7.OVERVIEW OF COMPUTER TOPICES

7.1 INTRODUCTION TO DATA STRUCTURES

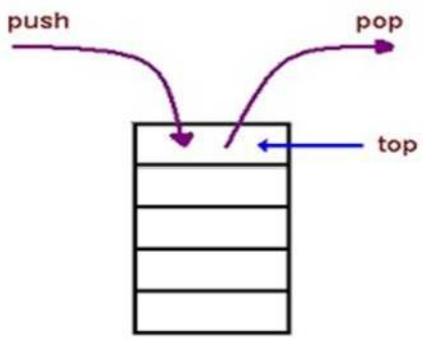
7.1.1 data structures

- ✓ Data structure is a collection of organized data that **are related to each other.**
- ✓ A data structure is a way to store and organize data in a computer, so that it can be used efficiently.
- ✓ Data structure can implements one (or) **more particular abstract data types (ADT**). ADT is a mathematical model for data type.
- ✓ Data structure is a provide a means to manage large amount of data efficiently for uses such as large data bases and internet indexing services.

Operations done on data structures

- ✓ Data organization
- ✓ Accessing technique : sequential (or) random
- ✓ Manipulating : selections for information

7.2 classify data structures



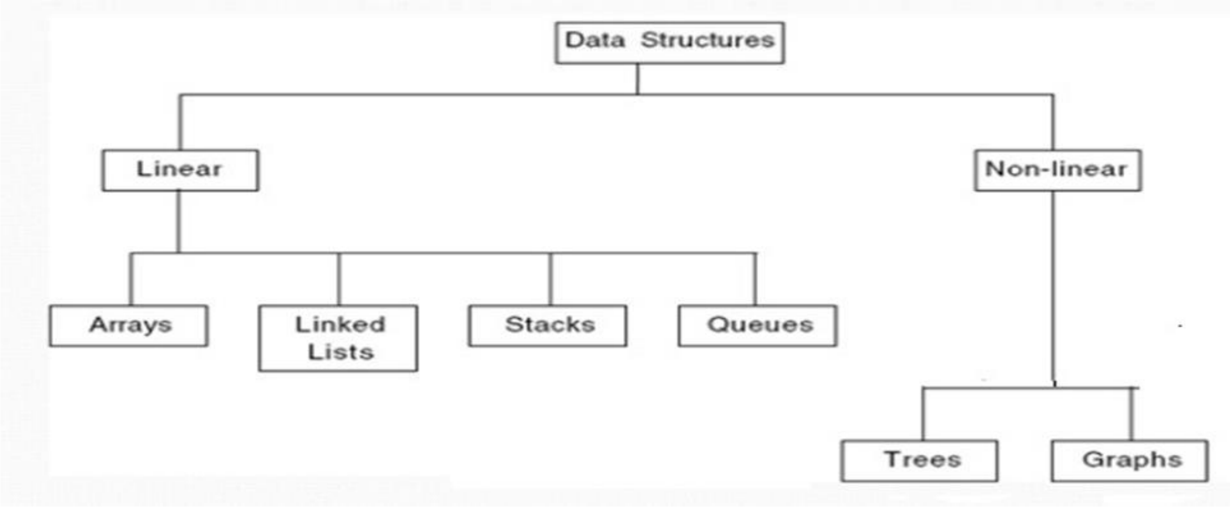
- ✓ Data structures are classified into following types
  1. Primitive data structures
  2. Non-primitive data structures

Primitive data structures

- ✓ Primitive data structures that can be **manipulated (or) operated by the machine instructions**.
- ✓ They have been different representation on different computer.
  Ex: Int, float, character, double.

Non-primitive data structures

- ✓ Non-primitive data structures that cannot be manipulated (or) operated directly by the machine instructions.
- ✓ These are **more complex.**
- ✓ Non-primitive data structures are classified into



1. Linear data structure
2. Non-linear data structures

Linear data structure

- ✓ The Element are stored and accessed in **contiguous memory locations** are called linear data structures.
  Ex: array, stack, queue, linked list

Non-linear data structure

- ✓ The Elements are stored and **accesses in noncontiguous memory location** are called non-linear data structure.
  Ex: tree, graph.

Examples:

- ✓ Array is uses to store data in **consecutive memory location**.
  EX: Int a{10}

Stack:

- ✓ Stack is a linear data structure in which data item is inserted and deleted at one end.
- ✓ Stack is called last in first out structure
- ✓ Stack has two operations
  1. Push
  2. Pop

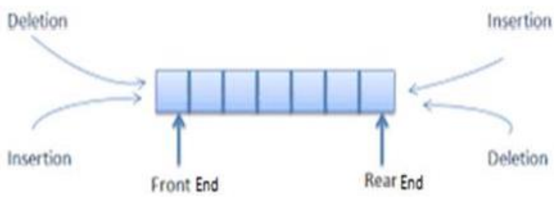
30
20
10

Stack

Queue:

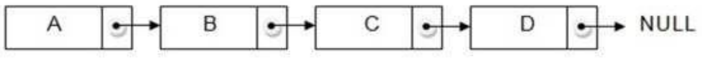
- ✓ Queue is a linear, sequential list of items that are accessed in the order **first in first out**.
- ✓ First item inserted in a queue is also the first one to be accessed, second item inserted in a queue is also the second one to be accessed.

