can be created, executed, and stopped.
- To accomplish a task, a process needs to have access to different system resources like I/O devices, CPU, memory etc.
- The process management function of an operating system handles allocation of resources to the processes in an efficient manner.

Memory Management

- In a computer, there may be multiple processes executing at the same time.
- Memory management is one of the tasks handled by the operating system.
- Memory management schemes handle the allocation of memory to different processes.
- Paging, Virtual memory

Virtual Memory

- A computer can address more memory than the amount physically installed on the system.
- This extra memory is actually called virtual memory and it is a section of a hard disk that's set up to emulate the computer's RAM.

File Management

- The file management function of the operating system involves handling the file system which consists of two parts—a set of files, and a directory structure.
- File is a collection of related information, has a name, and is stored on a secondary storage.
- It is the smallest named unit that can be written to a secondary storage device.

Device Management

- An operating system communicates with the devices controllers with the help of device drivers while allocating the device to the various processes running on the computer system.
- Device drivers are the software programs that are used by an operating system to control the functioning of various devices in a uniform manner.

Protection & Security

- User accounts—individual accounts for user Authentication—using password protection
- Access rights—define rights for access of different kind of information for different people.
- Data encryption—store data

User Interface(UI)

- The primary goal of operating system is to make the computer convenient for use by its user.
- It should allow users to easily access and communicate with the applications and the hardware.

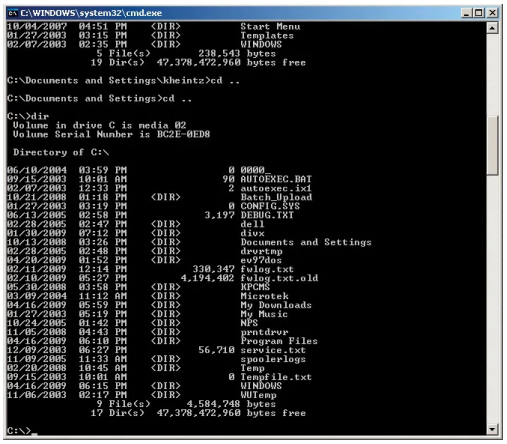
Types of UI

- The users can interact with the computer by using mainly two kinds of interfaces
  - Command Line Interface (CLI)
  - Graphical User Interface (GUI)

Command Line Interface

- CLI requires the user to interact with operating system in the form of text keyed in from the keyboard.
- In this, the user has to learn and remember the different commands required for copying, deleting, opening a file or folder etc.
- Example MS-DOS & Linux shell

Example- MS-DOS



Graphical User Interface

- The interface consists of icons, menus, windows, and pointers.
- The user need not learn the commands, instead, the user can give instructions by moving the pointer on the screen using a mouse and pressing the mouse button
- MS Windows, Linux, Mac OS

Example-GUI

Examples of OS

- Ms DOS
- Windows 11
- Linux
- Mac OS
- Android
- IOS

MS-DOS

- MS-DOS was the first widely-installed operating system for PCs in 1980s.
- MS-DOS is easy to load and install. It neither requires much memory for the operating system, nor a very powerful computer to run on.
- MS-DOS is a command line user interface operating system. This means that the user has to type single line commands through the command interface.

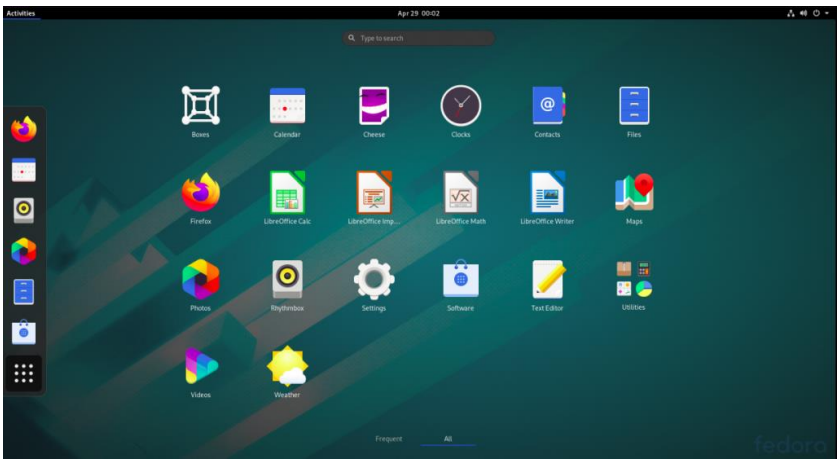
Windows OS

- Windows is a personal computer operating system from Microsoft.
- The Windows family of OS which is currently in use includes the Windows 9x family (Windows 95, Windows 98 and Windows 2000), Windows XP, Windows Vista, and Windows 7,8,11 operating systems.
- Windows family of OS is GUI-based operating system. Since GUI interfaces are easy to use and are user-friendly, these have become very popular.

Linux OS

- Linux is a 32-bit, multi-tasking OS. It supports multiple users and multiple processors.
- Linux is a reliable and secure OS, and is available almost for free. So, Linux is fast becoming very popular and powerful OS.
- Linux OS is easily available, such as Redhat Linux ver. 9, and, Debian·s—Ubuntu,Kubuntu, and Edubuntu.

Example-Linux OS



MacOS

- MacOS is a Unix operating system developed and marketed by Apple Inc since 2001.
- It is the primary operating system for Apple's Mac computers.
- Within the market of desktop and laptop computers it is the second most widely used desktop OS.

Mobile OS

HNDIT1032 Computer and Network Systems

Week 10,11- Install OS & System Utilities

Introduction

- OS controls and coordinates the use of hardware among the different application software and the users.
- It provides an interface that is convenient for the user to use, and facilitates efficient operations of the computer system resources.

Operating System Installation

- The installation and initial booting of the OS is called the operating system setup.
- Although it is possible to install an OS over a network from a server or from a local hard drive, the most common installation method for a home or small business is with CDs or DVD.

Steps of OS Installation

- Hard Disk Partitioning
- Hard Disk Formatting
- Default Setting
- Date & Time Setting
- Network Setting
- Accounts Setting
- Reboot the System

Hard Drive Partitioning

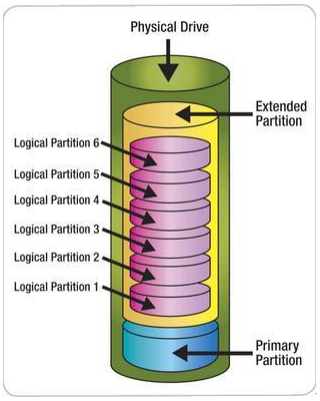
- A hard drive is divided into specific areas called partitions.
- Each partition is a logical storage unit that can be formatted to store information, such as data files and applications.
- During the installation process, most operating systems automatically partition and format available hard drive space

Types of Partitions

- Primary partition - This primary partition containing the operating system files is usually the first partition.
- Active partition - Only one primary partition per disk can be marked active. In most cases, the C: drive is the active partition and contains the boot and system files.

Types of Partitions cont…

- Extended partition - The extended partition normally uses the remaining free space on a hard drive or takes the place of a primary partition



Hard Drive Formatting

- A clean installation of an OS proceeds as if the disk were brand new. No information that is currently on the hard drive is preserved.
- The first phase of the installation process partitions and formats the hard drive.
- This process prepares the disk to accept the new file system.

File System

Windows operating systems use one of these file systems:

- New Technology File System (NTFS)
- File Allocation Table, 32 bit (FAT32)

Difference Between FAT32 and NTFS :

Characteristics	FAT32	NTFS
Structure	Simple	Complex
Maximum number of characters supported in a file name	83	255
Maximum file size	4GB	16TB
Encryption	Not encrypted	Encrypted with Encrypting File System (EFS)
Security	Network Type Only	Both local and network type

Difference Between FAT32 and NTFS :

Fault tolerance	No provision for Fault Tolerance	Automatic troubleshoot is present
Compatibility with Operating Systems	Windows 95/98/2000/2003/XP	Windows NT/2K/XP/Vista/7/8/10, macOS X, Linux
Compression	Compression is not allowed	Supports file compression
Accessing speed	Low	Relatively higher than other File Systems
User-level disk space	Not present	Present
Conversion	Allowed	Not allowed

FAT vs NTFS

	FAT32	NTFS	exFAT (FAT64)
Security	Low security	File and Folder Level permissions Encryption	exFAT can support access control lists (ACLs) that define permissions for user access
Compatibility	Compatible with Windows	Compatible with Windows	Compatible with Windows XP with SP2 or SP3, Windows Vista with SP1, Windows 7, Windows Server 2003 with SP2, Windows Server 2008, and Linux
File Size	Limit of 4 GB files Limit of 32 GB volumes	Limit of 16 TB files Limit of 256 TB volumes	Limit of 64 zetabytes (ZBs) files Limit of 512 TB volumes
Files per Volume	4.17 million	4.29 billion	Maximum of 16 exabytes (EBs)

Quick vs Full Format

- The quick format removes files from the partition, but does not scan the disk for bad sectors. Scanning a disk for bad sectors can prevent data loss in the future.

- The full format removes files from the partition while scanning the disk for bad sectors. It is required for all new hard drives.

Installation with Default Setting

- Install now-Sets up and installs the Windows

- What to know before installing Windows - Opens a Help and Support window describing the Upgrade and Custom options for installing

- Repair your computer - Opens the System Recovery Options utility to repair an installation.

Install Options

- Language to install
- Standards and formats that define currency and numerals
- Keyboard or input method
- Physical location of the installation
- Username and computer name
- Password for the administrative account
- Product key
- Time and date settings
- Network setting

Install Now

Network Setting

When configuring initial network settings during installation, you are prompted to select one of the following current locations

- Home network
- Work network
- Public network

Account Creation

- When users attempt to log in to a device or to access system resources, Windows uses the process of authentication to verify that the users are who they say they are.

- Authentication occurs when users enter a username and password to access a user account.

Types of Accounts

- A user with administrator privileges can make changes that impact all users of the computer, such as altering security settings or installing software for all users.
- Standard Accounts- has fewer permissions than an administrator account
- Guest Accounts - has limited permissions and must be turned on by an administrator

Complete the Installation

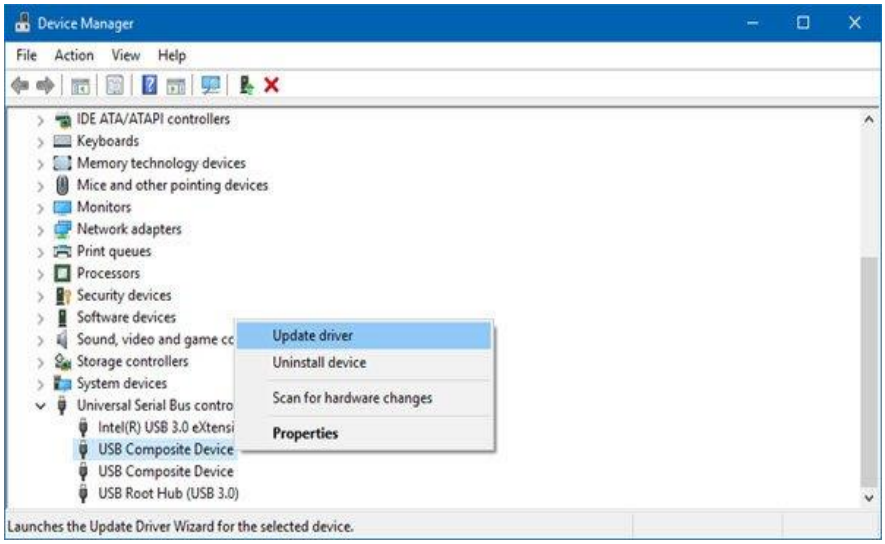
- After the Windows installation copies all the necessary OS files to the hard drive, the computer reboots and prompts you to create a user account.
- Microsoft Update Manager from the Start Menu to scan for new software, as well as install service packs and patches.

•Select Start > Settings > Update & Security > Windows Update .

Device Manager

- A **device driver** acts as a translator between the hardware and the software that uses the devices.
- In other words, it intermediates between the device and the software, in order to use the device
- Nowadays, the operating system comes preloaded with some commonly used device drivers, like the device driver for mouse, webcam, and keyboard.

Example-Device Driver



Other Installation Methods

- Network Installation
- Preboot Execution Environment (PXE) Installation
- Unattended Installation
- Image-based Installation
- Remote Installation

System Recovery

- The System Recovery Options are a set of tools that allow users to recover or restore an operating system when it has failed.
- The System Recovery Options are a part of the Windows Recovery Environment (WinRE). WinRE is a recovery platform based on the Windows Preinstallation Environment (PE).

System Image Recovery

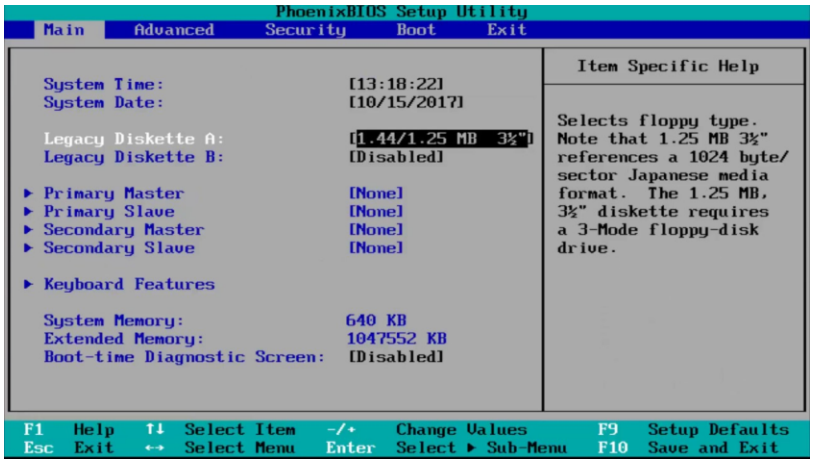
It allows users to back up the contents of their hard drive, including personal files and settings, if an operating system needs to be restored

While the recovery drive can only reinstall Windows on the system (or troubleshoot certain issues), a system image recovery would restore the entire system.

Windows Boot Process

- When the computer is powered on, it performs a Power On Self Test (POST).
- After POST, the BIOS locates and reads the configuration settings that are stored in the CMOS memory.
- The boot device priority is set in the BIOS and can be arranged in any order.

BIOS Setup Utility



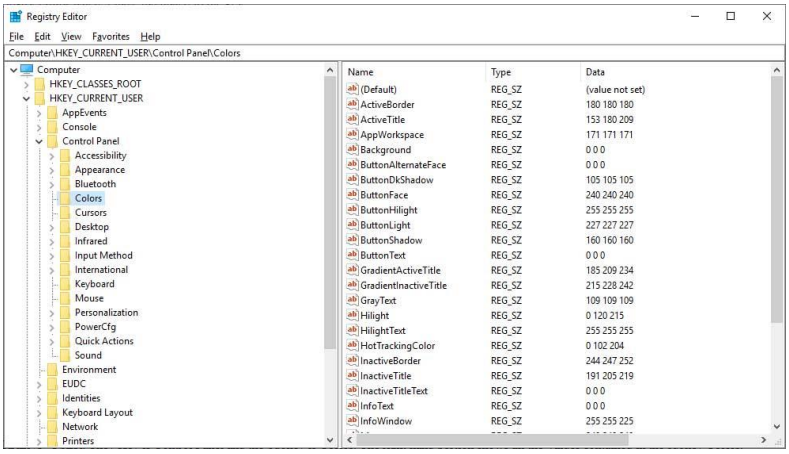
Startup Modes

- Safe Mode - Starts Windows but only loads drivers for basic components
- Safe Mode with Networking - loads the drivers for network components.
- Safe Mode with Command Prompt - loads the command prompt instead of the GUI
- Last Known Good Configuration - configuration settings that were used the last time that Windows started successfully

Windows Registry

- The Windows Registry keys are an important part of the Windows boot process.
- These keys are recognized by their distinctive names, which begin with HKEY_, as shown in the figure, followed by the name of the portion of the OS under their control.
- The Registry is also responsible for recording the location of Dynamic Link Library (DLL) files.

