Unit-1: Introduction to Computer System

Contents: Introduction to Computer, Characteristics, Applications and Classification of Computer, Mobile Computing, Anatomy of a Digital Computer, Computer Architecture, Memory and its Classification, Input and Output Devices, Interfaces.

Introduction

A computer is an electronic machine that takes input from a user, processes the given input and generates output in the form of useful information.

A computer accepts inputs in many forms such as data, programs and user reply.

DATA -> raw details that require processing for generating useful information

PROGRAM -> set of instructions that can be executed by computer in sequential or non-sequential order

USER REPLY -> input provided by the user in response to query asked by computer

Characteristics

1. Speed
   Computer can do any tasks in fractions of second. The speed of the computer is based on its hardware configuration.

2. Storage Capacity
   A computer can store a huge amount of data in many different formats.

3. Accuracy
   A computer carries out any calculation with a 100% accuracy. However, this depends on the configuration of the system and instruction from the user.

4. Reliability
   A computer processes results with 0 error. Mostly the error generated in the computer is due to user's fault.

5. Diligence
   Computer can be set to perform repetitive tasks for numerous times and the result will always be displayed with the same accuracy and efficiency. Computers aren't affected by human traits like dizziness, fatigue, distraction, tiredness, etc.

6. Versatility
   The same computer can be used for many different tasks for many different purposes.

Evolution of Computer

1. **Mechanical Era**
2. **First Generation Computer**
   Employed: 1940 – 1956
   Technology used: Vacuum Tube
   Tasks done: Mathematical Calculation

   Advantages: fast computing in their time, executed complex mathematical problems in efficient manner
   Disadvantages: Operated on machine language (0s and 1s), not flexible for running different applications, large and bulky in size and consumed high power

3. **Second Generation Computer**
   Employed: 1956 – 1963
   Technology Used: Transistors
   Improvements: development of printer, secondary storage, operating system technology, replacement of machine language with assembly language
   Tasks done: Mathematical Calculation

   Advantages: fast computing in their time, easy to program (assembly language), smaller in size and consumed less power
   Disadvantages: I/O devices not improved to considerable extent, generated huge amount of heat, beyond the access of households

4. **Third Generation Computer**
   Employed: 1964 – 1975
   Technology Used: Integrated Circuits (I.C.)
   Improvements: I.C.s made the size of computer smaller, performance efficient and faster and reliable

   Advantages: computational time reduced to nano-seconds, use of high-level language
   Disadvantages: low storage, costly

5. **Fourth Generation Computer**
   Employed: 1975 – 1989
   Technology Used: LSI, VLSI

Improvements: GUI, new Operating System, development of LAN

Advantages: Size and cost minimized, accessible by home users
Disadvantages: complex microprocessor design and fabrication,

6. **Fifth Generation Computer**
   Employed: 1989 onwards
   Technology used: ULSI
   Improvements: portable computers – laptop, pocket computer, PDA, etc. developed,developed parallel processing, invention of optical disk technology, Internet invented

   Advantages: True AI, advanced parallel processing, portability, superconductortechnology
   Disadvantages: sophisticated and complex tools

Classification Of Computer

S. No.	Basis of Classification	Types
1	Operating Principle	Analog Digital Hybrid
2	Application	General Purpose Special Purpose
3	Size and Capability	Micro Computer Mini Computer Mainframe Computer Super Computer

Anatomy of Digital Computer

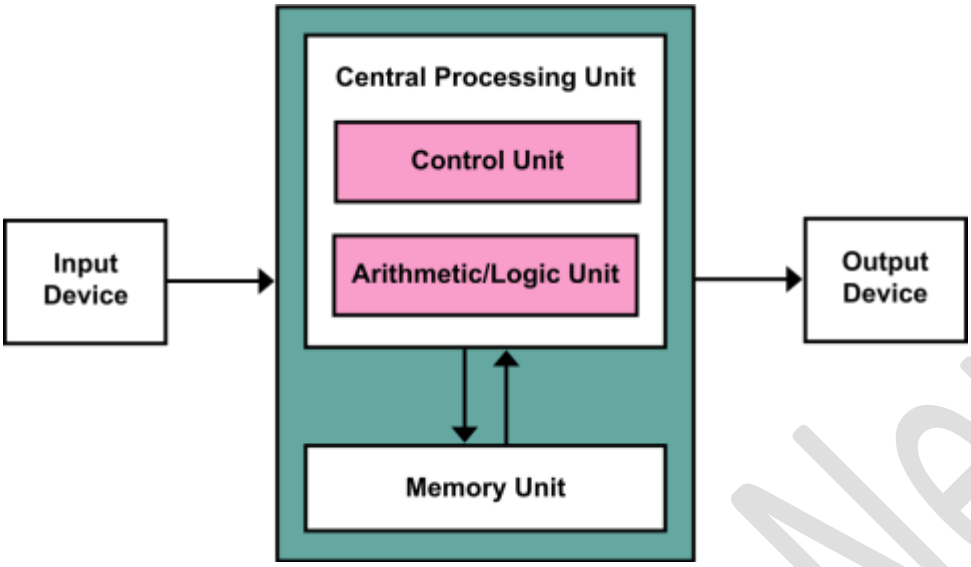


Figure: Vonn-Neuman Architecture/ Block Diagram of Computer

1. **Central Processing Unit**
   It is responsible for processing the data inside the computer system. It is also responsible for controlling all other components of the system.

   The main operation of the CPU includes four phases
   - Fetching instruction from memory
   - Decoding the instruction to decide what operation are to be performed
   - Executing Instructions
   - Storing the result back into memory

   Components of CPU
   1. Arithmetic/ Logical Unit
      ALU does arithmetic and logical operations. Arithmetic operations include addition, subtraction, multiplication and division. Arithmetic unit takes input instruction in the following form:

      opcode + operand + format code

      opcode – operation
      operand – data
      format code – format of the operand, e.g. fixed point or floating point

      Logical unit operates the data logically. Logical operations include greater than (>), less than (<), equals to (=), not equal to (! =), shift left, shift right, etc. This unit makes use of logical gates (AND, OR, NAND, NOR, etc.) to perform logical operations.

   2. Control Unit

This unit of CPU controls the flow of data and information. It maintains the sequence of operation being performed by the CPU. The control unit fetched instruction from storage area, decode the instructions and transmit the corresponding signal to ALU and the storage registers.

3. Main Memory

2. Memory

1. Main Memory

   RAM is the primary or main memory. It is volatile in nature and holds the data for a short period of time only, that is only until the system is running. Files and instructions are saved in different secondary storage systems and they are fetched to the RAM before the execution. This technique is known as swapping. Memory space available in the main memory directly affects the speed of the computer.

2. Cache Memory
   It is the smallest and fastest form of memory. The contents that requires to be fetched frequently are stored in the cache memory. Therefore, the processor before looking for the content in RAM checks here and goes to RAM only if the content isn't available here. Cache memory is always placed between RAM and the processor.

3. Register
   There are special purpose temporary storage units which are called registers. They are the form of memory with the highest transfer speed. These registers are used for holding instructions, data and intermediate results that are currently being processed.
   Examples: Program Counter (PC), Instruction Register, Memory Address Register, Memory Buffer Register, Memory Data Register, Accumulator, etc.

3. **Input Device**
   They are the computer peripherals that are used to send input signals to the computer for processing. The basic input device is keyboard.
   Example: mouse, scanner, digital camera, etc.

4. **Output Device**
   They are the computer peripherals that are used to display the results of the processed data. The basic output device is monitor.
   Example: speaker, printer, etc.

5. **Mass Storage Device**
   They are the peripherals that are used to store the processed data for future references.
   Example: Hard Drive, Solid State Drive, flash drive, etc.

Memory and Storage System

Besides processing data and getting the results for immediate use computer is used for storing data as well. Therefore, there are two types of memory in a computer system, one for storing data that are currently being handled by the CPU and another for storing data and results for future reference.

The storage system used for handling the running process is called primary memory. They are temporary in nature. And the storage which are used to store data and information for longer term is called secondary memory.

The data and information held by the primary memory can be directly accessed by the CPU using data and address buses. However, the data stored in the secondary memory is to be fetched to the primary memory through I/O channel first and the CPU reads the data from the secondary memory via the primary.

There is a third type of memory as well which is know as internal process memory. These are placed either near to the CPU or inside the CPU itself.

Memory and its types:

1. Internal Process
2. Memory Primary
3. Secondary

Memory Representation

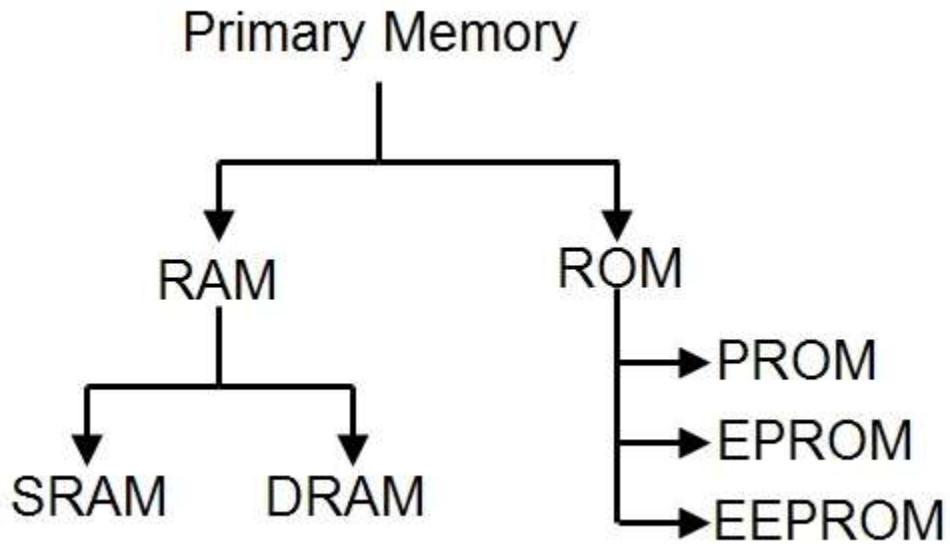
1 Byte = 8 Bits

1 KB = 1024 Bytes

1 MB = 1024 KB = 1048576 Bytes

1 GB = 1024 MB = 1073741824 Bytes

1 TB = 1024 GB = 1099511627776 Bytes



1. **RAM**

It is volatile in nature and loses all its content once the power of the computer is turned off. Hence RAM is used for storing the data and instructions only during the processing. Unlike Secondary form of memory, it is faster in data transfer. It is internal memory. It is also called Read/ Write memory as it can perform both read and write operations.

Ram can be further categorized in two types.

i. SRAM

In this type of RAM data is stored only until the power of the computer is on. It uses numbers of transistors to store a single bit of data. Based on the functioning nature it can be further classified as

a. Asynchronous SRAM

It performs operations without the use of system clock. It makes use of three signals for working, i.e. chip select (CS), write enable (WE) and output enable (OE).

b. Burst SRAM

It works in association with the system clock. Therefore, it is also known as synchronous SRAM. It is used with high-speed applications as the read and write cycles are synchronized with the clock cycle of the processor. The access waiting time gets reduced after the read and write cycle are synchronized.

c. Pipeline Burst SRAM

It uses the pipeline technology in which a large amount of data is broken up into different packets containing data. These packets are arranged in sequential manner in pipeline form and are sent to the processor simultaneously. It can handle large amount of data at a very high speed. In fact, it is the fastest form of SRAM.

ii. Dynamic SRAM

In this type of RAM, data is stored in a storage cell consisting of transistors and capacitors. Unlike SRAM, DRAM needs to be refreshed continuously with power supply because the capacitor has tendency to get discharged. DRAM is of four types.

i. Synchronous DRAM

It performs operation in association with the system clock cycle. It is used with the processor for storing data continuous manner. Continuous form of data storage helps in processing a greater number of instructions per unit time which ultimately increases the speed of data transfer.

ii. Rombus DRAM

It contains multiple address and data line that helps in increasing the data access speed. It is faster than Synchronous DRAM.

iii. Extended Data Out DRAM

It can access more than a bit of data at a time which helps in increasing data access rate. It allows to perform various tasks at a time such as read and write.

iv. Fast Page Mode DRAM

It makes use of paging in which read and write operation is performed by selecting the address of data from rows and columns of the matrix. Use of paging doesn't allow the use of bus at the memory of 66 MHz because of which reading and writing data from matrix consumes a lot of time.

2. ROM

ROM stores data permanently. This means unlike RAM; it can retain data even after the computer is turned off. Generally, contents of ROM cannot be erased, modified or changed. Devices such as calculator, laser printer, etc. uses ROM. It allows sequential access of data. It is divided into four types.

PROM

EPROM

ROM

EEPROM

Flash ROM

i. Programmable ROM (PROM)
It is a memory chip on which write operation can be performed only once. The data on this ROM is written permanently and cannot be erased afterwards. The writing process on such ROM is called 'Burning ROM'. It is mostly used in video games and electronic dictionaries.

ii. Erasable Programmable ROM (EPROM)
In such type of ROM, data can be erased or destroyed using Ultra-Violet (UV) rays. In such, facility of changing the content is available. It facilitates the storage of data for longer terms.

iii. Electrically Erasable Programmable ROM (EEPROM)
It is the type of ROM in which data can be erased or destroyed electrically with the means of electric charge. Here, data can be written or read at the rate of one bit per unit time which makes it slow.

iv. Flash ROM (FROM)
It is a variation of EEPROM that uses floating gate transistors which can store data for a longer period of time. It is mainly used in mobile phones, digital cameras, etc. It is the fastest form of ROM. It uses continuous memory cells for storing data. It is of two types.

a. NAND Flash ROM
b. NOR Flash ROM

Secondary Memory/ Storage System

1. Magnetic Storage System

i. Magnetic Tapes
They are plastic tapes with magnetic coating that are used for data storage. They are similar to normal recording tapes which can be used for storing audio and video. Data can be accessed sequentially.

Advantages:
- low cost and high storage
- easily transportable
- easy to handle and store

Disadvantages:
- low data transmission due to sequential transmission
- low life duration
- required protected environment for storage

ii. Magnetic Disks

It is a flat disk covered with magnetic coating for holding information. It is used to store digital information in the form of small and magnetized needles. It is large in storage size and cheaper than RAM. It allows random access of data and provides the facility of erasing and recording data as many times as required.

Advantages:

- High storage capacity and low cost
- Easy and direct access to data
- Less prone to corruption of data compared to magnetic tapes

Disadvantages:

- Prone to physical damage since it has physical moving part
- Slower than SSDs

2. Optical Storage System

This storage system uses the laser light as the optical medium to retrieve as well as record data. Example: CD-ROM, DVD, CR-R, CD-RW, DVD-R, DVD-RW

They are non-volatile and reliable compare to magnetic tapes.

Advantages:

- Large storage capacity
- Longer life-span than magnetic tapes
- Low 'cost-per-bit' for storage
- Portable

Disadvantages:

- Prone to scratches which could disturb or totally prevent the driver to perform R/W operations

3. **Magneto-Optical System**

It includes the features of both optical and magnetic disks. Its main objective is to store the data in personal computers for longer period of time. It performs R/W operation by making use of laser and optical technology. It has ferro magnetic particles enclosed in plastic coating. The laser beam used for R/W operation gets reflected due to magnetic surface of the disk.

It is slower in speed but it's manufacturing cost is high.

4. **Solid State Drive (SSD)**

It is the device that contain all the properties of hard drive to store the data, and uses the solid- state memory which has no moving part. It uses semiconductors to store data. Its main principle is to process data electronically. Since it has no mechanical moving part, the data access time is faster than that in HDD.

Advantages:

- Better performance – high access speed, random access of data, faster R/W operation
- Low power consumption and hear generation
- Highly reliable
- Small dimension/ compact size Disadvantages:
- High cost
- Lower capacity
- Low storage density
- Vulnerable – data loss, affected by power loss, electrostatic discharges and magnetic fields

Interface

A system of interaction or communication between a computer and another entity such as printer, another computer network or a human user. Devices such as cable, network card, monitor or keyboard that enables interaction or communication between computer and other entity.

Interface is of two types.

1. **Hardware Interface**
   Hardware interface exists in many of the components such as buses, storage devices, other I/O devices, etc. A hardware interface is described by mechanical, electrical and logical signal at the interface and protocols for sequencing them. Hardware interfaces can be parallel with several electrical connections carrying parts of data simultaneously or serially where data can be sent one bit at a time.

