UNIT V

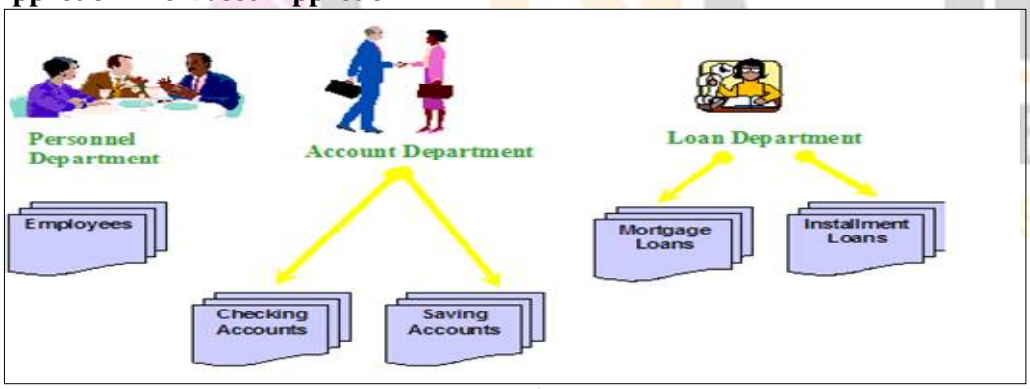
Data base Management System: Introduction, File oriented approach and Database approach, Data Models, Architecture of Database System, Data independence, Data dictionary, DBA, Primary Key, Data definition language and Manipulation Languages.
Cloud computing: definition, cloud infrastructure, cloud segments or service delivery models (IaaS, PaaS and SaaS), cloud deployment models/ types of cloud (public, private, community and hybrid clouds), Pros and Cons of cloud computing

Database-management system

A database management system (DBMS) is a collection of interrelated data and a set of programs to access those data. The collection of data, usually referred to as the database, contains information relevant to an enterprise.
The primary goal of a DBMS is to provide a way to store and retrieve database information that is both convenient and efficient. Database systems are designed to manage large bodies of information. Management of data involves both defining structures for storage of information and providing mechanisms for the manipulation of information. In addition, the database system must ensure the safety of the information stored, despite system crashes or attempts at unauthorized access. If data are to be shared among several users, the system must avoid possible anomalous results. Because information is so important in most organizations, computer scientists have developed a large body of concepts and techniques for managing data.

Purpose of Database

Approach File-Based Approach



File-based approach for banking system

One way to keep the information on a computer is to store it in the permanent files. The system has many application programs; each of them is defined to manipulate the data files. This application programs have been written on request of the users in the organization. The new application will be added to the system as the need arises. The system just described is called the file-based system. Consider a traditional banking system which using the file-based system in managing the organization's data in the picture below. As we can see, there are different departments in the Bank, each of them has their own applications which manage and manipulate different data files. For banking system, the programs can be the one to debit or credit an account, find the balance of an account, and a new mortgage loan or generate monthly statements etc.
Keeping organizational information in this approach has many disadvantages, including:

The disadvantages of file system processing

(i) Data Redundancy:

- Since files and applications are created by the different programmer of various departments over a long period of time, it might lead to several problems:
- Inconsistency in data format
- The same information may be kept in several different places (files).
- Data inconsistency which means various copies of the same data are conflicting; waste storage space and duplication of effort

(ii) Data Isolation

o It is difficult for a new application to retrieve the appropriate data which might be stored in various files.

(iii) Integrity problems

o Data values must satisfy certain consistency constraints which are specified in the application programs.

o It is difficult to add change the programs to enforce new constraint

(iv) Security problems

o There are constraint regarding accessing privileges

o Application is added to the system in an ad-hoc manner so it is difficult to enforce those constraints

(v) Concurrent – access anomalies

o Data may be accessed by many applications that have not been coordinated previously so it is not easy to provide a strategy to support multiple users to update data simultaneously. These difficulties have prompted the development of a new approach to managing a large amount of organizational information – database approach. In the following section, we shall see the concepts that have been introduced to get over the problems mentioned.