Example-Windows Registry



Multiboot

- You can have multiple operating systems on a single computer.
- There is a dual boot process for multiple operating systems on a computer.
- During the boot process, if the Windows Boot Manager (BOOTMGR) determines that more than one OS is present, you are prompted to choose the OS.

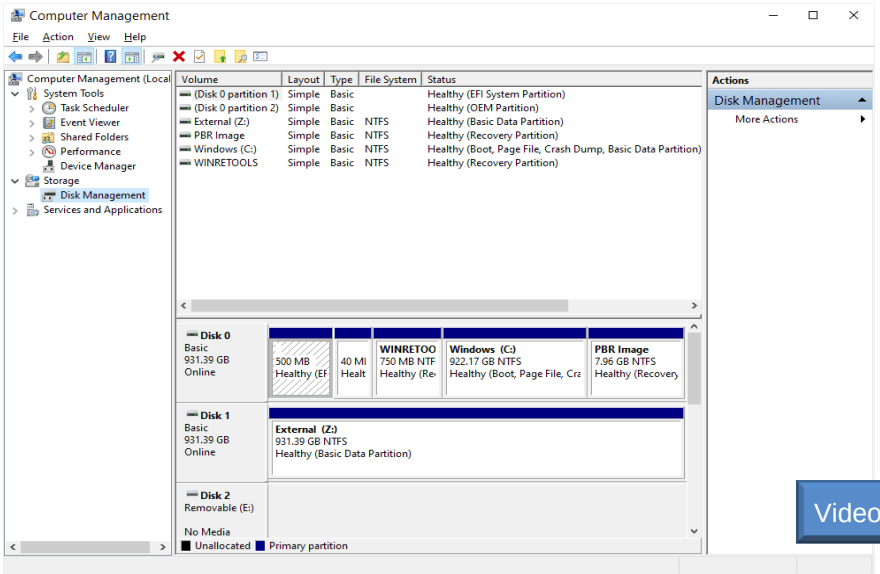
System Utilities

- Disk Management
- File Management
- Antivirus
- Compression Tools
- Disk Cleanup Tools
- Disk Defragment Tools
- Backup
- Performance Monitoring Tools

Disk Management

- View drive status
- Extend partitions
- Split partitions
- Assign drive letters
- Add drives
- Add array
- Start > right-click Computer > Manage > select Disk Management

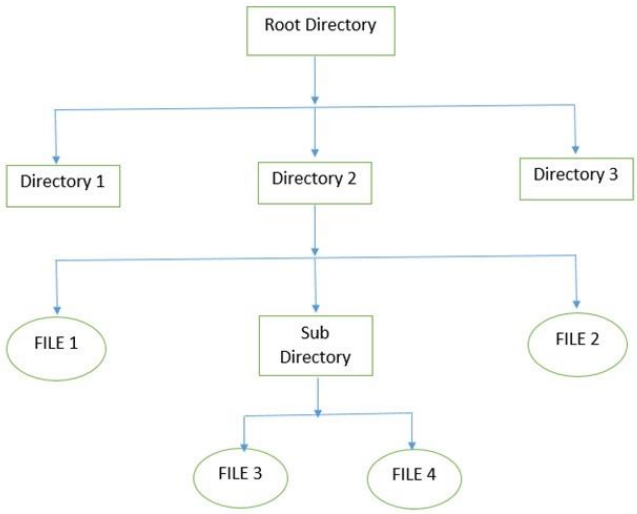
Disk Management



File Management

- File Management Systems are the most basic of all types of software.
- They are used to organize and store files on a computer, as well as index those files for easier retrieval.
- Most computers come with a basic file management system that is built into the operating system.

File Management



Antivirus

- Online threats are a serious problem. Viruses, malware, and hackers can ruin your computer and steal your data.
- Antivirus software is used to prevent, detect and remove viruses from your computer.
- A virus is a malicious piece of code that infects other files or computers for the purpose of replicating itself.

Example - Antivirus

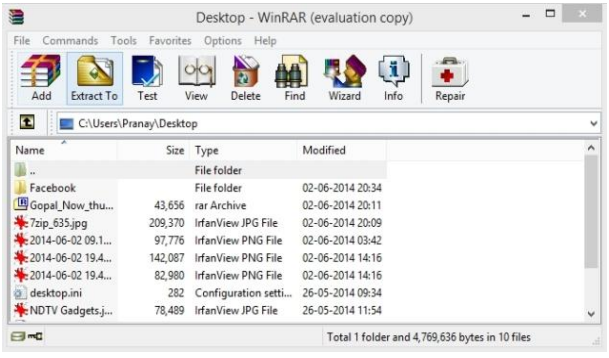
- Microsoft Defender
- Norton 360 LifeLock
- Bitdefender Antivirus
- Eset
- McAfee Total Protection
- Quickheal Antivirus

Compression Tools

- Compression tools are a set of computer programs that compress files.
- **Compression** is the process of taking data from a file and reducing its size of it.
- A compression tool **reduces the file's size by** removing blank spaces, repeating characters in a string, or combining two or more redundant files into one file - all without affecting the data in any way.

Example-Compression Tool

- WinZip
- WinRAR
- 7-Zip
- Zip Archiver
- PeaZip

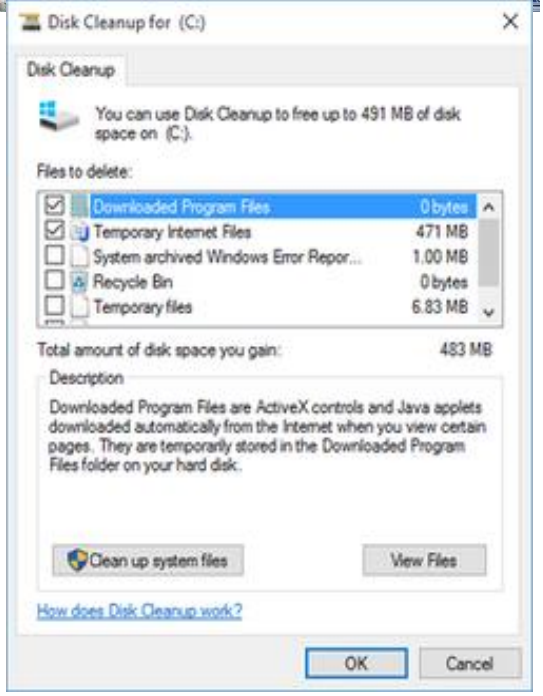


Disk Cleanup Tool

- Cleaning up your disk is one of the best ways to improve your computer's performance.
- Disk Cleanup Tool is a Microsoft utility that you can use to clean up all sorts of temporary files, including internet downloads, web browser cache, temporary Internet files, and much more.
- The Disk Cleanup Tool lets you choose specific types of files to be deleted or removed.
- You can also specify which hard drive to clean up or how much space to free up.

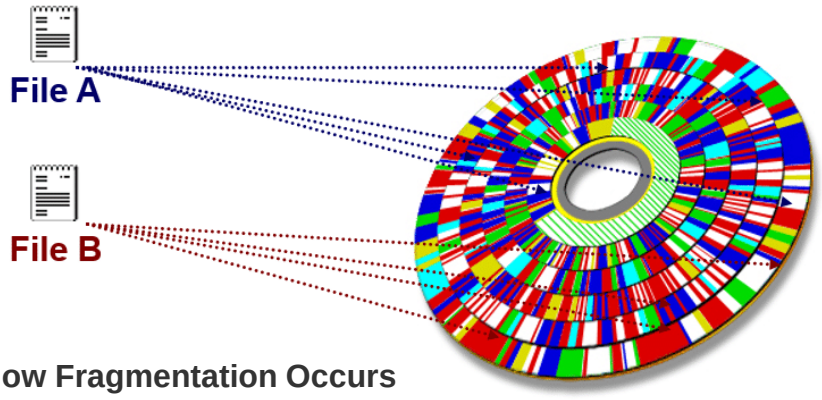
Example - Disk Cleanup Tools

- Open **File Explorer**.
- **Right-click on the hard drive** icon and select **Properties.**
- On the **General tab**, click **Disk Cleanup**



Disk Defragment Tool

Extra slide

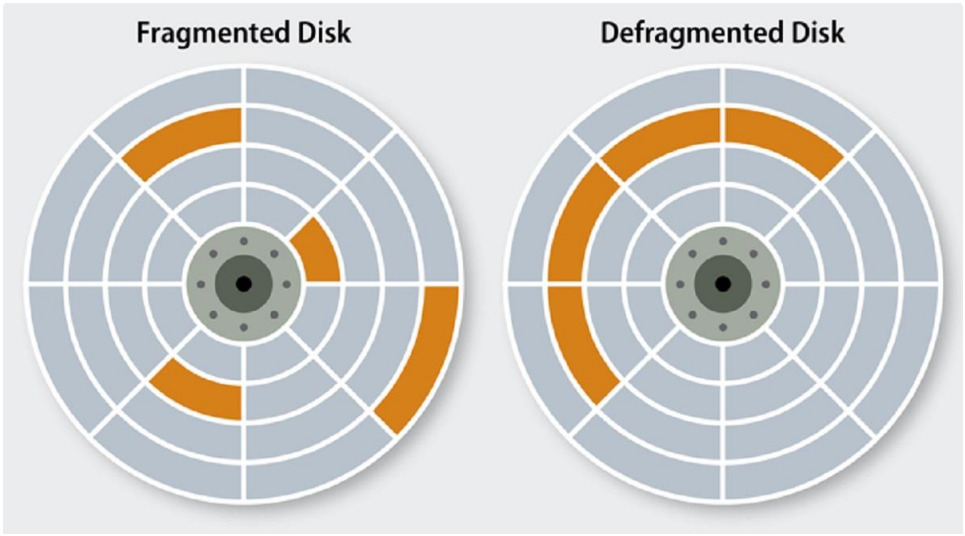


How Fragmentation Occurs

- Disk fragmentation occurs when a file is broken up into pieces to fit on the disk.
- Because files are constantly being written, deleted and resized, fragmentation is a natural occurrence.
- When a file is spread out over several locations, it takes longer to read and write resulting in slow computer performance.

Disk Defragment Tool

- Files become fragmented when data is written to disk, and there is not enough contiguous space to hold the complete file.
- Storage algorithms break the data apart so that it will fit into the available space.
- **The process of defragmentation** moves the data blocks on the hard drive around to bring all the parts of a file together.
- Defragmentation reduces file system fragmentation, increasing the efficiency of data retrieval and thereby improving the overall performance of the computer.
- At the same time, it cleans the storage and provides additional storage capacity.



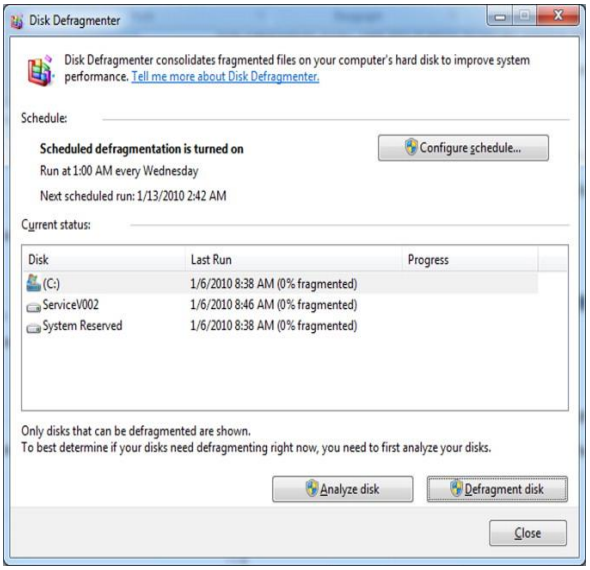
Video

Disk Defragment Tool

- Disk defragmenters are utilities designed to rearrange data on a hard drive, so that it is more evenly distributed and can be read from quicker.

- It's important to use disk defragmenters periodically in order to keep the system running smoothly.

Example-Disk Defragment Tools

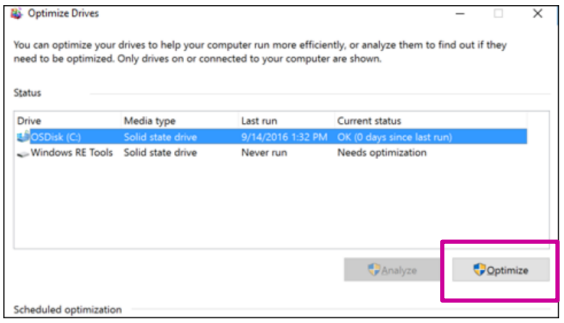


Example-Disk Defragment Tools

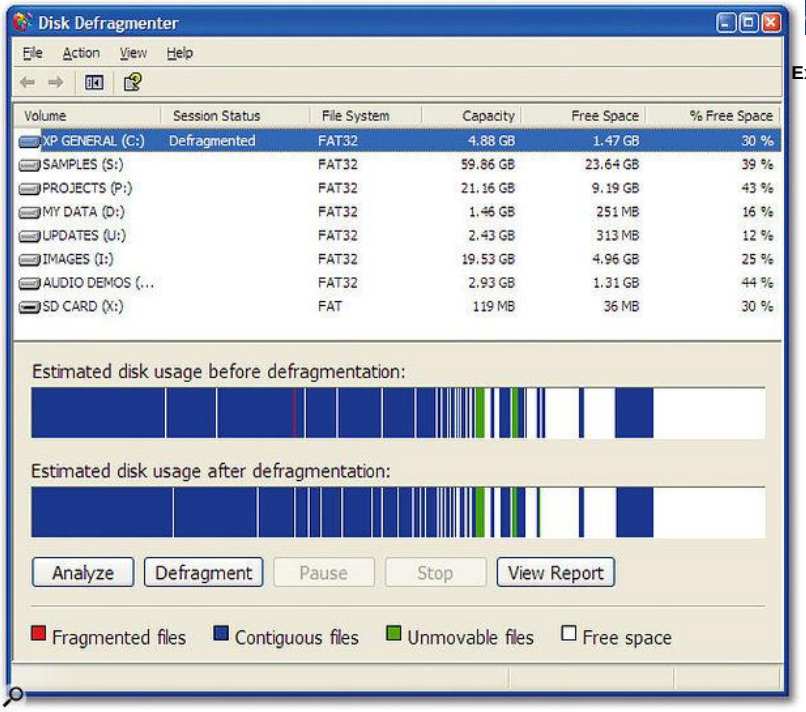
Extra slide

In windows 10

1. Select the search bar on the taskbar and enter **defrag.**
2. Select **Defragment and Optimize Drives.**



3. Select the disk drive you want to optimize.
4. Select the **Optimize** button.

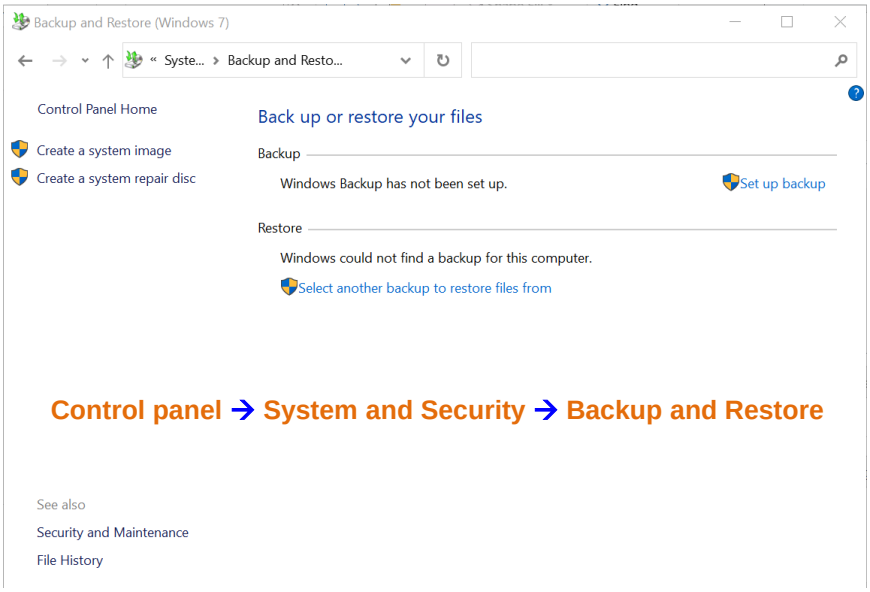


Extra slide

Backup & Restore

- A backup utility is a software application that automatically backs up your data.
- It can be external or internal hard drives, DVDs, CDs, and even online storage.
- When it comes to backing up your data, you have two options: manual or automated.
- Data restore is the process of copying backup data from secondary storage and restoring it to its original location or a new location.