   Serial -> 1 bit at a time
   Parallel -> 1 word at a time

2. **Software Interface**
   A software interface may refer to a wide range of different types of interface at different types of interfaces at different levels - an operating system may interface with a piece of hardware; application or program running on the operating system may need to interact via data streams, filters and pipelines. In Object oriented program, object within an application may need to interact via methods.

3. **User Interface**
   A user interface consisting of a set of dials, knobs, operating system commands, graphical display formats and other devices provided by a computer or a program to allow the users to communicate or use the computer or program. The popular means of user interface is Graphical User Interface (GUI) which provides pictorial (picture-oriented) way to interact with the system. GUI is easier to use and user-friendly interface.

Mobile Computing

Mobile computing is human-interaction by which a computer is expected to be transported during normal usage which allows transmission of data and information in different available forms. This involves mobile communication, mobile hardware and mobile software.

- Mobile communication issues include ad-hoc networks and infrastructure networks as well ascommunication properties, protocols, data formats and concrete technologies.
- Mobile software deals with the characteristics and requirements of mobile application.

Example: smartphone, smart card, laptop, wearable computer, etc.

Principles of Mobile Computing

1. Portability – facilitate movement of device within the mobile computing environment
2. Connectivity – availability to continuous connection w/ minimal lag & no interruption while movement
3. Social Interactivity – maintaining the connectivity to collaborate w/ other users
4. Individuality – adapting technology to meet individual needs

Unit-1: Computer Software

Contents: Introduction to Software, Types of Software, Program vs Software, Computer Virus and Antivirus

Introduction to Software

Among the two major components of a computer system, Software is one while Hardware being the other. Software refers to set of computer programs and related data that provide the instructions for telling a computer what to do and how to do. It is a set of instructions that guides the hardware and tells it how to accomplish each task.

Hardware refers to the physical equipment that are necessary for performing various operations such as storing results and providing output to users in desired form.

Types of Software

System Software

It is type of computer software that is designed to operate the computer hardware so that the basic

functionality and a platform for running application software is provided. Operating System and all other utility programs that manages computer resources at low level are system software.

Example: BIOS (Basic Input/ Output System) gets the computer system started after you turn it on, and it manages that data flow between operating system and other attached devices such as hard disk, video adapter, etc. System utilities such as the disk defragmenter and system restore are also system software.

Programming Software

It includes tools in form of programs or applications that software developers take in use to create, debug, maintain and support other programs and applications. Compiler, debugger, interpreter, linker and text editor are the parts programming software.

1. Compiler
   They convert high level language program into low level language program.

2. Assembler
   They convert assembly language program into low level language programs.

3. Interpreter
   It processes high level language line by line and simultaneously produce low level programs.

4. Linker
   Most low-level language allow the developer to develop large program containing multiple modules. Linker arranges the object code of all the modules that have been generated by the language translator into single program.

5. Debugger
   It is a software that is used to detect the errors and bugs in programs. It locates the position of errors in the program codes.

6. Text editor
   It is a program that allows user to work with texts in a computer system. It is used for documentation purpose and enables us to edit information present in existing document or file.

Example: C, C++, C#, BASIC, Java, Python, etc.

Application Software

It is a program of group of programs designed for individual users. It allows end-users to accomplish one or more specific non-computer related task.

Example: Word processor, presentation software, data management system, desktop publisher, web browsers, etc.

Program vs Software

A software is the superset of programs in which one or many programs are executed sequentially or simultaneously to perform a particular job. It is the end product of set of programs.

Example: MS-Excel

A program is a combination of lines of codes which takes input works on instruction on computer to generate output. A program is the group of instructions which when performed will generate a logical output.

Example: addition or subtraction operation in MS-Excel

Summarizing, program is a set of instructions that are executed by computer, where as software is set of programs.

Example: calculator is a software whereas addition, subtraction, etc. are set of programs that exist in the calculator

Computer Virus ad Antivirus

Computer Virus

A computer virus is a set of malicious code or program written to alter the way a computer operates. It is usually designed to spread from computer to computer. A virus operates by inserting or attaching itself to a legitimate program or document support macros in order to execute the codes.

Virus has the potential to cause unexpected or damaging effects such as harming system software by corrupting or damaging data. Once a virus successfully attach itself to a program, file or document, the virus will remain dormant until circumstances cause computer to execute its code. In order for a virus to infect any computer the infected program has to be run in order for the code to be executed.

Signs of Computer Virus

1. Frequent pop-up windows
2. Changes your homepage
3. Mass email being sent from your email account
4. Frequent crashes
5. Slow computer performance

Different types of Virus

1. Boot sector virus
   This type of virus can take control when you start or boot your computer. It spreads by plugging Flash drives.

2. Web scripting virus
   This type of virus exploits the code of web browsers and webpages. It spreads through infected webpages.

3. Browser hijacker
   This type of virus hijacks certain web browser functions and might automatically be directed to unintended sites.

4. Resident virus
   This is the general type of virus that inserts itself in a computer system memory. A resident virus can execute at anytime when operating system loads.

5. Direct-action virus
   This type of function comes into action when you execute a file containing a virus otherwise it remains dormant.

6. Polymorphic virus
   A polymorphic virus changes its code each time the infected file is executed. It does this to invade antivirus.

7. File infector virus
   This common virus inserts malicious code into executable files. i.e. files used to perform certain functions or operations on a system.

8. Macros virus
   Macros virus are written in some macro language used for software application. Such virus spread when you open an infected document often through email attachment.

Antivirus

Antivirus is a type of program designed and developed to protect computer from malware like computer virus, worm, spyware, botnets, boot-kits, keylogger, etc. Antivirus function to scan, detect and remove such viruses from the computer. Most antivirus incorporate both automated and manual filtering abilities. Instant scanning option may check files downloaded from internet, disks that are embedded into PCs and files that are made by software installers.

Features of Antivirus

1. Default deny protection
   It is implemented to prevent the entry of suspicious files by default.

2. Auto sand-box technology
   A virtual environment where suspicious and unknown files are secluded and run to check for any malicious activity without interfering the normal operations.

3. Containment technology
   It validates and authorizes the programs that are executable and ensure that processes are running without affecting the regular operation of the system.

4. Host intrusion protection system (HIPS)
   It terminates any malicious activity once found. This prevents malware from infecting the operating system, registry keys, personal data or the system memory.

Unit-3: Operating system

Contents: Introduction, Functions and Types of Operating System and Open Source Operating System

Introduction

An operating system is a software that makes the computer hardware to work while the computer hardware provides 'raw computer power', the operating system is responsible for making computer more useful for users. The operating system provides an interface for users to communicate with computer. It also manages the use of hardware, resources and enables proper implementation of application programs. In short, the operating system is the master of control program of a computer.

The main function of operating system includes:

1. Operating CPU of the computer.
2. Controlling Input/ Output devices that provides interface between user and the computer.
3. Handling the working of application programs with the hardware and other software system.
4. Managing the storage and retrieval of information using storage devices such as disks.

Functions of Operating System

The main function of operating system is t manage the resources such as memory and files of the computer system. The operating system also resolved the conflicts that arises when two users or programs request the same resources at the same time. Therefore it is also called resource manager of computer. Some of the important functions of operating system are:

1. Process management
   It manages the processes running in the computer system process. A process is basically a program that is being currently run by user or a computer.
   Example: A word processor application program such as MS Word runs processes in a computer system.

2. Memory Management.
   It manages the memory resources of a computer system. There are various resources of computer including primary memory or Random-Access Memory (RAM) and secondary memory like CDs and HDs. All the programs are loaded in the main memory before their execution. It is the function of operating system to determine how much memory should we provide at each process.

3. File Management
   It manages the files and directories of a computer system. A file can be defined as a collection of information or data that is stored in memory of computer system. Every file has a unique mane associated with it. The organization of files and directories in a computer system is referred to as file system. An operating system allows users to create, modify, save or delete files in a computer system.

4. Device Management
   The operating system deals with the management of peripheral devices such as printer, mouse and keyboard attached to a computer system. An operating system interacts with the hardware devices through a specific device driver. The primary task of the operating system is to manage the input/ output operation performed by end-users.

5. Security Management.
   It ensures security for a computer system from various threats such as virus attack and unauthorized access. An operating system uses various technique such as authentication, authorization, cryptography, etc. for ensuring security of a computer system.

Functions of Operating System

Process Management	Memory Management	File Management	Device Management	Security Management

Types of Operating System

Based on the capabilities and the types of application supported, operating system can be divided into six major categories viz.

1. **Batch Processing Operating System**

   They are capable of executing only one job at a time. The jobs a program submitted by different users are grouped into batches and one batch of job is provides as input to the computer system at a time. The jobs in the batch are processed on first come first serve basis. After execution of one job is completed the operating system automatically fetches the next job from the batch without any human intervention.

   Advantages:

   a) They were very efficient in their time as idle time for these computers are very less.
   b) The OS facilitates execution of jobs in organized manner.

   Disadvantages:

   a) Jobs are processed only in the order they are places and not per user's priority.
   b) Debugging of a program at execution is not possible.
   c) The executing jobs may enter an infinite loop as each job is not associated with proper times.

2. **Multi user Operating System**

   The multi user operating system enables multiple users to use the resource of a computer system at the same time. It allows number of users to work simultaneously on the same computer. It is usually implemented by following multiterminal configuration. In the configuration, a single powerful computer is connected to multiple terminals through serial ports. The computer system is responsible for processing different requests generated by various terminals at a time. Control computer is equipped with fast processor and a memory of large capacity for catering to multiple requests of end-users.
   Example: Linux, Unix, VM-386, etc.

   <u>Advantages</u>

   a) Allows resources of computer to be utilized in efficient manner.
   b) It enhances the overall productivity of various users by providing simultaneous access to various computer resources.

   <u>Disadvantages</u>

   a) It is complex and hence difficult to handle and maintain.
   b) It may result in inconsistent data if activities of a user aren't protected from other users.
   c) It is required to have robust security mechanism.

3. Multitasking Operating System

Multitasking operating system allow user to carry out multiple tasks at the same time on a single computer system. The multitasking OS are also known as several other names such as multi-processing, multi-programming, concurrent, or process scheduling operating system. In this type of operating system, different processes are executed simultaneously by implementing the concept of time slicing. According to this concept, a regular slice of CPU time is provided to each of the processes running in the computer system. It can be of two types, viz.

a) Preemptive Multitasking Operating System
   In this OS, slice of CPU time is allocated on some priority basis.

b) Co-operative Multitasking Operating System
   In this OS, time slices of CPU are assigned to the process depending on whether or not to give up CPU control for other running processes.
   Example: UNIX, Windows 2000, Linux, Windows XP.

Advantages:

a) It helps in increasing the overall performance of the system.
b) It helps in increasing overall productivity of user by performing number of tasks at the same time.

Disadvantages

a) Large amount of memory is required to execute several programs at a time.
b) Some mechanisms need to be implemented to ensure that the activity of one process do not interfere with the activities of other processes.

4. Rest- time Operating System

The real-time operating system is similar to multi-tasking operating system in their functionality. However, these OS are specially designed and developed for handling real time applications or embedded applications. The real time applications are those critical application that are required to be executed within a specific period of time.
Example of real time applications are; industrial robots, space-crafts, industrial control applications.

It is of two types, viz.

a) Head Real- time OS
   It is a type of OS where it is necessary to perform a task in a specified amount of time.

b) Soft Real-time OS
   In Soft Real-time OS, a task can be performed even after its allocated time has elapsed.

Example: M tox, Lynx, RTX

Advantages:

a) It is easy to design, develop and execute real-time application under real-time OS.
b) It is usually more compact as compared to other operating system hence requires less memory.

Disadvantages:

a) It is primarily focused on optimizing the execution time of an application and thus it sometimes overlooks some of other critical factor related to overall efficiency of the computer system.
b) It is used only for providing some dedicated functionality and cannot be used as a general-purpose OS.

5. Multiprocessor Operating System

Multiprocessor OS allow the use of multiple CPUs in a computer system for execution of multiple processes at the same time. The processes are executed faster compared to single processor.
Example: Linux, UNIX, Windows 2000, etc.

Advantages

a) It helps in improving the overall efficiency and through put of a computer system.
b) It helps in increasing reliability of a computer. If one CPU fails, other CPU takes control and execute the currently running processes.

Disadvantages:

a) Cost is very high.
b) A large amount of memory is required for running and executing several users program.

6. Embedded Operating System

It is somewhat similar to real-time OS. The embedded OS is installed on an embedded computer system which is used for performing computational task in electronic devices. This OS provides limited functionality that is required for corresponding embedded computer system.
Example: Palm OS, Window CE.

Advantages:

a) It allows implementation of embedded system in efficient manner.
b) System with embedded OS is easy to use and maintain.

Disadvantages:

a) It is possible to perform some specific operation with those OS.
b) This OS cannot be used in frequently changing environment.

Open Source Operating System

Open Source is a methodology or approach towards the design and development of software with the intention of giving user the access to the code. If we use open source software, not only we will be able to use it but also be able to see how it works, debug it, modify it and redistribute it. Open source software is licensed in a way that marked it legal to use as many copies as user wants. There's a core difference between open source and free software, both represent the same core idea but the open resource allows the commercial utilization of code with the motive of profit.

Example: Red hat gains significant revenue from sales, distribution, maintenance and consulting service provided by Open Source Software.

Being an open source program, program code of an open source operating system are available. The user can modify these codes and develop a new application according to their requirement. Example: Linux

Linux

It is an open source powerful UNIX based OS which runs on varieties of platforms including Intel, SPARCE and Power PC. It is a multi-user, multi-tasking, multi-programming operating system mainly popular for server OS. It is distributed through different distributors such as Red Hat, Mandrate, Open Suse, Ubuntu, Slackware, Sobayon, Debian, Mandriva, Fedora, Genten, Granular Linux.

Unit-4: Database Management System

Contents: Introduction to DBMS, DBMS Models, SQL, Database Design and Data Security, Data Warehouse, Data Mining, Database Administrator

What is Database?

Database is a collection of related data and data is a collection of facts and figures that can be processed to produce information.

Mostly data represents recordable facts. Data aids in producing information, which is based on facts. For example, if we have data about marks obtained by all students, we can then conclude about toppers and average marks.

A database management system stores data in such a way that it becomes easier to retrieve, manipulate, and produce information.

Characteristics of DBMS

Real-world entity: A modern DBMS is more realistic and uses real-world entities to design its architecture. It uses the behavior and attributes too. For example, a school database may use students as an entity and their age as an attribute.

Relation-based tables: DBMS allows entities and relations among them to form tables. A user can understand the architecture of a database just by looking at the table names.

Isolation of data and application: A database system is entirely different than its data. A database is an active entity, whereas data is said to be passive, on which the database works and organizes. DBMS also stores metadata, which is data about data, to ease its own process.

Less redundancy: DBMS follows the rules of normalization, which splits a relation when any of its attributes is having redundancy in values. Normalization is a mathematically rich and scientific process that reduces data redundancy.

Consistency: Consistency is a state where every relation in a database remains consistent. There exist methods and techniques, which can detect attempt of leaving database in inconsistent state. A DBMS can provide greater consistency as compared to earlier forms of data storing applications like file-processing systems.

Query Language: DBMS is equipped with query language, which makes it more efficient to retrieve and manipulate data. A user can apply as many and as different filtering options as required to retrieve a set of data. Traditionally it was not possible where file-processing system was used

ACID Properties: DBMS follows the concepts of Atomicity, Consistency, Isolation, and Durability (normally shortened as ACID). These concepts are applied on transactions, which manipulate data in a database. ACID properties help the database stay healthy in multi-transactional environments and in case of failure.

Multiuser and Concurrent Access: DBMS supports multi-user environment and allows them to access and manipulate data in parallel. Though there are restrictions on transactions when users attempt to handle the same data item, but users are always unaware of them.

Multiple views: DBMS offers multiple views for different users. A user who is in the Sales department will have a different view of database than a person working in the Production department. This feature enables the users to have a concentrate view of the database according to their requirements.

Security: Features like multiple views offer security to some extent where users are unable to access data of other users and departments. DBMS offers methods to impose constraints while entering data into the database and retrieving the same at a later stage. DBMS offers many different levels of security features, which enables multiple users to have different views with different features.