(vi) Database Approach

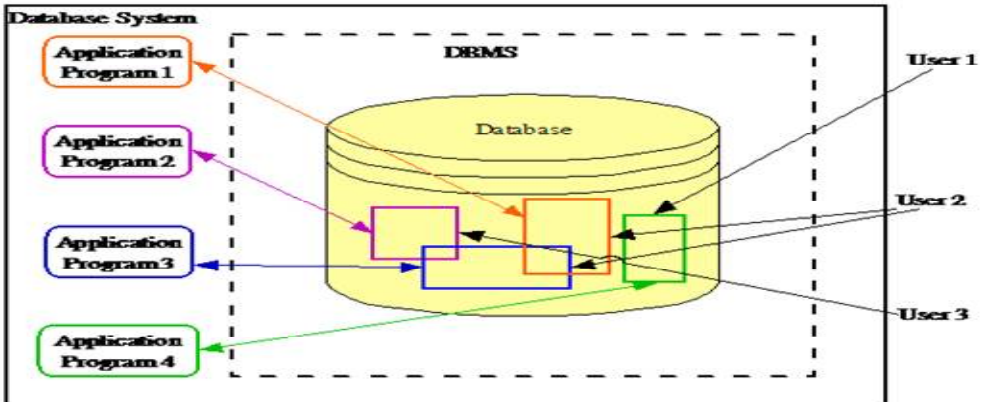
Database and database technology plays an important role in most of the social areas where the computer is used, including business, education, medicine etc.

Fundamental Concepts

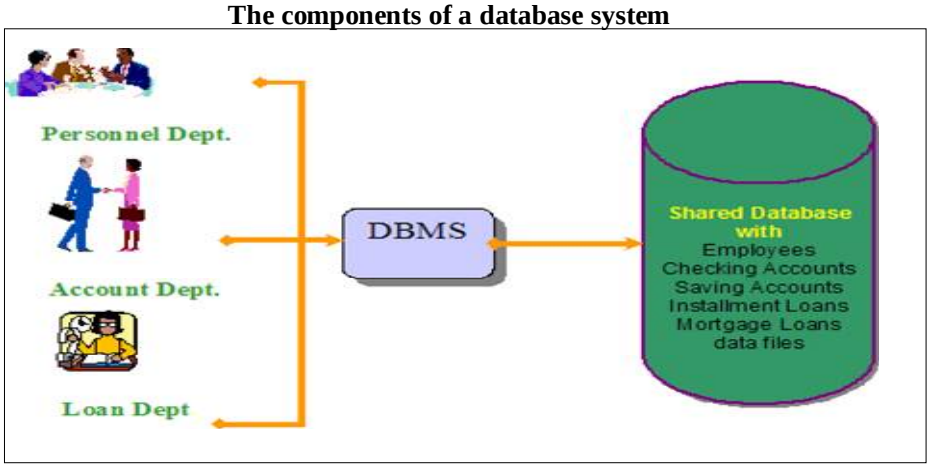
The database is a shared collection of related data which will be used to support the activities of the organization. The database can be viewed as a repository of data that is defined once and then is accessed by various users.

A database has the following properties:

- It is a representation of some aspect of the real world; or perhaps, a collection of data elements (facts) representing real-world information.
- The database is logically coherent and internally consistent.
- The database is designed, built, and populated with data for a specific purpose.



The components of a database system



Database approach for banking

system Characteristics of Database approach

There are many characteristics that distinguish the database approach with the file-based approach. In this section, we describe in detail some of those important characteristics.

- **Self-Describing Nature of a Database System**: Database System contains not only the database itself but also the descriptions of data structure and constraints (meta-data). This information is used by the DBMS software or database users if needed. This separation makes database system totally different from traditional file-based system in which data definition is a part of application programs
- **Insulation between Program and Data**: In the file base system, the structure of the data files is defined in the application programs so if the user wants to change the structure of a file, all the programs access to that files might need to be changed. On the other hand, in database approach, the data structure is stored in the system catalog not in the programs so such changes might not occur.
- **Support multiple views of data**: A view is a subset of the database which is defined and dedicated for

users of the system. Multiple users in the system might have different views of the system. Each view might contain only the interested data of a user or a group of users.

- **Sharing of data and Multi-user system**: A multi-user database system must allow multiple users to access the database at the same time. As the result, the multi-user DBMS must have concurrency control strategies to ensure that several users tries to access the same data item at a timed of so in the manners of that the data always be correct.

Benefits of Database Approach

-To control Data Redundancy

o In the Database approach, ideally, each data item is stored in only one place in the database

o However, in some case redundancy is still exists to improving system performance, but such redundancy is controlled and kept to minimum

– **Data Sharing**

o The integration of the whole data in an organization leads to the ability to produce more information from a given amount of data

– **Enforcing Integrity Constraints**

o DBMSs should provide capabilities to define and enforce certain constraints such as data type, data uniqueness.

- Restricting Unauthorized Access

o Not all users of the system have the same accessing privileges.

o DBMSs should provide a security subsystem to create and control the user accounts.

- Data Independence

o The system data descriptions are separated from the application programs.

o Changes to the data structure are handled by the DBMS and not embedded in the program.

- Transaction Processing

o The DBMS must include concurrency control subsystem to ensure that several users trying to update the same data do so in a controlled manner so that the result of the updates is correct.