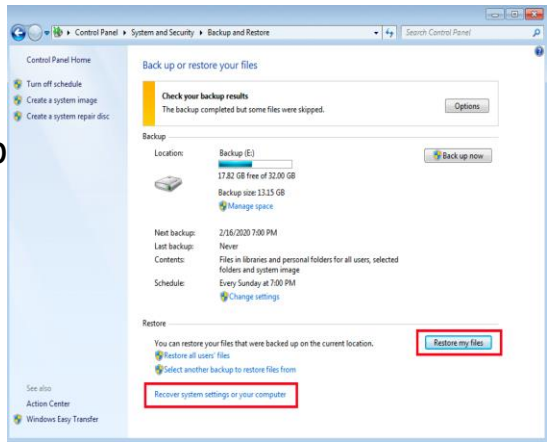
Example-Backup & Restore



Control panel → System and Security → Backup and Restore

Example-Backup & Restore

- Acronis True Image
- Backblaze
- Carbonite
- EaseUS ToDo Backup
- NovaBackup



Performance Monitoring Tools

- Microsoft, Windows Performance Monitor uses configuration information, performance counters and event trace data to make a full examination of a computer's performance.

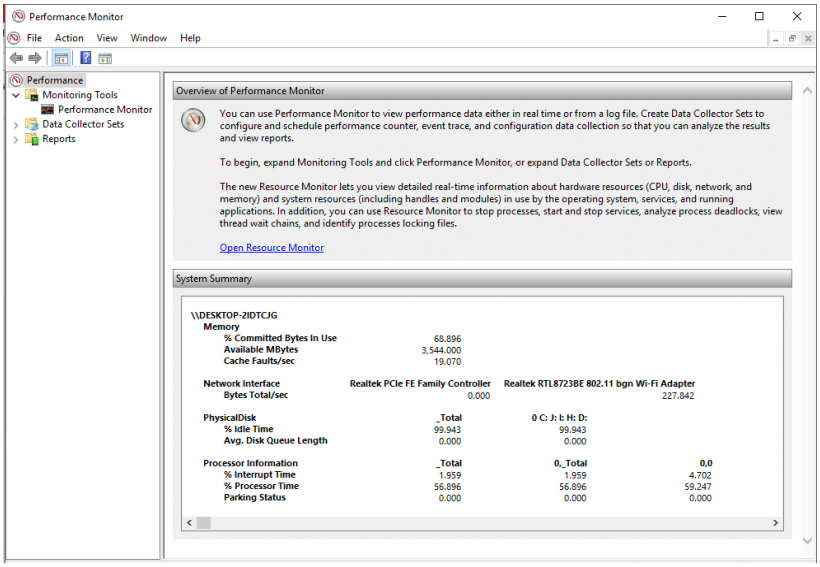
- All of the information can be combined into Data Collector Sets.

What is Performance Monitor?

Extra slide

- Our computer just ceases to respond, shuts down unexpectedly or behaves abnormally. There could be a number of reasons for such behavior and pointing out the exact reason could be of great help.
- Windows has a tool named **Performance Monitor**, which you can use for this purpose.
  - With this tool, you can keep a check on the performance of your system and identify how different programs affect the system performance.
  - You can analyze data related to your processor, memory, network, hard drive, etc.
  - It can tell you how the system resources are managed and other configuration information that might be useful for you.

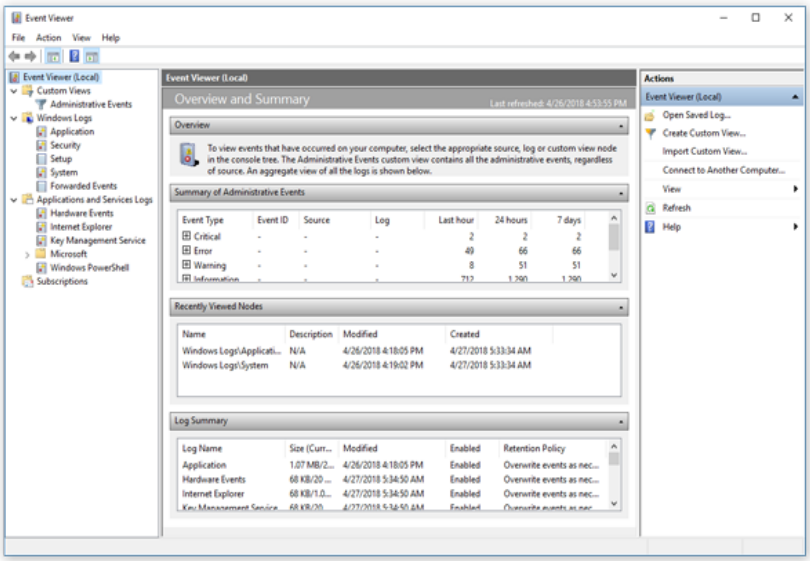
Example - Performance Monitor



Event Viewer

- The Windows Event Viewer shows a log of application and system messages, including errors, information messages, and warnings.
- It's a useful tool for troubleshooting all kinds of different Windows problems.

Example-Event Viewer



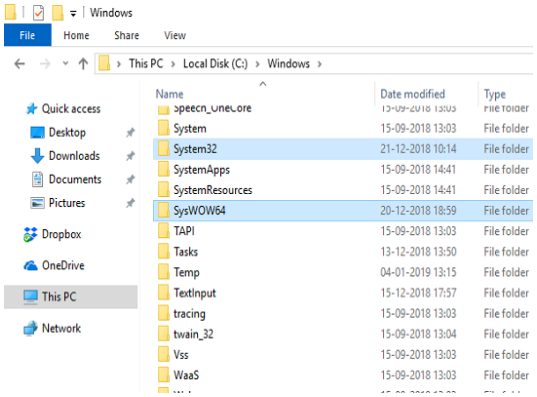
User File Location.

- By default, Windows 7 and Windows Vista stores most of the files created by users in the folder C:\Users\User_name\. Windows XP uses the folder C:\Documents and Settings\User_name\

- Each user's folder contains folders for music, videos, websites, and pictures

System File Location

- When the Windows OS is installed, all files that are used to run the computer are located in the folder C:\Windows\system32.

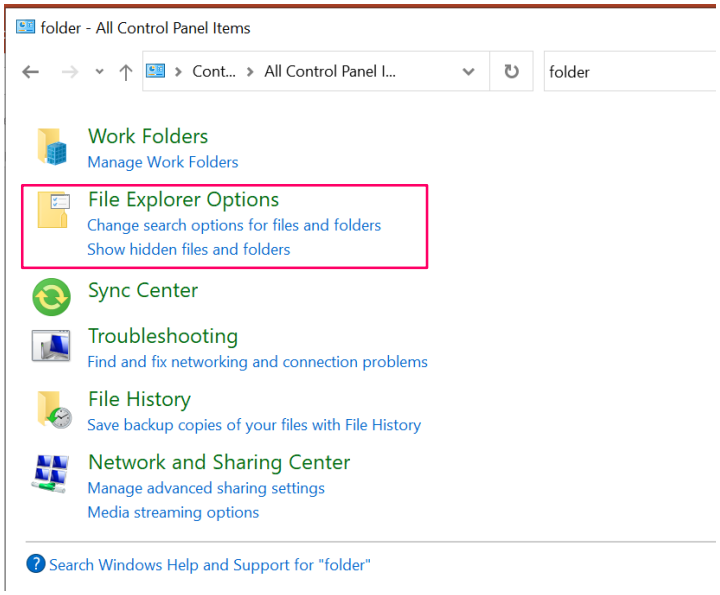


File Extensions and Attributes

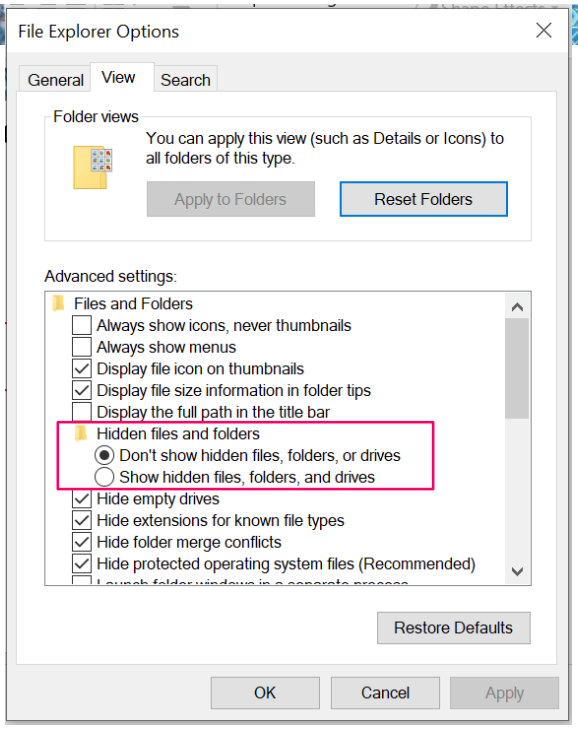
- By default, file extensions are hidden. To display the file extensions you must disable the Hide extensions for known file types setting in the Folder Options control panel utility.

- Start > Control Panel > Folder Options > View > uncheck

File Extensions and Attributes



File Extensions and Attributes



Example-File Extension

.docx - Microsoft Word (2007 and later)
.xlsx- Microsoft Excel
.txt - ASCII text only
.jpg - Graphics format
.pptx - Microsoft PowerPoint
.zip - Compression format

References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.

HNDIT1032 Computer and Network Systems

Week 12- Data Communication & Computer Network

Introduction

- This chapter provides an introduction to Computer networks and covers fundamental topics like data, information to the definition of communication and computer networks.
- The main objective of data communication and networking is to enable seamless exchange of data between any two points in the world.

Data Communications

- Data Communication is a process of exchanging data or information
- In case of computer networks this exchange is done between two devices over a transmission medium.
- This process involves a communication system which is made up of hardware and software.

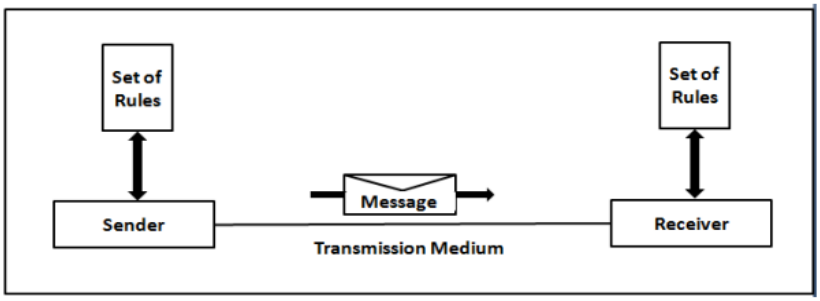
Characteristic of Data Communication

- The effectiveness of any data communications system depends upon the following three fundamental characteristics
  - Delivery
  - Accuracy
  - Timeliness
  - Jitter

- **Delivery.** The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.
- **Accuracy**. The system must deliver the data accuracy. Data that have been altered in transmission and left uncorrected are unusable.
- **Timeliness.** The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.
- **Jitter.** Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets. For example, let us assume that video packets are sent every 30 ms. If some of the packets arrive with 30-ms delay and others with 40-ms delay, an uneven quality in the video is the result.

Components of Data Communication

1. Message
2. Sender
3. Receiver
4. Medium
5. Protocol



- **Message.** The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.
- **Sender.** The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.
- **Receiver.** The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.
- **Transmission medium**. The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.
- **Protocols**. A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices. Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.

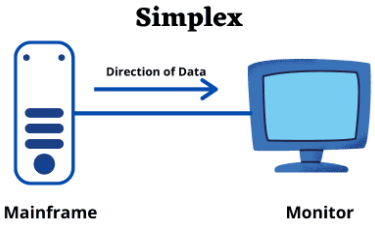
Data Flow

- Two devices communicate with each other by sending and receiving data.
- The data can flow between the two devices in the following ways.
  - Simplex
  - Half Duplex
  - Full Duplex

Simplex

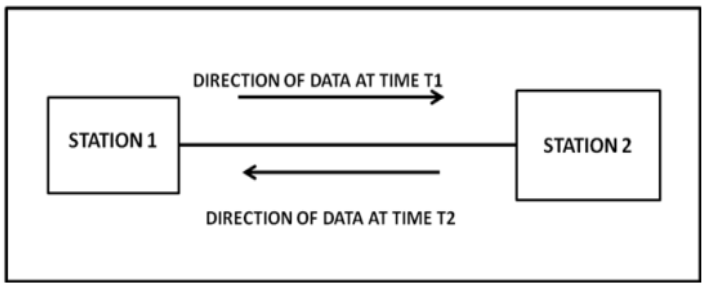
- In Simplex, communication is unidirectional Only one of the devices sends the data and the other one only receives the data.

- Example: in the below diagram: a cpu send data while a monitor only receives data.



Half Duplex

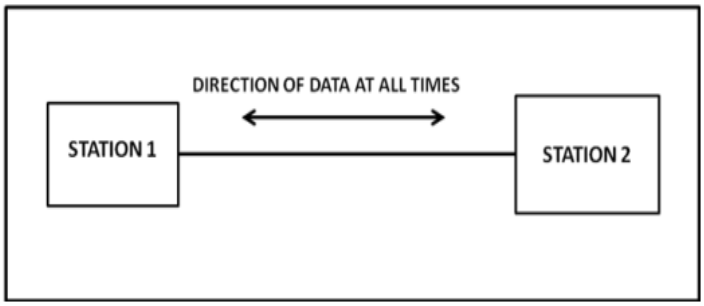
- In half duplex both the stations can transmit as well as receive but not at the same time.
- When one device is sending other can only receive and vice versa (as shown in figure above.) Example: A walkie-talkie.



Full Duplex

In Full duplex mode, both stations can transmit and receive at the same time.

Example: mobile phones



Computer Network

- A computer network can be defined as a collection of nodes.
- A node can be any device capable of transmitting or receiving data.
- The communicating nodes have to be connected by communication links.
- Computer Networks are used for data communications.

Categories of Network

Networks are categorized on the basis of their size.

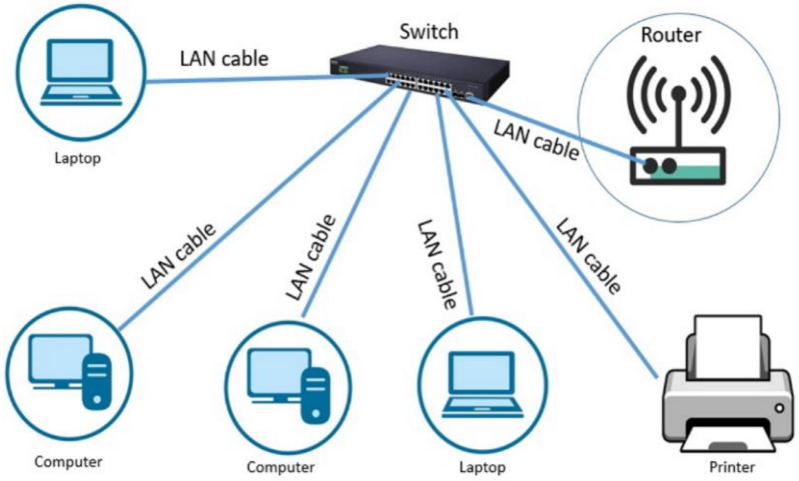
The three basic categories of computer networks are:

- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN).