Database Models

Data models define how the logical structure of a database is modeled. Data Models are fundamental entities to introduce abstraction in a DBMS. Data models define how data is connected to each other and how they are processed and stored inside the system.

Two types

Entity-Relationship Model

Entity-Relationship (ER) Model is based on the notion of real-world entities and relationships among them. While formulating real-world scenario into the database model, the ER Model creates entity set, relationship set, general attributes, and constraints.

ER Model is best used for the conceptual design of a database.

ER Model is based on:

- Entities and their attributes.

- An entity in an ER Model is a real-world entity having properties called attributes. Every attribute is defined by its set of values called domain.

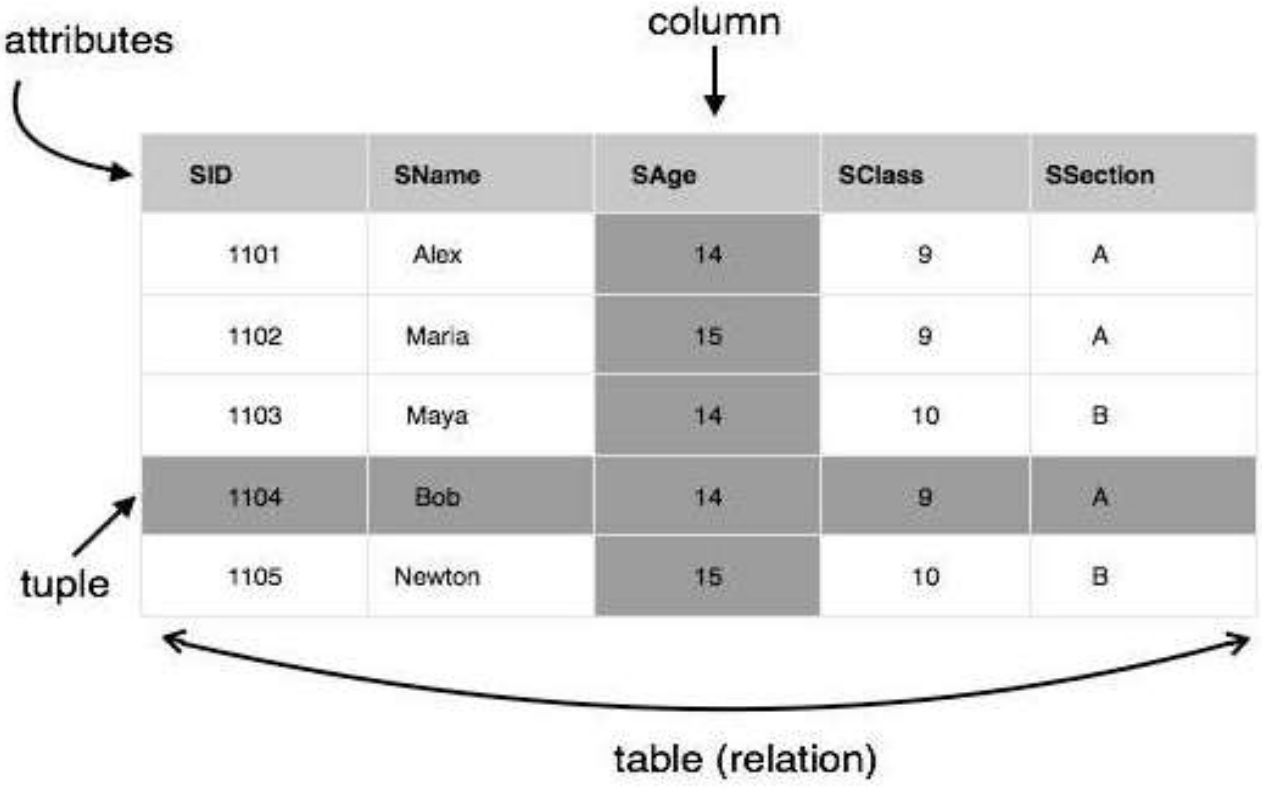
For example, in a school database, a student is considered as an entity. Student has various attributes like name, age, class, etc.

Relationships among entities

The logical association among entities is called relationship. Relationships are mapped with entities invarious ways. Mapping cardinalities define the number of associations between two entities.

Relational Model

The most popular data model in DBMS is the Relational Model. It is more scientific model than others.This model is based on first-order predicate logic and defines a table as an n-ary relation.



SID	SName	SAge	SClass	SSection
1101	Alex	14	9	A
1102	Maria	15	9	A
1103	Maya	14	10	B
1104	Bob	14	9	A
1105	Newton	15	10	B

The main highlights of this model are:

1. Data is stored in tables called relations.
2. Relations can be normalized.
3. In normalized relations, values saved are atomic values.
4. Each row in a relation contains a unique value
5. Each column in a relation contains values from a same domain.

6.

SQL (Structured Query Language)

What is SQL?

SQL is Structured Query Language, which is a computer language for storing, manipulating and retrieving data stored in relational database. SQL is the standard language for Relation Database System. All relational database management systems like MySQL, MS Access, Oracle, Sybase, Informix, postgres and SQL Server use SQL as standard database language.

Why SQL?

Allows users to access data in relational database management systems.

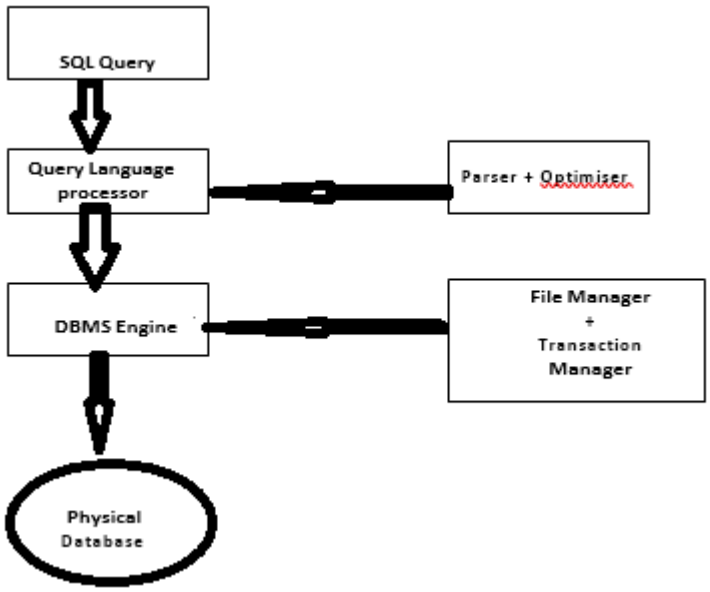
Allows users to describe the data.

Allows users to define the data in database and manipulate that data.

Allows to embed within other languages using SQL modules, libraries & pre-compilers.

Allows users to create and drop databases and tables

SQL Process



When you are executing an SQL command for any RDBMS, the system determines the best way to carry out your request and SQL engine figures out how to interpret the task.

There are various components included in the process. These components are Query Dispatcher, Optimization Engines, Classic Query Engine and SQL Query Engine, etc. Classic query engine handles all non-SQL queries, but SQL query engine won't handle logical files

SQL Commands

The standard SQL commands to interact with relational databases are CREATE, SELECT, INSERT, UPDATE, DELETE and DROP. These commands can be classified into groups based on their nature.

DDL	Data Definition Language:
CREATE	Creates a new table, a view of a table, or other object in database
ALTER	Modifies an existing database object, such as a table.
DROP	Deletes an entire table, a view of a table or other object in the database.
DML	Data Manipulation Language:
INSERT	Creates a record
UPDATE	Modifies records
DELETE	Deletes records
DCL	Data Control Language:
GRANT	Gives a privilege to user
REVOKE	Takes back privileges granted from user
DQL	Data Query Language:
SELECT	Retrieves certain records from one or more tables

Database concepts

A database is a collection of logically related records.

A relational database stores its data in 2-dimensional tables.

A table is a two-dimensional structure made up of rows (tuples, records) and columns (attributes, fields).

Example: a table of students engaged in sports activities, where a student is allowed to participate in at most one activity

Student ID	Activity	Fee

100	Skiing	200
150	Swimming	50
175	Squash	50
200	Swimming	50

Table Characteristics

1. Field

Every table is broken up into smaller entities called fields. The fields in the CUSTOMERS table consist of Student ID, Activity, Fee.

A field is a column in a table that is designed to maintain specific information about every record in the table.

2. Record (Row)

A record, also called a row of data, is each individual entry that exists in a table. For example, there are 4 records in the above table. Following is a single row of data or record in the CUSTOMERS table.

3. Column

each column has a unique attribute name

each column (attribute) description (metadata) is stored in the database order is unimportant

all entries in a column have the same data type

a primary key is an attribute or a collection of attributes whose value(s) uniquely identify each row in a relation

4. Primary Keys

a primary key is an attribute or a collection of attributes whose value(s) uniquely identify each row in a relation

a primary key should be minimal: it should not contain unnecessary attributes

we assume that a student is allowed to participate in at most one activity then the only possible primary key in the above table is StudentID

Sometimes there is more than one possible choice. Each possible choice is called a candidate key

If we allow the students to participate in more than one activity then the only possible primarykey is the combined value of StudentID and Activity

such a multi-attribute primary key is called a composite key or concatenated key

5. Composite Keys

A table can only have one primary key but sometimes the primary key can be made up of severalfields

LicensePlate	State	Make	Model	Year
LVR120	NJ	Honda	Accord	2003
BCX50P	NJ	Buick	Regal	1998
LVR120	CT	Toyota	Corolla	2002
908HYY	MA	Ford	Windstar	2001
UHP33X	NJ	Nissan	Altima	2006

Concatenation means putting two things next to one another.

License Plate is not a possible primary key, because two different cars can have the same license plate number if they're from different states but if we concatenate LicensePlate and State, the resulting value of (LicensePlate, State) must be unique.

example: "LVR120NJ" and "LVR120CT"

6. Foreign Key: A foreign key is an attribute or a collection of attributes whose value are intended to match the
primary key of some related record (usually in a different table)

STATE table:

State Abbrev	StateName	Union Order	StateBird	State Population
CT	Connecticut	5	American robin	3,287,116
MI	Michigan	26	robin	9,295,297
SD	South Dakota	40	pheasant	696,004
TN	Tennessee	16	mocking bird	4,877,185
TX	Texas	28	mocking bird	16,986,510

State Abbrev	CityName	City Population
CT	Hartford	139,739
CT	Madison	14,031
CT	Portland	8,418
MI	Lansing	127,321
SD	Madison	6,257
SD	Pierre	12,906
TN	Nashville	488,374
TX	Austin	465,622
TX	Portland	12,224

primary key in STATE table: StateAbbrev

primary key in CITY table: (StateAbbrev, CityName)

foreign key in CITY relation: StateAbbrev

Database Design

Database design provides a means to represent real world entities in a form that can be processed by the computer. Database models present a process of abstracting real world entities into computer representations.

To develop a good design, one has to understand the meaning of information and the intended use of stored representation within the computer system. Once we develop the understanding and identify the use of information in the application, we can determine how much and what kind of information we require.

After determination of application's information requirement, it will be clear that which data entities represent information redundancies, entities that are critical, useful and are not related to the applications.

It is important to collect and analyze the static and dynamic information available about real world application before starting the database design.

For evolving a good database design, it is important that one uses a model, a database design model. The database design models have following benefits.

They provide a means to represent real-world objects in computer usable form

They capture and represent associations and relationships among the real-world objects, allowing the application designers to capture the dynamic nature of the real-world enterprise's activities.

They define how the objects in the application interact in logical terms

They allow the database designer to capture static and dynamic organization and flow of information within the modeled enterprise.

They allow designers and users of the system to better understand the static and dynamic behavior of the system being modeled.

They help in improving the maintainability, scalability and reliability of the system.

Steps of Database Design

1. Requirement analysis

   To determine how to construct the DBMS for an application, the designer must first determine the scope of the problem requiring the database system.

   Requirement analysis are used to define the scope of the requirement of an application

   It includes

   Defining the human factors of the application

   Defining the application's functionality

   Defining all the information managed and used by the application

   Determining from where to where all interfaces to an application are derived

   Identifying all the resource requirements including hardware, software and other physical resources.

   Deciding on the security requirements and mechanisms

   Defining the quality, reliability, performance and operational aspect of the application.

2. Information Modeling

   The objective of information modeling is to identify the major entities that are fundamental in an application and model them in the target database schema model

   The information collected during the requirement analysis stage forms the input for information modeling. This information will enable the database designer to fully and correctly define the major entities to be modeled in the database

   The attributes that define the entities of the application are grouped together according to the data model used and stored for further reference.

3. Design Constraints

   The database systems require certain controls and limits for it to truly represent the real-world system behavior.

   These limits or controls are called constraints in database parlance

   There are many kinds of database constraints as follows

a. Structural Constraint
b. Type Constraint
c. Range Constraint

d. Relationship Constraint
e. Temporal Constraint

1. Structural Constraint

   The structure of the information within the database gives an idea about entities in the database.

   For example, simple data structures are represented using simple structures while complex data structures will need advanced structures.

   Structural constraints are specified to force the placement of information into structures that best matches the application

2. Type constraints

   A type constraint limits the application to only one representation of information for an entity's attribute.

   For example, the database designer might want to limit the name attribute to a fixed length character string, the age attribute to a number etc. Type constraints allow a limitation of the range of information representations that an attribute can have.

3. Range Constraints

   Range constraints can limit the values an attribute can take. It refers to the possible values that a particular data item can have. Range constraints can be used to limit the value of a particular attribute within a range.

   For example, We can specify that the employee numbers should be in the range 1000-9999.

4. Relational constraints

   These constraints represent relationships on values between entities. For example, there could be a relationship constraint between the entities Manager and Employee that the maximum bonus of manager should not be greater than six times that of the employee

5. Temporal Constraints

   These constraints indicate the time period for which some information is valid. For example, the value of attribute sale tax or exercise duty is valid for a specific period. Once the period is over, new values will come into effect.

Database Security

Database security involves protecting a database from unauthorized access, malicious destruction and even any accidental loss or misuse. Due to the high value of data incorporate databases, there is strong motivation for unauthorized users to gain access to it, for instance, competitors or dissatisfied employees.

1. Authorization

   Authorization is the granting of a right or privilege that enables a subject to have legitimate access to a system or a system's object.

   Usually, a user or subject can gain access to or a system through individual user accounts where each user is given a unique identifier, which is used by the operating system to determine that they have the authorization to do so.

2. Access Control

   Access controls to a database system is based on the granting and revoking of privileges. A privilege allows a user to create or access (that is read, write or modify) a database object or to execute a DBMS utility.

   The DBMS keeps track of how these privileges are granted to users and possibly revoked, and ensures that at all times only users with necessary privileges can access an object.

3. Views

   A view is created by querying one or more of the base tables, producing a dynamic result table for the user at the time of the request. The user may be allowed to access the view but not the base tables which the view is based. The view mechanism hides some parts of the database from certain users and the user is not aware of the existence of any attributes or rows that are missing from the view.

4. Backup and recovery

   Backup is the process of periodically taking a copy of the database and log file to offline storage media. Backup is very important for a DBMS to recover the database following a failure or damage.

5. Encryption

   Encryption is the process of encoding of the data using a special algorithm that renders the data unreadable by any program without the decryption key . Data encryption can be used to protect

highly sensitive data like customer credit card numbers or user password. Some DBMS products include encryption routines that would automatically encode the sensitive data when they are stored or transmitted over communication channels

6. RAID (Redundant Array of Independent Disks)

   The DBMS should continue to operate even though if one of the hardware components fails. The hardware that the DBMS is running on must be fault-tolerant where the DBMS should continue operating and processing even if there is hardware failure.

   The main hardware components that should be fault-tolerant are disk drives, disk controllers, CPU, power supplies and cooling fans

Data Warehouse

Data Warehouse is a collection of data designed to support management decision making. The primary goal of a data warehouse is providing access to the data of an organization, data consistency, capacity to separate and combine data, inclusion of tools set to query, analyze and present information, publishing user data, driving business engineering etc.

A data warehouse essentially combines information from several sources into one comprehensive database. For example, in the business world, a data warehouse might incorporate customer information from a company's point-of-sale systems (the cash registers), its website, its mailing lists and its comment cards. Alternatively, it might incorporate all the information about employees, including time cards, demographic data, salary information, etc.

