University Institute of Computing

Bachelor of Computer Application

Database Management System

(23CAT-251/23SCT-251)

Topics to be Covered(Lecture No-8)

1. DBMS Languages Introduction
2. Types of DBMS Languages

DBMS Languages
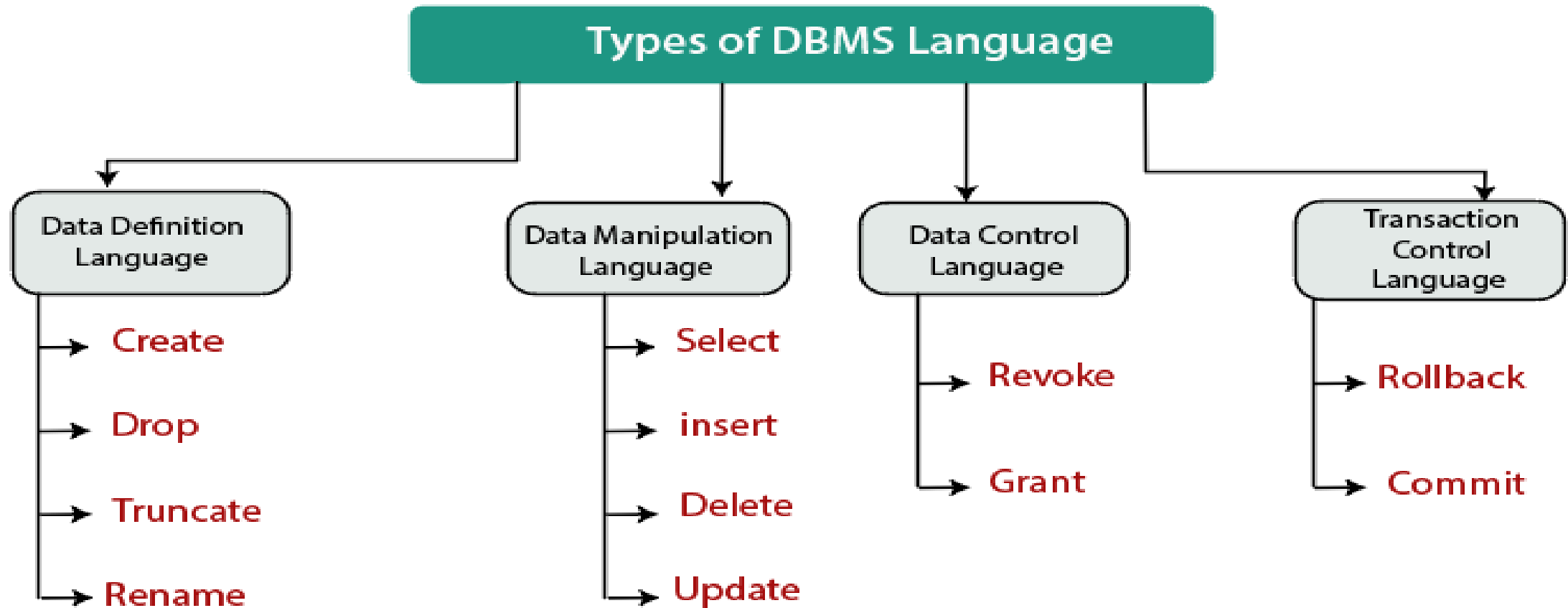
DML commands

Mention a few DML commands in SQL?

Data Manipulation Language (*DML*) has following SQL command:

- **SELECT** – it retrieves records from tables.
- **INSERT** – it creates a record.
- **UPDATE** – it modifies records.
- **DELETE** – it deletes records.

| Slide 3 | Presenter view

02/02/2025

DDL Commands

Data Definition Language (DDL)

A DDL is a language used to define data structures and modify data.

DDL Commands:

- Create
  - CREATE TABLE employee(empID int, Ename char(20), Esalary int, Eadd varchar(25));
- Alter
  - ALTER TABLE employee ADD Ecountry varchar (50);
- Drop
  - DROP TABLE employee;
- Truncate
  - TRUNCATE TABLE employee;
- Rename
  - SELECT Ename AS Emp_name FROM employee;

DCL Commands

DCL (Data Control Language)

- DCL statements control the level of access that users have on database objects.

GRANT - gives user's access privileges to database

GRANT – allows users to read/write on certain database objects

REVOKE - withdraw access privileges given with the GRANT command

REVOKE – keeps users from read/write permission on database objects

TCL Commands

TCL (Transaction Control Language)

- TCL statements allow you to control and manage transactions to maintain the integrity of data within SQL statements.
- **BEGIN Transaction** – opens a transaction
COMMIT Transaction – commits a transaction
ROLLBACK Transaction – ROLLBACK a transaction in case of any error

References of Text Books

ØFundamentals of Database Systems by R.Elmasri and S.B.Navathe, Pearson Education, New Delhi.

ØAn Introduction to Database Systems by C.J. Date, Pearson Education, New Delhi.

ØA Guide to the SQL Standard, Data, C. and Darwen, H, Reading, Addison-Wesley Publications, New Delhi.

ØYouTube Link- Video Lectures

Øhttps://www.youtube.com/watch?v=T7AxM7Vqvaw&list=PLdo5W4Nhv31b33 kF46f9aFjoJPOkdlsRc

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Objectives

- To understand concepts of Data models

Outline

Ø Fundamentals Concepts :

- What is a Data Model?
- Characteristics of Data Model
- Types of Data Model
- Hierarchical Data Model
- Examples of Hierarchical Data Model

Data 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.

- It provides the conceptual tools for describing the design of a database at each level of data abstraction.

- It describes the design of database to reflect entities, attributes, relationship among data, constrains etc.
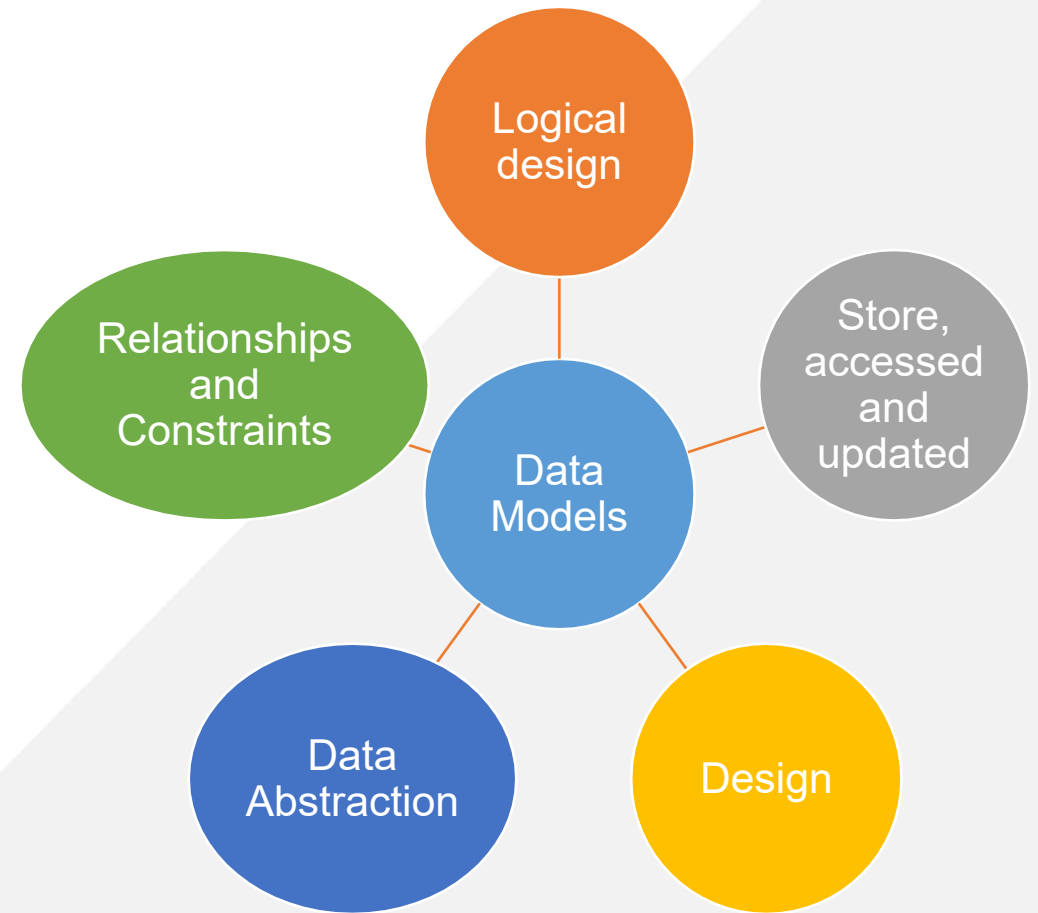
Characteristics of Data Models