Local Area Network

- LAN connects computers in a small area like a room, building, office or a campus spread up to a few kilometers.
- They are privately owned networks, with a purpose to share resources and to exchange information.
- The computers in a LAN are generally connected using cables.

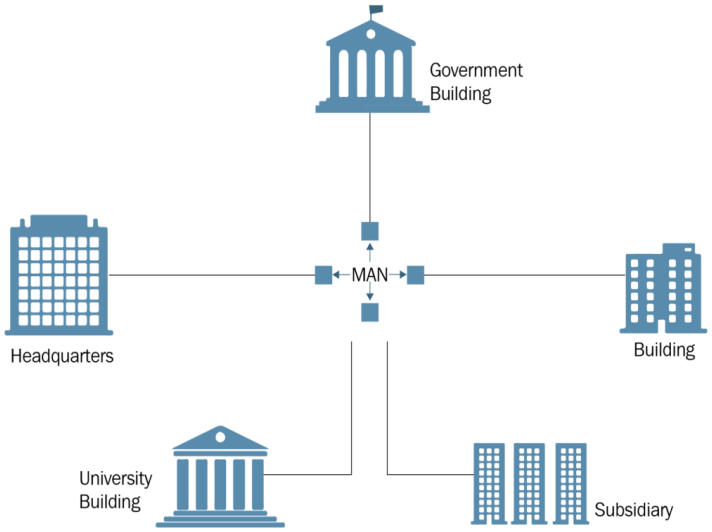
Example-LAN



Metropolitan Area Network

- MAN is a computer network spread over a city. Cable television network is an example of MAN.
- The computers in a MAN are connected using coaxial cables or fiber optic cables.
- MAN also connects several LAN spread over a city

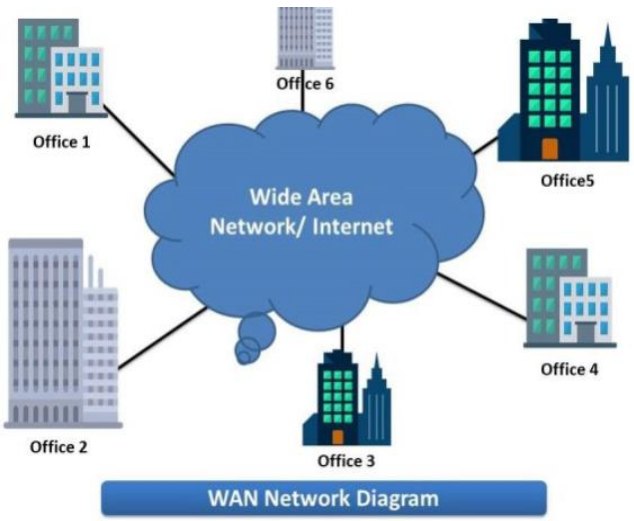
Example-MAN



Wide Area Network

- WAN is a network that connects computers over long distances like cities, countries, continents, or worldwide .
- WAN uses public, leased, or private communication links to spread over long distances.
- WAN uses telephone lines, satellite link, and radio link to connect.

Example-WAN



Advantages of Computer Networks

- Central usage of data
- Anyone can connect
- Data Sharing
- Flexible
- Reliable

Disadvantages

- Cost of network
- Virus and malware
- Lack Robustness
- Lack of independence

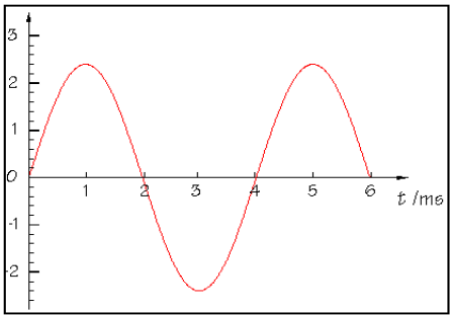
Data & Signal

- To be transmitted, data must be transformed to electromagnetic signals.
- Signal can be
  - Analog
  - Digital

Analog Signal

An analog signal has infinitely many levels of intensity over a period of time.

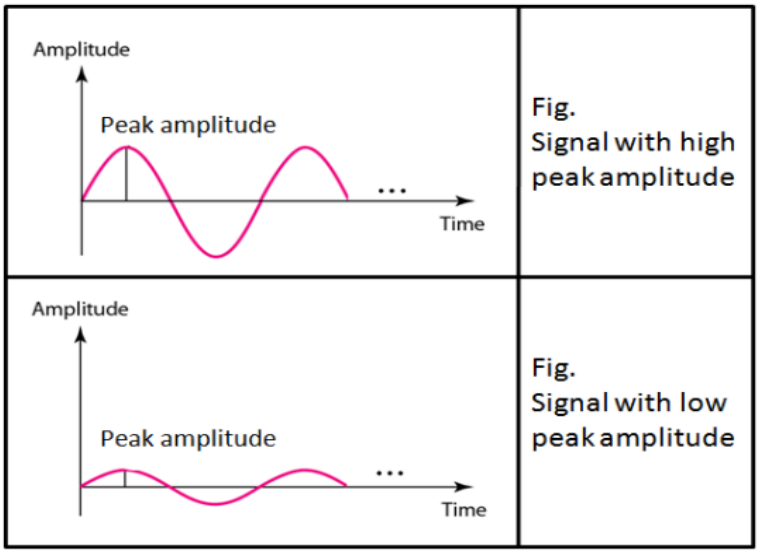
A simple analog signal is a sine wave that cannot be further decomposed into simpler signals.



Characteristic of Analog Signal

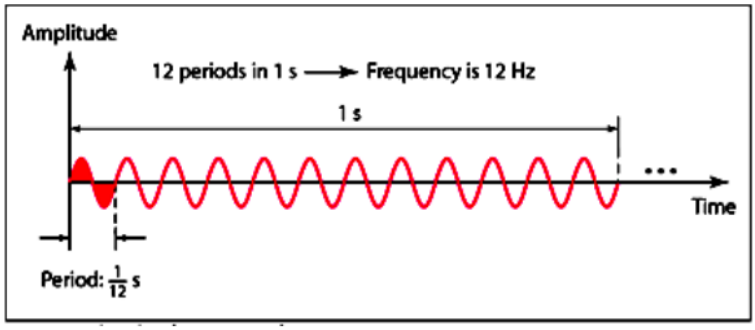
- A sine wave is characterized by three parameters:
  - Peak Amplitude
  - Frequency
  - Phase

Peak Amplitude



Frequency

- **Frequency** refers to the number of cycles completed by the wave in one second.
- **Period** refers to the time taken by the wave to complete one second. (The period is defined as the time needed for one complete cycle of the vibration or oscillation)



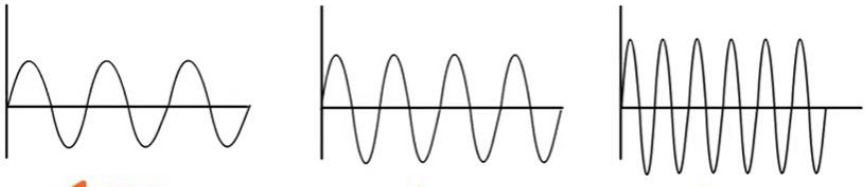
Video

FREQUENCY ?

No of Wave Cycles or No of Oscillations completed in 1 sec.

Denoted by f

S.I unit is Hertz

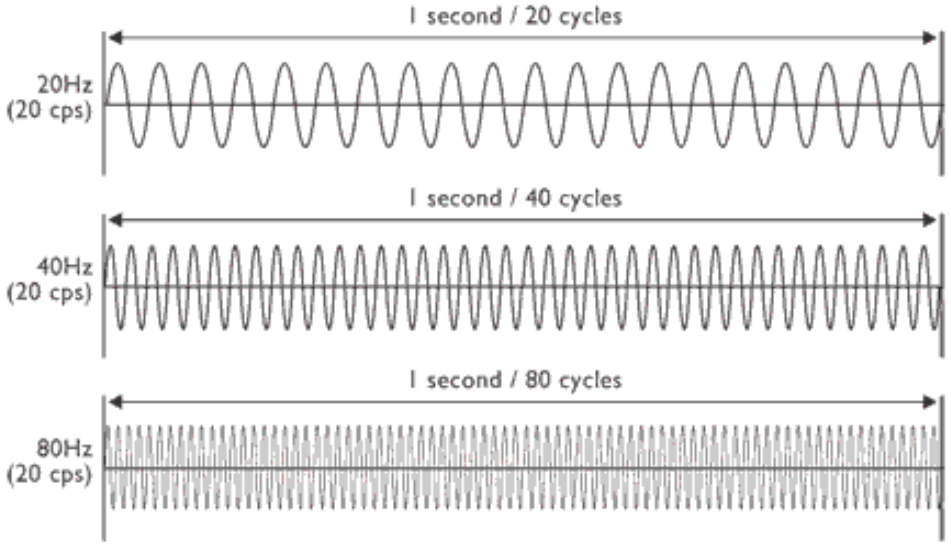


1 sec
3 Wave Cycles
3 Hertz

1 sec
4 Wave Cycles
4 Hertz

1 sec
6 Wave Cycles
6 Hertz

Extra Example for Frequency

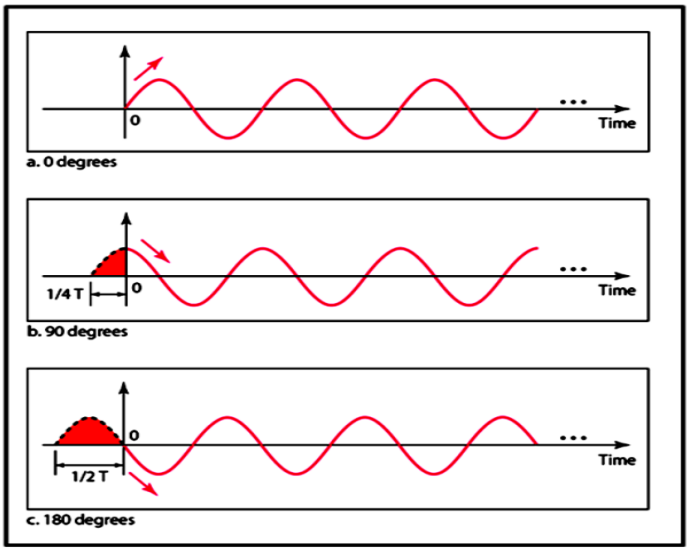


Phase

- It indicates where the wave is in its cycle.
- It is measured in degrees (0°-360°) or radians (0-2π) and is denoted with the Greek symbol Phi (φ).

Different phases of a sine wave.

Phase



Relation between Frequency & Period

$$T = 1/f$$
$$\text{Or}$$
$$f = 1/T$$

Example1. A wave has a frequency of 100hz. Its period(T) is given by

$$T = 1/F = 1/100 = 0.01 \text{ sec}$$

Example2. A wave completes its one cycle in 0.25 seconds. Its frequency is given by

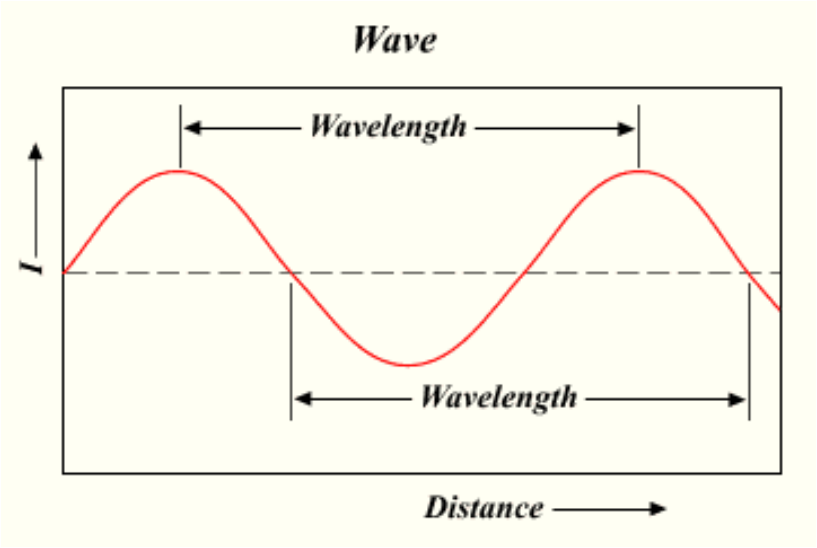
$$F = 1/T = 1/0.25 = 4 \text{ Hz}$$

Wavelength

- The wavelength of a signal refers to the relationship between frequency (or period) and propagation speed of the wave through a medium.
- The wavelength is the distance a signal travels in one period.

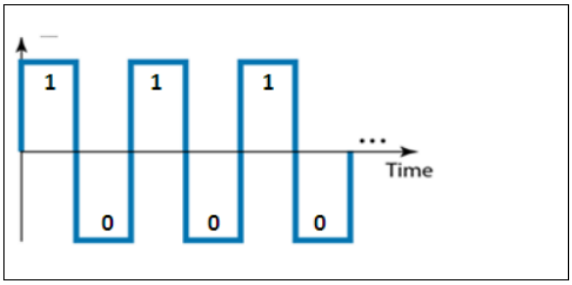
$$\text{Wavelength} = \text{Propagation Speed} \times \text{Period}$$
$$\text{OR}$$
$$\text{Wavelength} = \text{Propagation Speed} \times \frac{1}{\text{Frequency}}$$

Wavelength



Digital Signal

- A digital is a signal that has discrete values.
- The signal will have value that is not continuous.
- Information in a digital signal can be represented in the form of voltage levels.



Bit Interval

- It is the time required to send one bit.
- It is measured in seconds

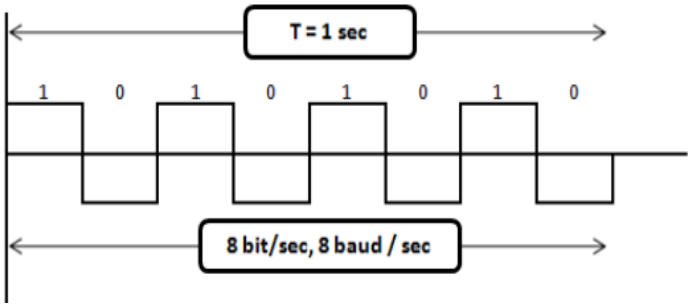
Bit Rate

- It is the number of bits transmitted in one second.
- It is expressed as bits per second (bps).
- Relation between bit rate and bit interval can be as follows.

Bit rate = 1 / Bit interval

Baud Rate

- It is the rate of Signal Speed, i.e the rate at which the signal changes.
- A digital signal with two levels _0‘ & _1‘ will have the same baud rate and bit rate.



Transmission of Digital Signal

Baseband Transmission-

The signal is transmitted without making any change to it (ie. Without modulation)

Broadband Transmission-

In broadband transmission we use modulation, i.e we change the signal to analog signal before transmitting it

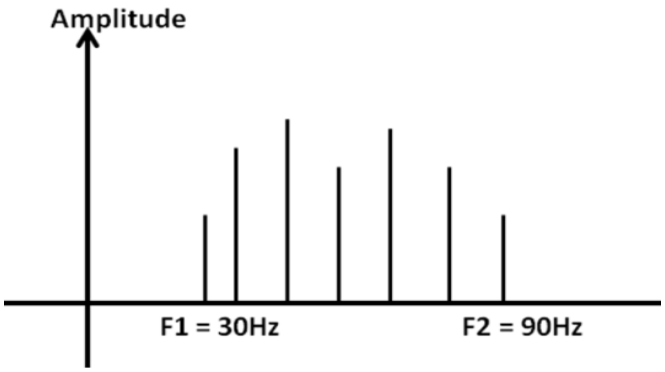
Bandwidth of a Signal

- Bandwidth can be defined as the portion of the electromagnetic spectrum occupied by the signal.

- It may also be defined as the frequency range over which a signal is transmitted.

For example,
A 4kHz signal bandwidth can transmit a telephone conversation whether it is through
- lower frequency, like a wired telephone or
- modulated to a higher frequency, ie cell phone.

