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Unit-III

Concept of Database and Database Management System

Database

A database is a collection of related files and is usually integrated, linked or cross-referenced to one another**.**

Hierarchy of database as under:

- **Database**: This is a collection of Files.
- **File:** This is a collection of Records.
- **Record:** This is a collection of Fields.
- **Field:** This is a collection of Characters.
- **Characters:** These are a collection of Bits.

This hierarchy is shown in the Fig. 1:

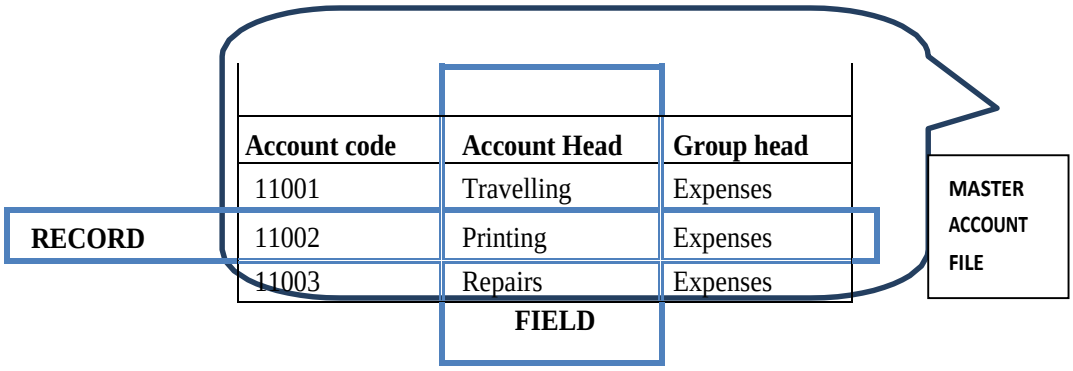


Fig. 1: Hierarchy of Databases

Database Management Systems (DBMS)

Every enterprise needs to manage its information in an appropriate and desired manner. The enterprise has to do the following for this:

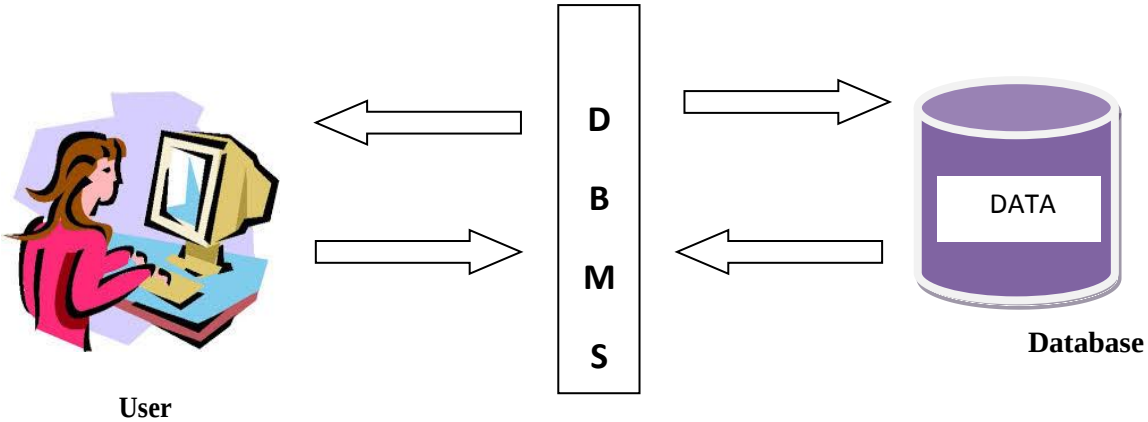
- Knowing its information needs;
- Acquiring that information;
- Organizing that information in a meaningful way;
- Assuring information quality; and
- Providing software tools so that users in the enterprise can access information they require.

To achieve the above objectives, we use Data Base Management System. Let's think of a DBMS as basically just a computerized record keeping. Database is just an electronic filing cabinet i.e., a collection of computerized data files. Even this simple system helps us do various operations on the files, such as:

- Adding new files to database,
- Deleting existing files from database,
- Inserting data in existing files,

- Modifying data in existing files,
- Deleting data in existing files, and
- Retrieving or querying data from existing files.