Characteristic	Explanation
Pictorial	A good data model should be an accurate graphical depiction of the entities and their relationships
Rigorous and Specific	A good data model should be specific with regard to the identification of all entities and their relationships and rigorous in the identification and specification of the attributes associated with each entity.
Top-down Decomposable	A good data model should be decomposable in the sense that the level of detail for each entity and its associated attributes can be investigated at various levels of detail or aggregation.
Provide Focus	A good data model should be focused on the data associated with a single system and contained within a single system boundary.
Minimally Redundant	A good data model will display minimal redundancy with regard to repeated entity types, data redundancy, and many-to-many relationships.
Transparent	The actual data and the physical structure of the database should be discernable from looking at the graphical data model.
Easily Navigated	A good data model should be laid out in an organized fashion to allow for the relationships among the entities to be easily followed.
Predicts the Final System	A good data model should be an accurate prediction of the physical implementation of the system.

Types of Data Models
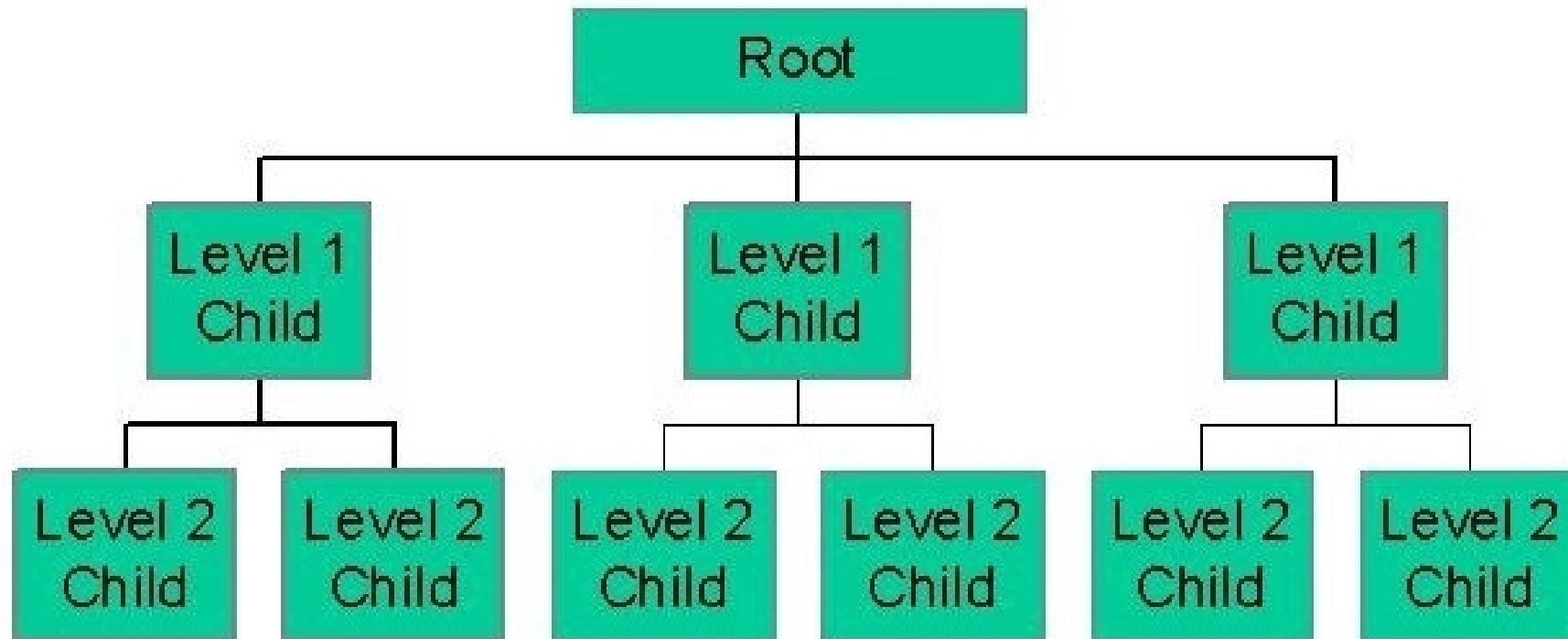
Hierarchical Model
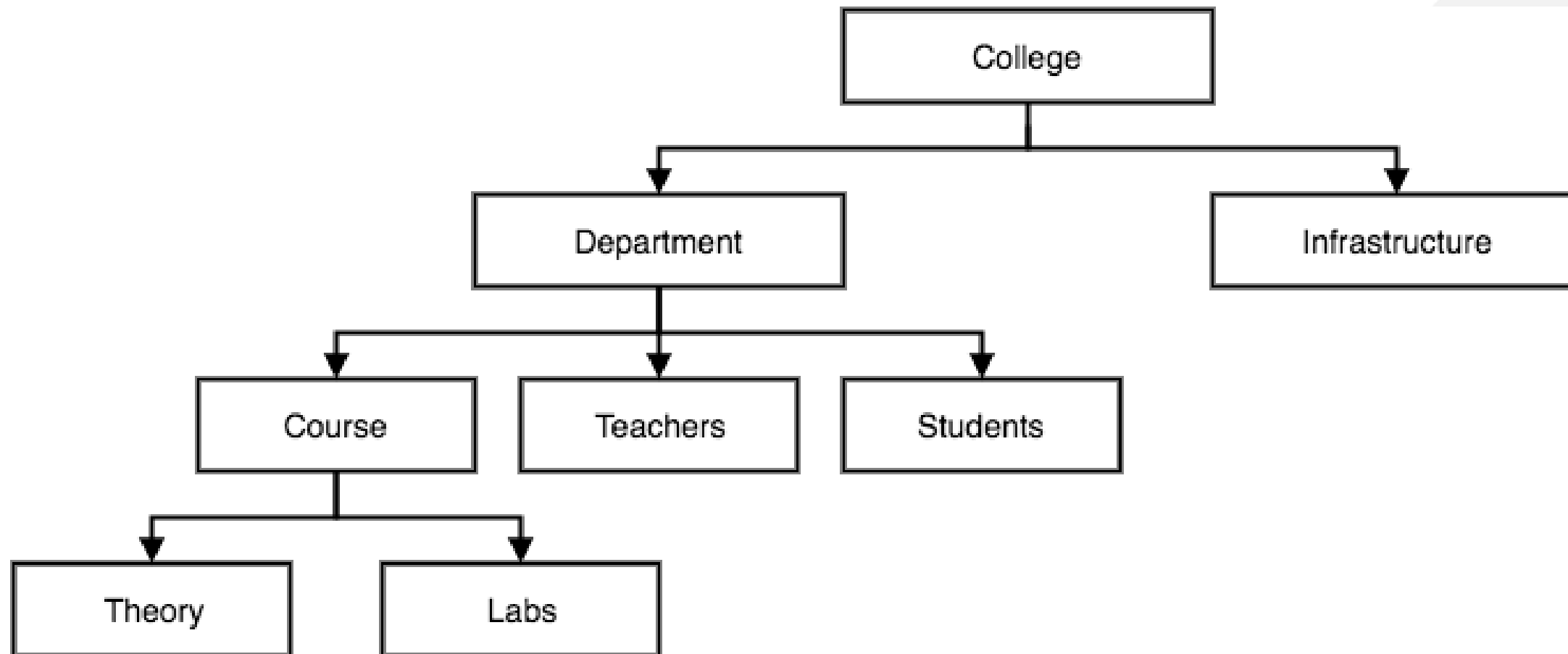
Network Model

Relational Model

Hierarchical Data Model

- In **hierarchical model**, data is organized into a tree like structure with each record is having one parent record and many children.