Example-Bandwidth



It has a minimum frequency of F1 = 30Hz and maximum frequency of F2 = 90Hz.
Hence the bandwidth is given by F2 – F1 = 90 – 30 = 60 Hz

References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.

HNDIT1032 Computer and Network Systems

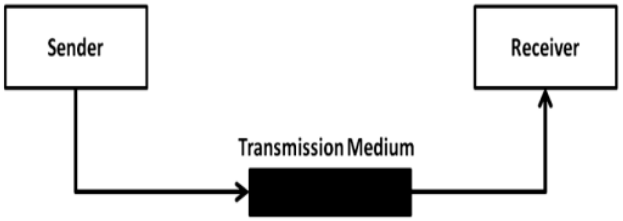
Week 13- Transmission Media & Topology

Introduction

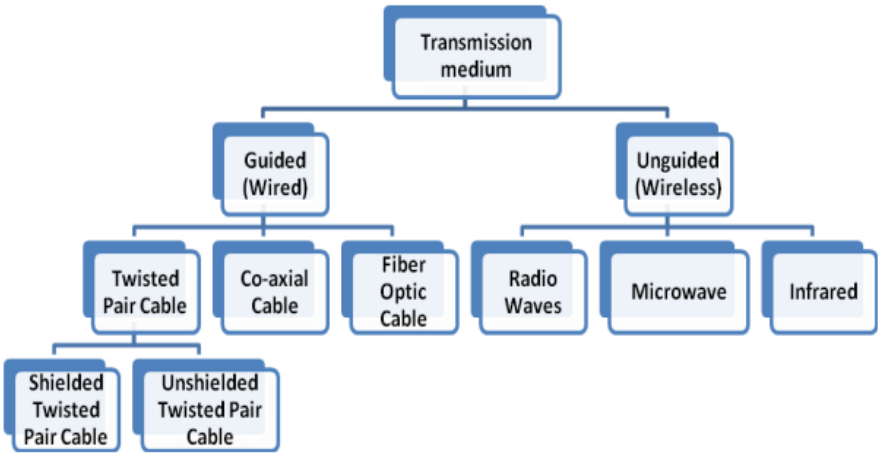
- In Data Communication networking, it is worth understanding the medium through which data passes and what are the available mediums and their types.
- This chapter give a thorough understanding of the different types of transmission medium used for data communication

Transmission Media

- A transmission medium can be defined as anything that can carry information from a source to a destination.
- The transmission medium is usually free space, metallic cable or fiber – optic cable.



Categories of Transmission Media



Guided Media

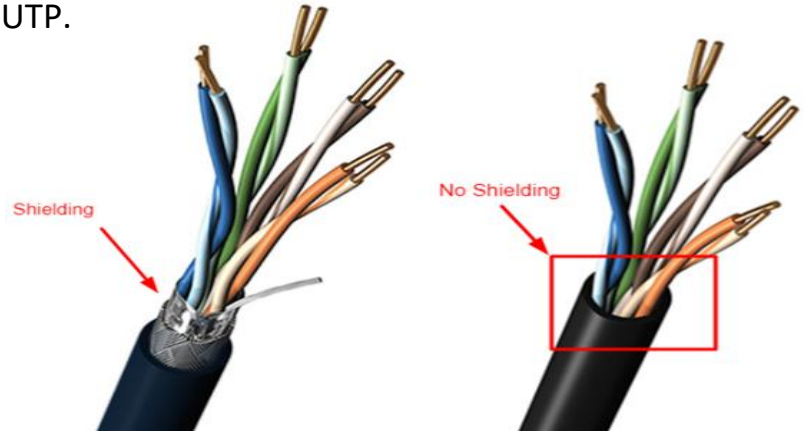
- Guided Transmission media uses a cabling system that guides the data signals along a specific path.
  - Twisted-Pair Cable
  - Coaxial Cable
  - Fiber-Optical Cable

Twisted Pair Cable

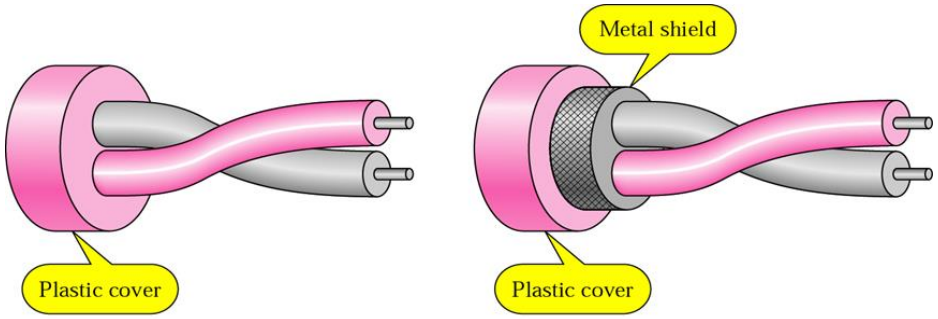
- The wires is twisted together in pairs.
- Twisted pair cables are most effectively used in a system that uses a balanced line method of transmission.
  - Unshielded Twisted pair(UTP)
  - Shielded Twisted Pair(STP)

UTP vs STP

- Cables with the shield are called shielded twisted pair and commonly abbreviated STP.
- Cables without a shield are called unshielded twisted pair or UTP.



UTP vs STP



a. UTP b. STP

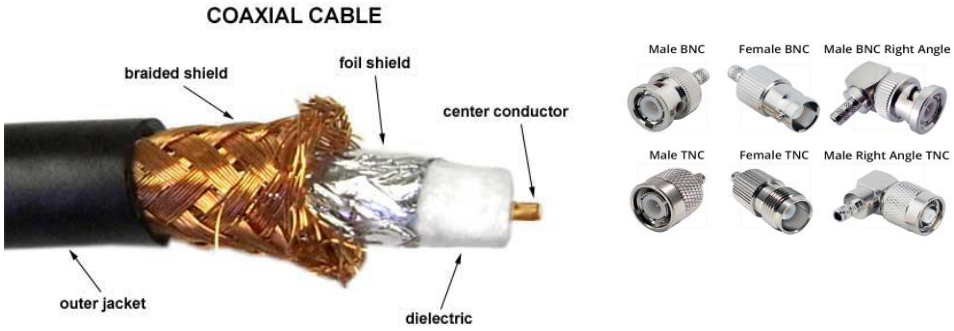
Twisted Pair Connectors

Twisted pair connectors and protective caps, cable and network card

Coaxial Cable

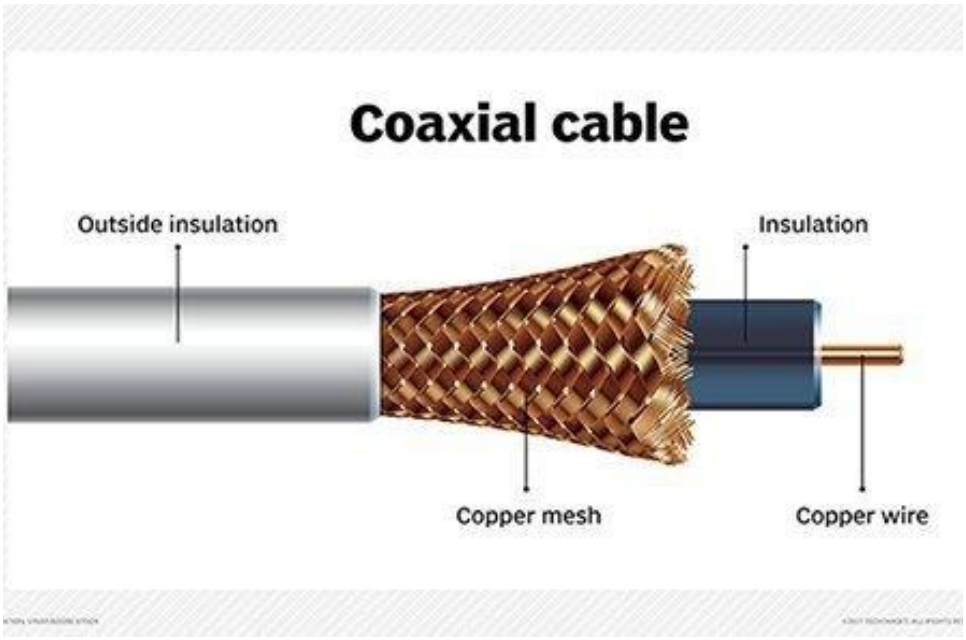
- Coaxial cable consists of 2 conductors.
- The inner conductor is contained inside the insulator with the other conductor weaves around it providing a shield.
- An insulating protective coating called a jacket covers the outer conductor.
- A coaxial cable is **a type of shielded and insulated copper cable that is used in computer networks**

Coaxial Cable Connectors



Extra

It consists of **four primary components**, as follows:
1.A core copper wire, which serves as the primary channel
2.A dielectric plastic insulator, which surrounds the copper
3.A braided copper/aluminum sheath beneath the insulator. This is used to protect from external electromagnetic interference.
4.The last layer, which is made of Teflon or plastic coating, is used to protect the inner layers from physical damage, such as fire and water.

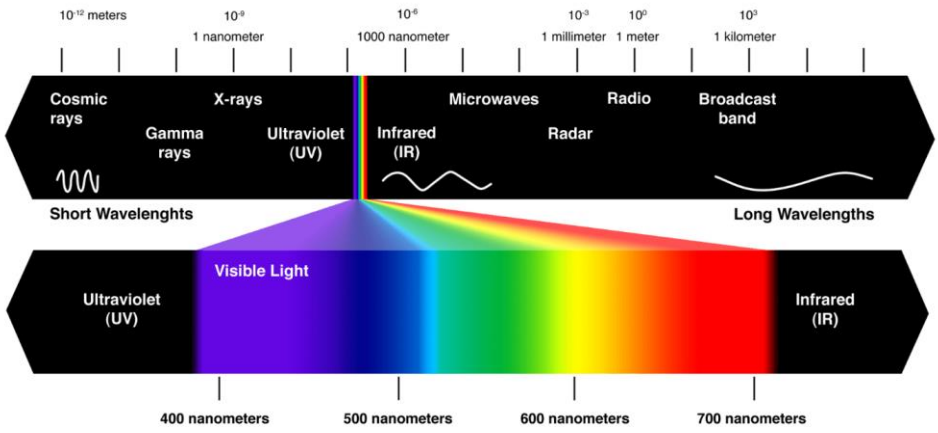


Fiber Optic Cable

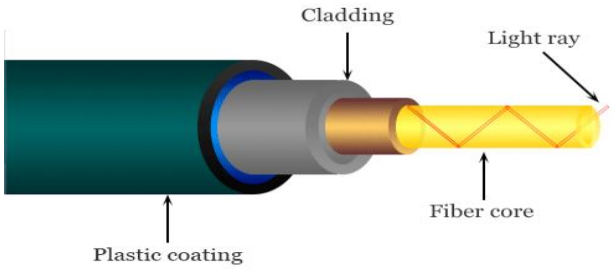
- Optical fiber consists of thin glass fiber that can carry information at frequencies in the visible light spectrum.
- The typical optical fiber consists of a very narrow strand of glass called the cladding.
- The device generating the message has it in electromagnetic form (electrical signal); this has to be converted into light (i.e. optical signal) to send it on optic fiber cable.

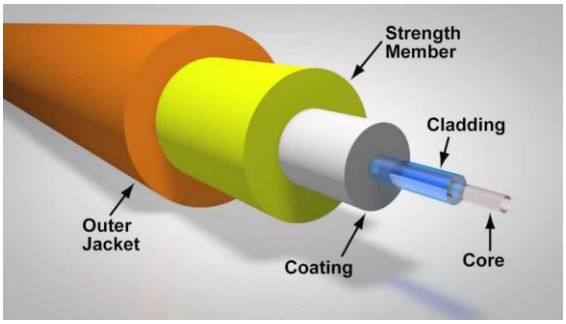
The visible light spectrum

Extra

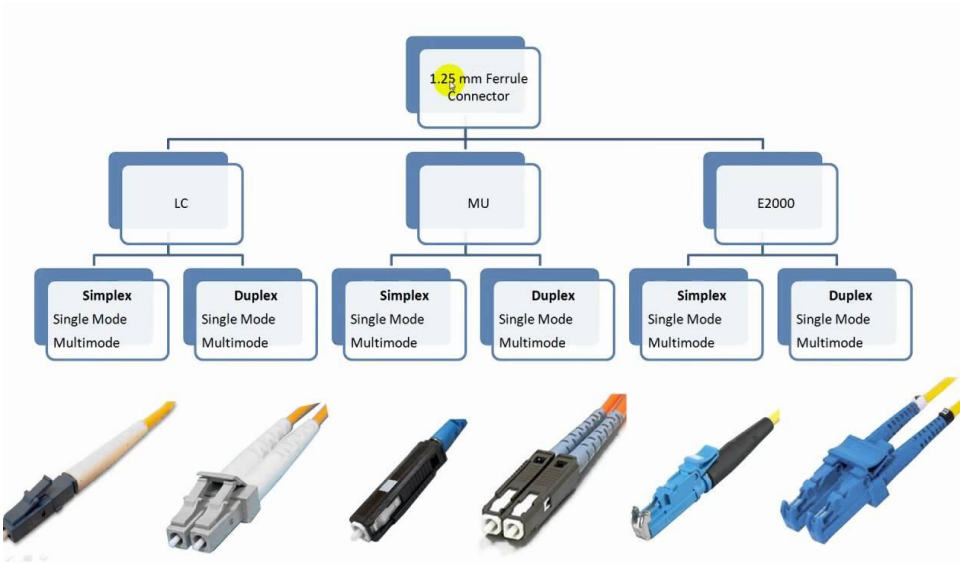


Structure of a Fiber Cable





Types of Fiber Optical Connectors



Advantages of Fiber Cables

- Small size and lightweight
- Easy availability
- No electrical or electromagnetic interference
- Large Bandwidth

Advantages of Fiber Optic Cable

Extra

- **Greater Bandwidth**

  The most notable advantage of a fibre optic cable is that it provides significantly improved performance when it comes to bandwidth. The volume of data that can be transmitted is far greater than and is unrivalled by any other type of cable-based communication.

- **Longer Distances**

  Fibre optic cables are designed to carry signals over much longer distances than traditional cabling as they offer low power loss.

- **Thin & Lightweight**

  Optical fibres are much thinner and lighter than copper wires, allowing them to be drawn into smaller diameters, making them more suitable for places where space is restricted.

- **Superior Carrying Capacity**

  Due to how thin the fibres are, more of them can fit into a given-diameter cable than copper wires.

Advantages of Fiber Optic Cable

Extra

- **Less Interference**

  As fibre optic cables don't carry an electrical signal, they are resistant to electromagnetic interference. Not only does this mean the rate of error is low, but it also helps to enhance the cable's ability to transfer data quickly over longer distances without suffering considerable signal degradation.

  Also, unlike electrical signals, light signals from one fibre don't interfere with those of other fibres.

- **High-Level Security**

  Fibre transmission offers a level of security that simply cannot be matched by other materials. As they don't radiate electromagnetic energy, it is extremely difficult to 'listen' in or tap. This makes it the most secure medium available for carrying sensitive data.

- **Strong, Reliable & Flexible**

  Optic fibres possess greater tensile strength and are sturdier than metal fibres of the same diameter, which means they're less likely to suffer damage. Fibre also isn't as affected anywhere near as much by weather, moisture or corrosive elements as metal wiring can be.

Disadvantages of Fibre Optic Cable

Extra

- **Production & Installation Cost**

  The cost to produce optic fibre cabling is higher than that of copper. Installation is also more expensive as special test equipment is usually required.

- **Fragility**

  As they are made of glass, fibre optic cables are more fragile than electrical wires like copper cabling. If you bend them too much, they will break.

- **Splicing Difficulties**

  When deploying a new fibre optic network or expanding an existing one, the fibres need to be properly sliced in order to avoid network disruptions. This is a very delicate process – if the fibres aren't properly connected, the signal will suffer.