- Providing multiple views of data

o A view may be a subset of the database. Various users may have different views of the database itself.

o Users may not need to be aware of how and where the data they refer to is stored

- Providing backup and recovery facilities

o If the computer system fails in the middle of a complex update program, the recovery subsystem is responsible for making sure that the database is restored to the stage it was in before the program started executing.

Comparison between DBMS & File System

DBMS	File System
1. DBMS is a collection of data and user is not required to write the procedures for managing the database. 2. DBMS provides an abstract view of data that hides the details. 3. DBMS is efficient to use since there are wide varieties of sophisticated techniques to store and retrieve the data. 4. DBMS takes care of Concurrent access using some form of locking. 5. DBMS has crash recovery mechanism DBMS protects user from the effects of system failures. 6. DBMS has a good protection mechanism.	1. File system is a collection of data. Any management with the file system, user has to write the procedures 2. File system gives the details of the data representation and Storage of data. 3. In File system storing and retrieving of data cannot be done efficiently. 4. Concurrent access to the data in the file system has many problems like a. Reading the file while other deleting some information, updating some information 5. File system doesn't provide crash recovery mechanism. Eg. While we are entering some data into the file if System crashes then content of the file is lost. 6. Protecting a file under file system is very difficult.

Data Models in DBMS

A database models how the logical structure of a database, including the relationships and constraints that determine how data can be stored and accessed. Individual database models are designed based on the rules and concepts of whichever broader data model the designers adopt. Most data models can be represented by an accompanying database diagram.

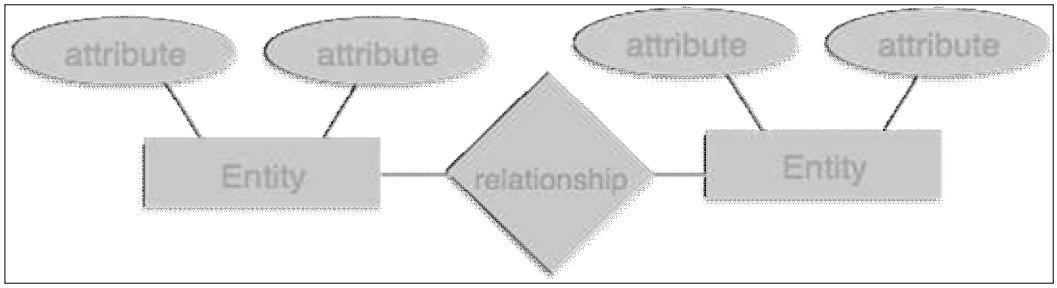
Entity-Relationship Model

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.*
- **Relationships**

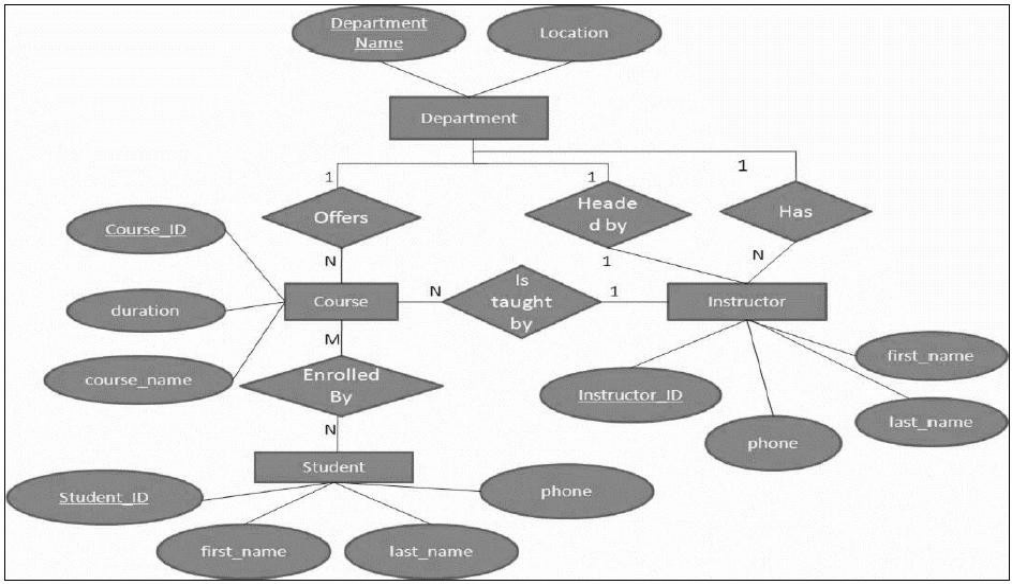
among entities. These concepts are explained below.