DBMS are software that aid in organizing, controlling and using the data needed by the application programmer. They provide the facility to create and maintain a well-organized database. Applications access the DBMS, which then accesses the data. Commercially available Data Base Management Systems are Oracle, My SQL, SQL Servers and DB2 etc.



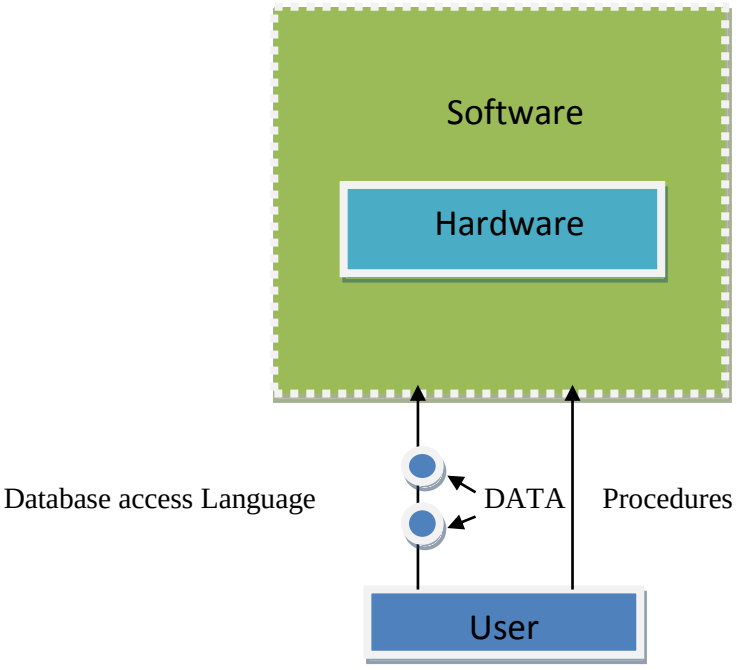
User communicate to the DBMS
Interface for the efficient and faster
Way of for her requirement.

Different programmes to insert
delete, update and query database
For information

Fig 2: Database and Database Management System

Components of DBMS

DBMS have several components, each performing very significant tasks in the database management system environment. Below is a list of components within the database and its environment. There are six major components of database system:



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1. **Data**: Data is defined as collection of fact in raw. It is not in directly useful and some processing to become useful.

2. **Hardware**: Hardware is a term used for physical components of the computer system (such as CPU, VDU etc.). Depending upon size of the database, suitable hardware is selected.

3. **Software**: This is the set of programs used to control and manage the overall database. This includes the DBMS software itself, the Operating System, the network software being used to share the data among users, and the application programs used to access data in the DBMS.

4. **Procedures:** Procedures refer to general instructions to use a database management system. This includes procedures to setup and install a DBMS, to login and logout of DBMS software, to manage databases, to take backups, generating reports etc.

5. **Database Access Language:** Database Access Language is a simple language designed to write commands to access, insert, update and delete data stored in any database.

   Structured Query Language (SQL) as we all know is the **database language** by the use of which we can perform certain operations on the existing database and also we can use this language to create a database. SQL uses certain commands like Create, Drop, and Insert etc. to carry out the required tasks.

   These SQL commands are mainly categorized into five categories as:

   i. DDL – Data Definition Language
   ii. DQL – Data Query Language
   iii. DML – Data Manipulation Language
   iv. DCL – Data Control Language
   v. TCL – Transaction Control Language

   (i) DDL (Data Definition Language): DDL or Data Definition Language actually consists of the SQL commands that can be used to define the database schema. It simply deals with descriptions of the database schema and is used to create and modify the structure of database objects in the database.

   Examples of DDL commands:

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

   (ii) DQL (Data Query Language): DQL statements are used for performing queries on the data within schema objects. The purpose of DQL Command is to get some schema relation based on the query passed to it.

   Example of DQL:

   - **SELECT** – is used to retrieve data from the database.

(iii) **DML (Data Manipulation Language):** The SQL commands that deals with the manipulation of data present in the database belong to DML or Data Manipulation Language and this includes most of the SQL statements.

Examples of DML:

- **INSERT** – is used to insert data into a table.
- **UPDATE** – is used to update existing data within a table.
- **DELETE** – is used to delete records from a database table.