- **Installation & Construction Risk**

  Due to how small and compact the fibre optic cable is, it is highly susceptible to becoming cut or damaged during installation or any construction/renovation activities. It is therefore necessary to consider restoration, backup and survivability.

Fiber Optic Cable Uses

Extra

- **Internet**

  Fiber optic cables are widely used in internet cables due to their ability to transmit large amounts of data at very high speeds.

- **Computer Networking**

  Networking between computers in a single building is made easier and faster with fiber optic cables. This helps to increase the productivity and efficiency of a business as the time is takes to transfer files and information is decreased.

- **Telephone**

  Fiber optic communication allows you to connect faster and have clearer conversations both within and outside the country.

Comparison of Guided Transmission Media

Characteristics	UTP	STP	Coaxial Cables	Fiber Optic Cables
Bandwidth	10 Mbps - 100 Mbps	10 Mbps - 100 Mbps	10 Mbps	100 Mbps -1 Gbps
Maximum cable segment	100 meters	100 meters	200 - 500 meters	2 k.m. - 100 k.m.
Interference rating	Poor	Better than UTP	Better than Twisted Pair Cable	Very good as compared to any other cable
Installation cost	Cheap	Costly than UTP	Costlier than twisted pair wires	Costliest to install
Bend radius	360 degrees / feet	360 degrees / feet	360 degrees / feet or 30 degrees / feet	30 degrees / feet
Security	Low	Low	Low	High

Unguided Transmission(Wireless) Media

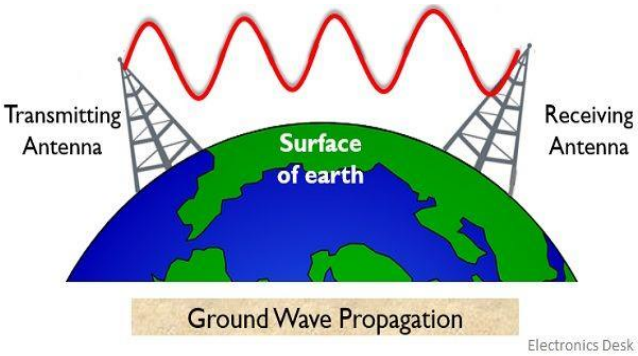
- Unguided media transport data without using a physical conductor.
- This type of communication is often referred to as wireless communication.
- It uses wireless electromagnetic signals to send data.

Types of Unguided Transmission Media

- There are three types of Unguided Media
  - Radio waves.
  - Microwaves.
  - Infrared.

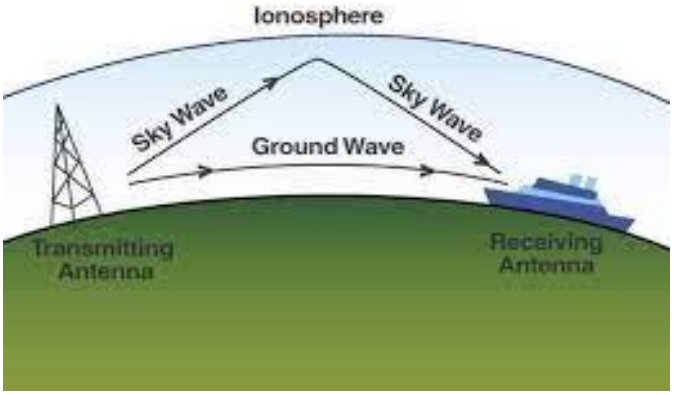
Ground Wave Propagation

- Follows contour of the earth
- Can Propagate considerable distances Frequencies up to 2 MHz
- Example a. AM radio



Sky Wave Propagation

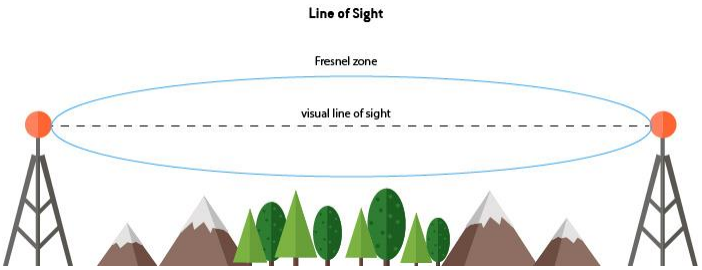
- Signal reflected from ionized layer of atmosphere back down to earth



Line of Sight Propagation

Transmitting and receiving antennas must be within line of sight

Example-Satellite Communication



Satellite and microwave transmission *are two common examples of Line of sight communication*

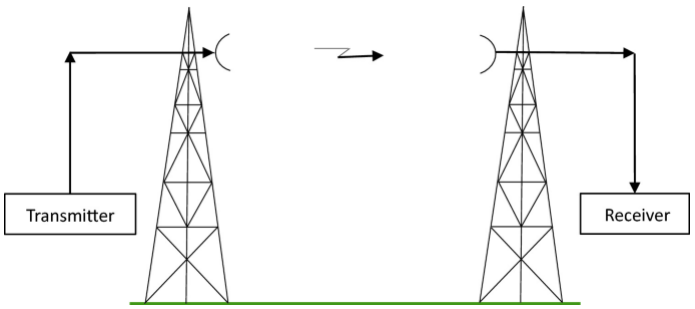
Radio Waves

- Radio waves are omnidirectional when an antenna transmits radio waves they are propagated in all directions.
- Radio waves particularly those waves that propagate in sky mode, can travel long distances.
- Example-AM,FM

Microwaves

- Electromagnetic waves having frequencies between 1 and 300 GHz are called microwaves.
- Microwaves are unidirectional; when an antenna transmits microwaves they can be narrowly focused.
- This means that the sending and receiving antennas need to be aligned.
- Parabolic dish antenna and horn antenna are used for this means of transmission.

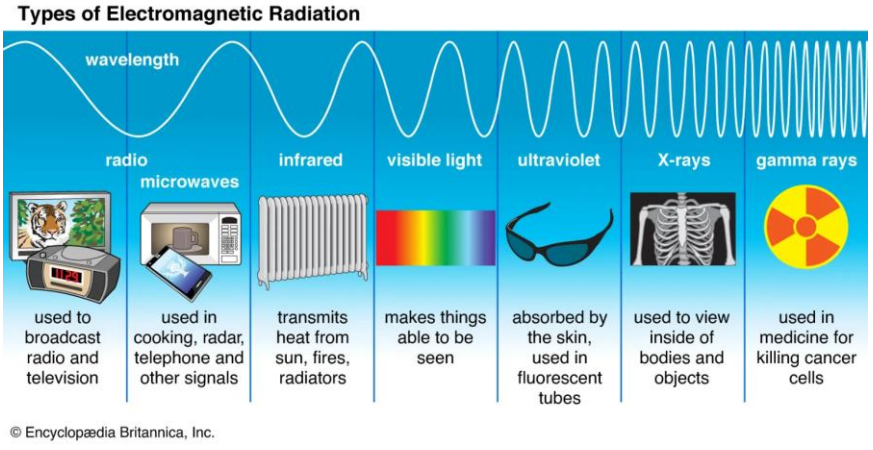
Example-Microwaves



Infrared

- Infrared signals with frequencies ranges from 300 GHz to 400 GHz can be used for short range communication.
- Infrared signals, having high frequencies, cannot penetrate walls.
- There are number of computer devices which are used to send the data through infrared medium e.g. keyboard mice, PCs and printers.

Electromagnetic Spectrum



What is a Topology?

- The virtual shape or structure of a network is referred as topology.

- The pattern or layout of interconnections of different elements or nodes of a computer network is a network topology that might be logical or physical.

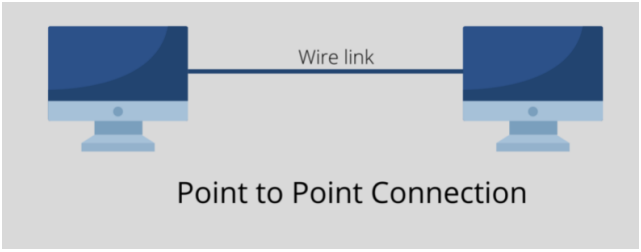
Basic Types of Topology

- Point-to-point
- Bus (point-to-multipoint)
- Ring topology
- Star topology
- Hybrid topology
- Mesh topology
- Tree topology

Point-to-point

It is the basic model of typical telephony.

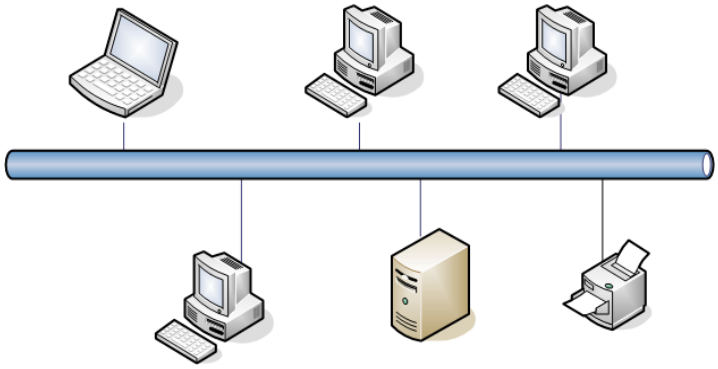
The simplest topology is a permanent connection between two points.



Bus

- LANs that make use of bus topology connects each node to a single cable.
- Some connector connects each computer or server to the bus cable.
- Easy to connect a computer or peripheral to a linear bus. Requires less cable length than a star topology.
- If there is a break in the main cable then entire network shuts down.

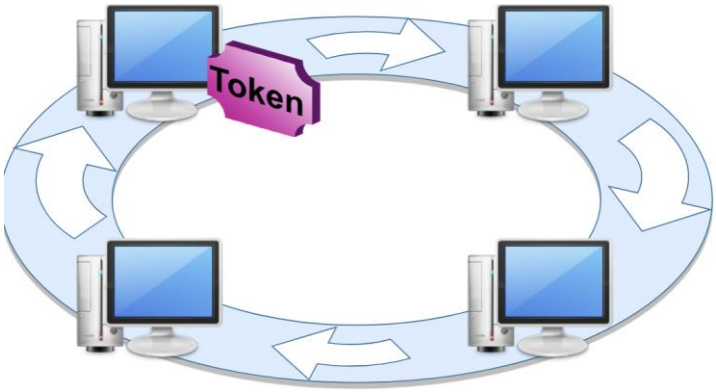
Example-Bus Topology



Ring

- A network topology is the physical architecture of how the computers connect to each other.
- The ring topology is relatively easy to set up, at least on small scales.
- Any single device failure can bring down the entire loop.

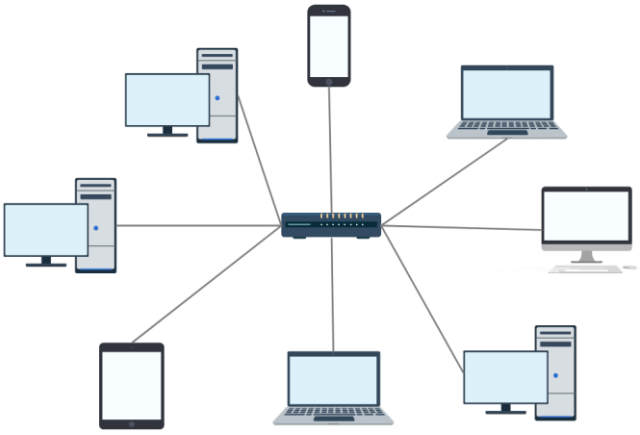
Example-Ring Topology



Star

- The topology when each network host is connected to a central hub in LAN is called Star. Each node is connected to the hub with a point-to-point connection.
- Easy to install and wire & easy to detect faults and to remove parts.
- Requires more cable length.
- More expensive than linear bus topologies.

Star Topology

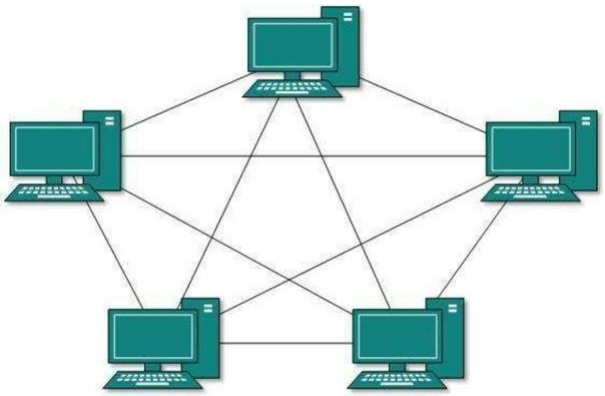


Mesh

- This setup involves the connection of some nodes to more than one nodes in the network via point-to point link.

- In such connection it is possible to take advantage of the redundancy without any complexity or expense of establishing a connection between each node.

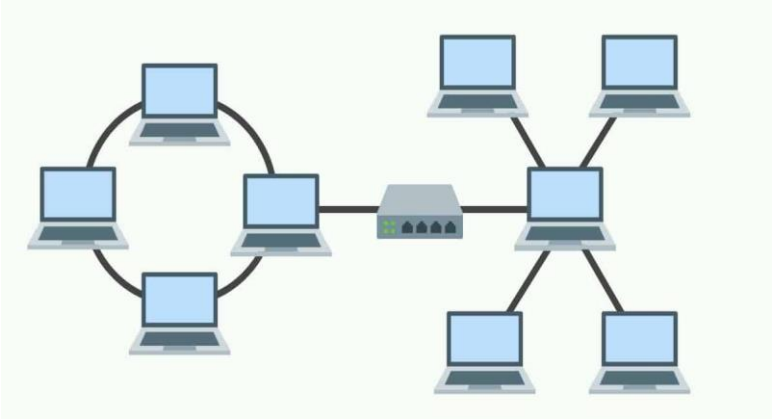
Example Mesh Topology



Hybrid

- Hybrid topologies are a combination of two or more different topologies.
- WANs sometimes have hybrid topologies because they connect a variety of LAN topologies.
- The big advantage of hybrid topologies is that they connect disparate topologies.

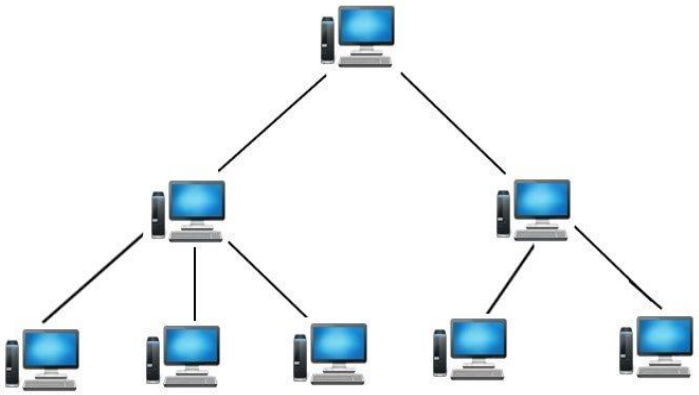
Example Hybrid Topology



Tree

- It may define by experts as tree topology is a combination of bus and star topologies in which all nodes are attached with the help of a single central node.
- Every node in this architecture is connected one to one in a hierarchy level, with each neighbouring node on its lower level.
- Each secondary node has a point-to-point link to the parent node, and all secondary nodes under its jurisdiction have point-to-point connections to the tertiary nodes.
- When examined in a visual sense, these systems resemble a tree structure.

Tree



References

- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.

HNDIT1032 Computer and Network Systems

Week 14- Communication Protocol , Network Devices & Internet

Introduction

- Data networks are a combination of software and hardware components.
- The hardware includes transmission media, devices, and transmission equipments.
- The software allows the hardware to interact with one another and provide access to the network.

Communication Protocol

- A Protocol is defined as a set of rules that governs data communications.
- A protocol defines **what** is to be communicated, **how** it is to be communicated and **when** it is to be communicated.
- For successful communication to occur, the sender and receiver must agree upon certain rules called protocol.