E-R Diagram

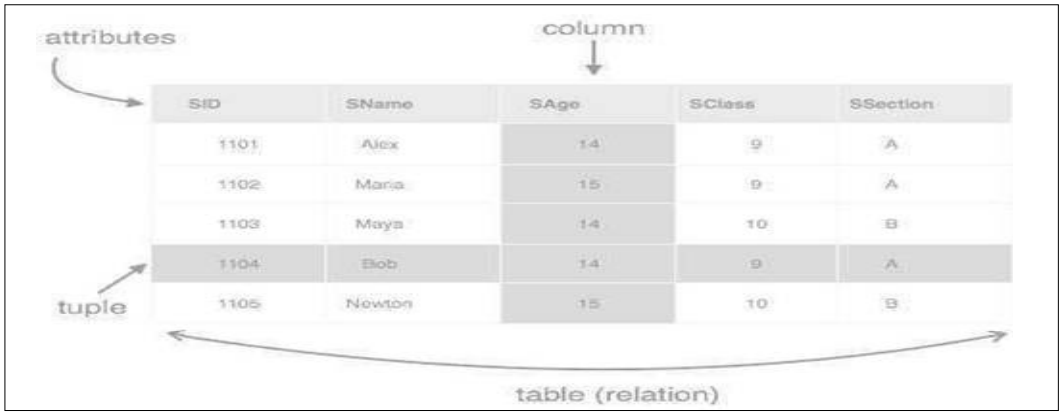
- **Entity** − An entity in an ER Model is a real-world entity having properties called **attributes**. Every **attribute** is defined by its set of values called **domain**. For example, in a school database, a student is considered as an entity. Student has various attributes like name, age, class, etc.
- **Relationship** − The logical association among entities is called ***relationship***. Relationships are mapped with entities in various ways. Mapping cardinalities define the number of association between two entities.
  Mapping cardinalities −
  - one to one
  - one to many
  - many to one
  - many to many

An Example of ER Model



Relational Model

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



Relational Database Model

The main highlights of this model are −

- Data is stored in tables called **relations**.
- Relations can be normalized.
- In normalized relations, values saved are atomic values.
- Each row in a relation contains a unique value.
- Each column in a relation contains values from the same domain.

Hierarchical Model

In this model, each entity has only one parent but can have several children. At the top of the hierarchy, there is only one entity which is called **Root**.

Advantages

• Simplicity
• Data Security and Data Integrity
• Efficiency

Disadvantages

• Implementation Complexity
• Lack of structural independence
• Programming complexity

Hierarchical Model

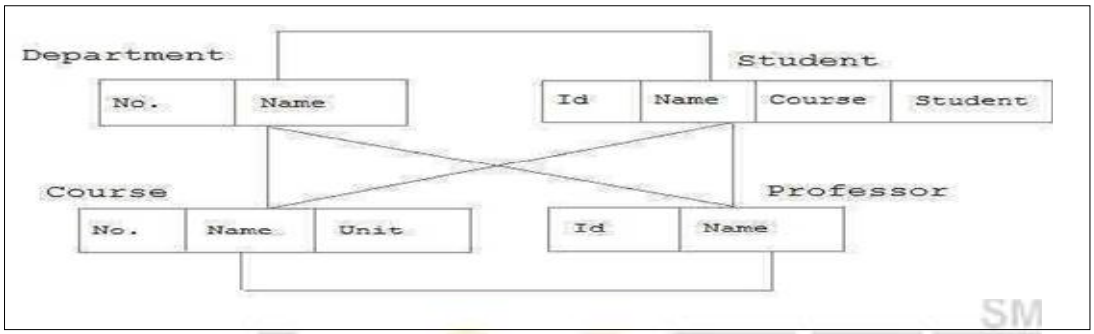
Network Model

In the network model, entities are organized in a graph, in which some entities can be accessed through several paths.

Advantages

• Conceptual Simplicity

• Ease of data access
• Data Integrity and capability to handle more relationship types
• Data independence
• Databa
se
standard
s
Disadva
ntages
• System complexity



• Absence of structural independence

Network Model

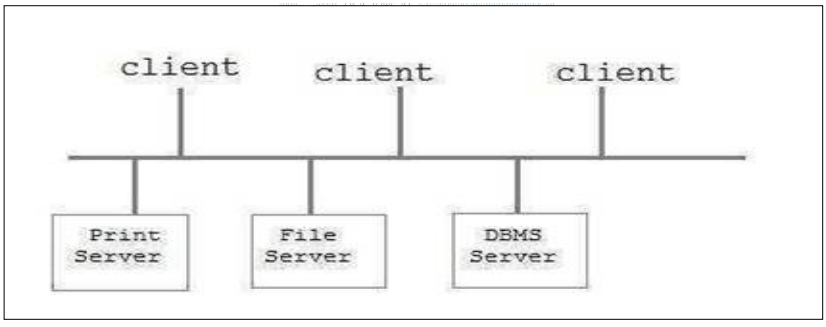
Database Architecture

Database architecture is logically divided into two types.