  Ex:



Linked list:

- ✓ Structure contains the link to the structure containing the next item. This type of list is called LINKED LIST.
- ✓ Each constructor of the list is called a node.



Linked List

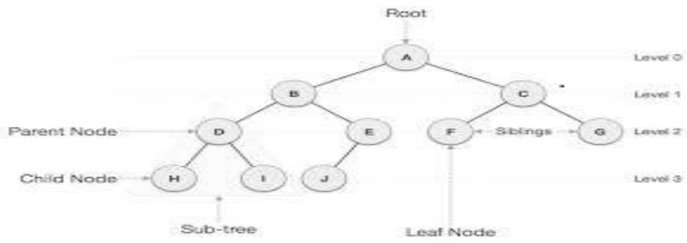
Linked list types are:

- ✓ Singly linked list
- ✓ Doubly linked list
- ✓ Circular linked list

Tree:

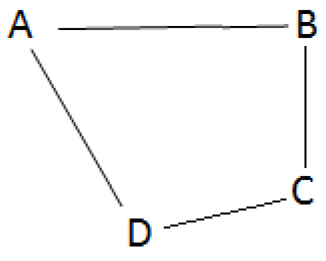
- ✓ **Binary Tree is a special datastructure used for data storage purposes. A binary tree has a special condition that each node can have a maximum of two children.**
- ✓ **A binary tree has the benefits of both an ordered array and a linked list as search as quick as in a sorted array and insertion or deletion operation are as fast as in linked list.**
- ✓ It shows **hierarchal relationship among data items**.

  Ex:

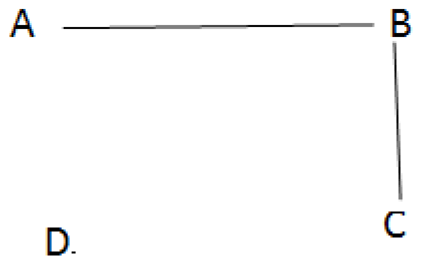


Graph:

- ✓ A Graph is a set of nodes and arcs. a nodes is also called as vertices and an arcs is called as edges.



Connected graph



non-connected graph

7.2 Introduction to database management system

7.2.1 Define terms Database and Database Management Systems:-

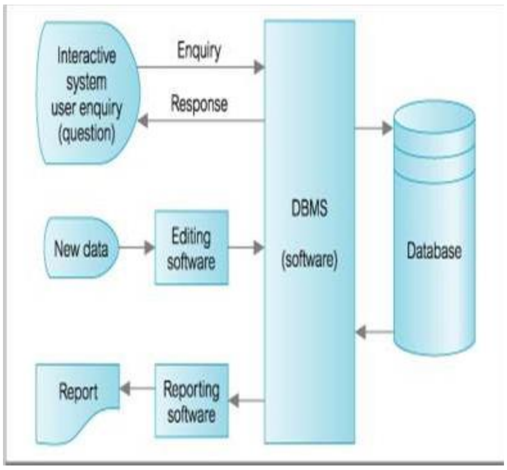
Database :-

- ✓ A database is defined as a **collection of data having an organized structure** and for a specific purpose.
- ✓ A database stores information, which is useful to an organization.

Example :-

- ✓ An airline database collection data about the airplane, the routers, airline reservation, airline schedule etc.
- ✓ A college database contains data about the students, faculty, administrative staff, courses, results etc.

DBMS:



- ✓ A database management system is a collection of programs which **enables its users to access** database, **manipulate data** and help in representation of database, manipulate data and help in representation of data.
  It also helps control access to the database by various users.
- ✓ A database management is system software for creating and managing databases.
- ✓ The DBMS provides users and programmers with **a systematic way to create, delete, update and manage the data.**
- ✓ DBMS is most useful for providing a centralized view of data that can be accessed by multiple users from multiple locations in a controlled manner.
  Example: - Electricity service provider using a DBMS to manage bills, client related issues etc .

7.2.2 List Advantages Of Database System:-

The major advantages of DBMS are

1. Controlling Data Redundancy
2. Improved data sharing
3. Improved data consistency
4. Improved data security
5. Better data integrity
6. Backup and recovery
7. Improved database access through a language

Controlling Data Redundancy:-

- ✓ DBMS **reduces the duplication of various data items** at various places. Multiple copies of the same data are reduced to single copy

Improved data sharing:-

- ✓ In DBMS data can be **shared by authorized users of the organization**.
- ✓ The DBA (Database Administrator) **manages the data and gives rights to users to access the data**. Many application programs can be authorized to access the same set of information simultaneously

Improved Data Consistency:-

- ✓ If the DBMS has redundancy to a minimum level, the database system enforces consistency.
- ✓ It means when a data item appears more than one in the database and it is updated the DBMS automatic ally updates each occurrence of a data item in the database.