Standards in Networking

- Standards are necessary in networking to ensure interconnectivity and interoperability between various networking hardware and software components
  - ISO International Organization for Standardization
  - ITU-T International Telecommunications Union
  - ANSI American National Standards Institute
  - IEEE Institute of Electrical & Electronics Engineers

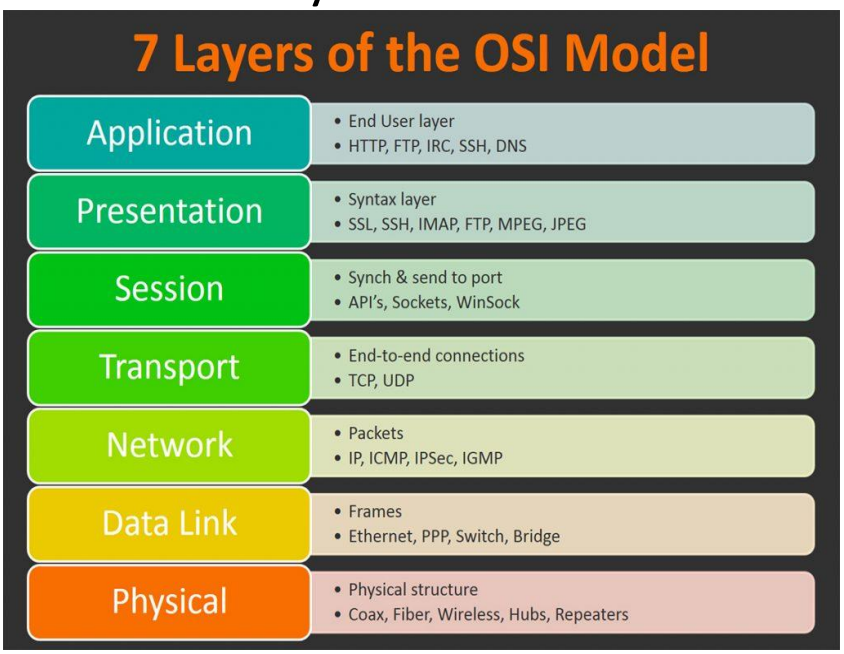
OSI Model

- The International Standards Organization (ISO) has developed a seven-layer reference model for data networks, known as Open System Interconnection (OSI) model.

- The OSI model specifies the functions of each layer.

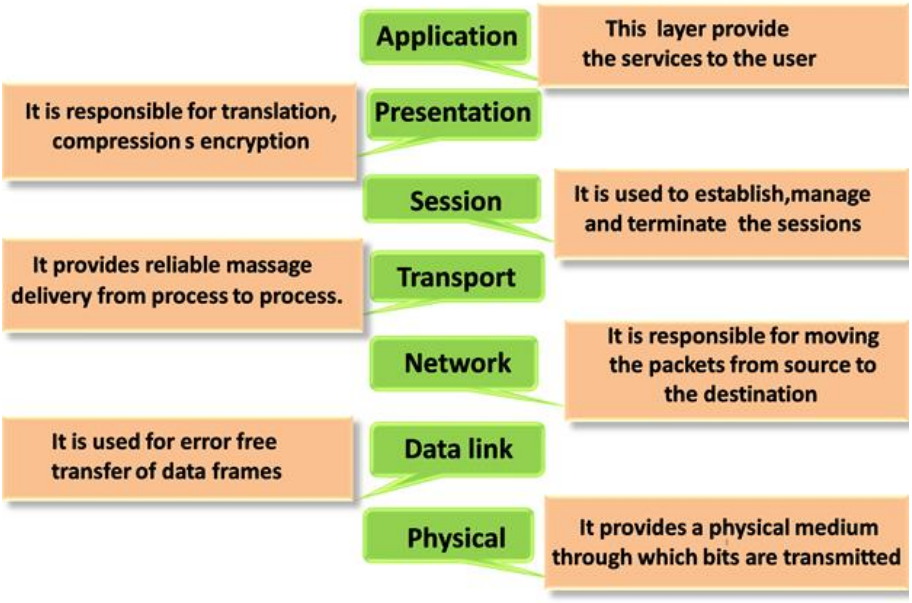
The Open Systems Interconnection (OSI) model **describes seven layers that computer systems use to communicate over a network**

Seven Layers of OSI Model

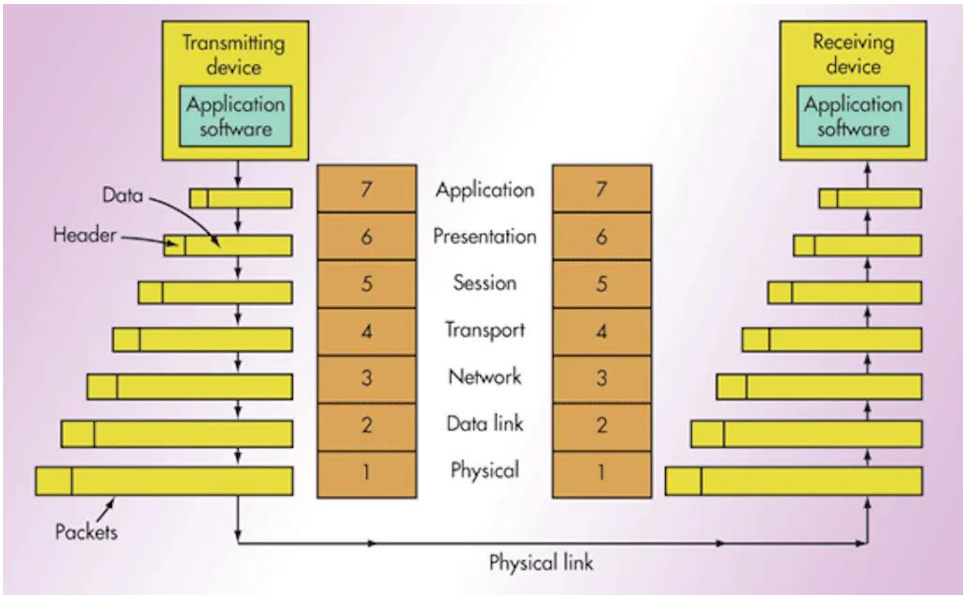


Seven Layers of OSI Model

Extra



Data Transfer in OSI Model



Network Devices

- Moreover there is a need to connect multiple computers and devices.
  - NIC
  - Repeater
  - Bridge
  - Hub
  - Switch
  - Router

Network Interface Card(NIC)

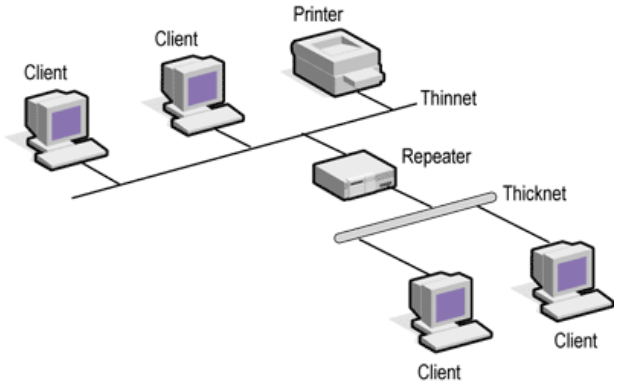
- A Network Interface Card (NIC) is a hardware device through which the computer connects to a network.
- NIC has an appropriate connector to connect the cable to it.
- At the data link layer, NIC converts the data packets into data frames, adds the Media Access address (MAC address) to data frames.

Example-NIC

Repeater

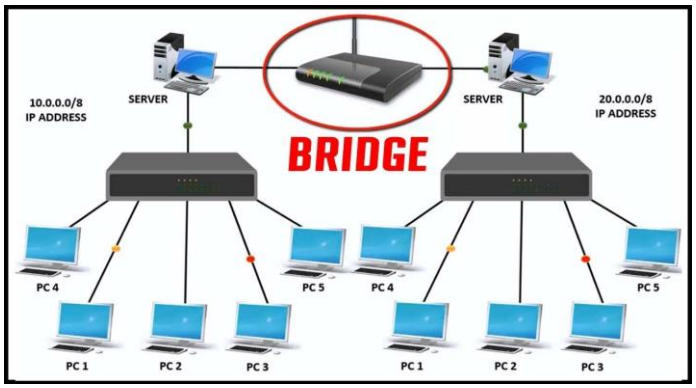
- Repeaters are used to extend LAN.
- It has only two ports and can connect only two segments of a network.
- Repeaters operate at the Physical layer of OSI reference model.
- They are useful when computers in a network are located far away from each other.

Example-Repeater



Bridge

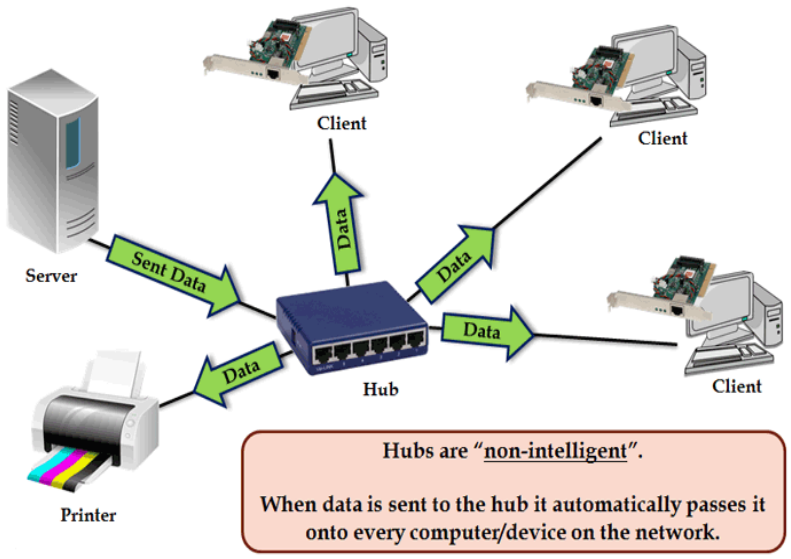
Bridge is used to connect two LAN segments like a repeater; it forwards complete and correct frames to the other segment.



Hub

- Hubs are used to connect multiple segments of the same network.
- Hubs are also used to connect computers to network that use Star topology.
- The port on the hubs can also be used to connect another hub, switch, bridge or router.
- It is preferable to use a hub in a small LAN having about 8–10 computers connected to it

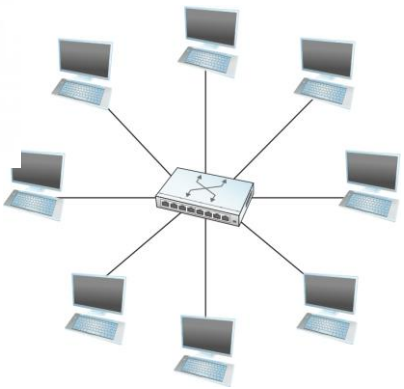
Example-Hub



Switch

- Switch also connects multiple computers in a network or different segments of the same network.
- Switches work at the Data Link Layer of the OSI reference model.
- Since a switch does not broadcast data, but sends the data from the source computer to the destination computer.

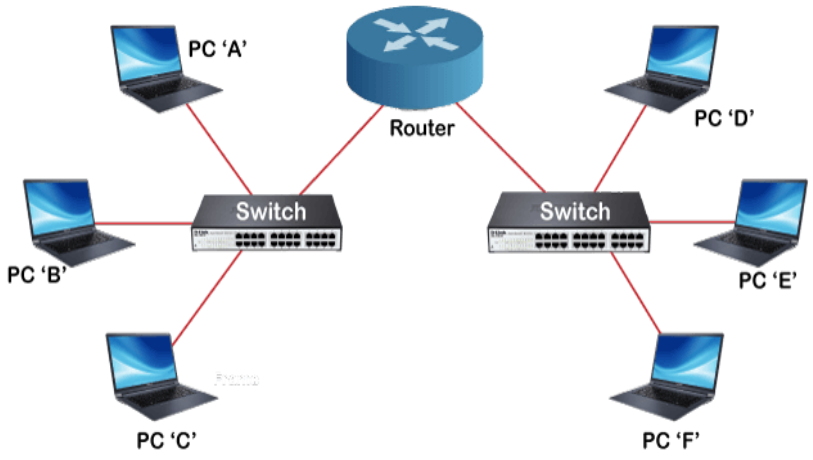
Example-Switch



Router

- A router has a processor, memory, and I/O interface for each network to which it connects.
- A router can connect two LANs, a LAN and a WAN, or two WANs.
- A router is used to interconnect the networks in the Internet.
- Router operates at the Network layer of the OSI model (layer 3).
- A router inspects a given data packet's destination Internet Protocol address (IP address), calculates the best way for it to reach its destination and then forwards it accordingly.

Example-Router

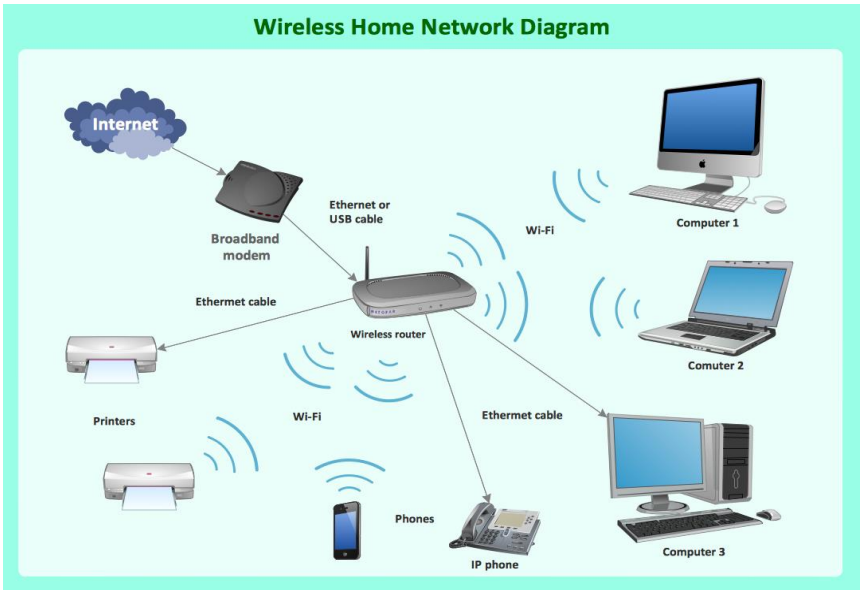


Connection of networks through Router

Wireless Networking

- Wireless network is a computer network connected wirelessly.
- The communication is done through a wireless media like radio waves, infrared or Bluetooth.
- Wireless networks have two main components
  - Access Point
  - Client

Example-Wireless Network



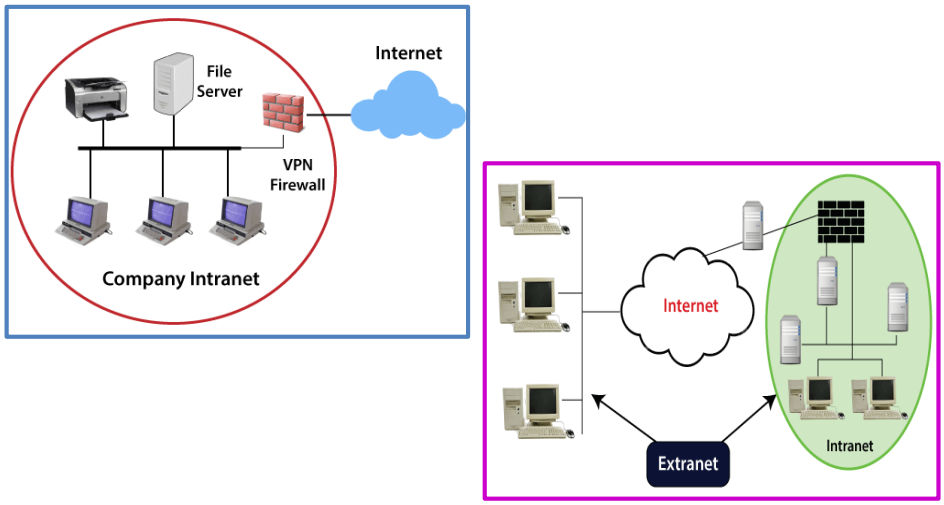
Intranet

- It refers to a private network that companies use for ensuring secure collaboration and communication among all the employees.
- The intranet is very useful when we want to store some useful, crucial information.
- It helps an organization streamline all documents, individuals, projects, tools, etc., within the workplace.