1. Logical two-tier Client / Server architecture
2. Logical three-tier Client / Server architecture

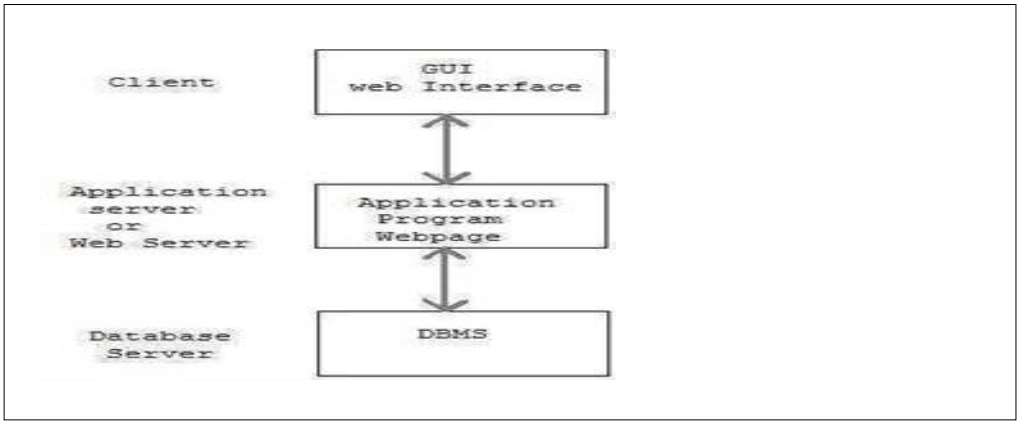
Two-Tier Architecture

Two-tier Client / Server Architecture



Two-tier Client / Server architecture is used for User Interface program and Application Programs that run on the client side. An interface called ODBC (Open Database Connectivity) provides an API that allows client side program to call the DBMS. Most DBMS vendors provide ODBC drivers. A client program connects to several DBMS's. In this architecture some variation of the client is also possible for example in some DBMS's more functionality is transferred to the client including data dictionary, optimization etc. Such clients are called **Data Server**.

Three-tier Client / Server Architecture



Three Tier Architecture

Three-tier Client / Server database architecture is commonly used architecture for web applications. An intermediate layer called **Application server** or Web Server stores the web connectivity software and the business logic (constraints) part of application used to access the right amount of data from the database server. This layer acts like a medium for sending partially processed data between the database server and the client.

Data Independence

A major objective for three-level architecture is to provide data independence, which means that upper levels are unaffected by changes in lower levels.
There are two kinds of data independence:

• Logical data independence

• Physical data independence

Logical Data Independence

Logical data independence indicates that the conceptual schema can be changed without affecting the existing external schemas. The change would be absorbed by the mapping between the external and conceptual levels. Logical data independence also insulates application programs from operations such as combining two records into one or splitting an existing record into two or more records. This would require change in the external/conceptual mapping to leave the external view unchanged.

Physical Data Independence

Physical data independence indicates that the physical storage structures or devices could be changed without affecting conceptual schema. The change would be absorbed by the mapping between the conceptual and internal levels. Physic 1data independence is achieved by the presence of the internal level of the database and the n, helping or transformation from the conceptual level of the database to the internal level. Conceptual level to internal level mapping, therefore, provides a means to go from the conceptual view (conceptual records) to the internal view and hence to the stored data in the database (physical records).

The Logical data independence is difficult to achieve than physical data independence as it

requires the flexibility in the design of database and prograll1iller should foresee the future requirements or modifications in the design.

Database Users:

Users are differentiated by the way they expect to interact with the system:

Application programmers:

Application programmers are computer professionals who write application programs. Application programmers can choose from many tools to develop user interfaces.

Rapid application development (RAD) tools are tools that enable an application programmer to construct forms and reports without writing a program.

Sophisticated users:

Sophisticated users interact with the system without writing programs. Instead, they form their requests in a database query language.

Specialized users:

Specialized users are sophisticated users who write specialized database applications that do not fit into the traditional data-processing framework.

Naïve users:

Naive users are unsophisticated users who interact with the system by invoking one of the application programs that have been written previously.

DBA (Data Base Administrator)

One of the main reasons for using DBMSs is to have central control of both the data and the programs that access those data. A person who has such central control over the system is called a database administrator (DBA). The functions of a DBA include:

• Schema definition. The DBA creates the original database schema by executing a set of data definition statements in the DDL.

