Database Management System (DBMS)
CSC403

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Unit 1

Introduction Database Concepts

What is Data?

Data can be facts related to any object in consideration.

For example,
Name of person, age, height, weight, etc. are some data related to person.
 A picture, image, file, pdf, etc. can also be considered data.

What is Database?

- A **database** is an systematic collection of data, so that it can be easily accessed and managed.
- The **main purpose** of the database is to operate a large amount of information by storing, retrieving, and managing data.

Example:
1. An online telephone directory uses a database to store data people, phone numbers, and other contact details.

2. Electricity service provider uses a database to manage billing, client-related issues, handle fault data, etc.

- Facebook- It needs to store, manipulate, and present data related to members, their friends, member activities, messages, advertisements, and a lot more.

- There are many **databases available** like MySQL, Sybase, Oracle, MongoDB, Informix, PostgreSQL, SQL Server, etc.

- Modern databases are managed by the database management system (DBMS).

Types of Databases

1. **Centralized database:**

- A centralized database is stored at a single location such as 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 organizations such as colleges, companies, banks etc.
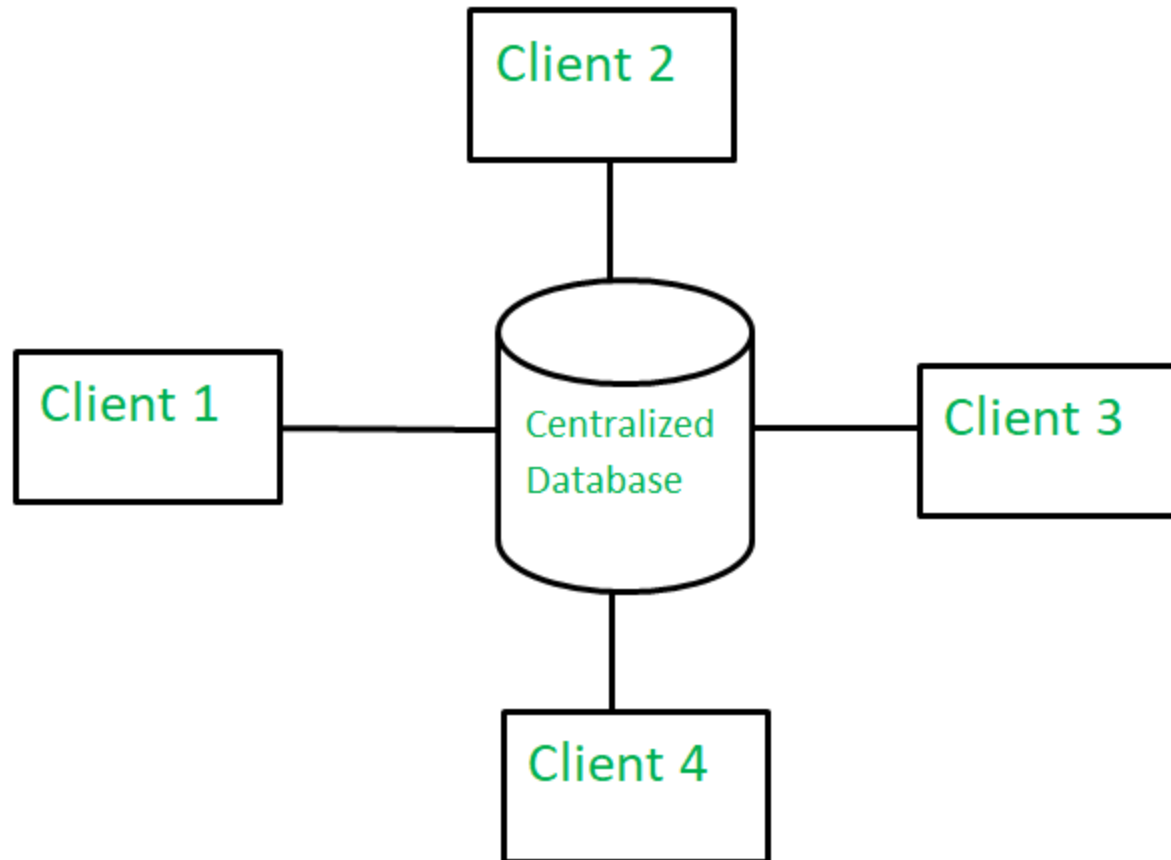
2. Distributed databases:

- A distributed database is basically a database that is not limited to one system, it is spread over different sites, i.e, on multiple computers or over a network of computers.
- A **distributed database** is a collection of multiple interconnected databases, which are spread physically across various locations that communicate via a computer network.
- In this type of database system, the data is not in one place and is distributed at various organizations.
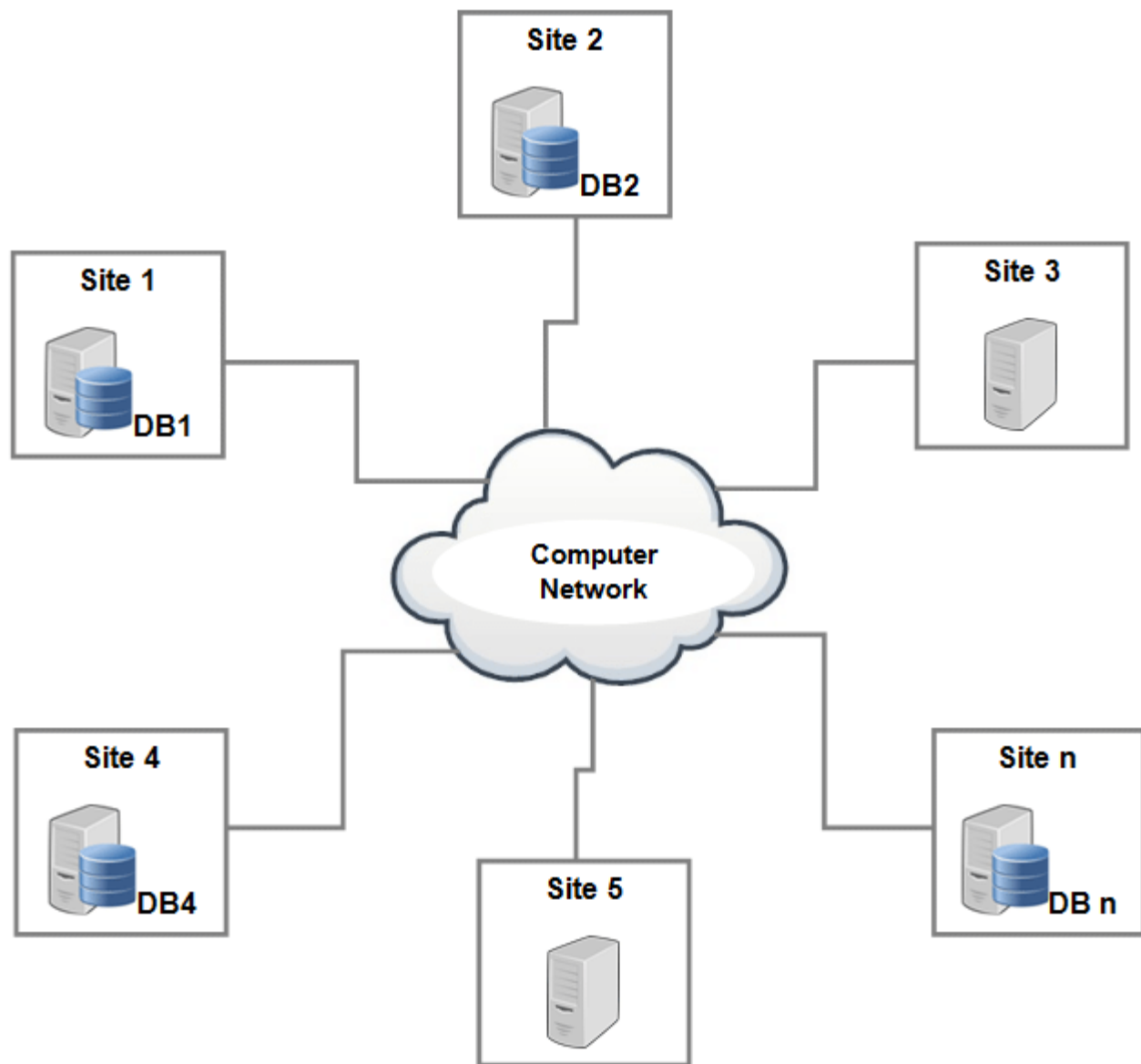
What is a Database Management System (DBMS)?