- The data are stored as **records** which are connected to one another through **links**. A record is a collection of fields, with each field containing only one value. The **type** of a record defines which fields the record contains.
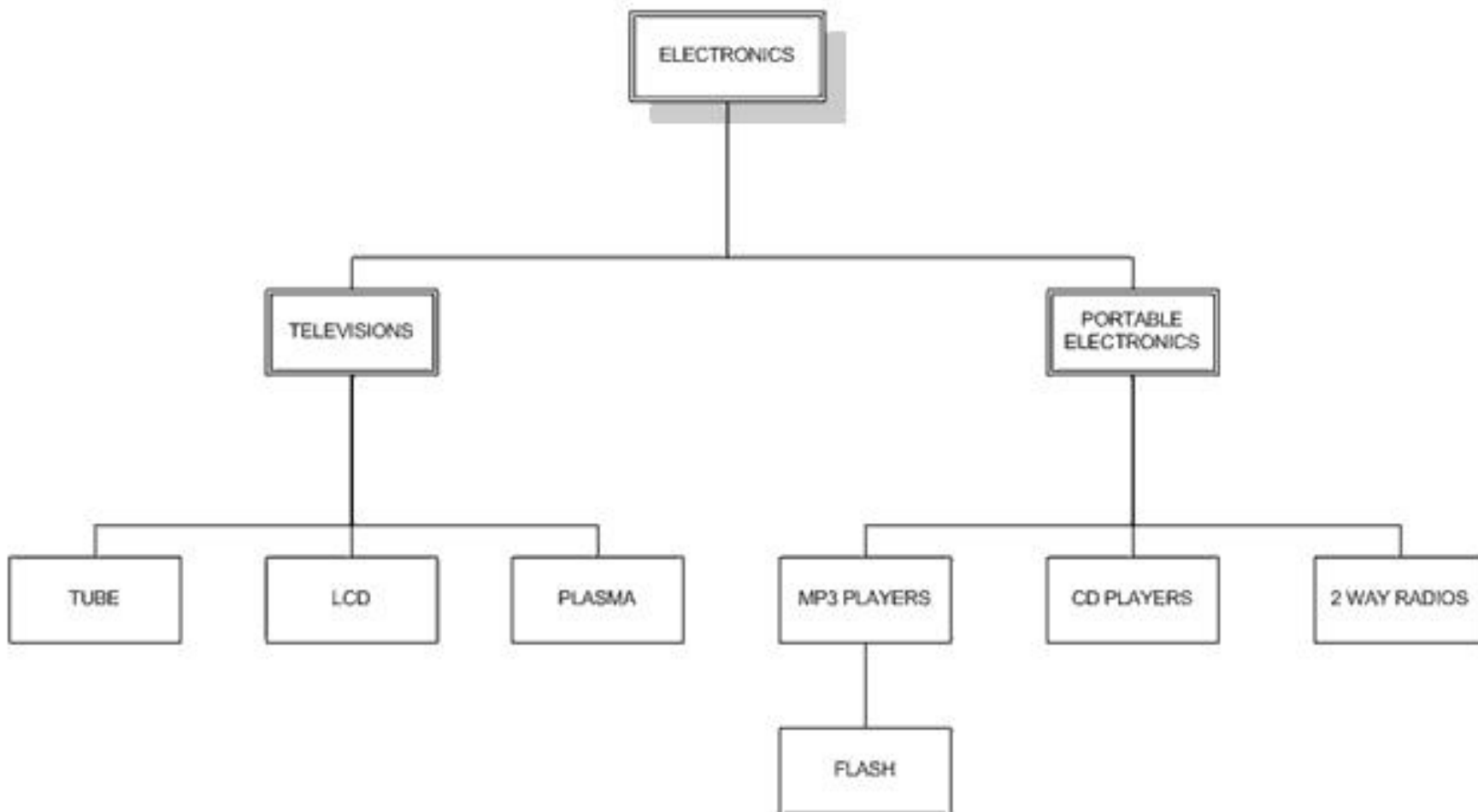
Hierarchical Data Model

Hierarchical Data Model

Hierarchical Data Model

REFERENCE BOOKS

ØFundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd Edition, Pearson Education, New Delhi.

ØAn Introduction to Database Systems by C.J. Date, 7th Edition, Pearson Education, New Delhi.

ØYouTube Link- Video Lectures

Øhttps://www.youtube.com/watch?v=T7AxM7Vqvaw&list=PLdo5W4Nhv31b33kF46f9aFjoJPOkdIsRc

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Topics to be Covered

1. Roles and Responsibilities of DBA

Data Independence

- The ability to modify a scheme definition in one level without affecting a scheme definition in a higher level is called **data independence**.

  In other words it allows changes to a structure of a database without requiring a user to make any changes in the way they access the data.

There are two types of Data Independence:

1. Logical Data Independence
2. Physical Data Independence

Who is a DBA?

- The DBA is a person or a group of person who is responsible for the management of database. The DBA is responsible for defining database structure, storage structure and access method, authorization access to the database by grant and revoke permissions to the users, for coordinating and monitoring its use, managing backups and software resources as needed.

- In case of small organizations the role of DBA is done by single person and in case of large companies there is a group of DBA's who share responsibilities.

Database Administrator DBA
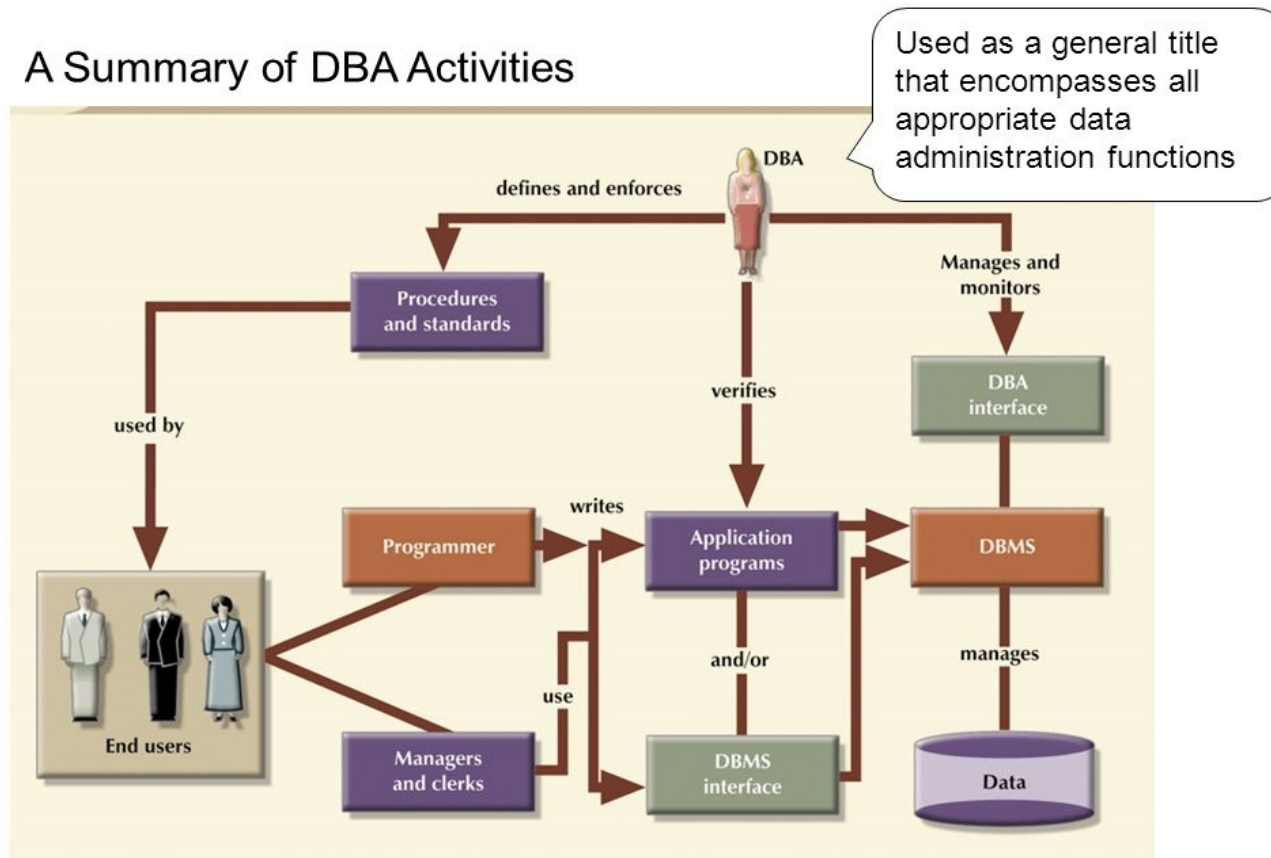
Responsibilities of DBA

1. Deciding the information content of the database:

It is the job of DBA to identify what kind of information to be stored in the database.