Improved data security:-

- ✓ Protection of the database **from unauthorized users** and only the authorized persons are allowed to access the database.
- ✓ Some of the users may be allowed to access only a part of database.

Better Data Integration:-

- ✓ In DBMS data in database is **stored in tables**. A single database **contains multiple tables** and **relationships can be created between tables**. This makes easy to retrieve and update data.

Backup and Recovery:-

- ✓ Most of the DBM'S provides the backup and recovery sub-systems that automatically create the backup of data and restore data if required.

Example:-

- ✓ if the computer system fails in the middle of an update operation of the program the recovery sub-system is responsible for making some that the database is restored .

Improved Database Access through Language:-

- ✓ Most of the DBM'S provide SQL (structured Query Language) as standard database access language It is used to access data from multiple tables of database.

7.2.3 Flat file database and Relational Database systems

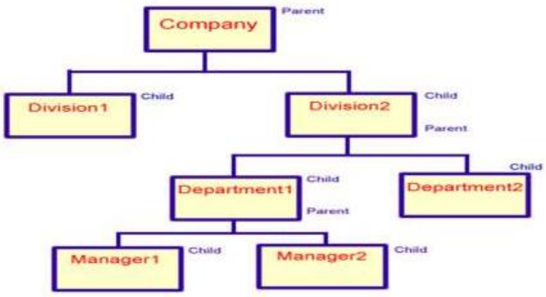
Flat File Database systems	Relational Database systems
1) All data is stored in **a single record.**	1) Data is often stored in **multiple records** in multiple tables, that are linked (or "related") via a common data value.
2) Database must be processed sequentially so that if you need the last record in the file, you must read all those that come before.	2) Records (or "rows") are typically read directly by means of an index.
3) Slower**, less flexible, difficult to access larger databases.**	3)RDBMS is faster, **more flexible, and provides much greater ease of access that flat files**
4) Designing flat file database is simple and requires little design knowledge.	4) Designing a relational database takes more planning than flat file database.
5)**Less secured**	5)**More secured at all the levels**
6) **More data duplication exists** in case of multiple files in databases.	6)**Less data duplication** (Less Data redundancy)
7) Difficult to control concurrent data accesses.	7) Concurrency control can be done easily.

7.2.4 LIST VARIOUS EXISTING DATABASE SYSTEM

There are four main types of database management system (DBMS) and these are based upon their management of database structures.

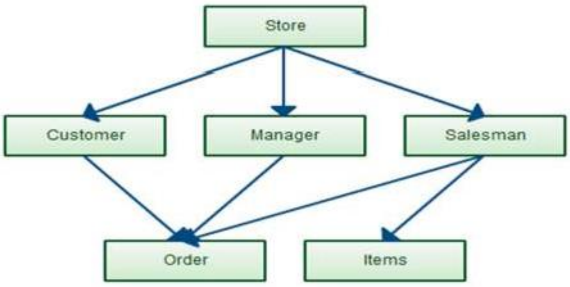
Hierarchical DBMS

- ✓ A DBMS is said to be hierarchical if the relationships among data in the database are establish in such a way that one data item is present as the subordinate of another one or a sub unit.
- ✓ Here subordinate means that items have "parent-child" relationships among them. Direct relationships exist between any two records that are stored con secutively.
- ✓ the data structure "tree" is following by the DBMS to structure the database.



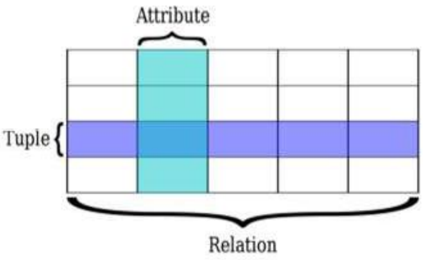
Network DBMS

- ✓ A DBMS is said to be a Network DBMS if the relationships among data in the database are of **type many-to-many**.
- ✓ The relationships among many-to-many appear in from of a network. **Structure of network database is extremely complicated** because of these many-to-many relationships in which one record can be used as akey of the entire database.



Relational DBMS

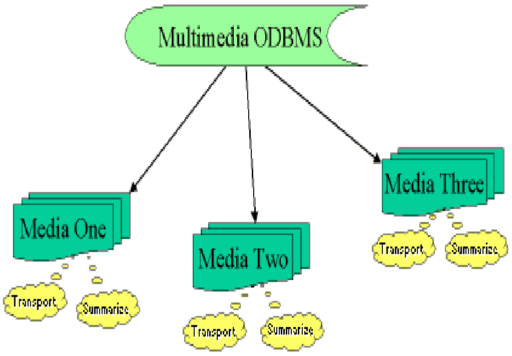
- ✓ A DBMS is said to be a relational DBMS or RDBMS if the database relationships are treated in from of a table .
- ✓ There are three keys on relational DBMS: relational, domain and attributes.
- ✓ It contains a fundamental constructs sets or records sets contains one to many relationship, records contains fields of table that is composed of rows and columns is used to organize the database and its structure and is actually a two dimension array in the computer memory a number of RDBMS are available.



- ✓ some popular example are **Oracle, Sybase, ingress, Informix, Microsoft SQL server**, and **Microsoft access**.