- **Database Management System (DBMS)** is a collection of programs that enable its users to access databases, manipulate data and represent data.
- It also helps to control access to the database.
- Database Management Systems had been first implemented in the 1960s.
- Charles Bachman's Integrated Data Store (IDS) is said to be the first DBMS in history.

Characteristics of databases

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

2. Less redundancy − DBMS follows the rules of normalization, which splits a relation when any of its attributes is having redundancy in values.

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

4. Query Language − DBMS is equipped with query language, which makes it more efficient to retrieve and manipulate data. A user can apply as many and as different filtering options as required to retrieve a set of data.

5. ACID Properties − DBMS follows the concepts of **A**tomicity, **C**onsistency, **I**solation, and **D**urability .These concepts are applied on transactions, which manipulate data in a database. ACID properties help the database stay healthy in multi-transactional environments and in case of failure.

6. Multiuser and Concurrent Access − DBMS supports multi-user environment and allows them to access and manipulate data in parallel.

7. Security − DBMS offers methods to impose constraints while entering data into the database and retrieving the same at a later stage. DBMS offers many different levels of security features, which enables multiple users to have different views with different features. For example, a user in the Sales department cannot see the data that belongs to the Purchase department. Additionally, it can also be managed how much data of the Sales department should be displayed to the user.

Quiz Time

1. What is the full form of DBMS?
   a) Data of Binary Management System
   b) Database Management System
   c) Database Management Service
   d) Data Backup Management System

2. What is a database?
a) Organized collection of information that cannot be accessed, updated, and managed
b) Collection of data or information without organizing
c) Organized collection of data or information that can be accessed, updated, and managed
d) Organized collection of data that cannot be updated

3. Who created the first DBMS?

a) Edgar Frank Codd
b) Charles Bachman
c) Charles Babbage
d) Sharon B. Codd

4.Which of the following is not an example of DBMS?
a) MySQL
b) MongoDB
c) IBM DB2
d) Google

5. Which of the following is not a feature of DBMS?
a) Minimum Duplication and Redundancy of Data
b) High Level of Security
c) Single-user Access only
d) Support ACID Property

File system vs DBMS

| Basis	File System	DBMS
Structure	The file system is software that manages and organizes the files in a storage medium within a computer.	DBMS is software for managing the database.
Data Redundancy	Redundant data can be present in a file system.	In DBMS there is no redundant data.
Backup and Recovery	It doesn't provide backup and recovery of data if it is lost.	It provides backup and recovery of data even if it is lost.
Query processing	There is no efficient query processing in the file system.	Efficient query processing is there in DBMS.
Consistency	There is less data consistency in the file system.	There is more data consistency because of the process of normalization.
Complexity	It is less complex as compared to DBMS.	It has more complexity in handling as compared to the file system.
Security Constraints	File systems provide less security in comparison to DBMS.	DBMS has more security mechanisms as compared to file systems.

Basis	File System	DBMS
Cost	It is less expensive than DBMS.	It has a comparatively higher cost than a file system.
User Access	Only one user can access data at a time.	Multiple users can access data at a time.

Application of DBMS

- Banking: all transactions
- Airlines: reservations, schedules
- Universities: registration, grades
- Sales: customers, products, purchases
- Online retailers: order tracking, customized recommendations
- Manufacturing: production, inventory, orders, supply chain
- Human resources: employee records, salaries, tax deductions