2. Define the storage structure and access strategies:

It is the DBA's job to decide the representation of the data in the database and for this purpose, he writes the storage structure definitions which is translated by DDL compiler.

3. **Define integrity constraints specification:**

DBA is responsible for the accuracy of data in a database by specifying integrity constraints and checks.

Responsibilities of DBA

4. Granting of authorization for data access:

The DBA must ensure that the only way to access the database is through the proper channels and for this purpose he defines the authorization checks to be carried out whenever access to sensitive data is attempted.

5. Define strategy for backup and recovery:

It is the responsibility of DBA to recover the data which is lost due to failure in the hardware or the operating system or due to human failure in the minimum time.

Responsibilities of DBA

6. Monitoring and optimizing the performance of the database:

DBA should diagnose the performance problems initially and handle the problems by making necessary modification. The modification may include managing indexes, modifying the database tables etc.

7. Installing and upgrading the DBMS and the application tool:

It is the duty of the DBA to install new versions of software's related to DBMS administration.

Frequently Asked Questions

Q1. Explain the objectives of Three Level Architecture.

Q2. Explain the three Level Architecture in detail with diagram.

Q3.Explain the mapping between various Levels in Three Level Architecture

Q4. Explain the process of Data Independence

Q5. Explain the Roles and Responsibilities of DBA in detail.

References of Text Books

Ø Fundamentals of Database Systems by R.Elmasri and S.B.Navathe, Pearson Education, New Delhi.

Ø An Introduction to Database Systems by C.J. Date, Pearson Education, New Delhi.

Ø A Guide to the SQL Standard, Data, C. and Darwen, H, Reading, Addison-Wesley Publications, New Delhi.

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Architecture of DBMS

Topics to be Covered(Lecture No-6)

1. Three Level Architecture Introduction
2. Objective of Three Level Architecture
3. Explanation of Three Level Architecture
4. Mapping between Views

Three Level Architecture

- The DBMS architecture is a framework where the structure of the DBMS is described. The main aim of designing the DBMS architecture is to provide users with an abstract view of the data by hiding certain details of how data is stored and maintained.

It consist of the three levels:

- External Level
- Conceptual Level
- Internal Level

Objectives of Three Level Architecture

The main objective of three level architecture is to enable multiple users to access the same data with a personalized view while storing the underlying data only once. This separation is desirable for the following reasons:
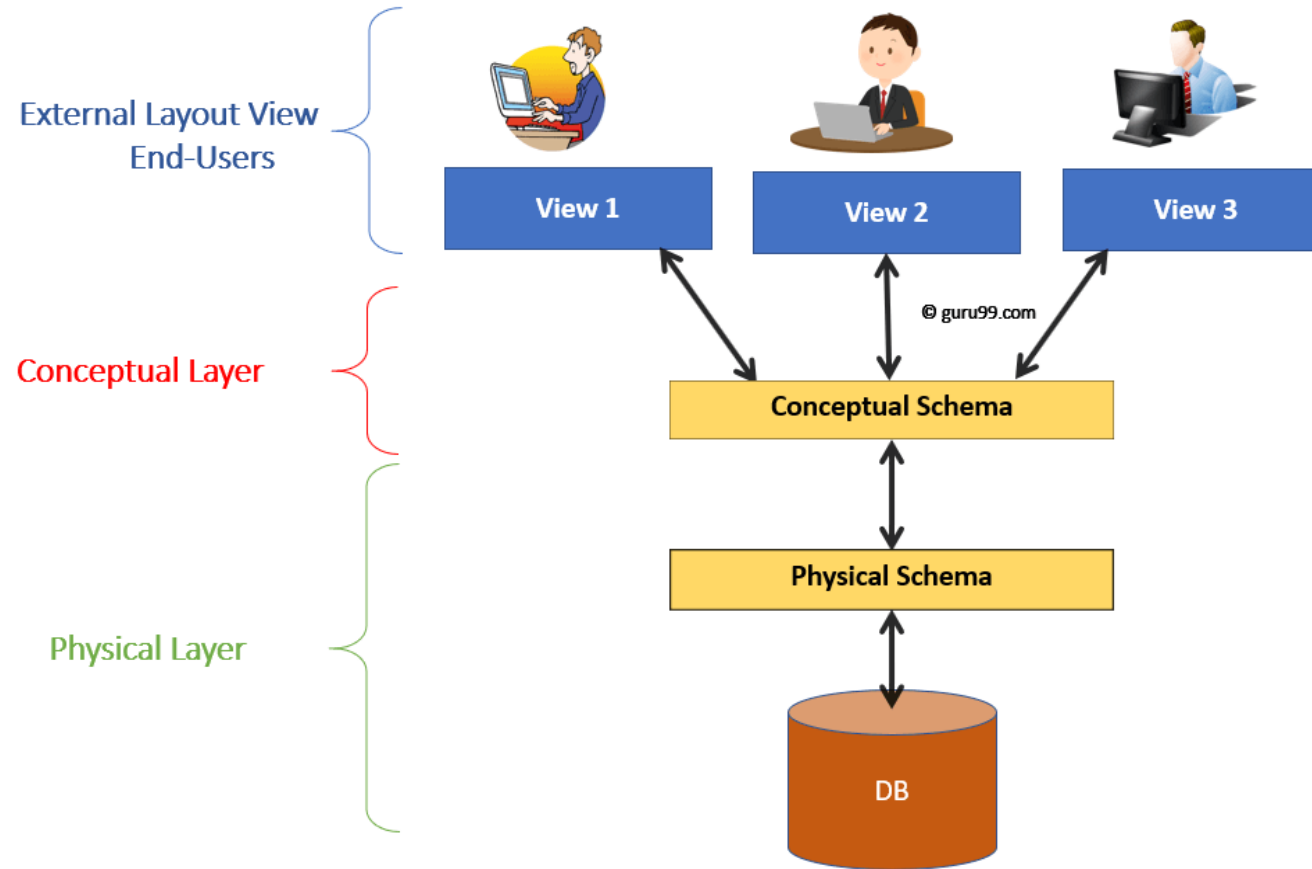
Ø Different users need different views of same data.

Ø The approach in which a particular user needs to see the data may change over time.