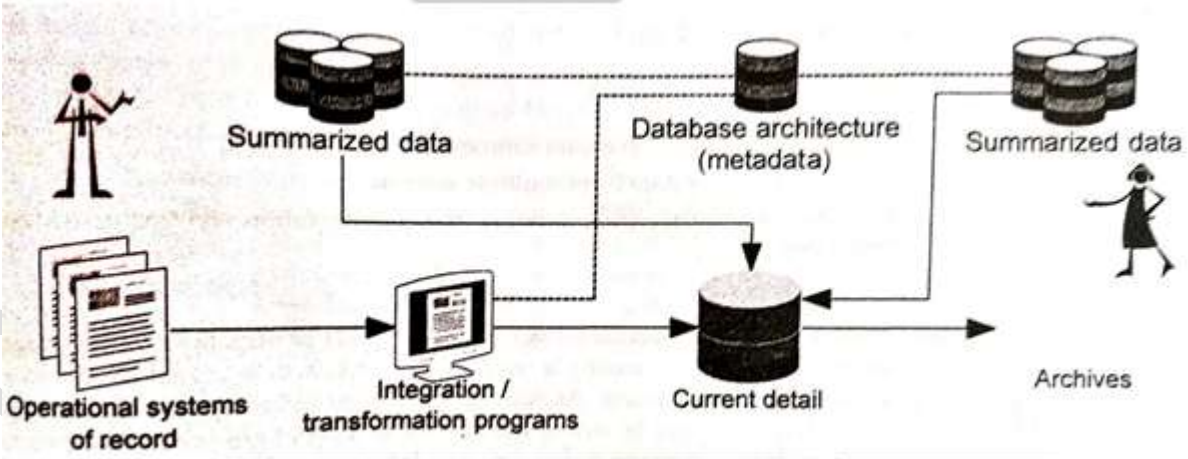


Fig: Concept of Data Warehouse

By combining all of this information in one place, a company can analyze its customers in a more holistic way, ensuring that it has considered all the information available. Data warehousing also makes data mining possible, which is the task of looking for patterns in the data that could lead to higher sales and profits.

The collection of data used by data warehouse may be characterized as subject-oriented, integrated, non-volatile and time-variants.

1. Subject Oriented

   Data is arranged and optimized to provide answer to questions from diverse functional areas. Data is organized and summarized by topic like Sales/Marketing/Finance/Distribution etc.

2. Integrated

   The data warehouse is a centralized, consolidated database that integrates data derived from the entire organization.

3. Multiple Sources
4. Diverse Sources
5. Diverse Formats
6. Time Variant

   The Data Warehouse represents the flow of data through time. It contains projected data from statistical models. Data is periodically uploaded then time-dependent data is recomputed.

7. Non-Volatile

   Once data is entered it is NEVER removed. It represents the company's entire history–Near term history is continually added to it. It is always growing and must support terabyte databases and multiprocessors. It is Read-Only database for data analysis and query processing

Data Warehouse Architecture

The main benefits of implementing a data warehouse are cost-effective decision-making, better business intelligence, enhanced customer service, business re-engineering, information system re-engineering etc.

Data Mining

Data mining refers to extracting or mining knowledge from large amounts of data. It is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems.

The overall goal of the data mining process is to extract information from a data set and transform it into an understandable structure for further use.

The key properties of data mining are

1. Automatic discovery of patterns
2. Prediction of likely outcomes
3. Creation of actionable information
4. Focus on large datasets and databases

Given databases of sufficient size and quality, data mining technology can generate new business opportunities by providing following capabilities

1. Automated prediction of trends and behaviors

   Data mining automates the process of finding predictive information in large databases. A typical example of a predictive problem is targeted marketing. Data mining uses data on past promotional mailings to identify the targets most likely to maximize return on investment in future mailings.

2. Automated discovery of previously unknown patterns

   Data mining tools sweep through databases and identify previously hidden patterns in one step. An example of pattern discovery is the analysis of retail sales data to identify seemingly unrelated products that are often purchased together. Other pattern discovery problems include detecting fraudulent credit card transactions and identifying anomalous data that could represent data entry keying errors

Tasks of Data Mining

Data mining involves six common classes of tasks;

1. Anomaly detection (Outlier/change/deviation detection)

   The identification of unusual data records, that might be interesting or data errors that require further investigation.

2. Association rule learning (Dependency modelling)

   It searches for relationships between variables. For example a supermarket might gather data on customer purchasing habits. Using association rule learning, the supermarket can determine which products are frequently bought together and use this information for marketing purposes. This is sometimes referred to as market basket analysis.

3. Clustering

   It is the task of discovering groups and structures in the data that are in some way or another "similar", without using known structures in the data.

4. Classification

   It is the task of generalizing known structure to apply to new data. For example, an e-mail program might attempt to classify an e-mail as "legitimate" or as "spam".

5. Regression

   It attempts to find a function which models the data with the least error.

6. Summarization

   It provides more compact representation of the data set, including visualization and report generation

Architecture of Data Mining

3. Pattern Evaluation Module:

   This component typically employs interestingness measures interacts with the data mining modules so as to focus the search toward interesting patterns. It may use interestingness thresholds to filter out discovered patterns. For efficient data mining, it is highly recommended to push the evaluation of pattern interestingness as deep as possible into the mining process so as to confine the search to only the interesting patterns.

4. User interface:

This module communicates between users and the data mining system, allowing the user to interact with the system by specifying a data mining query or task, providing information to help focus the search, and performing exploratory data mining based on the intermediate data mining results.
In addition, this component allows the user to browse database and data warehouse schemas or data structures, evaluate mined patterns, and visualize patterns in different forms

Database Administrator

A database administrator (DBA) is a specialized computer systems administrator who maintains a successful database environment by directing or performing all related activities to keep the data secure.

The top responsibility of a DBA is to maintain data integrity. This means the DBA will ensure that data is secure from unauthorized access but is available to users.

DBA is responsible for backing up systems in case of power outages or other disasters. A DBA is also frequently involved in tasks related to training employees in database management and use, designing, implementing, and maintaining the database system and establishing policies and procedures related to the organization's data management policy.

Database administrator can be classified as

1. System DBA Overview

   System DBAs typically have a background in system architecture and are responsible for the physical and technical aspects of a database. This can include installing upgrades and patches to fix program bugs and ensuring that the database works properly in a firm's computer system.

2. Application DBA Overview

   Application DBAs use complex programming languages to write or debug programs that work with the database. Usually this database has been designed for a specific application or a set of applications, such as customer service software.

Unit – 5: Data Communication and Computer Network

Contents: Introduction to Communication system, Modes of Communication, Introduction to Computer Network, LAN Topologies, Transmission Media, Network Devices, OSI Reference Model, Communication Protocols, Centralized vs Distributed System

Introduction to Data Communication

Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable.

For data communications to occur, the communicating devices must be part of a communication system made up of a combination of hardware (physical equipment) and software (programs).

Fundamental Characteristics

The effectiveness of a data communications system depends on four fundamental characteristics: delivery, accuracy, timeliness, and jitter.

1. 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.

2. Accuracy.

   The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable

3. Timeliness.

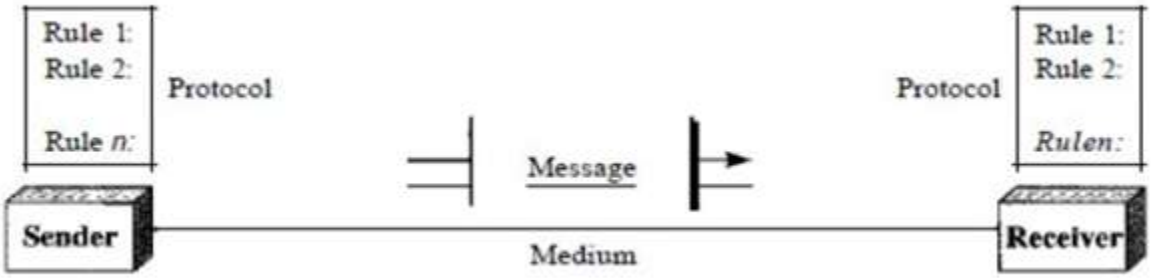
   The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.

4. Jitter

   Jitter refers to the variation in the packet arrival time. It is the uneven delay in the delivery of audio or video packets

Components of Data Communication

A data communications system has five components



Simplex:

In simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit; the other can only receive. Keyboards and traditional monitors are examples of simplex devices. The keyboard can only introduce input; the monitor can only accept output. The simplex mode can use the entire capacity of the channel to send data in one direction.

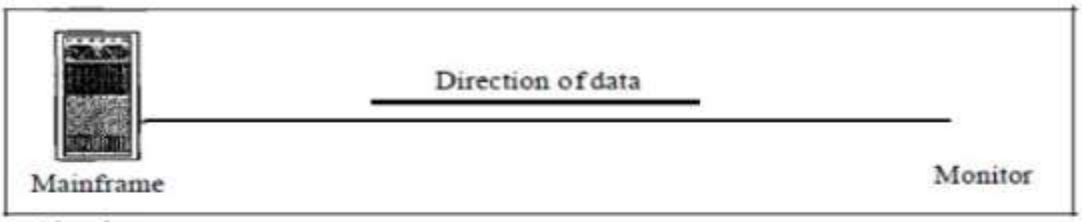
Half-Duplex:

In half-duplex mode, each station can both transmit and receive, but not at the same time. When one device is sending, the other can only receive, and vice versa. In a half-duplex transmission, the entire capacity of a channel is taken over by whichever of the two devices is transmitting at the time. Walkie-talkies and CB (citizens band) radios are both half-duplex systems. The half-duplex mode is used in cases where there is no need for communication in both directions at the same time; the entire capacity of the channel can be utilized for each direction

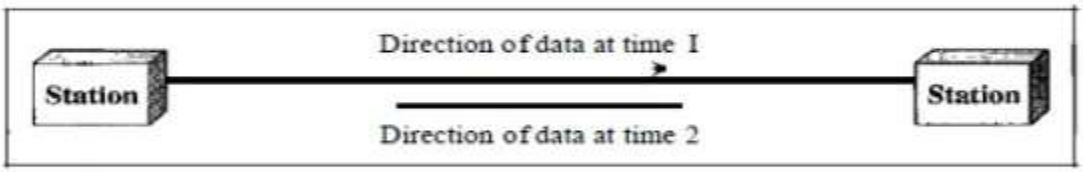
Full-Duplex:

In full-duplex both stations can transmit and receive simultaneously. The full-duplex mode is like a two way street with traffic flowing in both directions at the same time. In full-duplex mode, signals going in one direction share the capacity of the link: with signals going in the other direction. One common example of full-duplex communication is the telephone network. When two people are communicating by a telephone line, both can talk and listen at the same time. The full-duplex mode is used when communication in both directions is required all the time. The capacity of the channel, however, must be divided between the two directions.

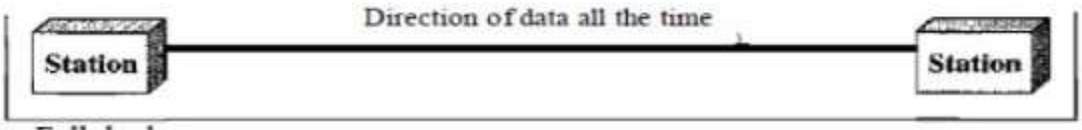
Data Flow in different modes



a. Simplex



b. Half-duplex



c. Full-duplex

Computer Network

A computer network is a group of computer systems and other computing hardware devices that are linked together through communication channels to facilitate communication and resource-sharing among a wide range of users.

Network Criteria

A network must be able to meet a certain number of criteria. The most important of these are performance, reliability, and security

1. Performance:

   Performance can be measured in many ways, including transit time and response time. Transit time is the amount of time required for a message to travel from one device to another. Response time is the elapsed time between an inquiry and a response. The performance of a network depends on a number of factors, including the number of users, the type of transmission medium, the capabilities of the connected hardware, and the efficiency of the software.

2. Reliability:

   Network reliability is measured by the frequency of failure, the time it takes a link to recover from a failure, and the network's robustness in a catastrophe.

3. Security:

   Network security issues include protecting data from unauthorized access, protecting data from damage and development, and implementing policies and procedures for recovery from breaches and data losses.

Types of Connections

There are two types of connections.

1. Point-to-Point

   A point-to-point connection provides a dedicated link between two devices. The entire capacity of the link is reserved for transmission between those two devices.

2. Multipoint

   A multipoint (also called multidrop) connection is one in which more than two specific devices share a single link.

   In a multipoint environment, the capacity of the channel is shared, either spatially or temporally. If several devices can use the link simultaneously, it is a spatially shared connection. If users must take turns, it is a timeshared connection.

Types of Computer Network

Networks may be divided into different types and categories according to four different criteria

1. Geographic spread of nodes and hosts

   When the physical distance between the hosts is within a few kilometers, the network is said to be a Local area Network (LAN). LANs are typically used to connect a set of hosts within the same building (e.g., an office environment) or a set of closely-located buildings (e.g., a university campus)

   For larger distances, the network is said to be a Metropolitan Area Network (MAN) or a Wide Area Network (WAN). MANs cover distances of up to a few hundred kilometers and are used for interconnecting hosts spread across a city.

   WANs are used to connect hosts spread across a country, a continent, or the globe

2. Access restrictions

   Most networks are for the private use of the organizations to which they belong; these are called private networks. Networks maintained by banks, insurance companies, airlines, hospitals, and most other businesses are of this nature

   Public networks, on the other hand, are generally accessible to the average user, but may require registration and payment of connection fees. Internet is the most-widely known example of a public network.

3. Communication model employed by the nodes

   The communication between the nodes is either based on a point-to-point model or a broadcast model.

4. Switching model employed by the nodes

   In the point-to-point model, nodes either employ circuit switching or packet switching. In circuit

switching, a dedicated communication path is allocated between A and B, via a set of intermediate nodes. In packet switching, data is divided into packets (chunks of specific length and characteristics) which are sent from A to B via intermediate nodes. Each intermediate node temporarily stores the packet and waits for the receiving node to become available to receive it.

LAN Topologies

Various topologies are possible for the broadcast LAN such as bus, ring or mesh topology.

1. BUS Topology

   A bus topology is multipoint. One long cable act as a backbone to link all the devices in a network. Nodes are connected to the bus cable by drop lines and taps.

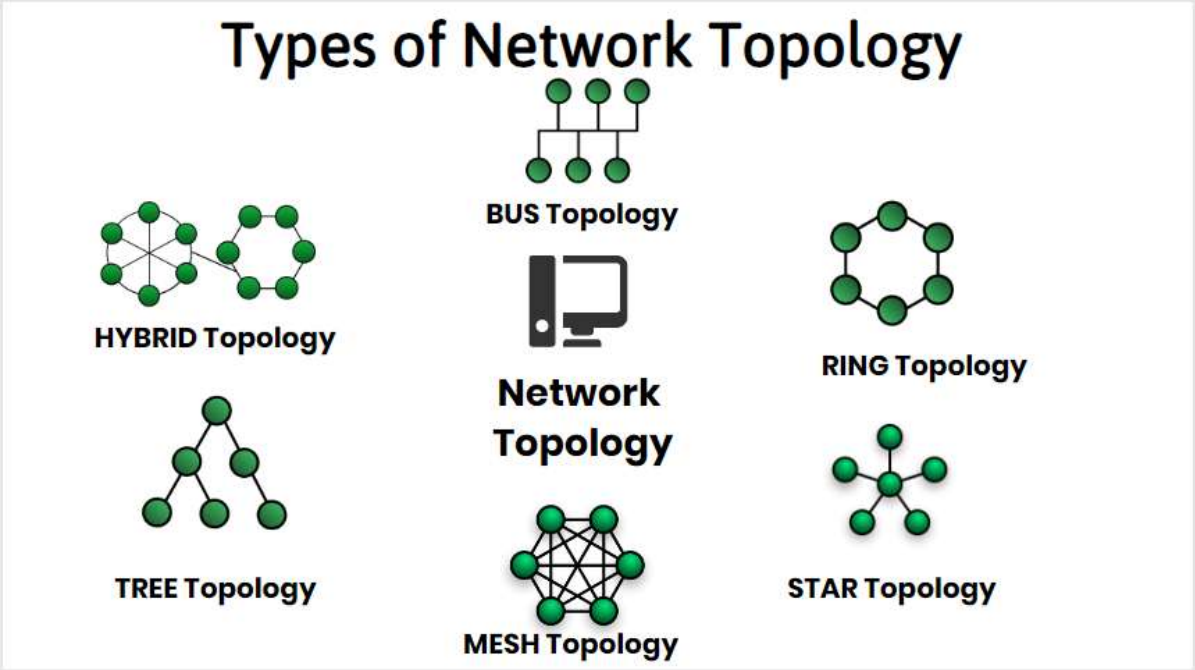
3. Star Topology:

   In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub. The devices are not directly linked to one another. Unlike a mesh topology, a star topology does not allow direct traffic between devices. The controller acts as an

   exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.