(iv) **DCL (Data Control Language):** DCL includes commands such as GRANT and REVOKE which mainly deals with the rights, permissions and other controls of the database system.

Examples of DCL commands:

- **GRANT**-gives user's access privileges to database.
- **REVOKE**-withdraw user's access privileges given by using the GRANT command.

(v) **TCL (transaction Control Language):** TCL commands deals with the transaction within the database.

Examples of TCL commands:

- **COMMIT**– commits a Transaction.
- **ROLLBACK**– rollbacks a transaction in case of any error occurs.
- **SAVEPOINT**–sets a save point within a transaction.
- **SET TRANSACTION**–specify characteristics for the transaction.

6. **Users:** There are three type of users of the DBMS:-

- **Database Administrators (DBA):** Database Administrator or DBA is the one who manages the complete database management system. DBA takes care of the security of the DBMS, its availability, managing the license keys, managing user accounts and access etc.
- **Application Programmer or Software Developer:** This user group is involved in developing and designing the parts of DBMS.
- **End User:** These days all the modern applications, web or mobile, store user data. How do you think they do it? Yes, applications are programmed in such a way that they collect user data and store the data on DBMS systems running on their server. End users are the one who store, retrieve, update and delete data.

Advantages of DBMS

Major advantages of database management system are:

- **Controlling Data Redundancy**: Data is recorded in only one place in the database and it is not duplicated.
- **Data consistency**: Data items appears only once, and the updated value is immediately available to all users

- **Control over concurrency**: In computer file-based system in updating, one may overwrite the value recorded by the other.
- **Backup and recovery procedures**: Automatically creates the backup of data and restore data if required.
- **Data Independence**: Separation of data structure of database from application program that uses the data is called data independence.
- **Efficient data access**: The DBMS uses several powerful functions to store and retrieve data efficiency.
- **Data integrity and security:** The DBMS enforce integrity constraints to get a kind of protection against prohibited access of data**.**

Disadvantages of DDBMS:

Major disadvantages of database management system are:

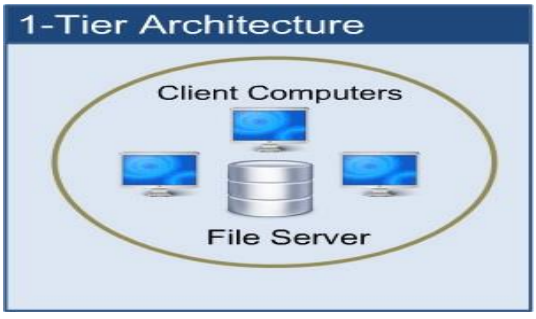
- DBMS required high initial cost
- DBMS is extremely complex software
- Technical staff requirement
- Database failure
- High conversion cost
- High maintenance cost
- High hardware cost

Architecture of a DBMS

A Database Management system is not always directly available for users and applications to access and store data in it. A Database Management system can be **centralised** (all the data stored at one location), **decentralised** (multiple copies of database at different locations) or **hierarchical**, depending upon its architecture. DBMS architecture may be: **single tier** or **two tires or three tier**.

- ## Single tier architecture (1-Tier architecture)

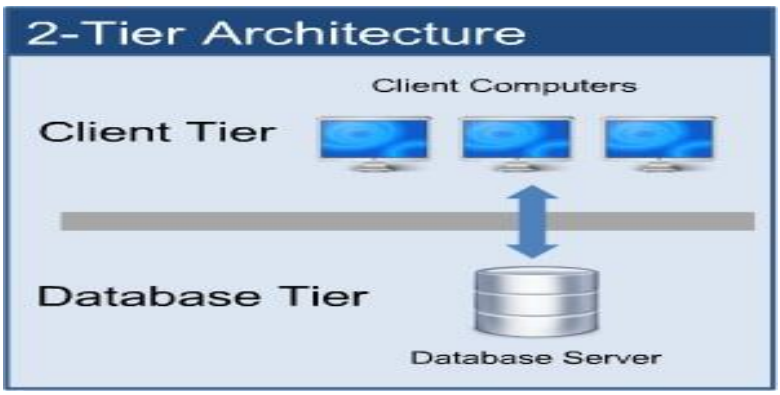
One-tier architecture involves putting all of the required components for a software application or technology on a single server or platform.