Overall system structure
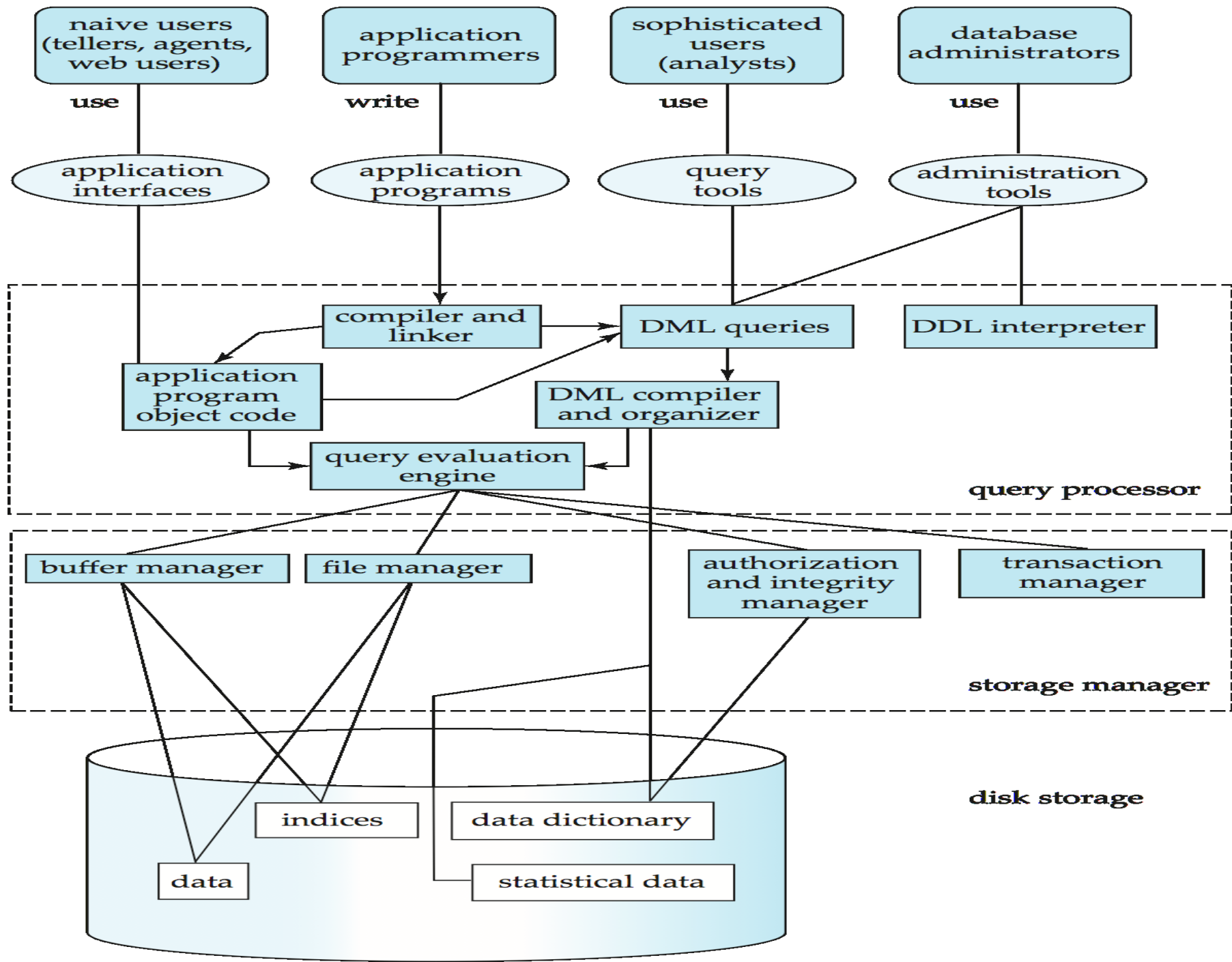
Database Management System Internals

1. Database Users
2. Storage management
3. Query processing

The design of Database System must include the considerations of the interface between the **database system** and the **operating system.**

Functional Components of a database system are:

1. **Query Processor Components**
DML compiler: Translates DML statements into low level instructions that query evaluation engine can understand.
DDL interpreter : interprets DDL statements and records them in a set of tables containing metadata.
Query Evaluation Engine: Executes low-level instructions generated by DML compiler

2.Storage Manger Components

Authorization & Integrity Manager: Test satisfaction of integrity constraints and checks authority of users to access data.