• Storage structure and access method definition.

• Schema and physical-organization modification. The DBA carries out changes to the schema and physical organization to reflect the changing needs of the organization, or to alter the physical organization to improve performance.

• Granting of authorization for data access. By granting different types of authorization, the database administrator can regulate which parts of the database various users can access. The authorization information is kept in a special system structure that the database system consults whenever someone attempts to access the data in the system.

Routine maintenance. Examples of the database administrator's routine maintenance activities are:

– Periodically backing up the database, either onto tapes or onto remote servers, to prevent loss of data in case of disasters such as flooding.
– Ensuring that enough free disk space is available for normal operations, and upgrading disk space as required.
– Monitoring jobs running on the database and ensuring that performance is not degraded by very expensive tasks submitted by some users.

Data Dictionary

A Meta data (also called the data dictionary) is the data about the data. It is the self-describing

nature of the database that provides program-data independence. It is also called as the System Catalog. It holds the following information about each data element in the databases, it normally includes:

- Name
- Type
- Range of values
- Source
- Access authorization
- Indicates which application programs use the data so that, when a change in a data structure is contemplated, a list of the affected programs can be generated.

The data dictionary is used to control the database operation, data integrity, and accuracy. Metadata is used by developers to develop the programs, queries, controls, and procedures to manage and manipulate the data. Metadata is available to database administrators (DBAs), designers and authorized user as online system documentation. This improves the control of database administrators (DBAs) over the information system and the user's understanding and use of the system.

Active and Passive Data Dictionaries

The data dictionary may be either active or passive. An active data dictionary (also called integrated data dictionary) is managed automatically by the database management software. Consistent with the current structure and definition of the database. Most of the relational database management systems contain active data dictionaries that can be derived from their system catalog.

The passive data dictionary (also called non-integrated data dictionary) is the one used only for documentation purposes. Data about fields, files, people and soon, in the data processing environment, are. Entered the dictionary and cross-referenced. The passive dictionary is simply a self-contained application. It is managed by the users of the system and is modified whenever the structure of the database is changed. Since this modification must be performed manually by the user, it is possible that the data dictionary will not be current with the current structure of the database.

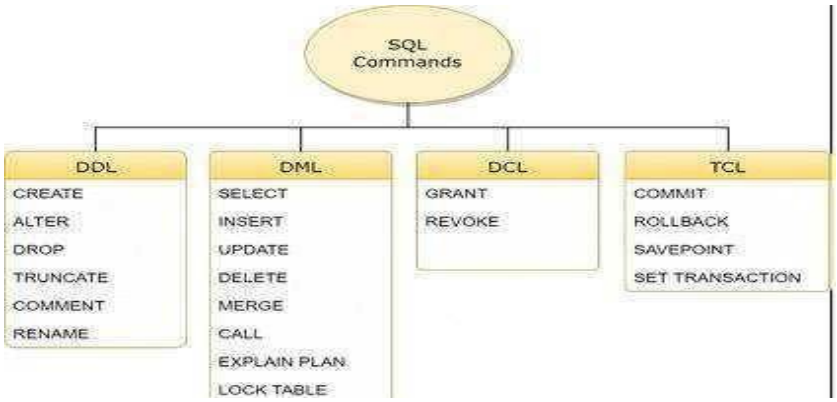
Primary Key

A primary key is a special relational database table column (or combination of columns) designated to uniquely identify all table records.

A primary key's main features are:

- It must contain a unique value for each row of data.
- It cannot contain null values.
- A primary key is either an existing table column or a column that is specifically generated by the database according to a defined sequence.

SQL Commands in DBMS



DDL

DDL is short name of Data Definition Language, which deals with database schemas and descriptions, of how the data should reside in the database.

CREATE–to create database and its objects like (table, index, views, stored procedure, function and triggers) ALTER – alters the structure of the existing database
DROP – delete objects from the database
TRUNCATE – remove all records from a table, including all spaces allocated for the records are removed COMMENT – add comments to the data dictionary
RENAME – rename an object

DML

DML is short name of Data Manipulation Language which deals with data manipulation and includes most common SQL statements such SELECT, INSERT, UPDATE, DELETE etc and it is used to store, modify, retrieve, delete and update data in the database.