4. Mesh Topology

   In a mesh topology, every device has a dedicated point-to-point link to every other device. The term dedicated means that the link carries traffic only between the two devices it connects.



Transmission Media

A transmission medium can be broadly 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. The information is usually a signal that is the result of a conversion of data from another form.

Guided Media

A signal traveling along any of these media is directed and contained by the physical limits of the medium. Twisted-pair and coaxial cable use metallic (copper) conductors that accept and transport signals in the form of electric current. Optical fiber is a cable that accepts and transports signals in the form of light.

1. Twisted-Pair Cable

   A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together. One of the wires is used to carry signals to the receiver, and the other is used

only as a ground reference. The signal sent by the sender on one of the wires causes interference (noise) and crosstalk creating unwanted signals. Twisting the pair of cable reduces interference and cross talk between signals. For example, Twisted-pair cables are used in telephone lines to provide voice and data channels.

2. Coaxial Cable

   Coaxial cable (or coax) carries signals of higher frequency ranges than those in twisted pair cable. Instead of having two wires, coax has a central core conductor of solid or stranded wire (usually copper) enclosed in an insulating sheath, which is, in turn, encased in an outer conductor of metal foil, braid, or a combination of the two.

3. Fiber Optic Cable:

   A fiber-optic cable is made of glass or plastic and transmits signals in the form of light. To understand optical fiber, we first need to explore several aspects of the nature of light. Optical fibers use reflection to guide light through a channel. A glass or plastic core is surrounded by a cladding of less dense glass or plastic. The difference in density of the two materials must be such that a beam of light moving through the core is reflected off the cladding instead of being refracted into it.

   Advantages

   - Higher bandwidth. Fiber-optic cable can support dramatically higher bandwidths
   - Less signal attenuation. Fiber-optic transmission distance is significantly greater than that of other guided media. A signal can run for 50 km without requiring regeneration.
   - Immunity to electromagnetic interference. Electromagnetic noise cannot affect fiber-optic cables.
   - Resistance to corrosive materials. Glass is more resistant to corrosive materials than copper.
   - Light weight. Fiber-optic cables are much lighter than copper cables.
   - Greater immunity to tapping. Fiber-optic cables are more immune to tapping than copper cables. Copper cables create antenna effects that can easily be tapped.

   Disadvantages

   - Installation and maintenance is difficult
   - Unidirectional light propagation. Propagation of light is unidirectional. If we need bidirectional communication, two fibers are needed.

UNGUIDED MEDIA: WIRELESS

Unguided media transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication. Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them.

Unguided signals can travel from the source to destination in several ways: ground propagation, sky propagation, and line-of-sight propagation

Network device

1. Repeaters

   A repeater is a device that operates only in the physical layer. Signals that carry information within a network can travel a fixed distance before attenuation endangers the integrity of the data. A repeater receives a signal and, before it becomes too weak or corrupted, regenerates the original bit pattern. A repeater does not actually connect two LANs; it connects two segments of the same LAN.

2. Bridges or Link Layer Switches

   A bridge or Link layer switch (or simply Switch) operates in both the physical and the data link layer. As a physical layer device, it regenerates the signal it receives. As a data link layer device, the bridge can check the physical (MAC) addresses (source and destination) contained in the frame. A bridge has filtering capability. A bridge has a table that maps addresses to ports.

3. Hubs

   A Hub is a device that operates only in the physical layer. It is basically used for connecting stations in a physical star topology. The main disadvantage of Hub is that it broadcast data to all the devices connected to it. So, chances of collision and data corruption is high in hubs.

4. Routers

   A router is a three-layer device that routes packets based on their logical addresses (host-to-host addressing). A router normally connects LANs and WANs in the Internet and has a routing table that is used for making decisions about the route. The routing tables are normally dynamic and are updated using routing protocols.

   There are three major differences between a router and a repeater or switch.

   - A router has a physical and logical address for each of its interfaces.
   - A router acts only on those packets in which the link layer destination address matches the address of the interface at which the packet arrives.
   - A router changes the link layer address of the packet when it forwards the packet

5. Gateway

   A gateway is normally a computer that operates in all five layers of the Internet or seven layers of OSI model. A gateway takes an application message, reads it, and interprets it. This means that it can be used as a connecting device between two internetworks that use different models

Fig: OSI-ISO Reference Model

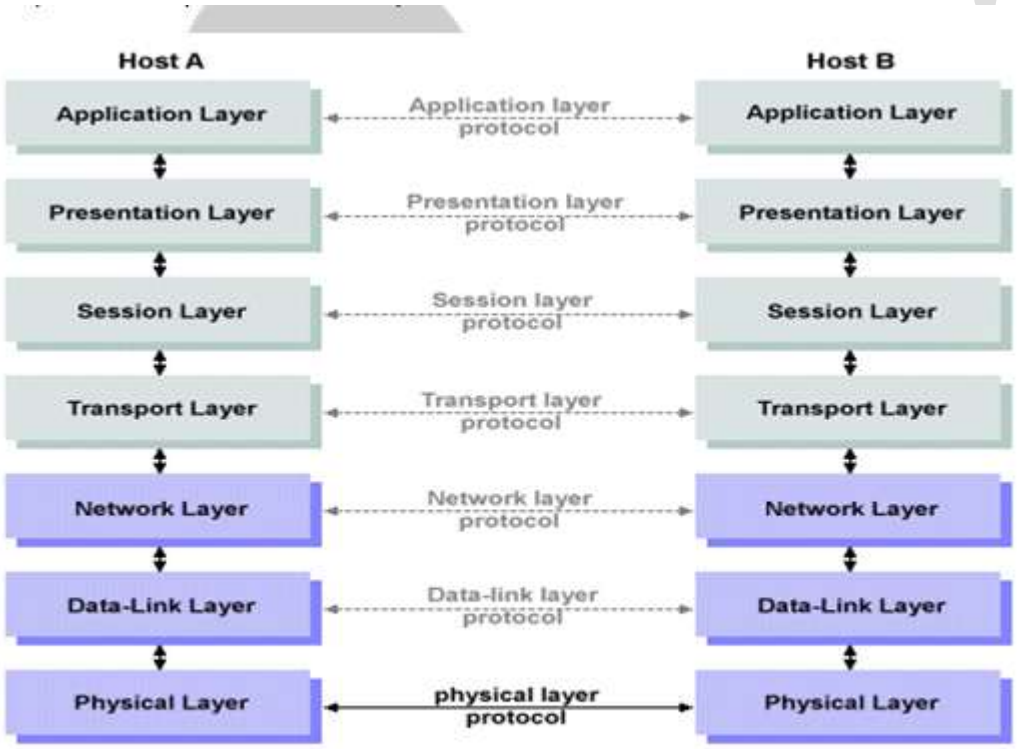


Fig: OSI-ISO Reference Model

Physical Layer

The physical layer coordinates the functions required to carry a bit stream over a physical medium. It deals with the mechanical and electrical specifications of the interface and transmission medium. It also

defines the procedures and functions that physical devices and interfaces have to perform for transmission to occur.

Data Link Layer

The data link layer transforms the physical layer, a raw transmission facility, to a reliable link. It makes the physical layer appear error-free to the upper layer (network layer).

Other responsibilities of the data link layer include the following

- **Framing** - The data link layer divides the stream of bits received from the network layer into manageable data units called frames

- Physical addressing
- **Flow control** - If the rate at which the data are absorbed by the receiver is less than the rate at which data are produced in the sender, the data link layer imposes a flow control mechanism to avoid overwhelming the receiver
- **Error control** - The data link layer adds reliability to the physical layer by adding mechanisms to detect and retransmit damaged or lost frames. It also uses a mechanism to recognize duplicate frames. Error control is normally achieved through a trailer added to the end of the frame
- **Access control** - When two or more devices are connected to the same link, data link layer protocols are necessary to determine which device has control over the link at any given time

Network Layer

The network layer is responsible for the source-to-destination delivery of a packet, possibly across multiple networks (links). Whereas the data link layer oversees the delivery of the packet between two systems on the same network (links), the network layer ensures that each packet gets from its point of origin to its final destination.

Other responsibilities of the network layer include the following:

- **Logical addressing** - The physical addressing implemented by the data link layer handles the addressing problem locally. If a packet passes the network boundary, we need another addressing system to help distinguish the source and destination systems. The network layer adds a header to the packet coming from the upper layer that, among other things, includes the logical addresses of the sender and receiver.
- **Routing** - When independent networks or links are connected to create internetworks (network of networks) or a large network, the connecting devices (called routers or switches) route or switch the packets to their final destination. One of the functions of the network layer is to provide this mechanism.

Transport Layer

The transport layer is responsible for process-to-process delivery of the entire message. A process is an application program running on a host. Whereas the network layer oversees source-to-destination delivery of individual packets, it does not recognize any relationship between those packets. It treats each one independently, as though each piece belonged to a separate message, whether or not it does.

The transport layer, on the other hand, ensures that the whole message arrives intact and in order, overseeing both error control and flow control at the source-to-destination level.

Other function includes

- **Connection control** - The transport layer can be either connectionless or connection oriented.
- **Flow control** - Like the data link layer, the transport layer is responsible for flow control. However, flow control at this layer is performed end to end rather than across a single link.
- **Error control** Like the data link layer, the transport layer is responsible for error control. However, error control at this layer is performed process-to-process rather than across a single link. The sending transport layer makes sure that the entire message arrives at the receiving transport layer without error (damage, loss, or duplication). Error correction is usually achieved through retransmission.

Session Layer

The services provided by the first three layers (physical, data link, and network) are not sufficient for some processes. The session layer is the network dialog controller. It establishes, maintains, and synchronizes the interaction among communicating systems.

Specific responsibilities of the session layer include the following:

- **Dialog control** - The session layer allows two systems to enter into a dialog. It allows the communication between two processes to take place in either half duplex (one way at a time) or full-duplex (two ways at a time) mode.
- **Synchronization** - The session layer allows a process to add checkpoints, or synchronization points, to a stream of data

Presentation Layer

The presentation layer is concerned with the syntax and semantics of the information exchanged between two systems

- **Translation** - Different computers use different encoding systems, the presentation layer is responsible for interoperability between these different encoding methods. The presentation layer at the sender changes the information from its sender-dependent format into a common format. The presentation layer at the receiving machine changes the common format into its receiver-dependent format
- **Encryption** - To carry sensitive information, a system must be able to ensure privacy. Encryption means that the sender transforms the original information to another form and sends the resulting message out over the network. Decryption reverses the original process to transform the message back to its original form.
- **Compression** - Data compression reduces the number of bits contained in the information. Data compression becomes particularly important in the transmission of multimedia such as text, audio, and video.

Application Layer

The application layer enables the user, whether human or software, to access the network. It provides user interfaces and support for services such as electronic mail, remote file access and transfer, shared database management, and other types of distributed information services.

Specific services provided by the application layer include the following:

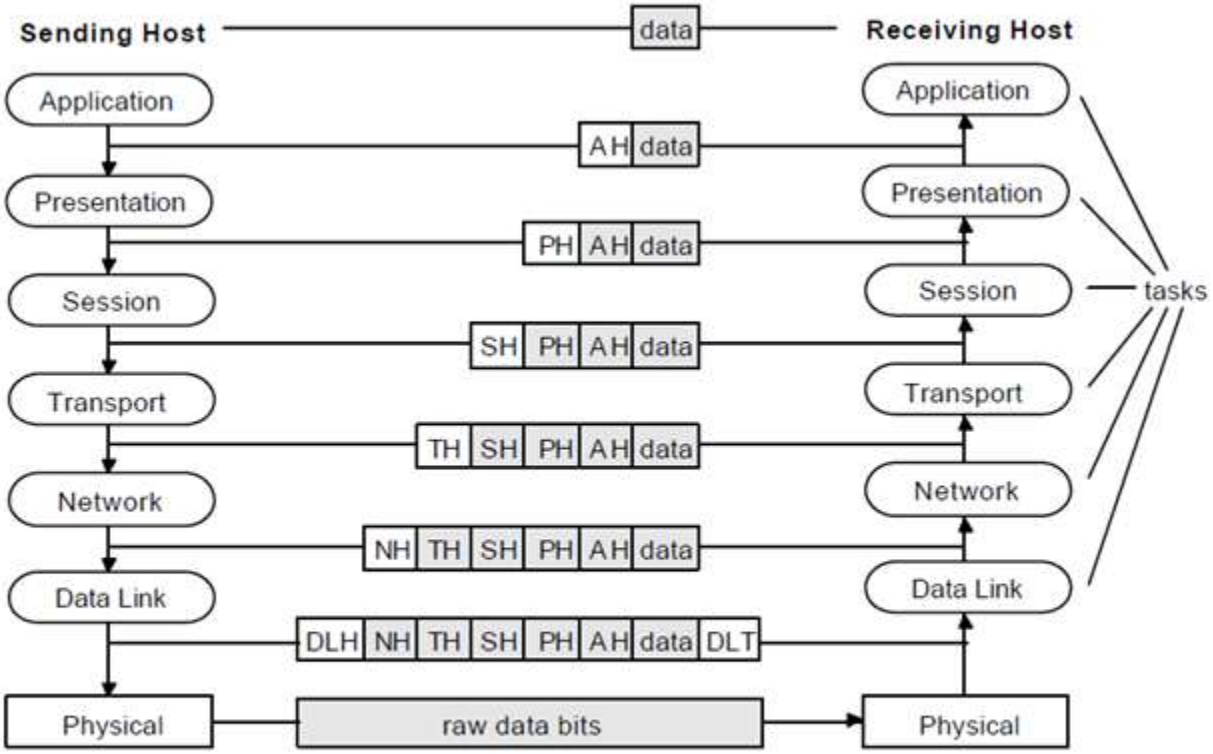


Fig: OSI Layers as Software tasks

Fig: OSI Layers as Software tasks

Communication Protocols

All communications between devices require that the devices agree on the format of the data. The set of rules defining a format is called a protocol. At the very least, a communications protocol must define the following:

- rate of transmission (in baud or bps)
- whether transmission is to be synchronous or asynchronous
- whether data is to be transmitted in half-duplex or full-duplex mode

In addition, protocols can include sophisticated techniques for detecting and recovering from transmission errors and for encoding and decoding data.

Centralized vs Decentralized System

Distributed System

A distributed system is a collection of independent computers that appear to the users of the system as a single system. A Distributed system consists of multiple autonomous computers, each having its own private memory, communicating through a computer network. Information exchange in a distributed system is accomplished through message passing.

Examples

- World Wide Web (WWW) is the biggest example of distributed system.
- The internet
- An intranet which is a portion of the internet managed by an organization
- Network of branch office computers

Advantages of Distributed Systems over Centralized Systems

- **Economics** - A collection of microprocessors offers a better price/performance than mainframes. Low price/performance ratio: cost effective way to increase computing power.
- **Speed** - A distributed system may have more total computing power than a mainframe. Ex. 10,000 CPU chips, each running at 50 MIPS. Not possible to build 500,000 MIPS single processor since it would require 0.002 sec instruction cycle. Enhanced performance through load distributing.
- **Inherent distribution** - Some applications are inherently distributed. Ex. a supermarket chain.
- **Reliability** - If one machine crashes, the system as a whole can still survive. Higher availability and improved reliability.
- **Incremental growth** - Computing power can be added in small increments. Modular expand-ability
- **Another deriving force** - The existence of large number of personal computers, the need for people to collaborate and share information.
- **Open system** - This is the most important point and the most characteristic point of a distributed system. Since it is an open system it is always ready to communicate with other

systems. An open system that scales has an advantage over a perfectly closed and self-contained system.