Transaction Manager: Ensures that the database remains in a consistent state despite the system failures, and concurrent transaction execution without confliction.

File Manager: Manages the allocation of space on disk storage and data structures used to represent information.

Buffer Manager: Responsible for fetching data from disk storage into main memory and decide what data to cache in memory.

In addition , several data structures are required as part of physical system implementation

Data Files : which stores the database itself

Data Dictionary : which stores metadata about the structure of the database.

Indices : which provide fast access to data items that hold particular values.

Statistical Data: which stores statistical information about the data in the database. This info is used by query processor to

select efficient ways to execute a query.

Database Users

1. **Database administrators**
2. **Naïve users**
3. **Application programmers**
4. **Sophisticated users**
5. **Specialized users**

Data Abstraction

Data Abstraction is a process of hiding unwanted or irrelevant details from the end user.

The database systems consist of complicated data structures and relations. For users to access the data easily, these complications are kept hidden, and only the relevant part of the database is made accessible to the users through data abstraction.
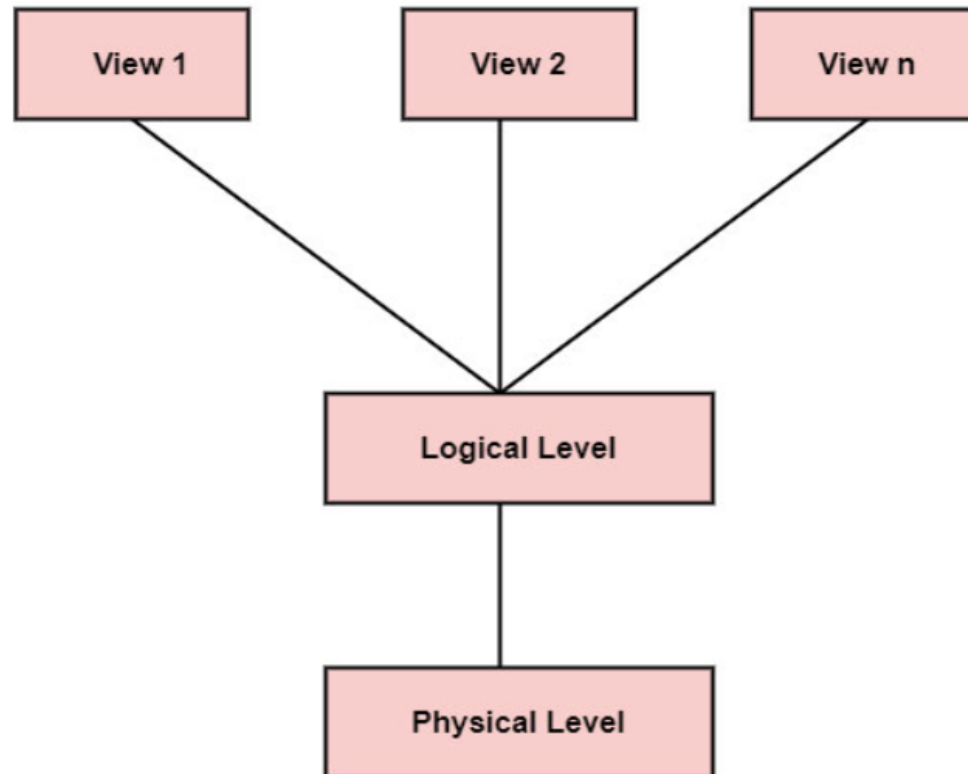
Levels of abstraction for DBMS

Mainly there are three levels of abstraction for DBMS, which are as follows −

1. Physical or Internal Level
2. Logical or Conceptual Level
3. View or External Level

Three Levels of Data Abstraction

1.Physical or Internal Level

It is the lowest level of abstraction for DBMS which defines how the data is actually stored, it defines data-structures to store data and access methods used by the database. Actually, it is decided by developers or database application programmers how to store the data in the database.

So, overall, the entire database is described in this level that is physical or internal level. It is a very complex level to understand.

For example, customer's information is stored in tables and data is stored in the form of blocks of storage such as bytes, gigabytes etc.