Ø The users of the database should not worry about the physical implementation and internal workings of the database such as data encryption, hashing etc
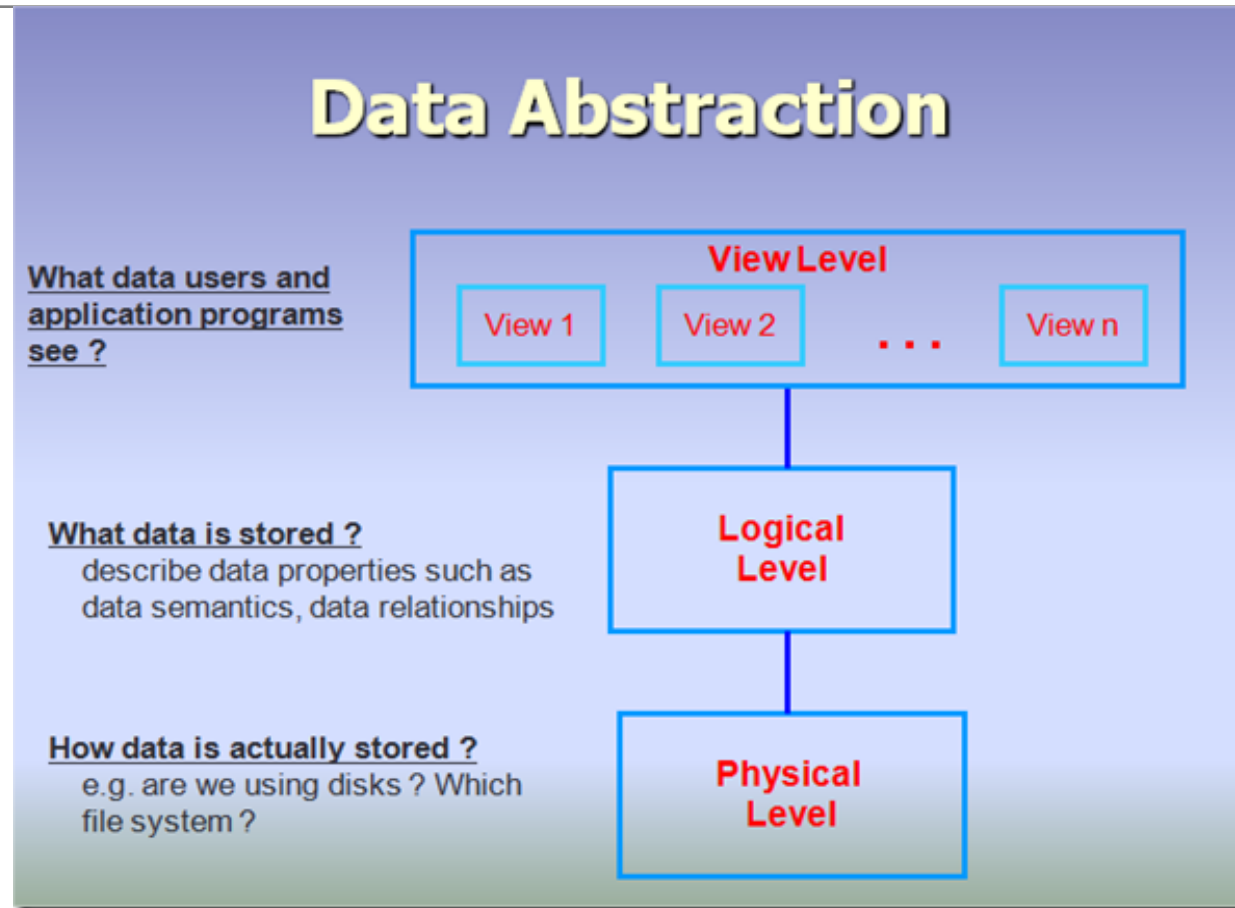
Objectives of Three Level Architecture

ØAll the user should be able to access the same data according to the requirement.

ØDBA should be able to change the conceptual structure of the database without affecting the user's view.

ØConceptual structure of the database should be unaffected by changes to physical aspects of the storage.

Three Level Architecture

External Layout View End-Users
- View 1
- View 2
- View 3

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Conceptual Layer
- Conceptual Schema

Physical Layer
- Physical Schema
- DB

Levels of Architecture

Data Abstraction

What data users and application programs see ?

View Level

View 1 | View 2 | . . . | View n

What data is stored ?
describe data properties such as data semantics, data relationships

Logical Level

How data is actually stored ?
e.g. are we using disks ? Which file system ?

Physical Level

External Level/View Level

- The user's view of the database.

- ☐ Consists of a number of different external views of the DB.

- ☐ Describes part of the DB for particular group of users.

- Provides a powerful and flexible security mechanism by hiding parts of the DB from certain users.

- ☐ It permits users to access data in a way that is customized to their needs, so that the same data can be seen by different users in different ways, at the same time.

So we can say that **Creating separate views of the database for different users help in ensuring the database security**.

Conceptual Level

- The logical structure of the entire database as seen by DBA.

- ☐ What data is stored in the database.

- ☐ Represents:

  - Entities, attributes, relationship

  - Constraints on data ,Security, integrity information

- ☐ The relationships among the data.

- ☐ Complete view of the data requirements of the organization, Independent of any storage consideration.

  While designing the database, the conceptual schema is first to be defines. It is defined using the DDL provided by the DBMS

Internal Level

- Physical representation of the Database on the computer.
- How the data is stored in the database and also describes the data structures and access method to be used by the database.
- **In Simple words we can say that it holds information about data.**
-   Physical implementation of the DB to achieve optimal run–

  Time performance and storage space utilization.

  - Storage space allocation for data and indexes

  - Record description for storage

  - Record placement

  - Data compression, encryption

Physical Level

As the name suggests, the Physical level tells us that where the data is actually stored i.e. it tells the actual location of the data that is being stored by the user.

Below the internal level is the physical level which is managed by the operating system under the directions of DBMS. It deals with the mechanism of physically storing data on a device such as disk. Managed by the OS under the direction of the DBMS.
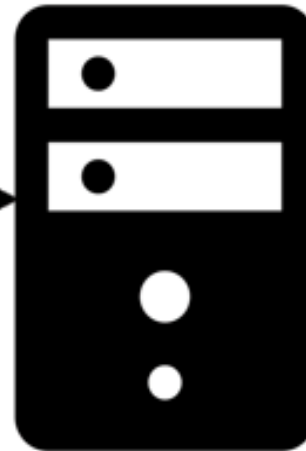
Three Level Architecture

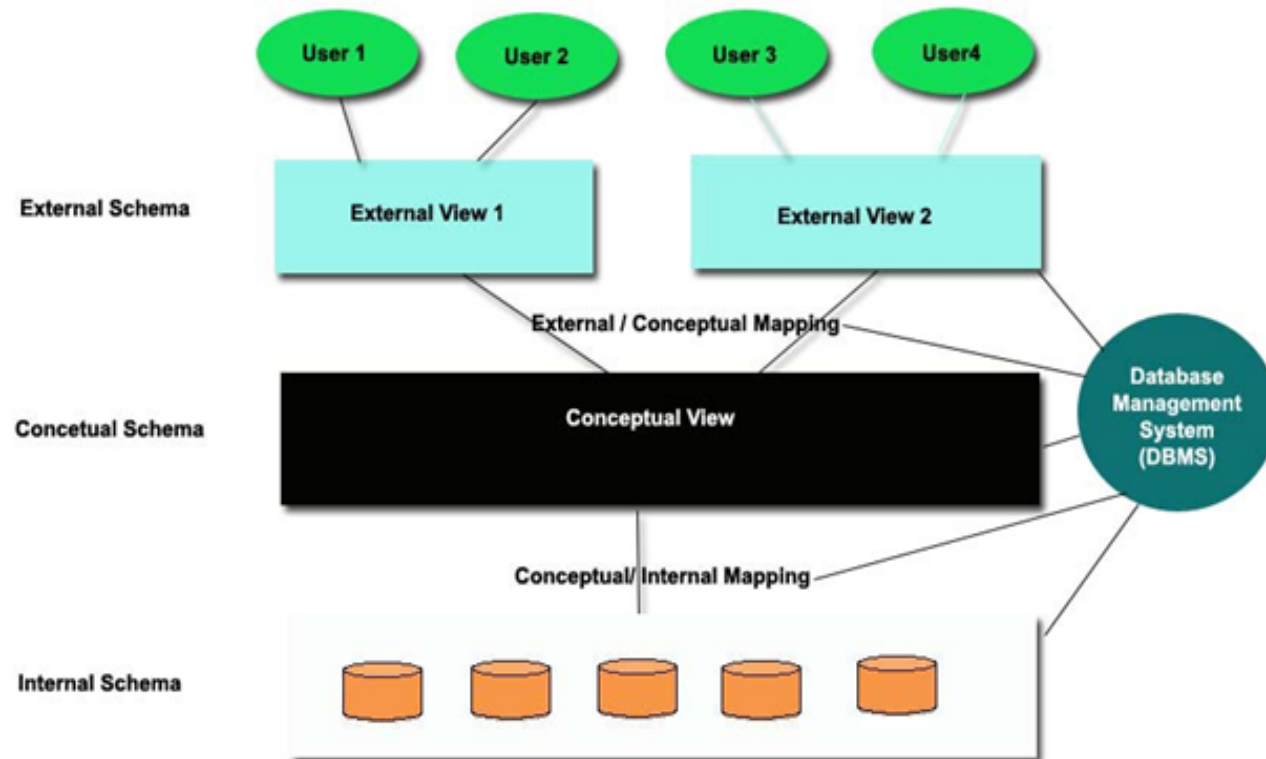External Level/ View Level — Client

Conceptual Level/ Logical Level — Server

Internal Level — Database

Mapping between Views

Mapping between Views

The three levels of DBMS architecture don't exist independently of each other. There may be correspondence between the three levels i.e. how they are actually correspond with each other. DBMS is responsible for the correspondence between the three types of schemas. **This correspondence between different levels is known as Mapping**

There are basically two types of mapping in the database architecture:

- Conceptual/ Internal Mapping
- External/ Conceptual Mapping

External/ Conceptual Mapping

ØExternal Conceptual Mapping:

- The external/ Conceptual mapping lies between the external level and the conceptual level.