Object-oriented DBMS

- ✓ **able to handle many new data type**, including **graphics, photographs, audio, and video**, object-oriented databases represent a significant advance over their other database cousins. Hierarchical and network database are all designed to handle structure data; that is, data fits into fields, rows, columns.
- ✓ They are useful for handling **small snippets of information such as names, addresses, zip codes**, product numbers, and any kind of statistic.
- ✓ On the other hand, an object-oriented database can be **used to store data from a variety of media sources**, such as **photographs and text,** and product work, as output, in a multimedia format.



7.3 Introduction to software engineering

7.3.1 Define software engineering:

- ✓ The application of a systematic, disciplined, quantifiable approach to the **analysis, implementation, development, operation and maintenance** of software.
- ✓ Programming is only part of software engineering.

7.3.2. Need For Software engineering:

- ✓ Software Engineering is required to **enforce the rules and regulations** for the software development process and to estimate various quantities ranging from user requirements **,cost,time,manpower,line of code and quality** of various modules of software development process to meet the customer requirements.

Software Engineering is needed for the following reasons:

- ✓ To develop a **frame work**, defining tasks performed at each step in the software development process.
- ✓ To meet the standards that defined **by ISO**/IEC 12207(An international standard for software development).
- ✓ To specify all the tasks required for deploying and maintaining software.
- ✓ To estimate the Line of code required for the proposed software development process.
- ✓ To estimate **various metrics (measures**) used to qualify the software.
- ✓ To estimate **the costs, time, requirement, resource requirement** for software development.
- ✓ To complete software development within times and **cost estimates** of customers.
- ✓ To test verify and validate the software.
- ✓ Hence, to produce a **high quality software** that **meets customer expectations**, software Engineering is needed.

7.3.3List the different lifecycle models in software engineering:

SDLC (software development life cycle):

- ✓ SDLC, Software Development Life Cycle is a process used by software industry to design, **develop and test high quality softwares**.
- ✓ The SDLC **aims to produce a high quality software** that meets or exceeds customer expectations, reaches completion within times and cost estimates.
- ✓ SDLC is the acronym of Software Development Life Cycle.
- ✓ It is also called as Software development process.
- ✓ The software development life cycle (SDLC) is a **framework defining tasks performed** at each step in the software development process.

- ✓ ISO/IEC 12207 is an international standard for software life-cycle processes. It aims to be the standard that defines all the tasks required for developing and maintaining software.

A typical Software Development life cycle consists of the following stages:

- Stage 1: **Planning and Requirement** Analysis
- Stage 2: Defining **Requirements**
- Stage 3: Designing the **product architecture**
- Stage 4: **Building or Developing** the Product
- Stage 5: **Testing** the Product
- Stage 6: **Deployment i**n the Market and Maintenance

SDLC Models

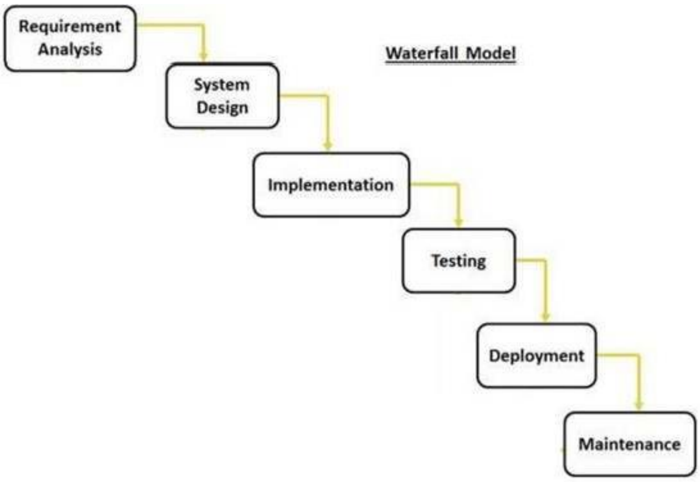
Following are the most important and popular SDLC models followed in the industry:

- ✓ Waterfall Model
- ✓ Iterative Model
- ✓ Spiral Model
- ✓ V-Model
- ✓ Big Bang Model

The other related methodologies are Agile Model, RAD Model, Rapid Application Development and Prototyping Models.

SDLC Waterfall Model

The SDLC waterfall model consists of different phases are



Requirement Gathering and analysis:

- ✓ All possible requirements of the system to be developed are captured in this phase and documented in a requirement specification doc.

System Design:

- ✓ The requirement specifications from first phase are studied. in this phase and system design is prepared. System Design helps in specifying hardware and system requirements and also helps in defining overall system architecture.

Implementation:

- ✓ With inputs from system design, the system is first developed in small programs called units, which are integrated in the next phase. Each unit is developed and tested for its functionality which is referred to as Unit Testing.

Integration and Testing:

- ✓ All the units developed in the implementation phase are integrated into a system after testing of each unit. Post integration the entire system is tested for any faults and failures.