Unit 6: Internet & WWW

Contents: ***Internet*** *- Introduction to Internet and its Applications. Connecting to the Internet, Client/Server Technology, Internet as a Client/Server Technology, Email, Video-Conferencing, Internet Service Providers, Domain Name Server, Internet Address, Internet Protocols (IP, TCP, HTTP, FTP, SMTP, POP, Telnet, Gopher, WAIS), Introduction to Intranet, Internet vs. Intranet vs. Extranet, Advantages & Disadvantages of Intranet*

World Wide Web (WWW) *- World Wide Web and Its Evolution, Architecture of Web, Uniform Resource Locator (URL), Browsers, Search Engine, Web Servers: Apache, IIS, Proxy Server; HTTP Protocol, FTP protocol.*

Introduction to Internet

The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite (TCP/IP) to serve billions of users worldwide. It is a network of networks that consists of millions of private, public, academic, business, and government networks, of local to global scope that are linked by a broad array of electronic, wireless and optical networking technologies.

The Internet carries a vast range of information resources and services, such as the interlinked hypertext documents of the World Wide Web (WWW) and the infrastructure to support electronic mail

Application of Internet

1. **E-mail** - Email is now an essential communication tools in business. With e-mail you can send and receive instant electronic messages.
2. **24 hours a day - 7 days a week**: Internet is available,24x7 days for usage.
3. **Information** - Information is probably the biggest advantage internet is offering. There is a huge amount of information available on the internet for just about every subject, ranging from government law and services, trade fairs and conferences, market information, new ideas and technical support
4. **Services** - net banking, job searching, purchasing tickets, hotel reservations, guidance services
5. **E-commerce, Entertainment, Software downloads** etc.

Limitations of Internet

Theft of Personal information

Negative effects on family communication

Internet addiction

Children using the Internet

Virus threat, Spamming

Connecting to the Internet

Many home and small business users connect to the Internet via high-speed broadband Internet service. With broadband Internet service, your computer or mobile device usually is connected to the Internet the entire time it is powered on. Examples of broadband Internet service include cable, DSL, fiber, radio signals, and satellite.

1. Cable Internet service provides high-speed Internet access through the cable television network via a cable modem
2. DSL (digital subscriber line) provides high-speed Internet connections using regular copper telephone lines.
3. Fiber to the Premises (FTTP) uses fiber-optic cable to provide high-speed Internet access to home and business users.
4. Fixed wireless provides high-speed Internet connections using a dish-shaped antenna on your house or business to communicate with a tower location via radio signals.
5. A cellular radio network offers high-speed Internet connections to devices with built-in compatible.
6. A Wi-Fi (wireless fidelity) network uses radio signals to provide high-speed Internet connections to compatible or properly equipped wireless computers and devices.
7. Satellite Internet service provides high-speed Internet connections via satellite to a satellite dish that communicates with a satellite modem

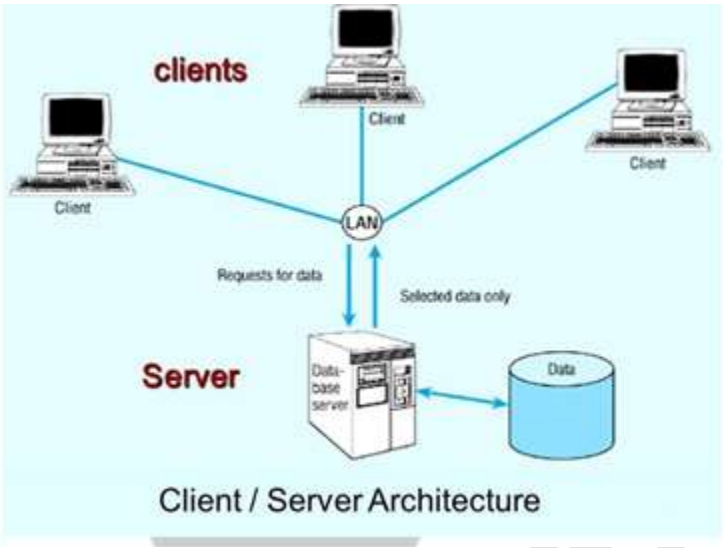
Client Server Technology

1. Client/Server is a term used to describe a computing model for the development of computerized systems. This model is based on the distribution of functions between two types of independent and autonomous processors: servers and clients.
2. A client is any process that requests specific services from server processes. A server is a process that provides requested services for clients. Client and server processes can reside in the same computer or indifferent computers connected by a network.

Client Server Architecture

The client server architecture has two major components; the client and the server.

- The Server is where all the processing, computing and data handling is happening, whereas the Client is where the user can access the services and resources given by the Server (Remote Server).
- The clients can make requests from the Server, and the Server will respond accordingly.
- Generally, there is only one server that handles the remote side. But to be on the safe side, we do use multiple servers will load balancing techniques

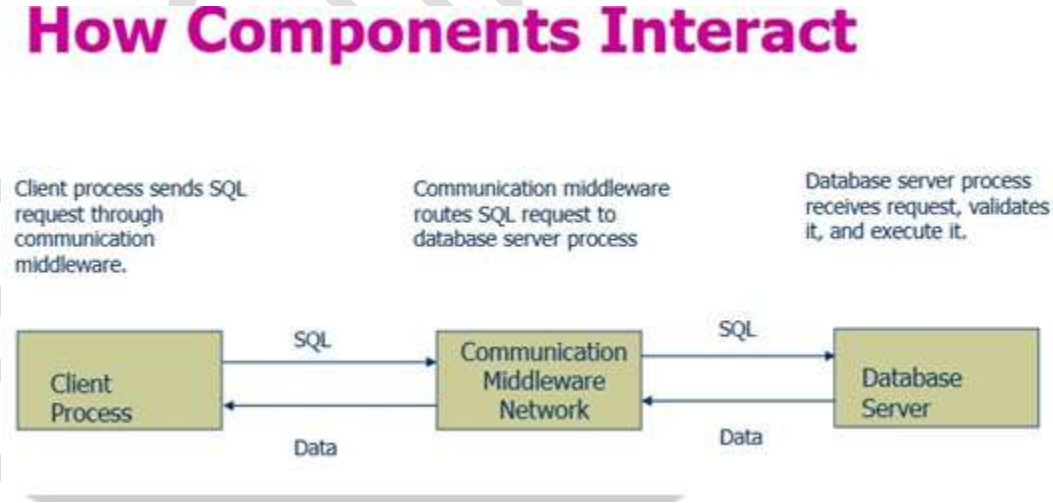


Advantages

1. Easier to Build and Maintain
2. Better Security
3. Stable

Disadvantages

1. Single point of failure
2. Less scalable



Internet as client/server technology

- Internet is massive network of networks and world wide web is a system of interlinked hypertext documents accessed via the internet.

- To complete the flow of accessing information over the web there is need of client/server architecture.
- client/server describes the flow of information between two computer programs in which one computer program (client) makes a service request to another computer program (the server), which provide service requested by the client.
- Clients rely on servers for required resources. It is network architecture in which each computer or process on the network is either a client or a server. Hence, we could describe internet as client/server technology.

For example: When you check your bank account from a computer, a client program forwards a request to a server program at the bank. That program may in turn forward a request to its own client program which then sends a request to a database server at another bank computer. Once the account balance is retrieved from database, it is returned back to the client which in turn serves it back to the client in your computer, which then displays the information.

E-Mail (Electronic Mail)

One of the most popular Internet services is electronic mail (e-mail).

At the beginning of the Internet era, the messages sent by electronic mail were short and consisted of text only. But today, electronic mail is much more complex. It allows a message to include text, audio, and video. It also allows one message to be sent to one or more recipients.

Components of E-Mail Architecture

1. **User Agent** - The first component of an electronic mail system is the user agent. It provides service to the user to make the process of sending and receiving a message easier .It includes composing, reading, replying, forwarding and handling messages.
2. **Addresses** - To deliver mail, a mail handling system must use an addressing system with unique addresses. In the Internet, the address consists of two parts: a local part and a domain name, separated by an @ sign .
    a. **Local Part** - The local part defines the name of a special file, called the user mailbox, where all the mail received for a user is stored for retrieval by the message access agent.
    b. **Domain Name** - The second part of the address is the domain name. An organization usually selects one or more hosts to receive and send e-mail; the hosts are sometimes called mail servers or exchangers. The domain name assigned to each mail exchanger either comes from the DNS database or is a logical name (for example, the name of the organization).

Internet Service Providers

An Internet Service Provider (ISP) is a company such as Worldlink, Vianet etc that provides Internet access to companies, families, and even mobile users. ISPs use fiber-optics, satellite, copper wire, and other forms to provide Internet access to its customers.

The type of Internet access varies depending on what the customer requires. For home use, cable or DSL (digital subscriber line) is the perfect, affordable choice.

The amount of bandwidth is usually what drives the price. Bandwidth is the amount of data that can be sent through an internet connection in a given amount of time.

ISPs connect to one another by forming backbones, which is another way of saying a main highway of communications. Backbones usually consist of fiber-optic media.

Domain Name Server(DNS)

For communication to take place successfully, the sender and receiver both should have addresses and they should be known to each other . Addressing in the application program is different from that in other layers. There is a alias name of address of remote host. The application program uses an alias name instead of IP address.

To map a alias name onto an IP address, an application program calls a library procedure called the resolver, passing it the name as a parameter

The resolver sends a query containing the name to a local DNS server, which looks up the name and returns a response containing the IP address to the resolver, which then returns it to the caller.

The query and response messages are sent as UDP packets. Armed with the IP address, the program can then establish a TCP connection with the host or send it UDP packets

DNS Name Space

For the Internet, the top of the naming hierarchy is managed by an organization called ICANN (Internet Corporation for Assigned Names and Numbers).

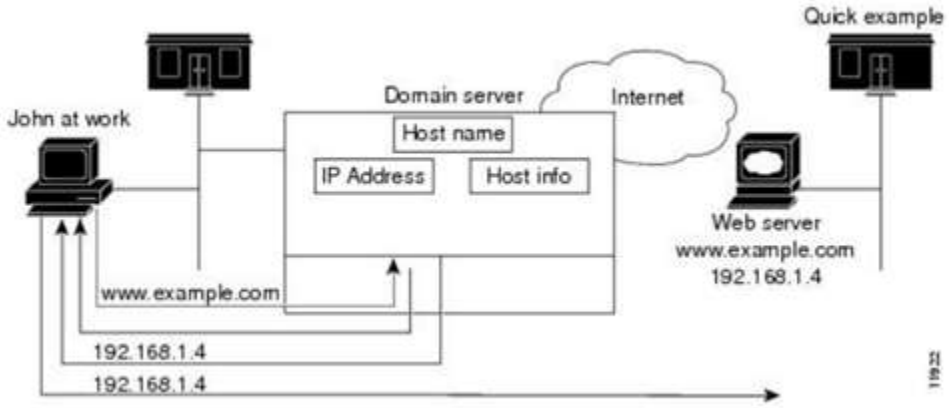
Conceptually, the Internet is divided into over 250 top-level domains, where each domain covers many hosts. Each domain is partitioned into subdomains, and these are further partitioned

The top-level domains come in two flavors: generic(eg. .com.,.edu,.net) and countries(.np,.au)

The country domains include one entry for every country, as defined in ISO 3166.

How DNS Works?

- John's workstation sends a request to the DNS server about the IP address of www.example.com.
- The DNS server checks its database to find that www.example.com corresponds to 192.168.1.4
- The server returns this address to John's browser.
- The browser uses the address to locate the website

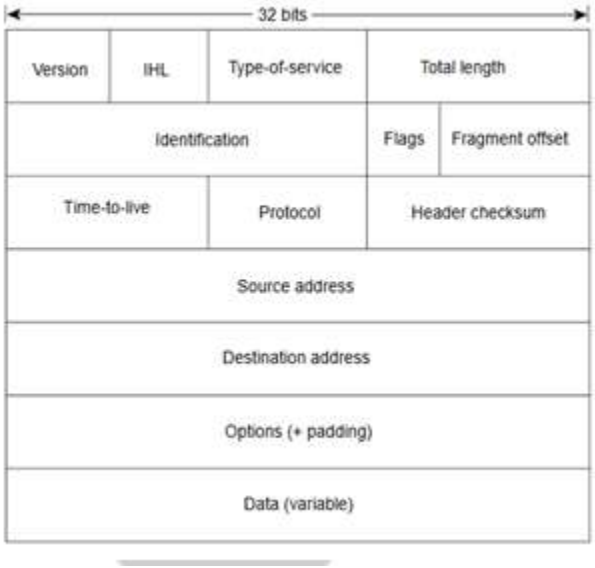


Intenet Protocol (IP)

- Internet Protocol (IP) is a network-layer (Layer 3) protocol that contains addressing information and some control information that enables packets to be routed.
- IP is the primary network-layer protocol in the Internet protocol suite. Along with the Transmission Control Protocol (TCP), IP represents the heart of the Internet protocols.
- IP has two primary responsibilities: providing connectionless, best-effort delivery of datagrams through an internetwork and providing fragmentation and reassembly of datagrams to support data links with different maximum-transmission unit (MTU) sizes.
- IP includes a set of rules that embody the idea of unreliable packet delivery:
- How hosts and routers should process packets
- How and when error messages should be generated
- The conditions under which packets can be discarded.

IP Packet Format

IP packet contains several types of information, as illustrated in Figure



Internet Address (IP address, Domain Names, Electronic mail address, URL)

IP address

1. IPV4 Address

   An IPv4 address is a 32-bit address that uniquely and universally defines the connection of a device (for example, a computer or a router) to the Internet. IPv4 addresses are unique. They are unique in the sense that each address defines one, and only one, connection to the Internet. Two devices on the Internet can never have the same address at the same time.

   A protocol such as IPv4 that defines addresses has an address space. An address space is the total number of addresses used by the protocol. If a protocol uses N bits to define an address, the address space is 2N because each bit can have two different values (0 or 1) and N bits can have 2N values. IPv4 uses 32-bit addresses, which means that the address space is 2^32 or 4,294,967,296 (more than 4 billion).

   There are two prevalent notations to show an IPv4 address: binary notation and dotted decimal notation.

   Binary Notation :In binary notation, the IPv4 address is displayed as 32 bits. Each octet is often referred to as a byte. Eg. 01110101 10010101 00011101 00000010

   Dotted-Decimal Notation :To make the IPv4 address more compact and easier to read, Internet addresses are usually written in decimal form with a decimal point (dot) separating the bytes

   Eg: 117.149.29.2

Classes of IP address

1. Class A Address

The network field is 7 bit long and host field is 24 bit long. But the host numbers will range from 0.0.0.0 to 127.255.255.255.The 0 field in first field identifies that it is a class A network.

2. Class B Address

The class B format is shown below. The first two fields identify the network and the number inthe first field must be in range 128-192. Class b networks are large. IP address ranges from 128.0.0.0 to 191.255.255.255.

3. Class C addres: The IP address ranges from 192.0.0.0 to 223.255.255.255
4. Class D address
5. Class E address Format

Transmission control Protocol (TCP)

- The TCP provides reliable transmission of data in an IP environment. TCP corresponds to the transport layer (Layer 4) of the OSI reference model. Among the services TCP provides are stream data transfer, reliability, efficient flow control, full-duplex operation, and multiplexing
- TCP offers reliability by providing connection-oriented, end-to-end reliable packet delivery through an internetwork. It does this by sequencing bytes with a forwarding acknowledgment number that indicates to the destination the next byte the source expects to receive.
- TCP offers efficient flow control, which means that, when sending acknowledgments back to the source, the receiving TCP process indicates the highest sequence number it can receive without overflowing its internal buffers.
- Full-duplex operation means that TCP processes can both send and receive at the same time. Finally, TCP's multiplexing means that numerous simultaneous upper-layer conversations can be multiplexed over a single connection.
- To use reliable transport services, TCP hosts must establish a connection-oriented session with one another. Connection establishment is performed by using a "three-way handshake" mechanism.

SMTP

- The actual mail transfer is done through message transfer agents. To send mail, a system must have the client MTA, and to receive mail, a system must have a server MTA. The formal protocol that defines the MTA client and server in the Internet is called the Simple Mail Transfer Protocol (SMTP).
- SMTP is used two times, between the sender and the sender's mail server and between the two mail servers. SMTP simply defines how commands and responses must be sent back and forth.

- Commands and Responses

SMTP uses commands and responses to transfer messages between an MTA client and an MTAserver.

Mail Transfer Phases

The process of transferring a mail message occurs in three phases: connection establishment, mail transfer, and connection termination.