- Its role is to define the correspondence (communication) between a particular external view and the conceptual view.

- It gives the correspondence among the records of external and conceptual views. Any changes in the conceptual level are reflected in this mapping with the external schema unmodified.

Any changes in conceptual level can be viewed by user at external levels but their external schema remains unmodified.

# Conceptual/ Internal Mapping

Ø **Conceptual/ Internal Mapping**

- The conceptual/Internal mapping lies between the conceptual level and the internal level.

- Its role is to define the correspondence (communication) between records and fields of the conceptual level and files and data structures of the internal level.

- It enables the DBMS to find the actual record and combination of records in the physical storage that constitute a logical record in the conceptual schema, along with any constraints to be enforced on the operations for that logical record.

Conceptual level can view all the changes done in internal level through its mapping. This level doesn't know how data structure changes i.e. at internal level but can access the updated database through mapping

Data Independence
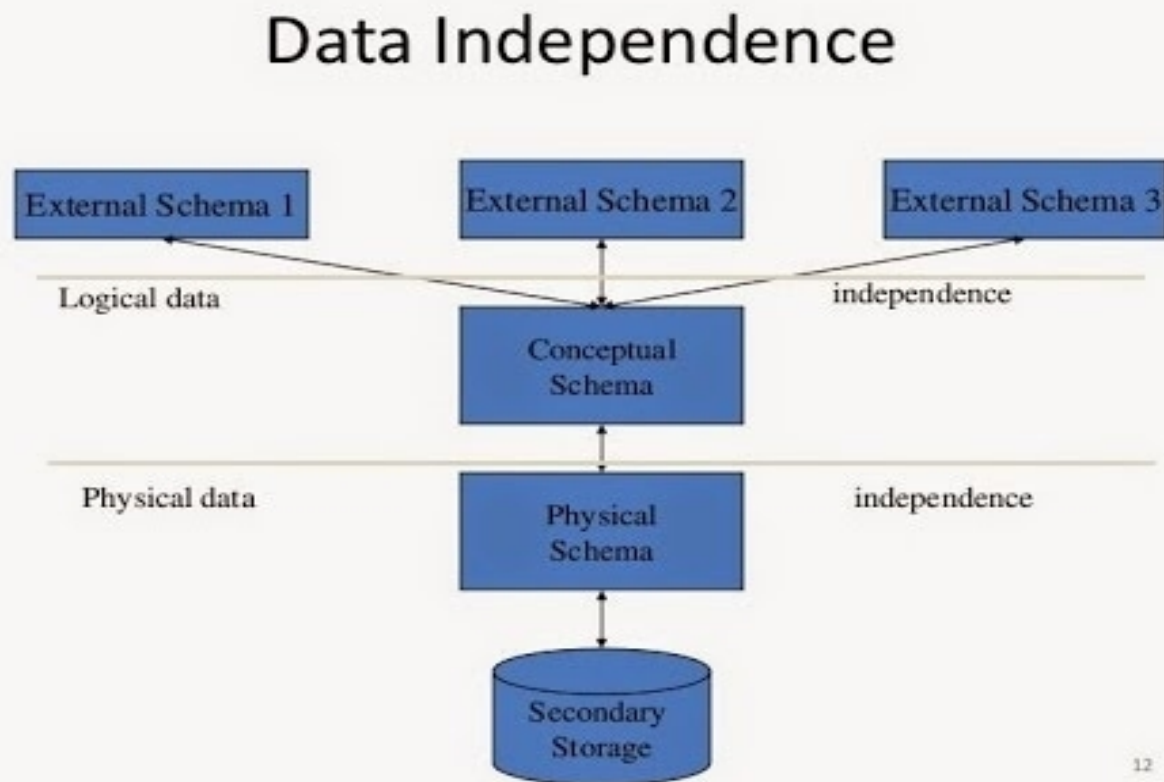
Logical Data Independence

- The ability to modify the conceptual scheme without causing application programs to be rewritten.

- ☐ Immunity of external schemas to changes in the conceptual schema.

- ☐ Usually done when logical structure of database is altered.

- For example: select EName, id, dept from employees at user level. It doesn't matter how many columns are added to the existing structure.

So to sum up, the capacity to change the conceptual schema without having to change the external schema is called as Logical Data Independence.

Polling Questions

The ability to change the conceptual schema without affecting the external schemas or application programs is known as _____

A) Program Data Independence

B) Logical Data Independence

C) Physical Data Independence

D) Data Abstraction

Physical Data Independence

- The ability to modify the internal scheme without having to change the conceptual or external schemas.

- ⬜Modifications at this level are usually to improve performance.

- If the physical structure changes, the DBMS is aware of these changes and still provides the same conceptual view before the changes because the conceptual view presented to the outside world remains constant.

So to sum up the physical data independence is the capacity to change the internal schema without having to change the conceptual schema.

Polling Questions

The separation of the data definition from the program is known as:

A) data dictionary

B) data independence

C) data integrity

D) referential integrity

Polling Questions

The ability to change the internal schema without affecting the external schemas or application programs is known as _____

A) Program Data Independence

B) Logical Data Independence

C)   Physical Data Independence

D)   Data Abstraction

References of Text Books

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ØAn Introduction to Database Systems by C.J. Date, Pearson Education,

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ØA Guide to the SQL Standard, Data, C. and Darwen, H, Reading, Addison-

Wesley Publications, New Delhi.

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(23CAT-251/23SCT-251)

Database Management System

SYLLABUS

23CAT-251	Database Management System	L	T	P
	Total Contact Hours: 45	3	-	-
	Applicable to which branch: All			
	Prerequisite: Nil			

Marks	
Internal: 40	External:60

Course Objective

1.	Gain a good understanding of the architecture and functioning of database management systems as well as associated tools and techniques, principles of data modeling using entity relationship and develop a good database design and normalization techniques to normalize a database.
2.	Understand the use of structured query language and its syntax, transactions, database recovery and techniques for query optimization.
3.	Acquire a good understanding of database systems concepts and to be in a position to use and design databases for different applications..

Course Outcome

1.	Define the basic concepts of database systems, file system, Role of DBA
2.	Describe the concept of DBMS Architecture, Data Base Models, ER Model, Concurrency Control and Recovery
3.	Apply SQL commands to create tables and query data in a relational DBMS
4.	Use normalization techniques to improve the database design
5.	Apply basic database optimization and indexing techniques to improve the performance and efficiency of database queries

CONTENT OF THE SYLLABUS

UNIT-I

[15]

- **Basic of Database Management System** Characteristics of database approach, various views of data models, Introduction to database languages & environments, Advantages of DBMS over file processing systems, DBMS Architecture, Mapping and Data Independence, DBA and its role. Self Study: Components of DBMS

- **Data Models** E-R Diagram, mapping constraints, keys, reduction of E-R diagram into tables. Roles and structural constraints, weak entities, Data Models: Hierarchical, Network and Relational Models and Comparision between them, Client Server Architecture. Self-Learning: Construction of ER Models

- **E-R and object modelling** Enhanced E-R and object modelling, Sub classes; Super classes, inheritance, specialization and generalization.

UNIT-II
[15]

- **File organization** Types of File organization: Indexed sequential access files; implementation using B & B++ trees, hashing, hashing functions, collision resolution, extendible hashing,

- Self-learning: dynamic hashing approach implementation and performance

- **Relational Databases:** Relational model concepts, Relational constraints, Types of SQL Constraints SQL: SQL queries, programming using SQL.

- **Relational Algebra** Introduction Selection & Projection, Set OPerators, Renamep, Joins, Dusion , Operators, Grouping & Ungrouping Relational Comparison .

UNIT-III

[15]

- **Normalization**: Need of Normalization, Normal form up to 3rd normal form and BCNF, Dependencies: Functional and Fully Functional Dependencies and Transitive Dependency

- **Transaction Management and Concurrency Control:** States and Properties of Transaction, Concurrency Related Problems,ACID Properties Locking techniques, Two- Phase Locking, Deadlock Detection and Recovery

- **Database Recovery** Failure Classification , Recovery & atomicity, BG-based Recovery, Shadow Paging & Advance recovery technique. Recovery Techniques Security and authorization. Recovery techniques, Database security. Self-learning: Introduction to Distributed Data Processing.