Basically, one-tier architecture keeps all of the elements of an application, including the interface, Middleware and back-end data, in one place. Developers see these types of systems as the simplest and most direct way.

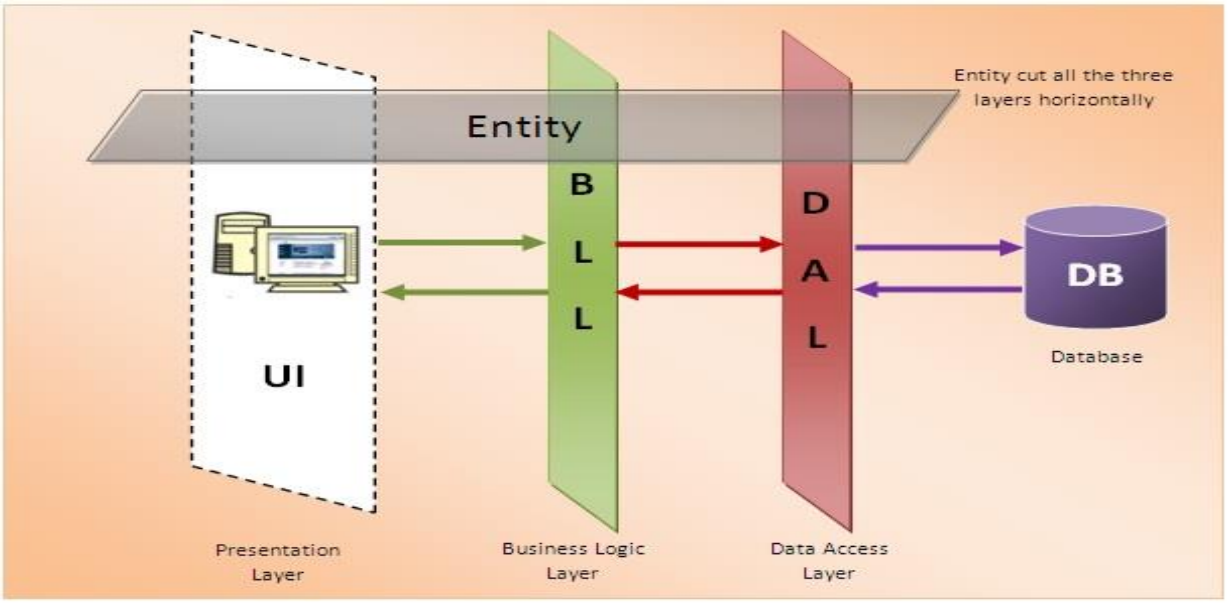
- **Two tire Architecture**

  The two-tier is based on Client Server architecture. The two-tier architecture is like client server application. The direct communication takes place between client and server. There is no intermediate between client and server.



- **Three tire architecture**

3-tier architecture separates its tiers from each other based on the complexity of the users and how they use the data present in the database. It is the most widely used architecture to design a DBMS. This architecture has different usages with different applications. It can be used in web applications and distributed applications. The strength in particular is when using this architecture over distributed systems.



[Basic 3-Tire architecture]

- **Database (Data) Tier or internal view or physical layer**– at this tier, the database resides along with its query processing languages. We also have the relations that define the data and their constraints at this level.

- **Application (Middle) Tier or Conceptual view/level or business logic level**− at this tier reside the application server and the programs that access the database. It is visible to database administrators (DBA) only. For a user, this application tier presents an abstracted view of the database. End-users are unaware of any existence of the database beyond the application. At the other end, the database tier is not aware of any other user beyond the application tier. Hence, the application layer sits in the middle and acts as a mediator between the end-user and the database.
- **User (Presentation) Tier or external view/level**− End-users operate on this tier and they know nothing about any existence of the database beyond this layer. At this layer, multiple views of the database can be provided by the application. All views are generated by applications that reside in the application tier.

DBMS Database Models

A database model defines the logical design and structure of a database and defines how data will be stored, accessed and updated in a database management system. While the **Relational Model** is the most widely used database model, there are other models too:

- Hierarchical Model
- Network Model
- Entity-relationship Model
- Relational Model

Hierarchical Model

This database model organises data into a tree-like-structure, with a single root, to which all the other data is linked. The hierarchy starts from the **Root** data, and expands like a tree, adding child nodes to the parent nodes.