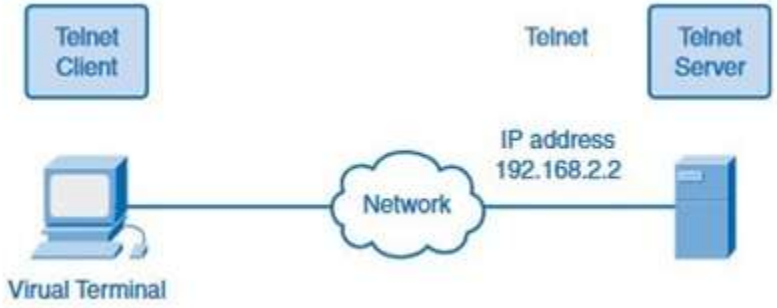
POP

- Post Office Protocol, version 3 (POP3) is simple and limited in functionality. The client POP3 software is installed on the recipient computer; the server POP3 software is installed on the mail server. Mail access starts with the client when the user needs to download e-mail from the mailbox on the mail server. The client opens a connection to the server on TCP port 110. It then sends its user name and password to access the mailbox. The user can then list and retrieve the mail messages, one by one.
- POP3 has two modes: the delete mode and the keep mode. In the delete mode, the mail is deleted from the mailbox after each retrieval. In the keep mode, the mail remains in the mailbox after retrieval. The delete mode is normally used when the user is working at her permanent computer and can save and organize the received mail after reading or replying. The keep mode is normally used when the user accesses her mail away from her primary computer (e.g., a laptop). The mail is read but kept in the system for later retrieval and organizing

TELNET

- TELNET is an abbreviation for TErminaL NETwork. It is the standard TCP/IP protocol for virtual terminal service as proposed by the International Organization for Standards (ISO).
- Telnet is a client/server protocol that provides a standard method of emulating text-based terminal devices over the data network. Both the protocol itself and the client software that implements the protocol are commonly referred to as Telnet
- A connection using Telnet is called a VTY(Virtual Terminal) session or connection. Telnet specifies how a VTY session is established and terminated. It also provides the syntax and order

of the commands used to initiate the Telnet session, and it provides control commands that can be issued during a session.



- Each Telnet command consists of at least 2 bytes. The first byte is a special character called the Interpret as Command (IAC)character. The IAC character defines the next byte as a command rather than text.
- Rather than using a physical device to connect to the server, Telnet uses software to create a virtual device that provides the same features of a terminal session with access to the server command-line interface (CLI).
- To support Telnet client connections, the server runs a service called the Telnet daemon. A virtual terminal connection is established from an end device using a Telnet client application.
- When a Telnet connection is established, users can perform any authorized function on the server, just as if they were using a command-line session on the server itself. If authorized, they can start and stop processes, configure the device, and even shut down the system.

FTP

- File Transfer Protocol (FTP) is the standard mechanism provided by TCP/IP for copying a file from one host to another. Although transferring files from one system to another seems simple and straightforward, some problems must be dealt with first. For example, two systems may use different file name conventions, two systems may have different ways to represent text and data.
- FTP differs from other client/server applications in that it establishes two connections betweenthe hosts.
- One connection is used for data transfer, the other for control information (commands and responses). Separation of commands and data transfer makes FTP more efficient. The control connection uses very simple rules of communication. We need to transfer only a line of command or a line of response at a time.
- The data connection, on the other hand, needs more complex rules due to the variety of data types transferred. However, the difference in complexity is at the FTP level, not TCP. For TCP, both connections are treated the same. FTP uses two well-known TCP ports: Port 21 is used forthe control connection, and port 20 is used for the data connection.

- The client has three components: user interface, client control process, and the client data transfer process. The server has two components: the server control process and the server datatransfer process.
- The control connection is made between the control processes. The control connection remains connected during the entire interactive FTP session.
- The data connection is made between the data transfer processes. The data connection is opened and then closed for each file transferred. It opens each time commands that involve transferring files are used, and it closes when the file is transferred
-

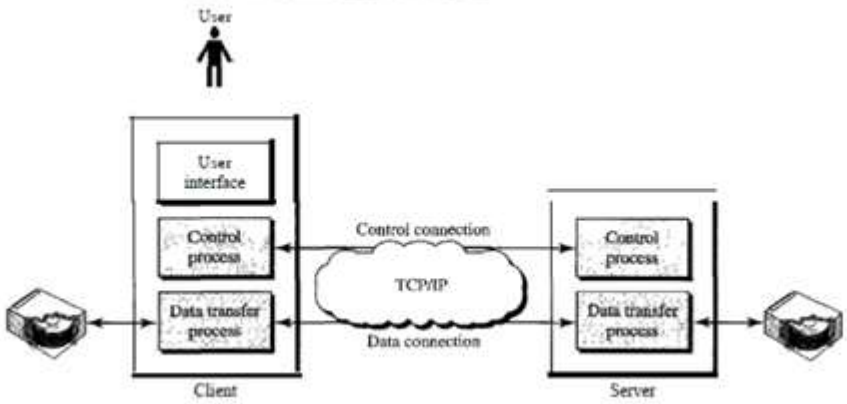


Fig: HTTP Transaction

HTTP

- The Hypertext Transfer Protocol (HTTP) is a protocol used mainly to access data on the World Wide Web. HTTP functions as a combination of FTP and SMTP. It is similar to FTP because it transfers files and uses the services of TCP. It uses only one TCP connection.
- There is no separate control connection; only data are transferred between the client and the server. HTTP is like SMTP because the data transferred between the client and the server looklike SMTP messages.
- HTTP uses the services of TCP, HTTP itself is a stateless protocol. The client initializes the transaction by sending a request message. The server replies by sending a response.
- The formats of the request and response messages are similar. A request message consists of a request line, a header, and sometimes a body. A response message consists of a status line, a header, and sometimes a body.

Gopher

- Gopher is an application-layer protocol that provides the ability to extract and view Web documents stored on remote Web servers.
- Gopher was conceived in 1991 as one of the Internet's first data/file access protocols to run ontop of a TCP/IP network. It was developed at University of Minnesota and is named after the school's mascot.

- Gopher was designed to access a Web server or database via the Internet. It requires that filesbe stored in a menu-style hierarchy on a Gopher server that is accessible through a Gopher- enabled client browser and/or directly.
- It initially supported only text-based file/document access but later came to support some image formats such as GIF and JPEG.
- Gopher was succeeded by the HTTP protocol and now has very few implementations. Gopher-based databases, servers or websites can be accessed through two search engines: Veronica and Jughead

WAIS

- The Wide Area Information Server idea is based on a search model of information, rather than a browse one. Sites that run WAIS servers have created a collection of indexed data that can thenbe retrieved by searches on these indexes. The access protocol to WAIS servers is based on the standard developed for library searching by ANSI (American National Standards Institute) with the unlikely title, Z39.50 (aka Information Retrieval Service and Protocol Standard).
- WAIS has four parts (like most information services except the richer WWW): the client, the server, the database, and the protocol.
- Client programs (e.g. the X Windows client xwaisq) construct queries, and send them using the protocol to the appropriate server. The server responds, and includes a 'relevance' measure forthe results of the search match to the query.
- The actual operation of the protocol is quite complex, as it permits exchanges to be broken into separate parts. WAIS permits retrieval of bibliographic, as well as contents (including images), data.
- A search request consists of seed words, or keys if you like, typed by a user into the client, together with a list of documents (identified by a unique global ID). The response is quite complex and includes a list of records, including the following fields:

    - Headline- basically a title/description
    - Rank- relative relevance of this document
    - Formats- list of formats available (text/postscript etc)
    - Document ID
    - Length

Intranet

- An Intranet is a private computer network that uses Internet protocols, network connectivity,and possibly the public telecommunication system to securely share part of an organization's information or operations with its employees.
- It uses the same concepts and technologies of the Internet (clients and servers) running on the TCP/IP protocol suite. HTTP, FTP and SMTP are very commonly used. Access to information is typically through browsers.

    - It is Platform independent.
    - No need to install special software on clients.

- Intranet Web servers differ from public Web servers in that the public must have the proper permissions and passwords to access the intranet of an organization.
- Intranets are designed to permit users who have access privileges to the internal LAN of the organization.
- Within an intranet, Web servers are installed in the network. Browser technology is used as the common front end to access information on servers such as financial, graphical, or text-based data.

Advantages

- Intranets help employees to quickly locate information and applications relevant to their roles and responsibilities.
- Standard interface, allowing "access from anywhere".
- Can serve as a powerful tool for communication within an organization.
- Permits information to be published.

Disadvantages

- Management does need to stop control of specific information, this problem can be minimized but with appropriate prudence.
- The other disadvantage of Intranet is security issue
- Intranet gathered everything in one location which is really good but if it is not prearranged then you will spoil everything.
- The cost of intranet is very high but has lots of advantages after implementing

Extranet

- An Extranet is a private network that uses Internet protocols, network connectivity, and possibly the public communication system to securely share part of an organization's information or operations with suppliers, partners, customers, or other businesses.
- It can be viewed as part of a company's Intranet that is extended to users outside the company.

- It is “a private internet over the Internet”. It is used to designate “private parts” of a website. Only registered users can navigate.
- It requires security and privacy.

    - Firewall server management
    - Issuance and use of digital certificates or similar means of authentication.
    - Encryption of messages.
    - Use of Virtual Private Networks (VPN) that tunnel through the public network.

    Advantages:

    - Can improve organization productivity.
    - Allows information to be viewed at times convenient for external
    - Information can be updated instantly.
    - Authorized users have immediate access to latest information.
    - Can improve relationships with customers

World Wide Web (WWW) and its evolution

The World Wide Web (WWW) allows computer users to position and view multimedia-based documents (i.e., documents with text, graphics, animations, audios and/or videos) on almost any subject.

Even though the Internet was developed more than three decades ago, the introduction of the WWW was a relatively recent event. In 1990, Tim Berners-Lee of CERN (the European Laboratory for Particle Physics) developed the World Wide Web and several communication protocols that form the backbone of the WWW.

The Internet and the World Wide Web will surely be listed among the most significant and profound creations of humankind. In the past, most computer applications ran on stand alone computers. (i.e., computers that were not connected to one another)

Today’s applications can be written to communicate among the world’s hundreds of millions of computers. The Internet makes our work easier by mixing computing and communications technologies. It makes information immediately and conveniently accessible worldwide. It makes it possible for individuals and small businesses to get worldwide contact

In the last decade, the Internet and World Wide Web have altered the way people communicate, conduct business and manage their daily lives. They are changing the nature of the way business is done.

Evolution

- March 1989 First proposal written at CERN by Tim Berners-Lee.
- October 1990 Tim Berners-Lee and Robert Cailliau submit revised proposal at CERN.
- November 1990 First prototype developed at CERN for the NeXT .
- March 1991 Prototype line mode browser available at CERN.

- January 1991 First HTTP servers outside of CERN set up including servers at SLAC and NIKHEF.
- July 1992 Viola browser for X-windows developed by P. Wei at Berkeley.
- November 1992 Midas browser (developed at SLAC) available for X-windows.
- January 1993 Around 50 known HTTP servers.
- August 1993 O'Reilly hosts first WWW Wizards Workshop in Cambridge, Mass. Approximately40 attends
- February 1993 NCSA releases first alpha version of "Mosaic for X. "
- September 1993 NCSA releases working versions of Mosaic browser for X-windows, PC/Windows and Macintosh platforms.
- October 1993 Over 500 known HTTP servers.
- December 1993 John Markov writes a page and a half on WWW and Mosaic in the New York Times business section. Guardian (UK) publishes a page on WWW.
    - May 1994 First International WWW Conference, CERN, Geneva, Switzer-land. Approximately 400 attended
    - June 1994cOver 1500 registered HTTPcservers.
    - July 1994MIT/CERN agreement to start WWW Organization.
    - October 1994 Second International WWW Conference, Chicago, Illinois, with over 1500 attendees

Architecture of Web

Uniform resource Locator (URL)

- A URL (Uniform Resource Locator) is a unique identifier used to locate a resource on the internet. It is also referred to as a web address. URLs consist of multiple parts -- including a protocol and domain name -- that tell a web browser how and where to retrieve a resource.
- End users use URLs by typing them directly into the address bar of a browser or by clicking a hyperlink found on a webpage, bookmark list, in an email or from another application.
- A URL is the most common type of Uniform Resource Identifier (URI). URIs are strings of characters used to identify a resource over a network. URLs are essential to navigating the internet.
- URL protocols include HTTP (Hypertext Transfer Protocol) and HTTPS (HTTP Secure) for web resources, mailto for email addresses, ftp for files on a File Transfer Protocol (FTP) server, and telnet for a session to access remote computers. Most URL protocols are followed by a colon and two forward slashes; mailto is followed only by a colon.
- **Parts of an URL**

    http://host.company.com:80/a/b/c.html?user=Alice&year=2008#p2

    - **Scheme (http:)**: identifies protocol used to fetch the content.
    - **Host name (//host.company.com)**: name of a machine to connect to.
    - **Server's port number (80)**: allows multiple servers to run on the same machine.
    - **Hierarchical portion (/a/b/c.html)**: used by server to find content.

- **Query parameters (?user=Alice&year=2008)**: provides additional parameters
- **Fragment (#p2)**: Have browser scroll page to fragment (html: p2 is anchor tag), Used onthe browser only; not sent to the server.

Browsers

A web browser is a software program that allows a user to locate, access, and display web pages.

In common usage, a web browser is usually shortened to "browser." Browsers are used primarily for displaying and accessing websites on the internet, as well as other content created using languages such as Hypertext Markup Language (HTML) and Extensible Markup Language (XML).

Browsers translate web pages and websites delivered using Hypertext Transfer Protocol (HTTP) into human-readable content.

They also have the ability to display other protocols and prefixes, such as secure HTTP (HTTPS), File Transfer Protocol (FTP), email handling (mailto:), and files (file:).

In addition, most browsers also support external plug-ins required to display active content, such as in-page video, audio and game content

Examples: Internet Explorer, Netscape Navigator, Opera, Firefox-which was developed from Mozilla (the open source version of Netscape), Chrome

Search Engine

A search engine is a software program or script available through the Internet that searches documents and files for keywords and returns the results of any files containing those keywords.

Today, there are many different search engines available on the Internet, each with their own abilities and features.

The first search engine ever developed is considered Archie, which was used to search for FTP files and the first text-based search engine is considered Veronica.

Today, the most popular and well-known search engine is Google. Other popular search engines include AOL, Ask.com, Baidu, Bing, and Yahoo.

Search engines contain millions and sometimes billions of pages, many search engines not only just search the pages but also display the results depending on their importance. This importance is commonly determined by using various algorithms.

The source of all search engine data is a spider or crawler, which automatically visits pages and indexes their contents. Once a page has been crawled, the data contained in the page is processed and indexed.

Web servers

A Web server is a program that uses HTTP (Hypertext Transfer Protocol) to serve the files that form Web pages to users, in response to their requests, which are forwarded by their computers' HTTP clients. Dedicated computers and appliances may be referred to as Web servers as well.

The process is an example of the client/server model. All computers that host Web sites must have Web server programs.

Leading Web servers include Apache (the most widely-installed Web server), Microsoft's Internet Information Server (IIS) and nginx (pronounced engine X) from NGNIX. Other Web servers include Novell's NetWare server, Google Web Server (GWS) and IBM's family of Domino servers.

Web servers often come as part of a larger package of Internet- and intranet-related programs for serving email, downloading requests for File Transfer Protocol (FTP) files, and building and publishing Web pages.

Considerations in choosing a Web server include how well it works with the operating system and other servers, its ability to handle server-side programming, security characteristics, and the particular publishing, search engine and site building tools that come with it.

- Apache server

  Apache Web Server is an open-source web server creation, deployment and management software. Initially developed by a group of software programmers, it is now maintained by the Apache Software Foundation.

  The software offers an extensible and secure web server with services in sync with modern HTTP standards. HTTP Server is compatible with most UNIX-based operating systems (such as Mac OS, Linux, Solaris, Digital UNIX, and AIX), on other UNIX/POSIX-derived systems and on Microsoft Windows.

  Apache HTTP Server was the most popular webserver from 1996 until June of 2016.While Apache still remains one of the world's most heavily-used webservers it lost market share to NGINX, Microsoft and others since 2016.

- IIS

  Internet Information Services (IIS) is a flexible, general-purpose web server from Microsoft that runs on Windows systems to serve requested HTML pages or files.