Course Outcome

CO Number	Title	Level
CO1	Define the basic concepts of database systems, file system, Role of DBA	Remember
CO2	Describe the concept of DBMS Architecture, Data Base Models, ER Model, Concurrency Control and Recovery	Understand

UNIT I

•**Basic of Database Management System** Characteristics of database approach, various views of data models, Introduction to database languages & environments, Advantages of DBMS over file processing systems, DBMS Architecture, Mapping and Data Independence, DBA and its role. Self Study: Components of DBMS

•**Data Model:** E-R Diagram, mapping constraints, keys, reduction of E-R diagram into tables. Roles and structural constraints, weak entities, Data Models: Hierarchical, Network and Relational Models and Comparision between them, Client Server Architecture. Self-Learning: Construction of ER Models

•**Enhanced E-R and object modelling,** Sub classes; Super classes, inheritance, specialization and

Topics to be Covered

1. Concept of Data and Information
2. Difference between Data and Information
3. Introduction to Databases
4. Operations Performed on Databases

Data

Data is raw Facts. By the term raw, we mean the facts that have not yet been processes to reveal their meaning

In simple words data can be facts related to any object in consideration.

- **For example** your name, age, height, weight, etc are some data related to you.
- A picture , image , file , pdf etc can also be considered data.

Example of Data

- Student fill an application form when they want to seek admission in a college. The admission form when filled properly consists of raw facts about the student. These raw facts are the student name, his father name, his address, his previous result etc.

Application Form

1. It considers facts symbols, images for reference or analysis.

a. Data

b. Information

c. Database

d. DBMS

Information

Information is manipulated and processed form of data i.e. it is meaningful form of data. It is used for making decisions.

For example: Data collected from students admission form can be used to generate different type of information.

It means this information is used for making decisions.

Thus to conclude information can be defined as the output produced when the data is being manipulated.

Differences
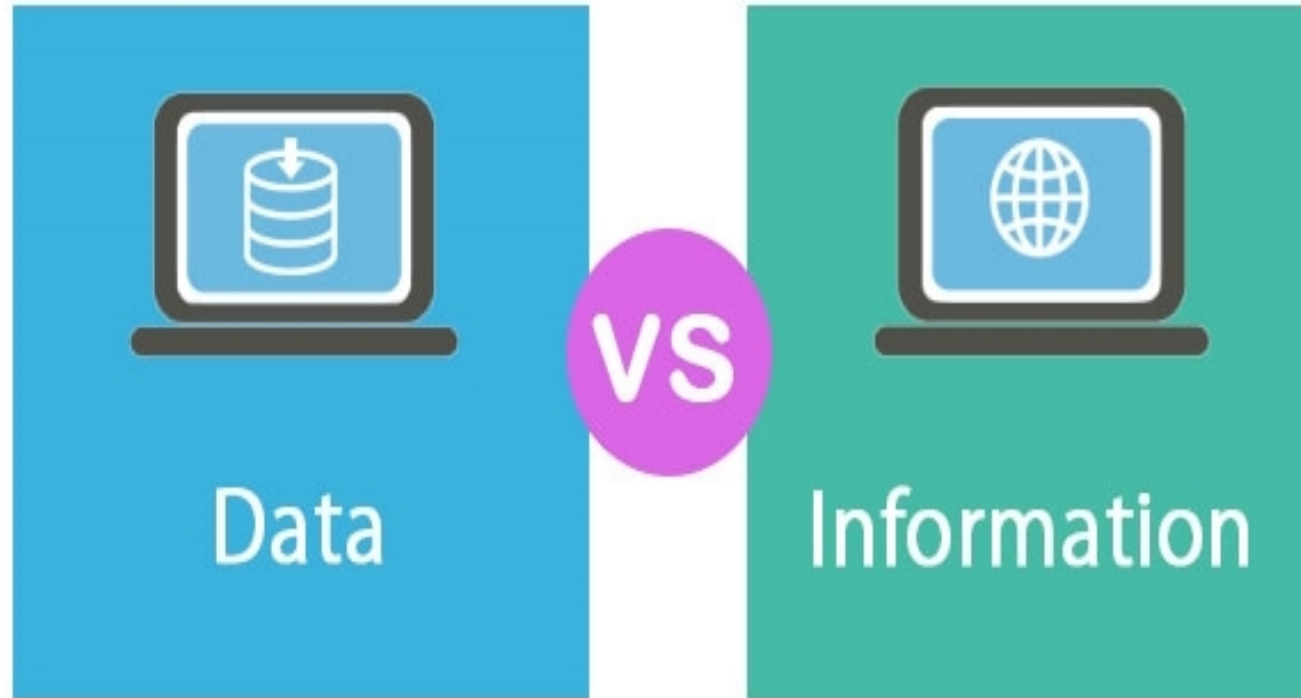
Data V/S Information

Data	Information
Data are simply raw facts and figures.	Information is the processed form of data.
Data is act as a Input	Information is act as a Output
Data is unorganized information	Information is organized
Data cannot add any knowledge to user.	But information will enhance the knowledge of the user.
Data does not contain an element of surprise.	Information contains the element of surprise.
Data is unrelated & uninterrupted.	Information is related and interrupted.
Data cannot lead to any action.	Information can lead to action.

The processed form of data is called as:

a) Data

b) Information

c) Database

d) Metadata

Database is a systematic collection of data. Databases support storage and manipulation of data. Databases make data management easy

Let's discuss few examples.

- An online telephone directory would definitely use database to store data pertaining to people, phone numbers, other contact details, etc.

- Your electricity service provider is obviously using a database to manage billing , client related issues, to handle fault data, etc.

Database

Let's also consider the facebook. It needs to store, manipulate and present data related to members, their friends, member activities, messages, advertisements and lot more.

We can provide countless number of examples for usage of databases .

Database Examples:

- Banking: accounts, Loans, customers
- Airlines: Reservation, Schedules
- Universities: Registration, Grades
- Sales: customers, products, purchases
- Online retailers: order tracking, customized recommendations

Database

With the increase demand of data in various organizations such as banks, university, railways, companies, telephone directories etc, it becomes a necessity to store data in an organized way so that it can be used again and again.

So Proper Definition of Database will be:

A database is a well organized collection of data that are related in a meaningful way, which can be shared by multiple users but stored only once.

Poll Question:

A collection of related data.

    a) Information

    b) Valuable information

    c) Database

    d) Metadata

Operations Performed on Databases

To maintain huge databases, we need certain operations which helps in maintaining the data in the database efficiently.

The most commonly used operations performed on the databases are:

1. **Insertion:** To add new data into the database.

2. **Updation:** To Modify the existing data.

3. **Deletion:** To delete the existing data from the database

4. **Selection:** To view or retrieve the stored data.

In addition to the above basic operations performed on the data in the database

we can also perform operations like sorting, merging etc

Database Management System
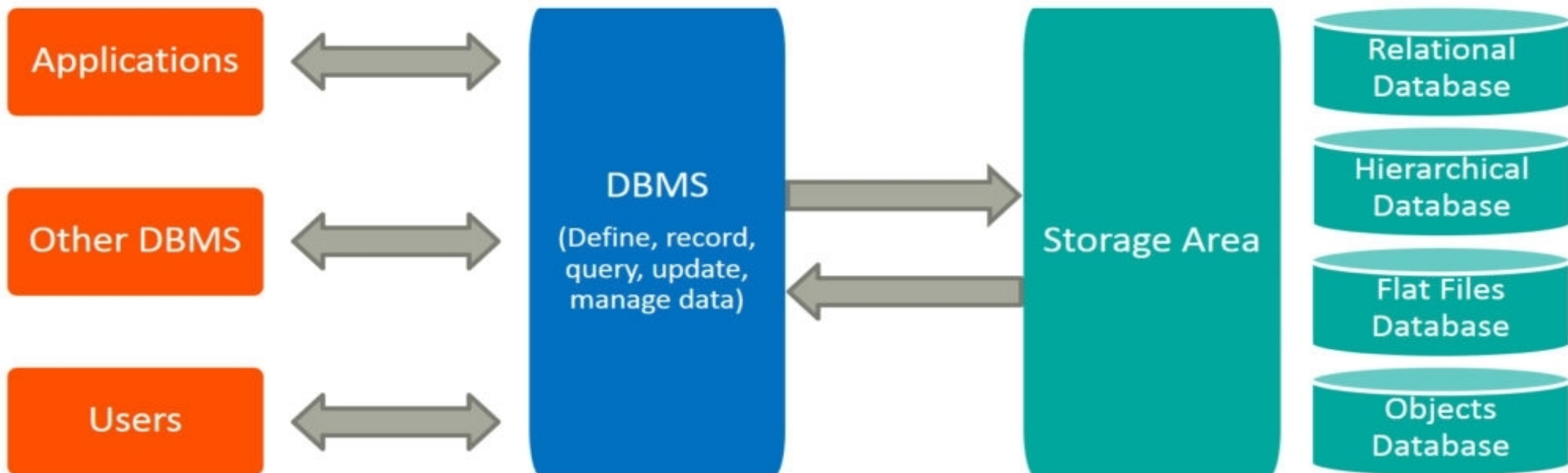
Advantages of DBMS

- **Controls database redundancy:** It can control data redundancy because it stores all the data in one single database file and that recorded data is placed in the database.