Extranet

- It is a private network existing within an organization.
- But the difference is that the extranet makes use of the internet for connecting to all the outsiders (it happens in a controlled manner).
- Thus, the extranet helps an organization connect with its suppliers and customers.

Example-Intranet & Extranet



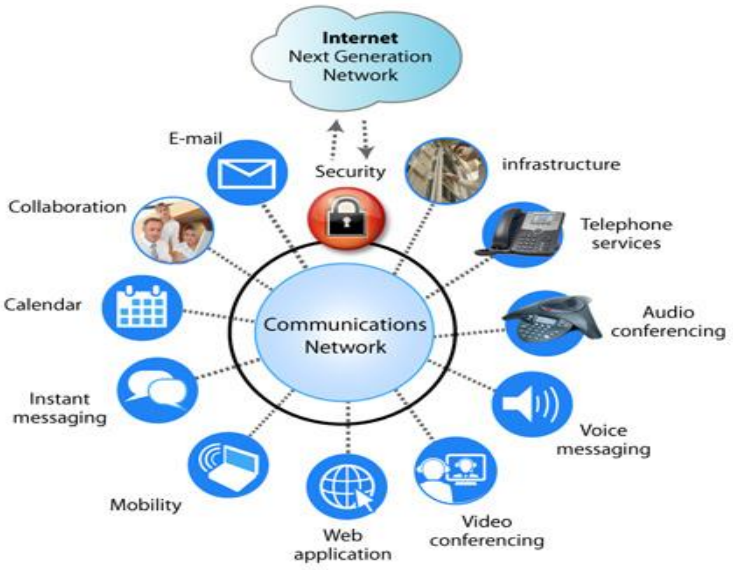
Internet

- Internet is a global network that connects billions of computers across the world with each other and to the World Wide Web.
- It uses standard internet protocol suite (TCP/IP) to connect billions of computer users worldwide.
- It is set up by using cables such as optical fibers and other wireless and networking technologies.

History of Internet

- The networking of computers has its origin at the US Department of Defense Advanced Research Projects Agency (DARPA).
- During 1970's DARPA developed the ARPANET as a WAN to connect different computers and later to connect computers on different networks (Internetworking).

Service of Internet



World Wide Web

- It is a system of creating, organizing, and linking of documents.
- Information is stored on WWW as a collection of documents that are interconnected with each other via links.
- The interconnected documents may be located on one or more than one computer, worldwide, thus, the name world wide web.

Connecting to Internet

- To be able to connect your computer to the Internet, you require—
  - TCP/IP enabled computer
  - Web browser software
  - An account with an ISP
  - A telephone line
  - A modem or Network Interface Card (NIC)

References

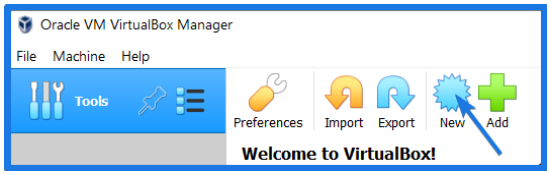
- Clements, A., The Principles of Computer Hardware, Oxford University Press (4th Ed), 2006.

1. Install & Open VirtualBox

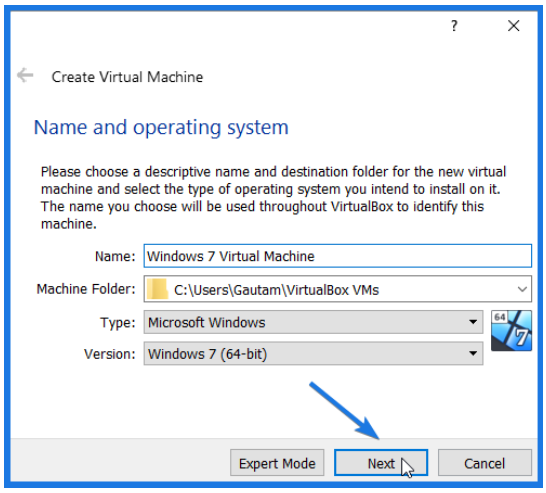
Download & Install VirtualBox from the given link. And after installation is completed

2. Create a Virtual Machine

Click on the New button to create a virtual machine.

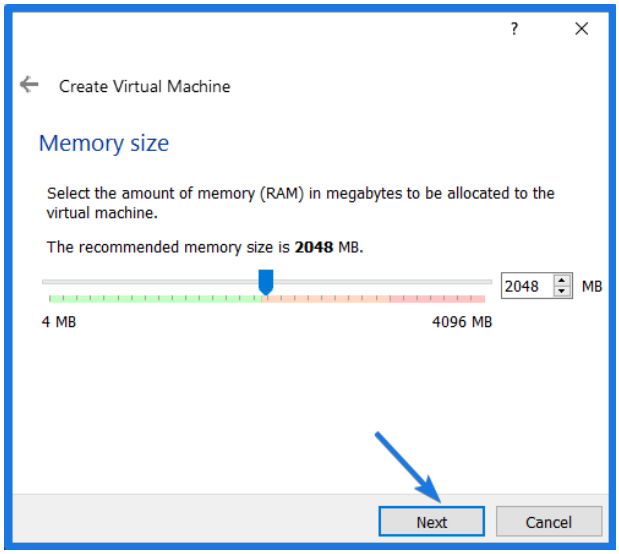


Now it will ask for **Name**, Type of OS like **Microsoft windows** and Version of OS like **Windows 7 64bit**. And then Click on **Next**.



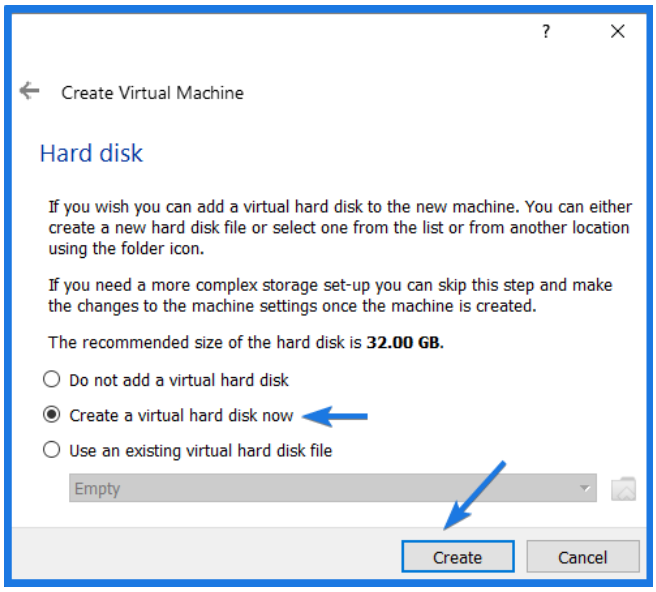
3. Memory Size (RAM)

Now select the amount of memory (RAM) to be allocated to the virtual machine. As for the Windows 7 Virtual PC recommended memory size is **2048Mb or 2Gb.**

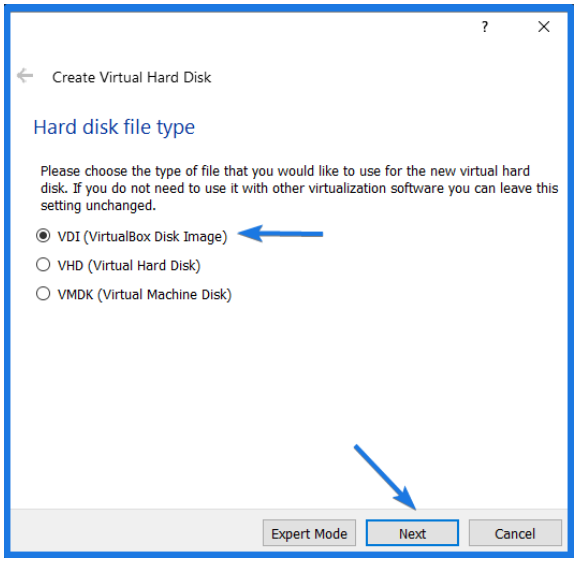


4. Create Virtual Hard Disk

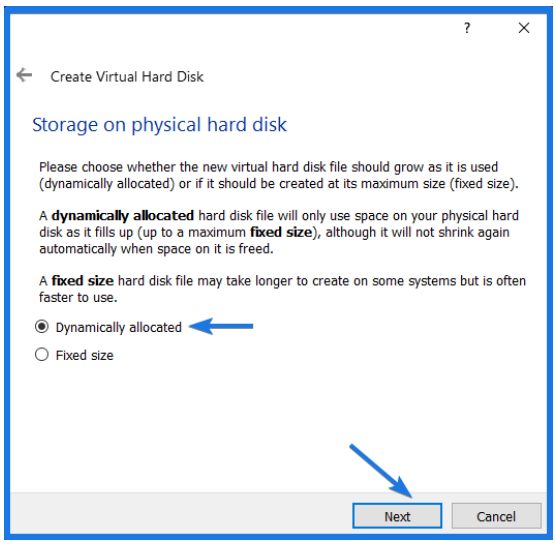
And the next step is creating a virtual hard drive for this virtual machine. And the recommended size is 32Gb. Just click on Create.



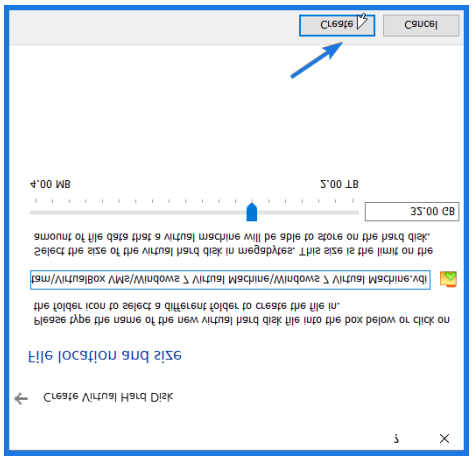
Now select the **VDI (VirtualBox Disk Image)** option as a Hard disk file type.



Now select the **Dynamically allocated** option as a type of storage on the physical hard disk. Click on **Next**.

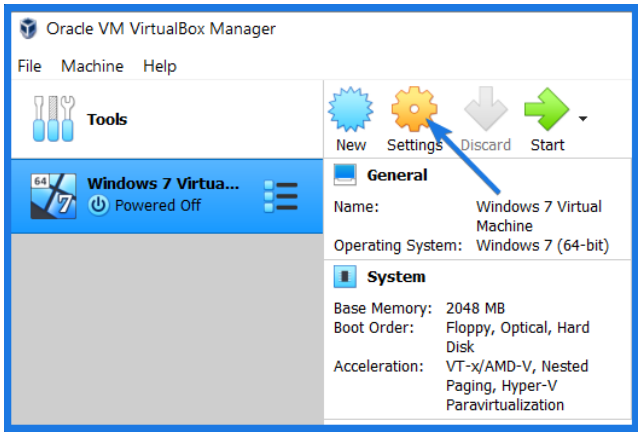


Now Select the **File location and size** of the virtual hard drive.

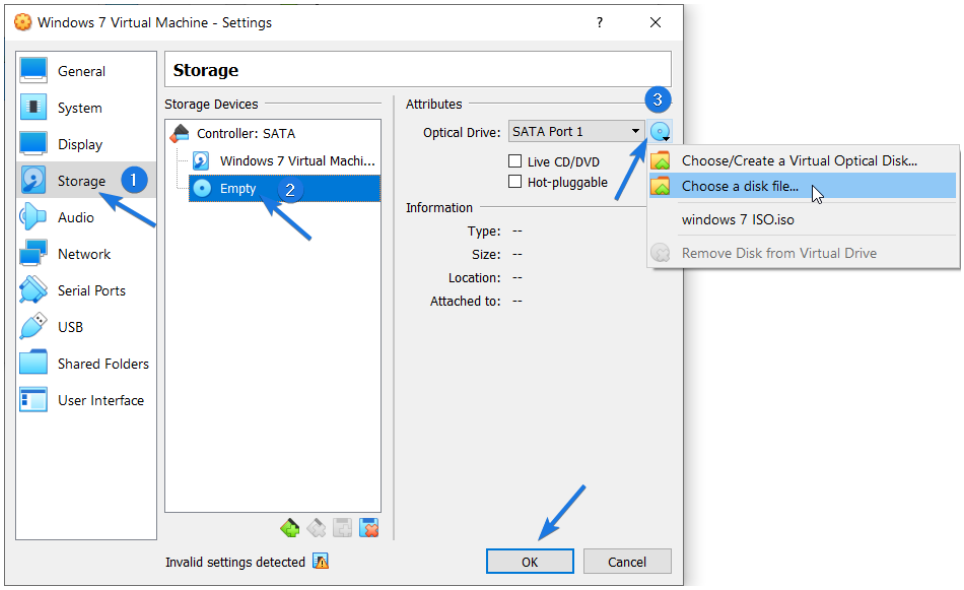


5. Configuring Virtual Machine

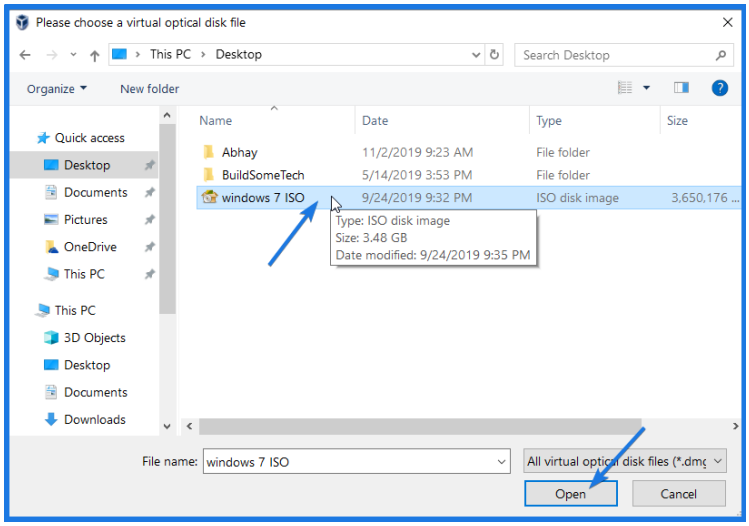
Now your Win7 Virtual machine is ready & here comes the configuration part. Click on **Settings**.



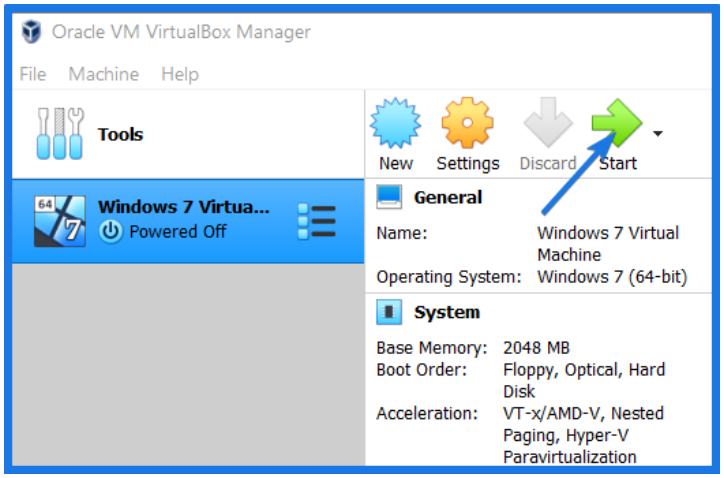
On the next screen, Go to Storage, then in the storage devices Click on Empty and then in optical drives Click on the Cd icon to Choose a disk file… So that you can install windows 7 on VirtualBox from ISO file.



Now Browse to the Windows 7 ISO image file, then Select & Click on Open.



That's it! Your windows 7 Virtualbox is ready to run. So Click on Start & it will start booting and loading the windows 7 files.



And Done! You can see Windows 7 Virtual Machine Running properly.