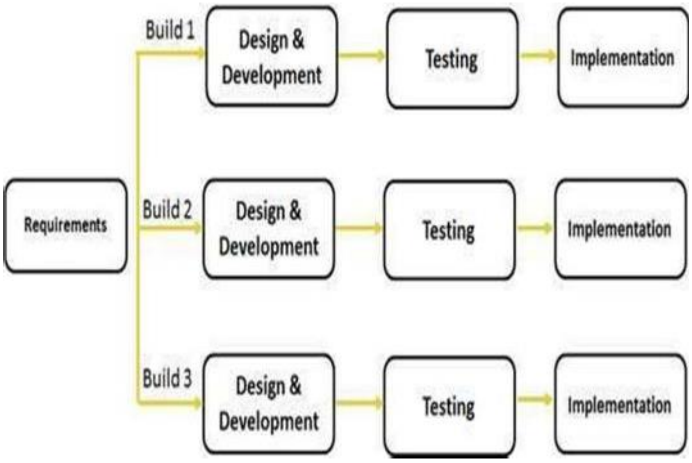
Deployment of system:

- ✓ Once the functional and nonfunctional testing is done, the product is deployed in the customer environment or released into the market.

Maintenance:

- ✓ There are some issues which come up in the client environment. To fix those issues patches are released. Also to enhance the product some better versions are released. Maintenance is done to deliver these changes in the customer environment.

SDLC Iterative Model

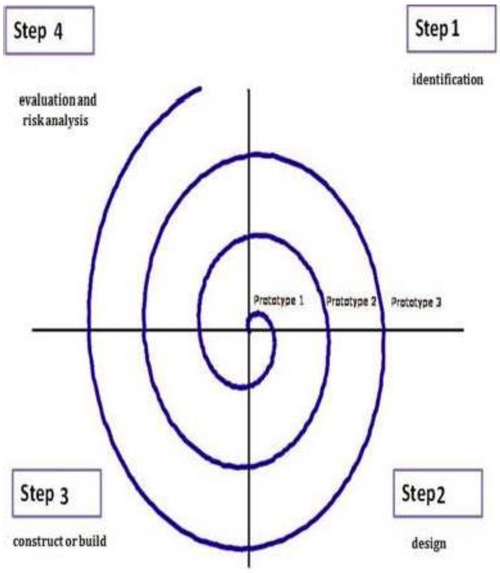


This model is most often used in the following scenarios:

- ✓ Requirements of the complete system are **clearly defined and understood.**
- ✓ Major requirements must be defined; however, some functionalities or requested enhancements may evolve with time.
- ✓ There is a **time to the market constraint**.
- ✓ A new technology is being used and is being learn by the development team while working on the project.
- ✓ Resources with needed skill set are not available and are planned to be used on contract basis for specific iterations.
- ✓ There are some **high risk features and goals which may change in the future**.

SDLC Spiral Model

The spiral model has four phases. A software project repeatedly passes through these phases in iterations called Spirals.



Identification:

- ✓ This phase starts with gathering the business requirements in the baseline spiral. In the subsequent spirals as the product matures, identification of system requirements.
- ✓ This also includes understanding the system requirements by continuous communication between the customer and the system analyst.

Design:

- ✓ Design phase starts with the conceptual design in the baseline spiral and involves architectural design, logical design of modules, physical product design and final design in the subsequent spirals.

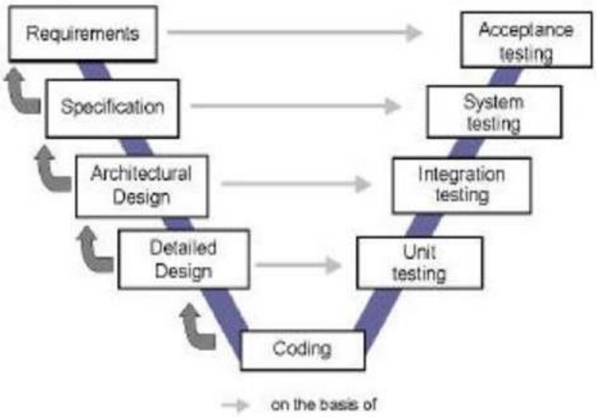
Construct or Build:

- ✓ Construct phase refers to production of the actual software product at every spiral. In the baseline spiral when the product is just thought of and the design is being developed a POC (Proof of Concept) is developed in this phase to get customer feedback.

Evaluation and Risk Analysis:

- ✓ Risk Analysis includes identifying, estimating, and monitoring technical feasibility and management risks, such as schedule slippage and cost overrun.
- ✓ After testing the build, at the end of first iteration, the customer evaluates the software and provides feedback.

