Information
Technology
Institute

Database Fundamentals

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Information Technology Institute

Objectives

- Introduce the fundamentals of Database
- Develop Skills:
  - Design
  - Construction
  - Modification
  - Use of Database

References:

- Ramez Elmasri, Fundamentals of Database Systems
- C. J. Date: An Introduction to Database Systems.

Course Duration

- Lectures: 15 hrs
- Labs: 12 hrs

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Grading System

- Assignments and lab work: 40%
- Final Exam : 60%

Chapter 1:

Introduction

Define Database, Database System, and it's properties

Define DBMS and it's Functions

Advantages and Disadvantages of database systems

Types of Different databases

Example

كشف الحاضرين عن يوم : 2008/09/09

المقر الرئيسى الإدارة التاريخ 9 9 2008 إعرض التقرير

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عدد الحاضرين : 106 عدد الموظفين : 160 نسبة الحضور : %66.25

الاسم	حضور	إنصراف	المقر	الإدارة
آمنة مجدى على صفوت محمد على	08:03	–	الرئيسى	برنامج التدريب الإحترافى
أحمد سيد عبد المنعم	09:43	–	الرئيسى	الشئون المالية والإدارية
أحمد صلاح مصطفى على	مواصل	–	الرئيسى	برنامج التدريب الإحترافى
أحمد عادل الدهيرى	مواصل	–	الرئيسى	برنامج التدريب الإحترافى
أحمد عادل عبد الحليم	08:50	–	الرئيسى	إدارة توكيد الجودة
أحمد فكرى محمد عبدالغفور	08:31	–	الرئيسى	برنامج التدريب الإحترافى
أحمد فوزى أحمد شوشة	08:34	–	الرئيسى	برنامج التدريب الإحترافى
أحمد محمد أبو العلا غريب	مواصل	00:05	الرئيسى	الشئون المالية والإدارية
أحمد محمد أحمد لطفى	07:56	–	الرئيسى	برنامج التدريب الإحترافى

File Based System

It’s a collection programs that perform services for the end user

Each program defines and manages its own data

Limitations of file based system approach

- Separation & Isolation of data

- Duplication of data

- Program data dependence

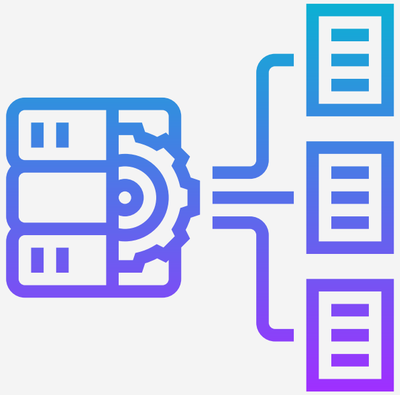
- Incompatible file formats

Definitions

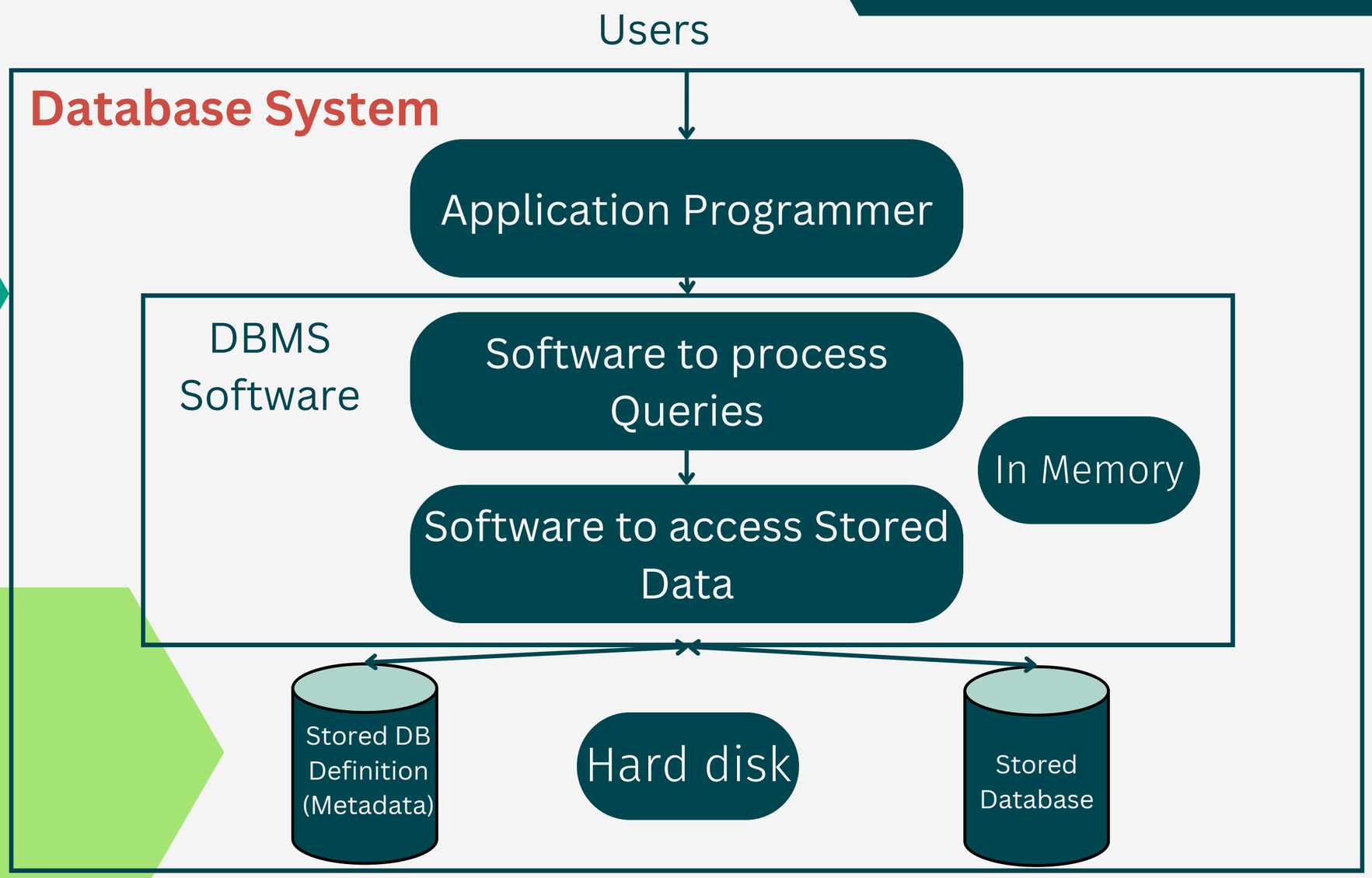
- **Database:** A collection of related data