  An IIS web server accepts requests from remote client computers and returns the appropriate response. This basic functionality allows web servers to share and deliver information across local area networks, such as corporate intranets, and wide area networks, such as the internet.

- Proxy Server

  A proxy server is a dedicated computer or a software system running on a computer that acts as an intermediary between an endpoint device, such as a computer, and another server from

which a user or client is requesting a service. The proxy server may exist in the same machine as a firewall server or it may be on a separate server, which forwards requests through the firewall.

An advantage of a proxy server is that its cache can serve all users. If one or more Internet sites are frequently requested, these are likely to be in the proxy's cache, which will improve user response time. A proxy can also log its interactions, which can be helpful for troubleshooting.

How Proxy server works??

When a proxy server receives a request for an Internet resource (such as a Web page), it looks in its local cache of previously pages. If it finds the page, it returns it to the user without needing to forward the request to the Internet. If the page is not in the cache, the proxy server, acting as a client on behalf of the user, uses one of its own IP addresses to request the page from the server out on the Internet. When the page is returned, the proxy server relates it to the original request and forwards it on to the user.

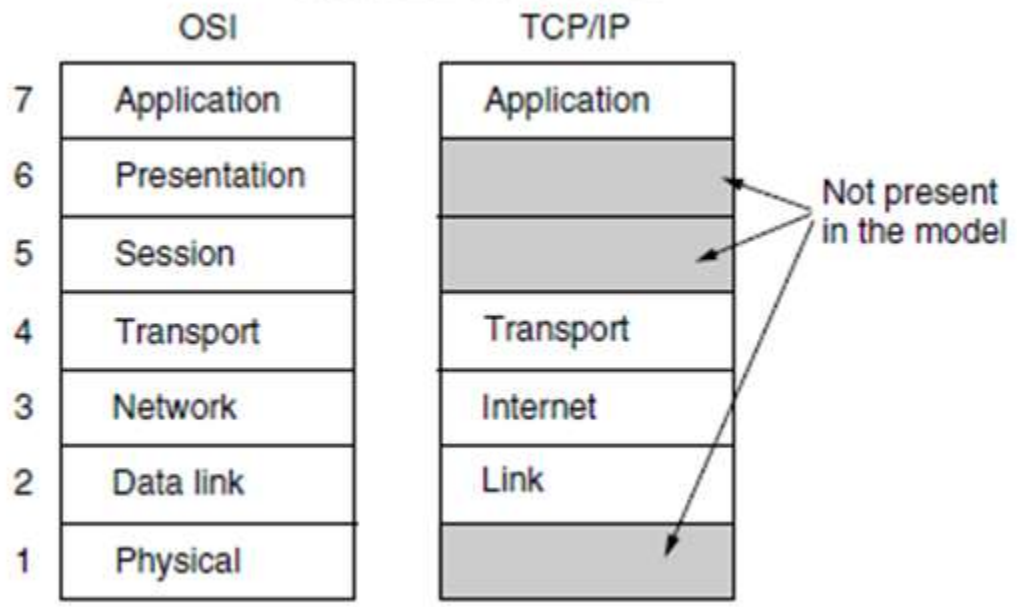
Proxy servers are used for both legal and illegal purposes. In the enterprise, a proxy server is used to facilitate security, administrative control or caching services, among other purposes.

In a personal computing context, proxy servers are used to enable user privacy and anonymous surfing. Proxy servers can also be used for the opposite purpose: To monitor traffic and undermine user privacy.

TCP/IP protocol

- TCP/IP Reference Model is a four-layered suite of communication protocols. It was developed bythe DoD (Department of Defense) in the 1960s.
- It is named after the two main protocols that are used in the model, namely, TCP and IP. TCP stands for Transmission Control Protocol and IP stands for Internet Protocol.

The four layers in the TCP/IP protocol suite are:



Link Layer

- The lowest layer in the model, the link layer describes what links such as serial lines and classic Ethernet must do to meet the needs of this connectionless internet layer.
- It is not really a layer at all, in the normal sense of the term, but rather an interface between hosts and transmission links.

Internet Layer

- The internet layer is the linchpin that holds the whole architecture together.
- Its job is to permit hosts to inject packets into any network and have them travel independentlyto the destination (potentially on a different network).
    - They may even arrive in a completely different order than they were sent, in which case it is the job of higher layers to rearrange them, if in-order delivery is desired.

- The internet layer defines an official packet format and protocol called IP (Internet Protocol), plus a companion protocol called ICMP (Internet Control Message Protocol) that helps it

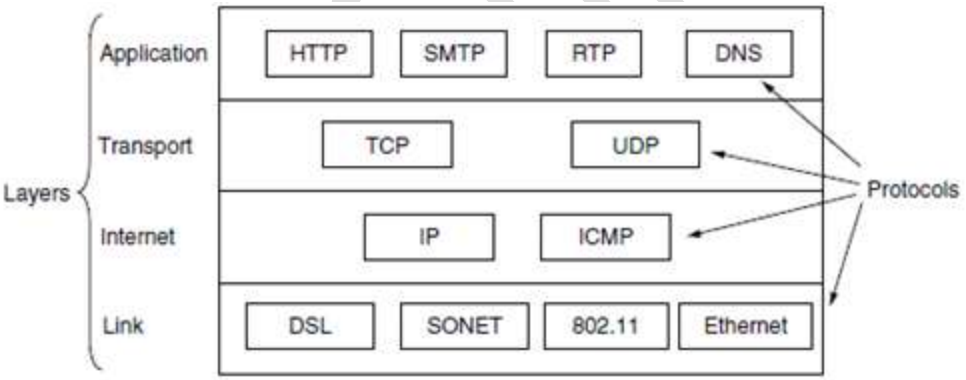
function. The job of the internet layer is to deliver IP packets where they are supposed to go. Packet routing is clearly a major issue here, as is congestion.

Transport Layer

- It is designed to allow peer entities on the source and destination hosts to carry on a conversation, just as in the OSI transport layer. Two end-to-end transport protocols have been defined here are UCP and UDP
- TCP (Transmission Control Protocol), is a reliable connection-oriented protocol that allows a byte stream originating on one machine to be delivered without error on any other machine in the internet. It segments the incoming byte stream into discrete messages and passes each oneon to the internet layer.
- At the destination, the receiving TCP process reassembles the received messages into the output stream. TCP also handles flow control to make sure a fast sender cannot swamp a slowreceiver with more messages than it can handle.
- UDP (User Datagram Protocol), is an unreliable, connectionless protocol for applications that donot want TCP's sequencing or flow control and wish to provide their own.
- It is also widely used for one-shot, client-server-type request-reply queries and applications in which prompt delivery is more important than accurate delivery, such as transmitting speech or video.

Application Layer

- On top of the transport layer is the application layer. It contains all the higher- level protocols. The early ones included virtual terminal (TELNET), file transfer (FTP), and electronic mail (SMTP).Many other protocols have been added to these over the years.



Unit 7 Contemporary Technologies 13 Hrs.

1. Multimedia,
2. 2. e-Commerce,
3. 3. e-Learning,
4. 4. e-Governance,
5. 5. e- Banking,
6. 6. Hypermedia,
7. 7. Geographical Information System,
8. 8. Virtual Reality,
9. 9. Augmented Reality,
10. 10. Artificial Intelligence,
11. 11. Ambient Intelligence,
12. 12. Robotics,
13. 13. Bit Coin

1. Multimedia:

Multimedia is a form of communication that combines different content forms such as text, audio, images, animations, or video into a single interactive presentation, in contrast to traditional mass media which featured little to no interaction from users, such as printed material or audio recordings. Popular examples of multimedia include video podcasts, audio slideshows and Animated videos.

Multimedia can be recorded for playback on computers, laptops, smartphones, and other electronic devices, either on demand or in real time (streaming). In the early years of multimedia, the term "rich media" was synonymous with interactive multimedia. Over time, hypermedia extensions brought multimedia to the World Wide Web.

2. Ecommerce:

E-commerce (electronic commerce) is the activity of electronically buying or selling of products on online services or over the Internet. E-commerce draws on technologies such as mobile commerce, electronic funds transfer, supply chain management, Internet marketing, online transaction processing, electronic data interchange (EDI), inventory management systems, and automated data collection systems. E-commerce is in turn driven by the technological advances of the semiconductor industry, and is the largest sector of the electronics industry.

E-commerce typically uses the web for at least a part of a transaction's life cycle although it may also use other technologies such as e-mail. Typical e-commerce transactions include the purchase of products (such as books from Amazon) or services (such as music downloads in the form of digital distribution such as iTunes Store).[1] There are three areas of e-commerce: online retailing, electronic markets, and online auctions. E-commerce is supported by electronic business.

3. E-Learning:

learning conducted via electronic media, typically on the internet.
"successful e-learning depends on the self-motivation of individuals to study effectively"

E-learning, also referred to as online learning or electronic learning, is the acquisition of knowledge which takes place through electronic technologies and media. In simple language, e-learning is defined as "learning that is enabled electronically". Typically, e-learning is conducted on the Internet, where students can access their learning materials online at any place and time. E-Learning most often takes place in the form of online courses, online degrees, or online programs.

4. E Governance:

Electronic governance or e-governance is the application of IT for delivering government services, exchange of information, communication transactions, integration of various stand-alone systems between government to citizen (G2C), government-to-business (G2B), government-to-government (G2G), Government-to-employees (G2E) as well as back-office processes and interactions within the entire government framework.[1] Through e-governance, government services are made available to citizens in a convenient, efficient, and transparent manner. The three main target groups that can be distinguished in governance concepts are government, citizens, and businesses/interest groups. In e-governance, there are no distinct boundaries,[2] finance and support.

5. E-Banking:

(E-banking) Online banking, also known as internet banking, web banking or home banking, is an electronic payment system that enables customers of a bank or other

financial institution to conduct a range of financial transactions through the financial institution's website. The online banking system will typically connect to or be part of the core banking system operated by a bank to provide customers access to banking services in place of traditional branch banking. Online banking significantly reduces the banks' operating cost by reducing reliance on a branch network, and offers greater convenience to customers in time saving in coming to a branch and the convenience of being able to perform banking transactions even when branches are closed. Internet banking provides personal and corporate banking services offering features such as viewing account balances, obtaining statements, checking recent transactions, transferring money between accounts, and making payments.

6. Hypermedia

hypermedia
/hʌɪpəˈmiːdɪə/
noun
an extension to hypertext providing multimedia facilities, such as those handling sound and video.
Hypermedia, an extension of the term hypertext, is a nonlinear medium of information that includes graphics, audio, video, plain text and hyperlinks. This designation contrasts with the broader term multimedia, which may include non-interactive linear presentations as well as hypermedia.

7. Geographical Information System

A geographic information system (GIS) is a type of database containing geographic data (that is, descriptions of phenomena for which location is relevant), combined with software tools for managing, analyzing, and visualizing those data. In a broader sense, one may consider such a system to also include human users and support staff, procedures and workflows, body of knowledge of relevant concepts and methods, and institutional organizations.

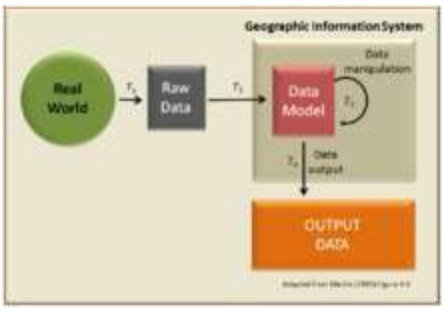


Fig: GIS Concept

7. Virtual Reality

Virtual reality (VR) is a simulated experience that can be similar to or completely different from the real world. Applications of virtual reality include entertainment (particularly video games), education (such as medical or military training) and business (such as virtual meetings). Other distinct types of VR-style technology include augmented reality and mixed reality, sometimes referred to as extended reality or XR.[1]

Currently, standard virtual reality systems use either virtual reality headsets or multi-projected environments to generate realistic images, sounds and other sensations that simulate a user's physical presence in a virtual environment. A person using virtual reality equipment is able to look around the artificial world, move around in it, and interact with virtual features or items. The effect is commonly created by VR headsets consisting of a head-mounted display with a small screen in front of the eyes, but can also be created through specially designed rooms with multiple large screens. Virtual reality typically incorporates auditory and video feedback, but may also allow other types of sensory and force feedback through haptic technology.

9. Augmented Reality:

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual,

auditory, haptic, somatosensory and olfactory.[1][2] AR can be defined as a system that incorporates three basic features: a combination of real and virtual worlds, real-time interaction, and accurate 3D registration of virtual and real objects.[3] The overlaid sensory information can be constructive (i.e. additive to the natural environment), or destructive (i.e. masking of the natural environment).[4] This experience is seamlessly interwoven with the physical world such that it is perceived as an immersive aspect of the real environment.[4] In this way, augmented reality alters one's ongoing perception of a real-world environment, whereas virtual reality completely replaces the user's real-world environment with a simulated one.[5][6] Augmented reality is related to two largely synonymous terms: mixed reality and computer-mediated reality.

10. Artificial Intelligence

Artificial intelligence (AI) is intelligence demonstrated by machines, as opposed to natural intelligence displayed by animals including humans. Leading AI textbooks define the field as the study of "intelligent agents": any system that perceives its environment and takes actions that maximize its chance of achieving its goals.[a] Some popular accounts use the term "artificial intelligence" to describe machines that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving", however, this definition is rejected by major AI researchers.[b]

AI applications include advanced web search engines (e.g., Google), recommendation systems (used by YouTube, Amazon and Netflix), understanding human speech (such as Siri and Alexa), self-driving cars (e.g., Tesla), automated decision-making and competing at the highest level in strategic game systems (such as chess and Go).[2][citation needed] As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI effect.[3] For instance, optical character

recognition is frequently excluded from things considered to be AI,[4] having become a routine technology.[5]

11. Ambient Intelligence

In computing, ambient intelligence (AmI) refers to electronic environments that are sensitive and responsive to the presence of people. Ambient intelligence was a projection on the future of consumer electronics, telecommunications and computing that was originally developed in the late 1990s by Eli Zelkha and his team at Palo Alto Ventures for the time frame 2010–2020.[1][2][3][4] Ambient intelligence would allow devices to work in concert to support people in carrying out their everyday life activities, tasks and rituals in an intuitive way using information and intelligence that is hidden in the network connecting these devices (for example: The Internet of Things). As these devices grew smaller, more connected and more integrated into our environment, the technological framework behind them would disappear into our surroundings until only the user interface remains perceivable by users.

12. Robotics

Robotics is an interdisciplinary branch of computer science and engineering.[1] Robotics involves design, construction, operation, and use of robots. The goal of robotics is to design machines that can help and assist humans. Robotics integrates fields of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, mathematics, etc.

Robotics develops machines that can substitute for humans and replicate human actions. Robots can be used in many situations for many purposes, but today many are used in dangerous environments (including inspection of radioactive materials, bomb detection and deactivation), manufacturing processes, or where humans cannot survive (e.g. in space, underwater, in high heat, and clean up and containment of hazardous materials and radiation). Robots can take on any form, but some are made to resemble humans in appearance. This is claimed to help in the acceptance of robots in certain replicative behaviors which are usually performed by people. Such robots attempt to replicate walking, lifting, speech, cognition, or any other human activity. Many of today's robots are inspired by nature, contributing to the field of bio-inspired robotics.

13. Bit Coin

Bitcoin (□) is a decentralized digital currency, without a central bank or single administrator, that can be sent from user to user on the peer-to-peer bitcoin network without the need for intermediaries.[7] Transactions are verified by network nodes through cryptography and recorded in a public distributed ledger called a blockchain. The cryptocurrency was invented in 2008 by an unknown person or group of people using the name Satoshi Nakamoto.[9] The currency began use in 2009[10] when its implementation was released as open-source software.[6]:ch. 1

Bitcoins are created as a reward for a process known as mining. They can be exchanged for other currencies, products, and services. Bitcoin has been criticized for its use in illegal transactions, the large amount of electricity (and thus carbon footprint) used by mining, price volatility, and thefts from exchanges. Some investors and economists have characterized it as a speculative bubble at various times. Others have used it as an investment, although several regulatory agencies have issued investor alerts about bitcoin.[11][12][13] In September 2021, El Salvador officially adopted Bitcoin as legal tender, becoming the first nation to do so.[14]