SELECT – retrieve data from a database INSERT – insert data into a table
UPDATE – updates existing data within a table DELETE – Delete all records from a database table MERGE – UPSERT operation (insert or update)
CALL – call a PL/SQL or Java subprogram
EXPLAIN PLAN – interpretation of the data access path LOCK TABLE – concurrency Control

Cloud Computing

A cloud is simply a centralized technology platform which provides specific IT services to a selected range of users, offering the ability to login from anywhere, ideally from any device and over any connection, including the Internet. Intercept IT believes that a true cloud computing service is one which removes the traditional barriers which exist between software applications,

data, and devices. In other words, it is the nirvana of computing from a user's perspective, no need to worry about location, device, or type of connection, all the data and the software applications required by the user are fully available and the experience remains consistent. The highest standards of data protection must be a given, whereby users do not have to think about protecting the integrity of the data they use and store.

Characteristics of Cloud Computing as per NIST

Cloud technology is in the news quite often these days, but it still seems to be mysterious and confusing to the non-techie crowd. Cloud options are enticing various industries across the board, which is why it's important to know its essential characteristics as a software offering. Here are the five main characteristics that cloud computing offers businesses today.

1. On-demand capabilities: *On-Demand Self-Service*

- **Enables consumers to get computing resources as and when required, without any human intervention**
- **Facilitates consumer to leverage "ready to use" services or, enables to choose required services from the service catalog**
- **Allows provisioning of resources using self-service interface**
  - **Self-service interface should be user-friendly**

A business will secure cloud-hosting services through a cloud host provider which could be your usual software vendor. You have access to your services and you have the power to change cloud services through an online control panel or directly with the provider. You can add or delete users and change storage networks and software as needed. Typically, you are billed for a monthly subscription or a pay-for-what- you- use scenario. Terms of subscriptions and payments will vary with each software provider.

2. Broad network access:

- **Cloud services are accessed via the network, usually the internet from broad range of client platforms such as:**
  - **Desktop computer**
  - **Laptop**
  - **Mobile phone**
- **Eliminates the need for accessing a particular computer to get the services from anywhere across the globe**

Your team can access business management solutions using their smart phones, tablets, laptops, and office computers. They can use these devices wherever they are located with a simple online access point. This mobility is particularly attractive for businesses so that during business hours or on-off- times, employees can stay on top of projects, contracts, and customers whether they are on the road or in the office. Broad network access includes private clouds that operate within a company's firewall, public clouds, or a hybrid deployment.

3. Resource pooling:

- **IT resources (server, storage, network) are pooled to serve multiple consumers**
  - **Based on multi-tenant model**
- **Consumer has no knowledge over the exact location of the provided resources**
- **Resources are dynamically assigned and reassigned based on the consumer demand**

The cloud enables your employees to enter and use data within the business management software hosted in the cloud at the same time, from any location, and at any time. This is an attractive feature for multiple business offices and field service or sales teams that are usually

outside the office.

4. Rapid elasticity:

- **Ability to scale IT resources rapidly as needed to fulfill the changing needs without service interruption**
  - **Resources can be both scaled up and scaled down dynamically**
- **To the consumer, the Cloud appears to be infinite**
  - **Consumer can start with minimal computing power and can expand their environment to any size**

If anything, the cloud is flexible and scalable to suit your immediate business needs. You can quickly and
easily add or remove users, software features, and other resources.

5. Metered service:

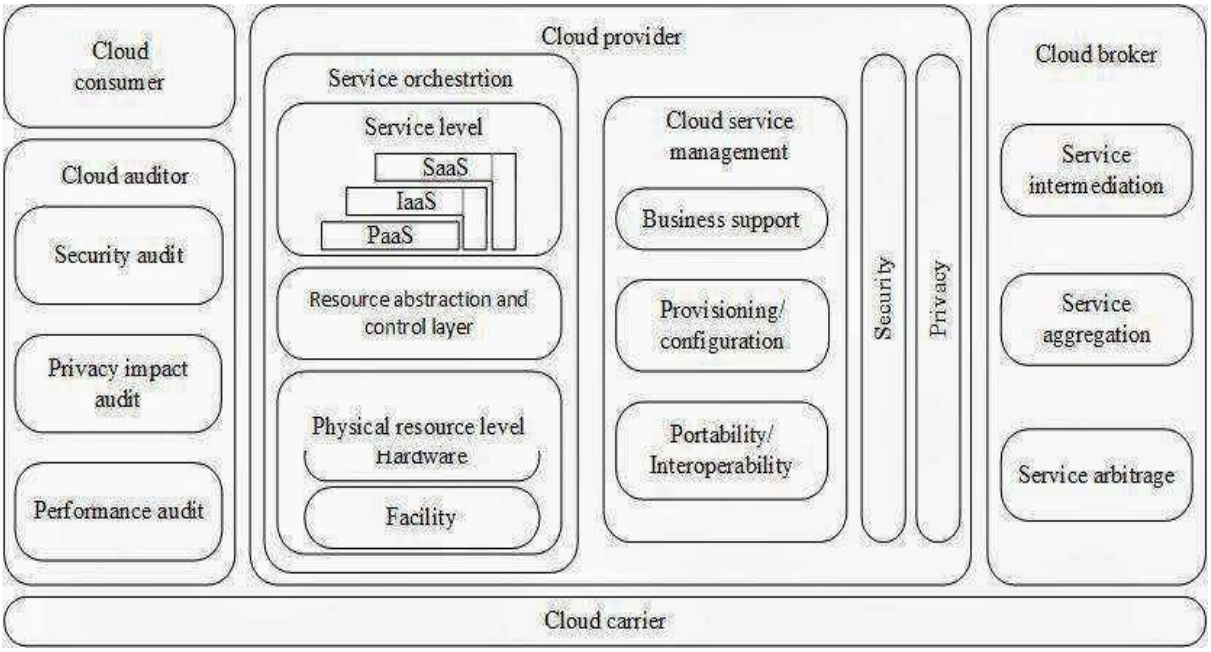
- **Consumers are billed based on the metered usage of Cloud resources**
  - **Costs incurred on a pay-per-use basis**
  - **Pricing/billing model is tied up with the required service levels**
  - **Resource usage is monitored and reported, which provides transparency for chargeback**
  - **Both to the Cloud service provider and to the consumer about the utilized service**