In this model, a child node will only have a single parent node.

This model efficiently describes many real-world relationships like index of a book, recipes etc.

In hierarchical model, data is organised into tree-like structure with one one-to-many relationship between two different types of data, for example, one department can have many courses, many professors and off-course many students.

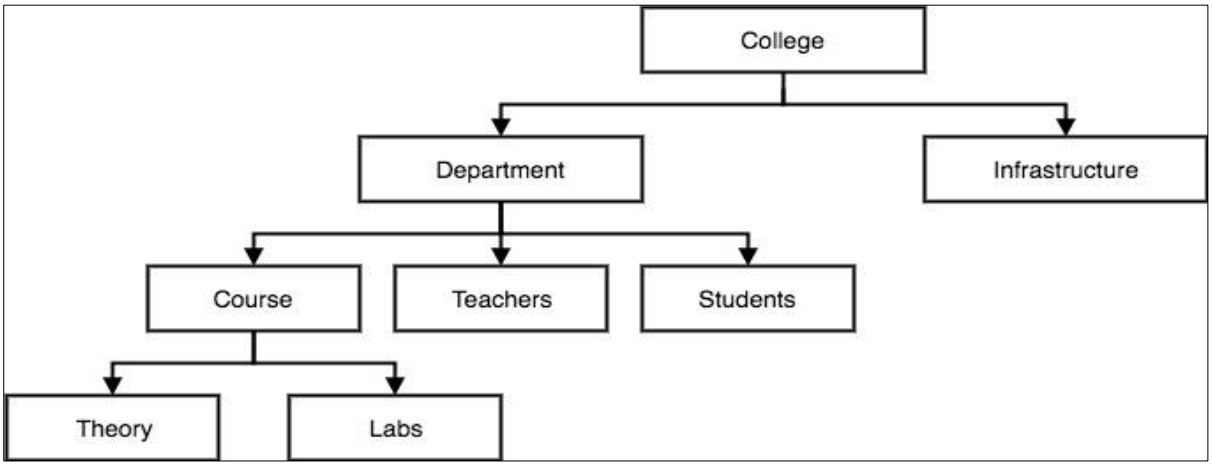


Fig.3: Hierarchical Model

- ## Network Model

This is an extension of the Hierarchical model. In this model data is organised more like a graph, and are allowed to have more than one parent node.

In this database model data is more related as more relationships are established in this database model. Also, as the data is more related, hence accessing the data is also easier and fast. This database model was used to map many-to-many data relationships.

This was the most widely used database model, before Relational Model was introduced.

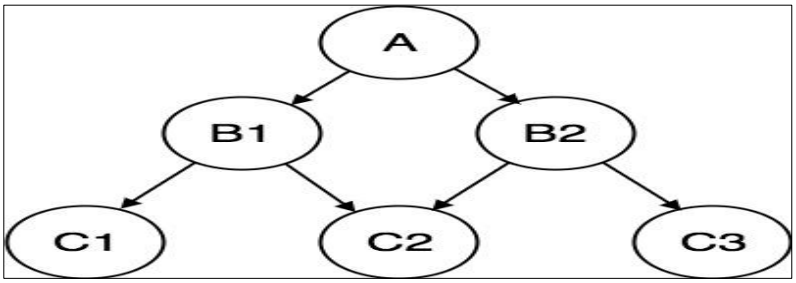


Fig.4: Network Model

- ## Entity-relationship Model

In this database model, relationships are created by dividing object of interest into entity and its characteristics into attributes.

Different entities are related using relationships.

E-R Models are defined to represent the relationships into pictorial form to make it easier for different stakeholders to understand.

This model is good to design a database, which can then be turned into tables in relational model (explained below).

Let's take an example, if we have to design a School Database, then **Student** will be an **entity** with **attributes** name, age, address etc. As **Address** is generally complex, it can be another **entity** with **attributes** street name, pin code, city etc, and there will be a relationship between them.