V Model

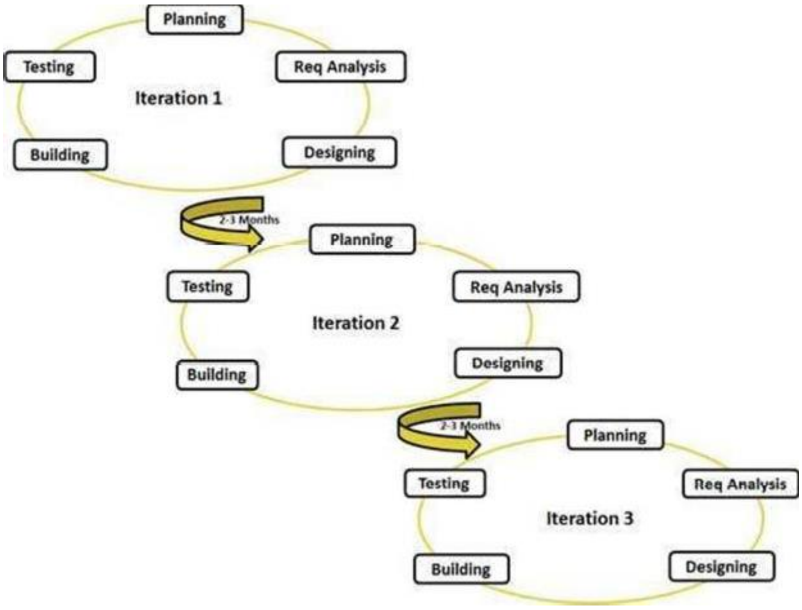


- ✓ The V - model is SDLC model where execution of processes happens in a sequential manner in V-shape. It is also known as Verification and Validation model.
- ✓ V - Model is an extension of the waterfall model and is based on association of a testing phase for each corresponding development stage.
- ✓ This is a highly disciplined model and next phase starts only after completion of the previous phase.

SDLC Big Bang Model

- ✓ The Big Bang model is SDLC model where there is no specific process followed.
- ✓ The development just starts with the required money and efforts as the input, and the output is the software developed which may or may not be as per customer requirement.
- ✓ B ig Bang Model is SDLC model where there is no formal development followed and very little planning is required. Even the customer is not sure about what exactly he wants and the requirements are implemented on the fly without much analysis.
- ✓ Usually this model is followed for small projects where the development teams are very small.

Agile Model



- ✓ Agile thought process had started early in the software development and started becoming popular with time due to its flexibility and adaptability.
- ✓ The most popular agile methods include Rational Unified Process (1994), Scrum (1995), Crystal Clear, Extreme Programming (1996), Adaptive Software Development, Feature Driven Development, and Dynamic Systems Development Method (DSDM) (1995). These are now collectively referred to as agile methodologies, after the Agile Manifesto was published in 2001.

Following are the Agile Manifesto principles

Individuals and interactions .

- ✓ In agile development, self-organization and motivation are important, as are interactions like co-location and pair programming.

Working software.

- ✓ Demo working software is considered the best means of communication with the customer to understand their requirement, instead of just depending on documentation.

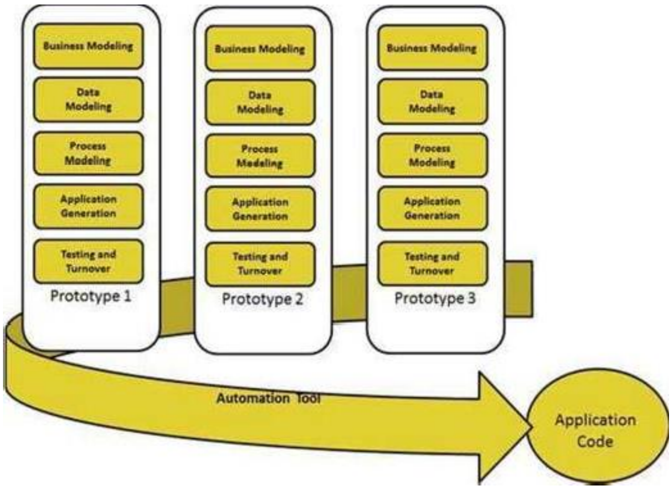
Customer collaboration .

- ✓ As the requirements cannot be gathered completely in the beginning of the project due to various factors, continuous customer interaction is very important to get proper product requirements.

Responding to change .

- ✓ Agile development is focused on quick responses to change and continuous development.

RAD MODEL



Following are the typical scenarios where RAD can be used:

- ✓ RAD should be used only when a system can be modularized to be delivered in incremental manner.
- ✓ It should be used if high availability of designers for modeling.
- ✓ It should be used only if the budget permits use of automated code generating tools.
- ✓ RAD SDLC model should be chosen only if domain experts are available with relevant business

knowledge.

- ✓ Should be used where the requirements change during the course of the project and working prototypes are to be presented to customer in small iterations of 2-3 months.

<u>Software Prototyping</u>

- ✓ The Software Prototyping refers to building software application prototypes which display the functionality of the product under development but may not actually hold the exact logic of the original software.
- ✓ Software prototyping is becoming very popular as a software development model, as it enables to understand customer requirements at an early stage of development.
- ✓ It helps get valuable feedback from the customer and helps software designers and developers understand about what exactly is expected from the product under development.

Following is the stepwise approach to design a software prototype:

<u>Basic Requirement Identification</u>:

- ✓ This step involves understanding the very basics product requirements especially in terms of user interface. The more intricate details of the internal design and external aspects like performance and security can be ignored at this stage.