Going back to the affordable nature of the cloud, you only pay for what you use. You and your cloud provider can measure storage levels, processing, bandwidth, and the number of user accounts and you are billed appropriately. A number of resources that you may use can be monitored and controlled from both your side and your cloud provider's side which provides transparency.

Cloud Computing Reference Model

- The NIST Cloud Computing Reference Architecture consists of five major actors. Each actor plays a role and performs a set of activities and functions. The reference architecture is presented as successive diagrams in increasing level of detail.
- Among the five actors, cloud brokers are optional, as cloud consumers may obtain service directly from a cloud provider.

1. **Cloud Consumer:** Person or organization that maintains a business relationship with, and uses service from, Cloud Providers**.**
2. **Cloud Provider:** A person, organization or entity responsible for making a service available to Cloud Consumers.
3. **Cloud Auditor:** A party that can conduct an independent assessment of cloud services, information system operations, performance and security of the cloud implementation.
4. **Cloud Broker:** An entity manages the use, performance, and delivery of cloud services, and negotiates relationships between Cloud Providers and Cloud Consumers.
5. **Cloud Carrier:** The intermediary that provides connectivity and transport of cloud services from Cloud Providers to Cloud Consumers.



Cloud computing service & deployment models

According to National Institute of Standards and Technology (NIST), Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and

released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.

Cloud Computing Service Models

Software as a Service (SaaS). The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g. web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, except for limited user-specific application configuration settings.

Platform as a Service (PaaS). The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

Infrastructure as a Service (IaaS). The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer can deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

Deployment Model: -

Private cloud. The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, third party, or some combination of them, and it may exist on or off premises.

Community cloud. The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

Public cloud. The cloud infrastructure is provisioned for open use by the public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.

Hybrid cloud. The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

Advantages of Cloud Computing

1. Usability: All cloud storage services reviewed in this topic have desktop folders for Mac's and PCs. This allows users to drag and drop files between the cloud storage and their local storage.
2. Bandwidth: You can avoid emailing files to individuals and instead send a web link to recipients through your email.
3. Accessibility: Stored files can be accessed from anywhere via an Internet connection.
4. Disaster Recovery: It is highly recommended that businesses have an emergency backup plan ready in the case of an emergency. Cloud storage can be used as a backup plan by businesses by providing a second copy of important files. These files are stored at a remote location and can be accessed through an internet connection.
5. Cost Savings: Businesses and organizations can often reduce annual operating costs by using cloud storage; cloud storage costs about 3 cents per giga byte to store data internally. Users can see additional cost savings because it does not require internal power to store information remotely.

Disadvantages of Cloud Computing

1. Usability: Be careful when using drag/drop to move a document into the cloud storage folder. These will permanently move your document from its original folder to the cloud storage location. Do a copy and paste instead of drag/drop if you want to retain the document's original location in addition to moving a copy onto the cloud storage folder.
2. Bandwidth: Several cloud storage services have a specific bandwidth allowance. If an organization surpasses the given allowance, the additional charges could be significant. However, some providers allow unlimited bandwidth. This is a factor that companies should consider when looking at a cloud storage provider.
3. Accessibility: If you have no internet connection, you have no access to your data.
4. Data Security: There are concerns about the safety and privacy of important data stored

remotely. The possibility of private data coming with other organizations makes some businesses uneasy.

5. Software: If you want to be able to manipulate your files locally through multiple devices, you'll need to download the service on all devices.