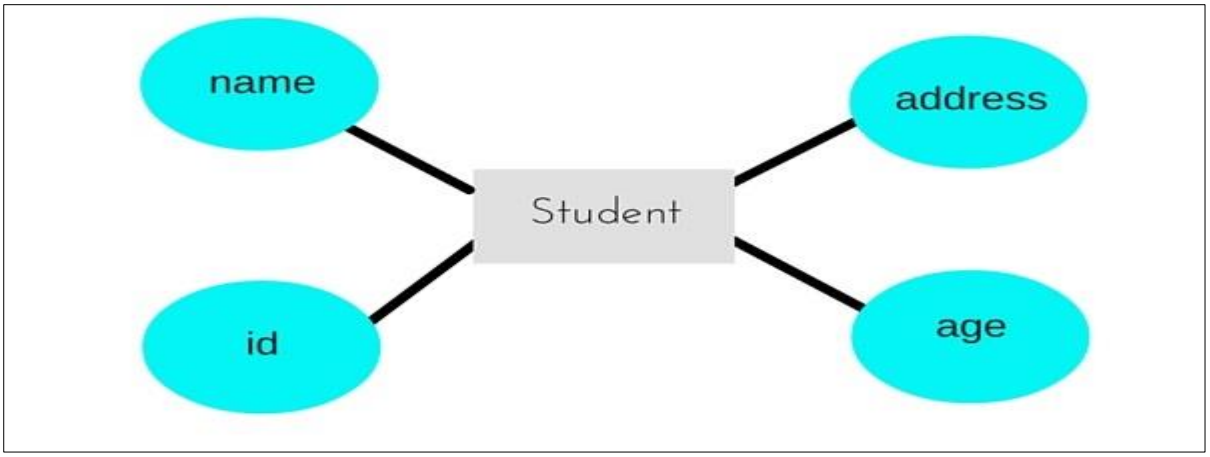


Fig.5: Entity Relationship model

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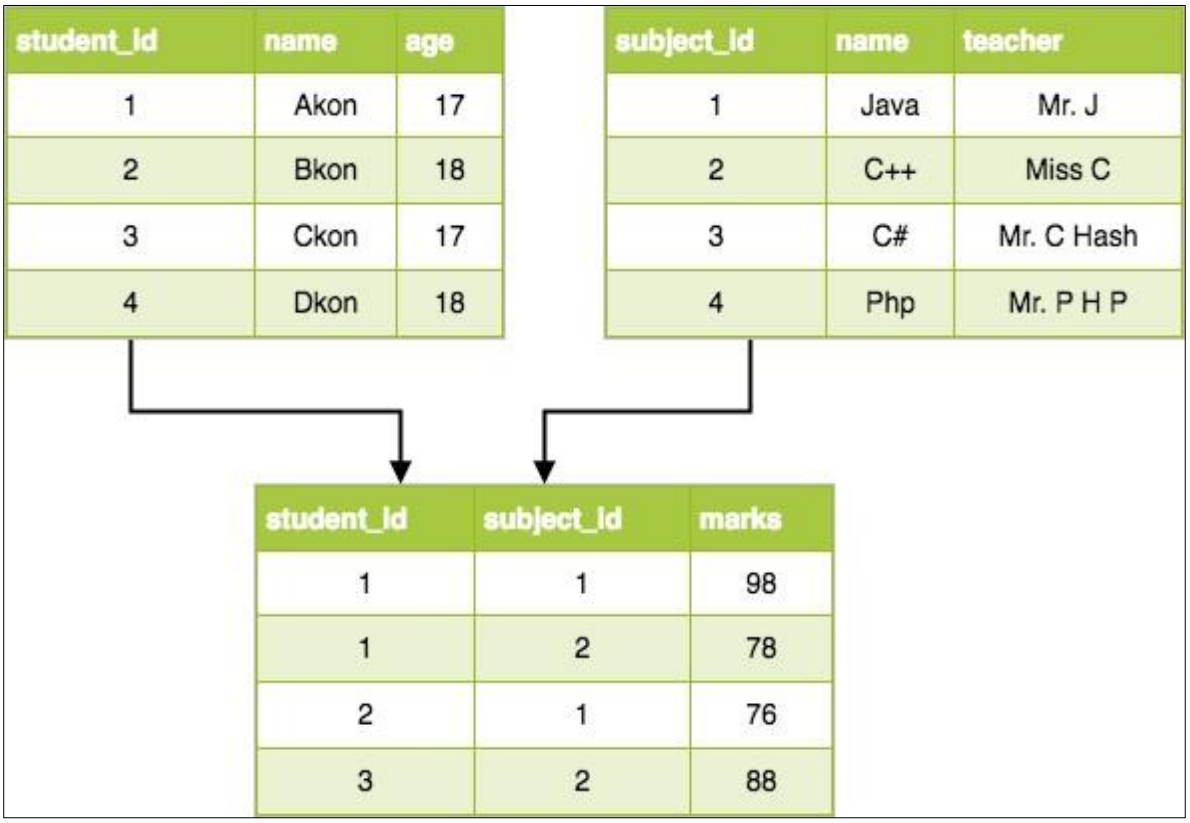
- # Relational Model