<u>Developing the initial Prototype</u>:

- ✓ The initial Prototype is developed in this stage, where the very basic requirements are showcased and user interfaces are provided. These features may not exactly work in the same manner internally in the actual software developed and the work arounds are used to give the same look and feel to the customer in the prototype developed.

<u>Review of the Prototype:</u>

- ✓ The prototype developed is then presented to the customer and the other important stakeholders in the project. The feedback is collected in an organized manner and used for further enhancements in the product under development.

<u>Revise and enhance the Prototype</u>:

- ✓ The feedback and the review comments are discussed during this stage and some negotiations happen with the customer based on factors like , time and budget constraints and technical feasibility of actual implementation.
- ✓ The changes accepted are again incorporated in the new Prototype developed and the cycle repeats until customer expectations are met

7.4 <u>Introduction to open source software</u>

<u>7.4.1</u> <u>Open source software</u>

- ✓ Open source software is a computer software with **its source code made available with a license** in which the copy right holder provides the right to study, change and distribute the software to any one and for any purpose
- ✓ Open source software may be **development in a collaborative public manner**.

(Or)

- ✓ Open source software is computer software that is distributed along with its source code under a special software license.
- ✓ The license allows users to use,change and improve the software's source code,and to redistribute the software either before or after it has been modified.
- ✓ If any user makes any modification to the source code,one of the conditions of open source is that the user/developer has to provide information to other developers about what has been changed, and how.
- ✓ The software that is created as a result of modifications to the source code may or may not be made available for free.

<u>Open source development:</u>

- ✓ Users should be treated as co-developers
- ✓ Early releases
- ✓ Frequent integration
- ✓ Several versions may be easy
- ✓ High modularization
- ✓ Dynamic decision making structure.

Open source software will be

1. lower cost
2. security
3. no vendor 'lock in'
4. better quality

- ✓ Open source is a **certification standard issued by the open source initiative** (OSI) that indicates that the source code of a computer program is made available free of charge to the general public.

Difference between open source vs conventional software

Conventional software	**Open source software**
1) Owned by **a company (or) individual**	1) Is not owned by a company individual
2.) Licensed **to use and distribute only**.	2.) Licensed to **use, distribute and to modify also.**
3.)access to the source code of the **software is not given to the user**	3.) User can access the source code.
4.)bugs are **corrected by the company**	4.) bugs are **corrected by the user who can modify** any test it
5.) it is **not free of cost**	5.) it **may (or) may not be free**
6.) quality **develop by the company**	6.) Offer high quality due to modifications done by developer.

7.4.2 open source software's

List of popular open source

Software type	Examples
Web browsers	✓ Mozilla Firefox, chromium,brave,waterfox,palemoon.
Data bases	✓ My SQl ,Post Gre SQl,neo4j,mongoDb
Operating systems	✓ Linux kernel, Ubuntu, red hat Unix, fedora
Office software: Alternative to MS office	✓ Open office, Libre office, Neo office
e-mail servers	✓ postfix, zimbra,open-exchange.
File servers	✓ Free NAS,
Other valuable systems	✓ Apache, Tom cat

7.5 INTRODUCTION TO SYSTEM ADMINISTRATION

7.5.1 List any Five Networking operating systems

- ✓ Network operating system (NOS) is the software that allows **multiple computers to communicate, share files** and hardware devices with one another.

Some examples of network operating systems are

- ✓ Novell Net Ware : Netware is a Novell network operating system (NOS) providing transparent remote file access, printer sharing and support for electronic mail and database systems
- ✓ Microsoft Windows NT : provides network services designed for business systems.
- ✓ Microsoft Windows 2000 R2 : suitable for small-to-medium-sized businesses.
- ✓ Microsoft Windows XP : For Home and Offices.
- ✓ Sun Solaris : Linux based NOS
- ✓ Linux : Supports WANs and MANs

7.5.2 Define Client and server

- ✓ Server: a server is defined as a computer system software and hardware used to **provided network service to other computers on the networks**.
- ✓ Servers are highly configured dedicated systems such as mainframes **that keeps on waiting for requests from other computers on the network**.
- ✓ There are several types of servers available based on the type of service they provide.
- ✓ Most commonly used server are **File-Server, Web-Server, E-Mail Server, DNS server**, **print server, gaming server** etc.
- ✓ Client: Client is a system (software and hardware**) used to send requests to the server**.
- ✓ Clients are the computers that provide the user interface and from where users can access the data applications that were that were requested from the server.
- ✓ These are ordinary PCs **loaded with personal or networking operating systems**.
- ✓ These are installed with client software.

- ✓ Any computer connected to network acts as a server. They normally execute programs that request a service from the server.
- ✓ Example: in banking system, the server is used to **store the database of the bank.** The clients are the computers operated by managers, clerks. A clerk may send a request to deposit some amount into the account of a customer, then clerk sends a request to deposit the server actually updates the database by adding amount to the existing balance.

7.5.3 Features of Networking operating system

- ✓ A network operating system is a software application that **provides a platform for both the functionality of an individual computer** and **for multiple computers** within an interconnected network.
- ✓ Basically, a network operating system **controls other software** and computer hardware to run applications.
- ✓ **Share resources, protect data and establish communication. Individual computers run** client operating system, while network system creates the software infrastructure for wireless, local and wide area network to function.