2. Logical or Conceptual Level

Logical level is the intermediate level or next higher level. It describes what data is stored in the database and what relationship exists among those data. It tries to describe the entire or whole data because it describes what tables to be created and what are the links among those tables that are created.
It is less complex than the physical level. Logical level is used by developers or database administrators (DBA). So, overall, the logical level contains tables (fields and attributes) and relationships among table attributes.

3.View or External Level

It is the highest level. In view level, there are different levels of views and every view only defines a part of the entire data. It also simplifies interaction with the user and it provides many views or multiple views of the same database.
View level can be used by all users (all levels' users). This level is the least complex and easy to understand.
For example, a user can interact with a system using GUI that is view level and can enter details at GUI or screen and the user does not know how data is stored and what data is stored, this detail is hidden from the user.

Data Independence

Data Independence is defined as a property of DBMS that helps you to change the Database schema at one level of a database system without requiring to change the schema at the next higher level.
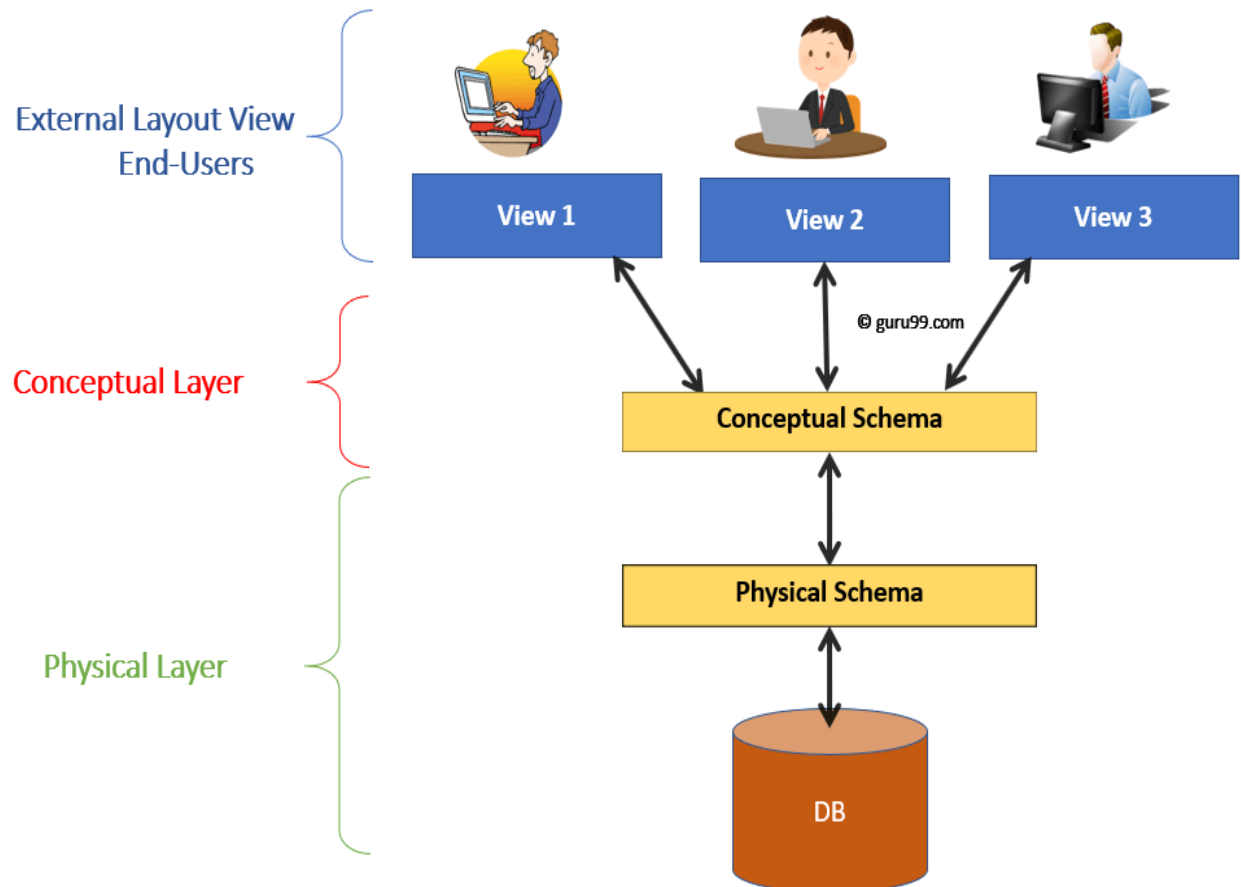
Types of Data Independence
In DBMS there are two types of data independence

1.Physical data independence
2.Logical data independence.