In this model, data is organised in two-dimensional **tables** and the relationship is maintained by storing a common field.

This model was introduced by E.F Codd in 1970, and since then it has been the most widely used database model, in fact, we can say the only database model used around the world.

The basic structure of data in the relational model is tables. All the information related to a particular type is stored in rows of that table.

Hence, tables are also known as **relations** in relational model.



student_id	name	age
1	Akon	17
2	Bkon	18
3	Ckon	17
4	Dkon	18

subject_id	name	teacher
1	Java	Mr. J
2	C++	Miss C
3	C#	Mr. C Hash
4	Php	Mr. P H P

student_id	subject_id	marks
1	1	98
1	2	78
2	1	76
3	2	88

Fig.6: Relational database model

Distributed database Management system (DDBMS)

A distributed database is a database in which portions of the database are stored in multiple physical locations, and in which processing is dispersed or replicated among different points in a network. Distributed databases can be homogeneous or heterogeneous. All the physical locations in a homogeneous distributed database system have the same underlying hardware and run the same operating systems and database applications. The hardware, operating systems or database applications in a heterogeneous distributed database may be different at each of the locations.

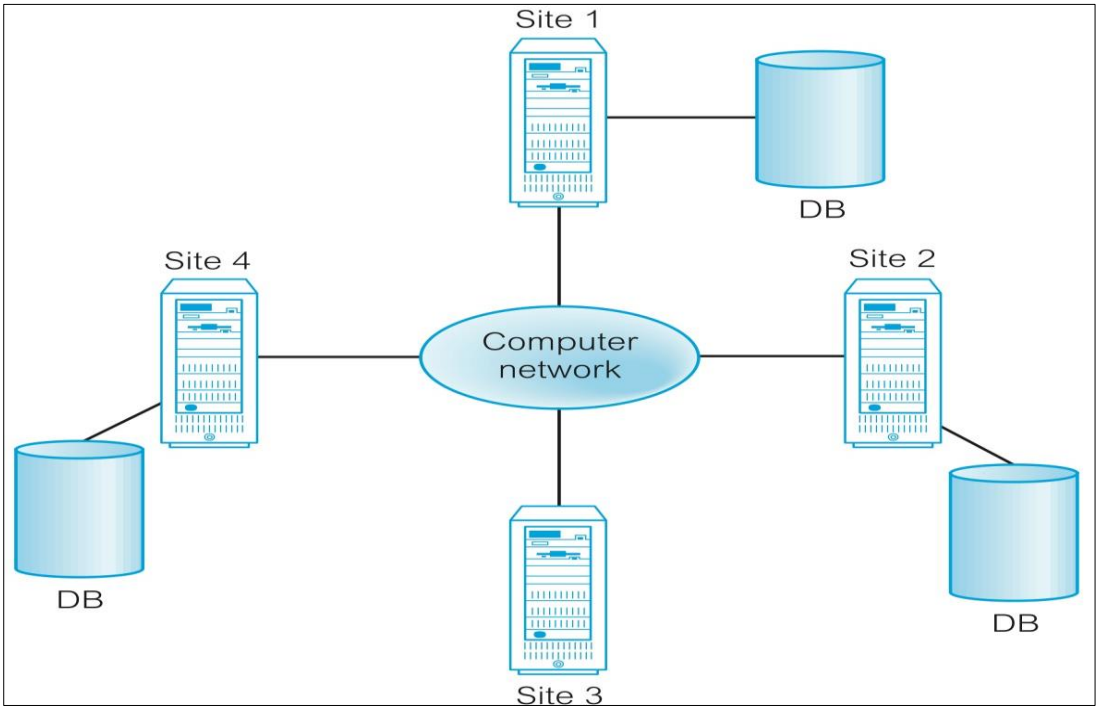


Fig 7: Distributed Database Management System

As we can be seen from the above diagram, all the information for the organisation located at different sites and every location has its own database and every site is connected through a communication network. This database is known as the distributed database.