Basic Operating Features:

- ✓ Supports basic underlying operating features of networks. These include support for processors and the **various protocols that allow computers to share data**.
- ✓ They can detect hardware within system to allow for asset discovery within the network also, they support the processing of other software application that runs on both individual computers and within the network.

Security Features:

- ✓ Support a number of security features that control access to the network these include **authorization and permission for access to the network**, with specific control features such as management, log-on controls and password.
- ✓ They also support **remote access and network monitoring**.

Networking:

- ✓ **Acts as the platform on which computer networking** take place basic feature allow for file, print and internet connections.
- ✓ Data backup and replication function are controller through the network operating system. They manage LAN and WAN by routing.
- ✓ The configure switches and other ports to work on network.

Administrative interface:

- ✓ To allows a network administrator to monitor and maintain the system. This interface will have a menu that allows the administrator to perform function such as formatting hard drives and setting up security protocols for both the system and individual users.
- ✓ He can also configure security and data backup requirement for individual computer or the network as a whole.

File-sharing services:

- ✓ One of the most important functions of a network operating system is its ability to share resources with other network users.
- ✓ The most common resource that‘s share is the server’s file system. A network server must be able to share some (or) all its disk space with other users so that those users can treat the server’s disk space as an extension of their own computer’s disk space.

7.5.4 Networking O.S. and Desktop OS

Desktop OS	Network OS
✓ Desktop OS runs the computer itself Example : Windows.	✓ Network OS allows for enhanced network operations such as file sharing, network printers, server access, etc. Example: Novell Netware.
✓ Contains only one version	✓ Comes in two versions-server version and client version
✓ Controls limited no. of resources	✓ Controls unlimited number of Resources
✓ Supports Single User	✓ Supports Multiple Users
✓ Limited supports to Client/Server Architecture	✓ Supports Client/Server architecture to the larger extent

7.5.5 File system

The system that is used by an operating system to organize and keep track of files on Hard disk. Each file system should

- ✓ Efficiently use the space available on the hard drive to store the necessary data.
- ✓ Catalog all the fields on the hard drive so that retrieval is fast and reliable.

Provide methods for performing basic file operations, such as delete, rename, copy, and move.

- ✓ Provide some kind of data structure that allows a computer to boot off the file system.
- ✓ Provide Compression and Encryption.
- ✓

7.5.6 FAT, FAT32 and NTFS

7.5.6.1 FAT

- ✓ File Allocation Table (FAT) is **a file system** that was created by Microsoft in 1977.
- ✓ FAT is still in use today as the preferred file system for floppy drive media and portable, high capacity storage devices like flash devices.
- ✓ FAT was the **primary file system used in all of Microsoft's consumer** operating systems from MS-DOS through windows ME.
- ✓ The File Allocation Table file system has seen advancements over time primarily due to the need to **support larger hard disk drives and larger file sizes**.
- ✓ Below is more information on the versions of the FAT file system namely FAT 12, FAT 16 and FAT 32.
- ✓ FAT 16 is generally called as FAT: **FAT16**-The second implementation of FAT was FAT16, introduced in 1988.
- ✓ FAT16 was the primary file system for MS-DOS 4.0 up to Windows 95.
- ✓ FAT16 supports drive sizes up to 2GB. It supports 65536 clusters. The filename must be 8.3 i.e . Filename must contain up to 8 characters with a 3 letter extension.

7.5.6.2 FAT32

- ✓ The FAT32 file system is the latest version of the FAT file system. It was introduced in 1996 for windows 95 OSR2 users and was the primary file system for consumer windows versions through windows ME.
- ✓ FAT32 supports drive sizes up to 8TB. Filenames up to 255 characters are supported.

The FAT 32 file system has the following properties:

- ✓ FAT partitions cannot extend beyond 2TB.
- ✓ Files stored to a FAT partition cannot exceeds 4GB.
- ✓ FAT partitions need to be defragmented often to maintain responsible performance.
- ✓ FAT partitions larger than 32GB are generally not recommended.

7.5.6.3 NTFS

- ✓ `New Technology File System (NTFS) is a file system that was introduced by Microsoft in 1993 with Windows NT 3.1. NTFS supports hard drive sizes up to 256TB.
- ✓ NTFS is the primary file system used in Microsoft's Windows 7, Windows vista, Windows XP, Windows 2000 and Windows NT operating systems.
- ✓ The Windows server line of operating system also primarily use in NTFS, Windows server 2003, Windows server 2003 R2, Windows server 2003 with SPL, Windows server 2003 with SP2. It supports filenames up to 255 characters.

NTFS has the following properties:

- ✓ NTFS partitions can extend up to 16EB (about 16 million TB)
- ✓ Files stored to NTFS partitions can be as large as the partitions.
- ✓ NTFS partitions occasionally become fragmented and should be defragmented every one to two months.
- ✓ NTFS partitions can be read from and written to by Windows and Linux systems and , can only be read from by Mac OS X, with the assistance of the NTFS-3G driver, can written to NTFS partition.