Levels of Database

1.Physical/Internal
2.Conceptual
3.External

Consider an Example of a University Database. At the different levels this is how the implementation will look like:

Type of Schema	Implementation
External Schema	**View 1**: Course info(cid:int,cname:string) **View 2**: studeninfo(id:int. name:string)
Conceptual Shema	Students(id: int, name: string, login: string, age: integer) Courses(id: int, cname:string, credits:integer) Enrolled(id: int, grade:string)
Physical Schema	•Relations stored as unordered files. •Index on the first column of Students.

Physical Data Independence

Physical data independence refers to the ability to change the data's physical structure without affecting the conceptual level.

Physical changes include using a new storage device or moving the database's location, changing the data structure, or altering indexes to speed up data retrieval.

Example: The patient database could be moved from drive C to drive D, but the conceptual schema and external views remain unchanged because of physical data independence.

Logical Data Independence

Logical data independence, on the other hand, allows users to change the conceptual schema without changing the external views.

For example, the hospital billing department could add a column to the database table for each patient's insurance policy number. Having logical data independence means that the view of the food services department and other users are not changed even though modifications were made to the conceptual level.

Due to Logical independence, any of the below change will not affect the external layer.

1.Add/Modify/Delete a new attribute, entity or relationship is possible without a rewrite of existing application programs
2.Merging two records into one
3.Breaking an existing record into two or more records

Quiz Time

1. With DBMS , Multiple user can access the same data at a same time

A.True

B.False

2. _____is a process of hiding unwanted or irrelevant details from the end user.

A. Data Abstraction

B. Data Independence

C. Data Restoration

D. Data Cleaning

3. Physical changes does not include_____

A. using a new storage device

B. moving the database's location

C. changing the data structure

D. Merging two records into one

4. Logical data independence, allows users to change the conceptual schema without changing the _____

A. External views

B. Conceptual views

Database Administrator (DBA)

A **Database Administrator (DBA)** is individual or person responsible for controlling, maintenance, coordinating, and operation of database management system.

Types of Database Administrator (DBA) :

•**Administrative DBA –**
Their job is to maintain server and keep it functional. They are concerned with data backups, security, trouble shooting, replication, migration etc.

•**Data Warehouse DBA –**
-Accountable for merging data from various sources into data warehouse. They also design warehouse, with cleaning and scrubs data prior to loading.

•**Development DBA –**
They build and develop queries that meets firm or organization needs.

- **Application DBA –**

They particularly manages all requirements of application components that interact with database and accomplish activities such as application installation and coordinating, application upgrades, database cloning, data load process management, etc.

- **Architect –**

They are held responsible for designing schemas like building tables. They work to build structure that meets organization needs. The design is further used by developers and development DBAs to design and implement real application.

Role and Duties of Database Administrator (DBA) :

•**Decides hardware** –
They decides economical hardware, based upon cost, performance and efficiency of hardware, and best suits organization. It is hardware which is interface between end users and database.

•**Manages data integrity and security** –
Data integrity need to be checked and managed accurately as it protects and restricts data from unauthorized use. DBA eyes on relationship within data to maintain data integrity.

•**Database design** –
DBA is held responsible and accountable for database design ,integrity and security control.

•**Database implementation –**
DBA implements DBMS and checks database loading at time of its implementation.

•**Query processing performance –**
DBA enhances query processing

Q.1 A Database Administrator is individual or person responsible for controlling, maintenance, coordinating, and operation of database management system.

A. True
B. False

Q.2

In which of the following architecture client, server, and Database all reside on the same machine.

A. 1 Tier
B. 2 Tier
C. 3 Tier

Thank you…

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Database Management System
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