- **Integrity can be maintained**: It can be maintained by applying constraints to the table

- **Inconsistency can be Removed :** As the database is centralized the database so changes once made are reflected to all the tables where a particulars field is stored.

- **Data sharing:** In DBMS, the authorized users of an organization can share the data among multiple users.

Advantages of DBMS

- **Confliction can be removed:** As DBA is responsible for DBMS so DBA select the best file structure and accessing strategy to get better performance for the representation and use of the data

- **Backup:** It provides backup and recovery subsystems which create automatic backup of data from hardware and software failures and restores the data if required.

- **multiple user interface:** It provides different types of user interfaces like graphical user interfaces, application program interfaces

- **Security can be maintained:** Passwords can be applied in a database system or file can be secured by DBA. Also in a database system, there are different coding techniques to code the data i.e. safe the data from unauthorized access.

Polling Questions:

Database Management System (DBMS) is:

A. Collection of data describing one particular enterprise

b. Collection of programs to access data

c. Collection of interrelated data

d. All Options are correct

Disadvantages of DBMS

- **Cost of additional Hardware and Software:** It requires a high speed of data processor and large memory size to run DBMS software.

- **Size:** It occupies a large space of disks and large memory to run them efficiently.

- **Complexity of backup and recovery:** Backup and recovery are fairly complex in DBMS environment.

- **Higher impact of failure:** Failure is highly impacted the database because in most of the organization, all the data stored in a single database and if the database is damaged due to electric failure or database corruption then the data may be lost forever.

- **Threat to data Integrity:** Since a large number of users could be using .a database concurrently, technical safeguards are necessary to ensure that the data remain correct during operation.
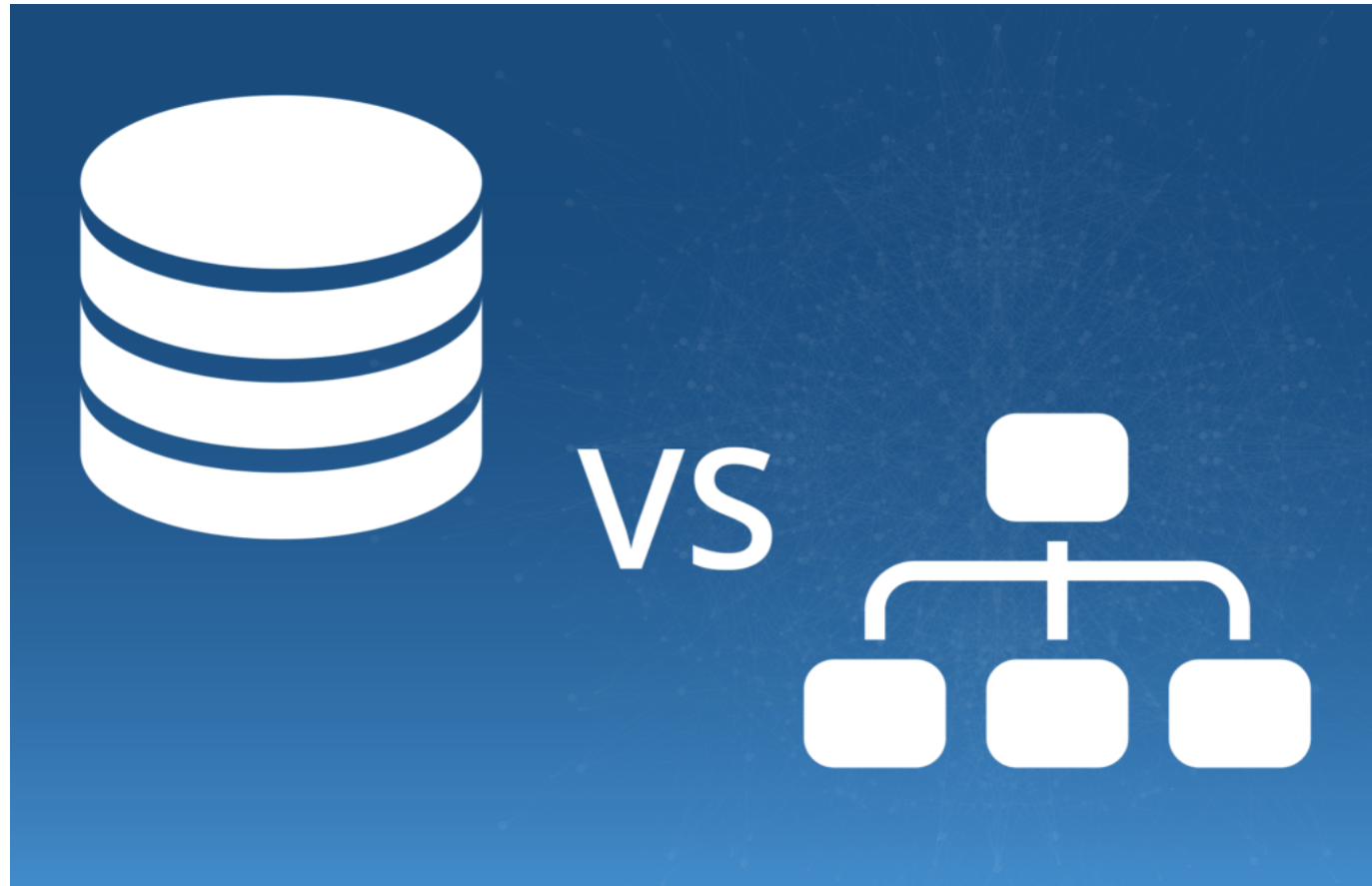
File System vs. DBMS

FILE SYSTEM
VERSUS
DBMS

FILE SYSTEM	DBMS
Software that manages the data files in a computer system	Software to create and manage databases
Helps to store a collection of raw data files into the hard disk	Helps to easily store, retrieve and manipulate data in a database
Tasks such as storing, retrieving and searching are done manually, so it is difficult to manage data	Operations such as updating, searching, selecting data is easier since it allows using SQL querying
Has data inconsistency	Provides higher data consistency using normalization
There is more redundant data	There is low data redundancy
Provides more security to data	Comparatively less data security
Backup and recovery process is not efficient because it is not possible to recover the lost data	Has a sophisticated backup and recovery
Appropriate to handle data of a small-scale organization or individual users	Suitable for medium to large organizations or multiple users
Handling is easy	Handling is complex
Ex: NTFS and Ext	Ex: MySQL, MSSQL, Oracle, DB2

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Polling Questions:

Database management systems are intended to _____.

   A. eliminate data redundancy

   B. establish relationship among records in different files

   C. manage file access

  d. All Options are correct

Polling Questions:

Which of the following is a serious problem of file management systems?

   A. Difficult to update

   B. Lack of data independence

   C. Data redundancy

  d. All Options are correct

REFERENCE BOOKS

Ø Fundamentals of Database Systems by R. Elmasri and S.B. Navathe, 3rd Edition, Pearson Education, New Delhi.

Ø An Introduction to Database Systems by C.J. Date, 7th Edition, Pearson Education, New Delhi.

Ø YouTube Link- Video Lectures

Ø https://www.youtube.com/watch?v=T7AxM7Vqvaw&list=PLdo5W4Nhv31b33kF46f9aFjoJPOkdlsRc

THANK YOU