Advantages of DDBMS

Some advantages of Distributed Database Management System are:

- Data is located near "greatest demand" site
- Faster data access
- Faster data processing
- Easily expandable
- Improved communication
- Reduced operating cost
- User-friendly interface
- Less -danger single-point failure
- Processer's independence

Disadvantages of DDBMS:

Some disadvantages of Distributed Database Management System are:

- Complexity of management and control
- More complex of query processing
- Security
- Lack of standards
- Increased storage requirement
- Increased training cost

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Centralized Database Management system (CDBMS)

A centralized database is a database that is located, stored and maintained in a single location. This single location is most often a central computer or database system, for example a desktop, a server CPU, a mainframe computer. It is maintained and modified from that location only and usually accessed using an internet connection such as a LAN or WAN. The centralized database is used by organisations such as colleges, companies, banks etc.

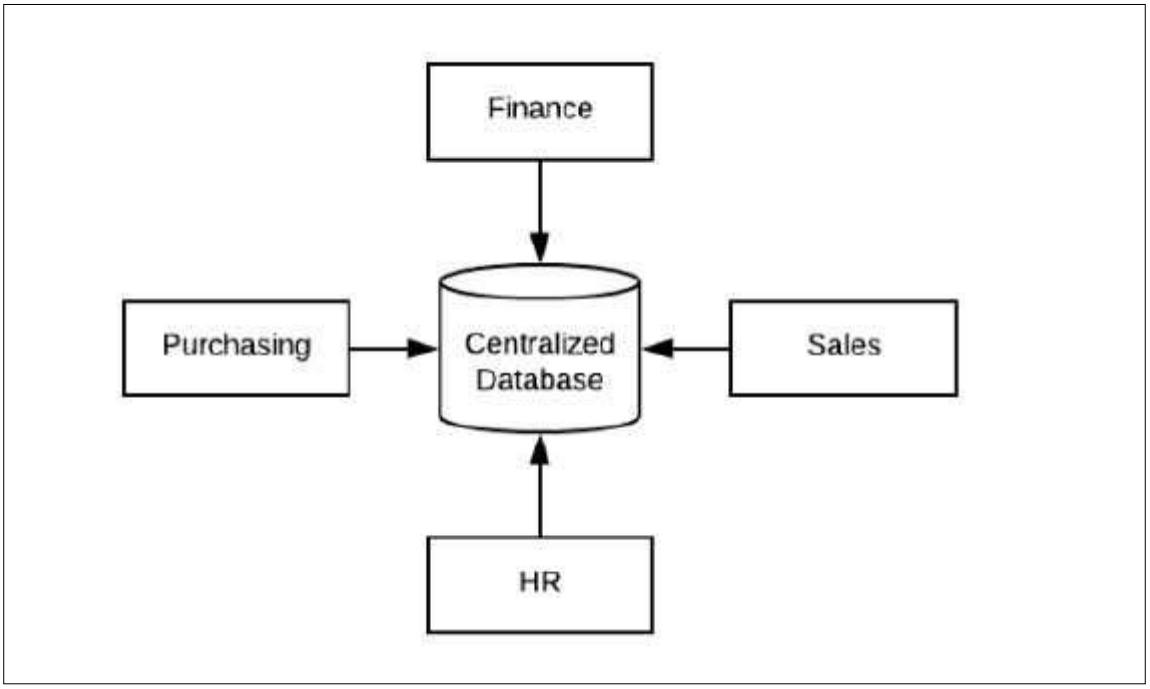

Fig 8:- Centralized Database Management System

As we can be seen from the above diagram, all the information for the organisation isstored in a single database. This database is known as the centralized database.

Advantages of CDBMS:

- Some advantages of Centralized Database Management System are:
- Easy to query processing
- Easy to take backup of the files
- Provides maximum data integrity
- Minimum redundancy
- Easy to access
- Cost effective

Disadvantages CDBMS:

- Time consuming
- Less efficient
- Recovery