- **Database Management System (DBMS):** A Software package/ system to facilitate the creation and maintenance of a computerized database.

- **Database System:** The DBMS software together with the data itself.
- Sometimes, the applications are also included. (Software + Database)



Database Management System (DBMS)



DBMS Pros

- Controlling Redundancy
- Restricting Unauthorized Access
- Sharing data
- Enforcing Integrity Constraints
- Inconsistency can be avoided
- Providing Backup and Recovery

DBMS Cons

- DBMS is expensive
- May be incompatible with any other available DBMS

Database Users

1.System Analyst Analysis and requirement gathering

2.Database Designer Create database design

3.Database Administrator (DBA)

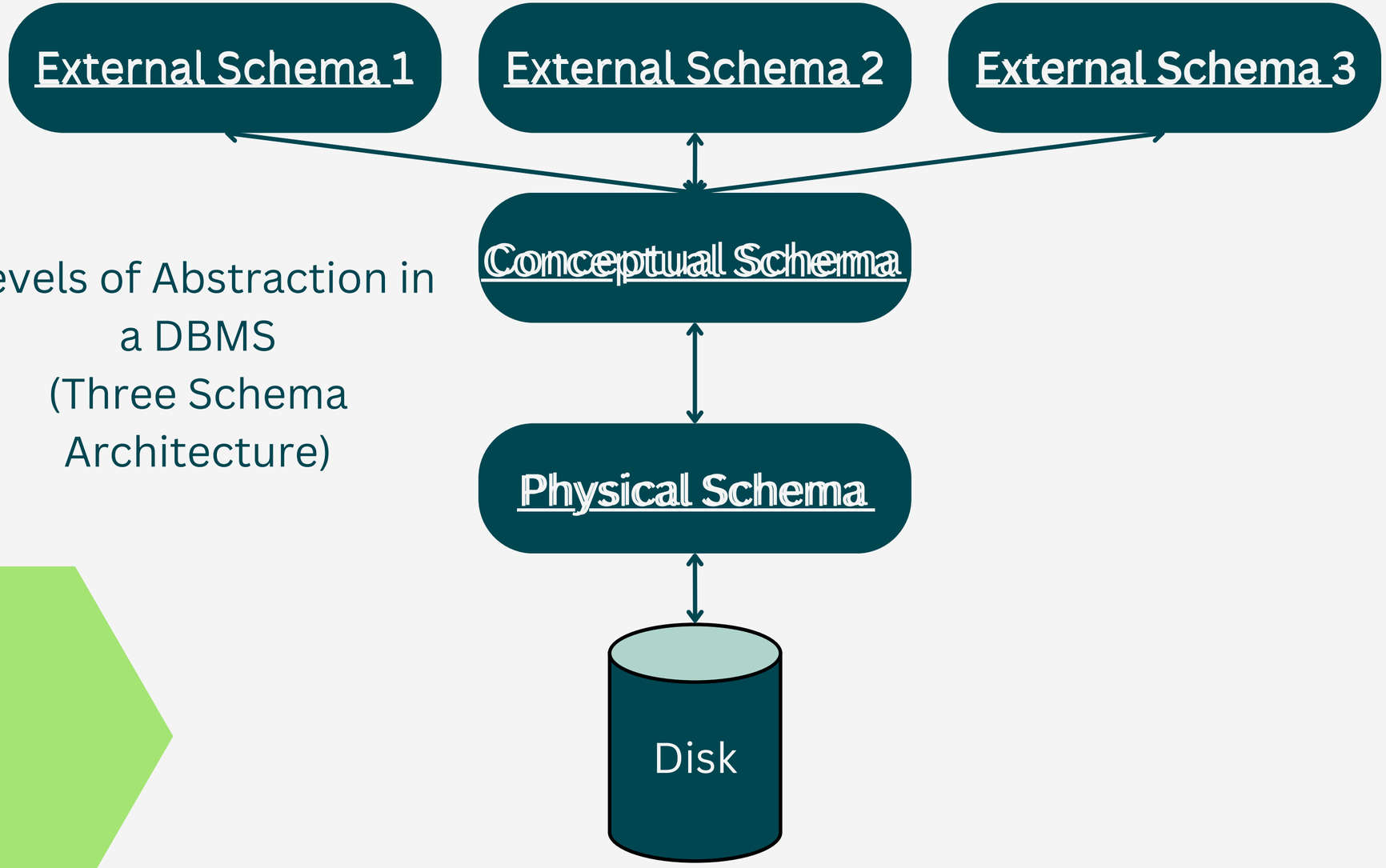
- Install DBMS
- Create BD schema and populate data.
- create users and authorized access to DB.
- Maintain DB performance.

4.Application Programmer Develop, Test, Debug the application

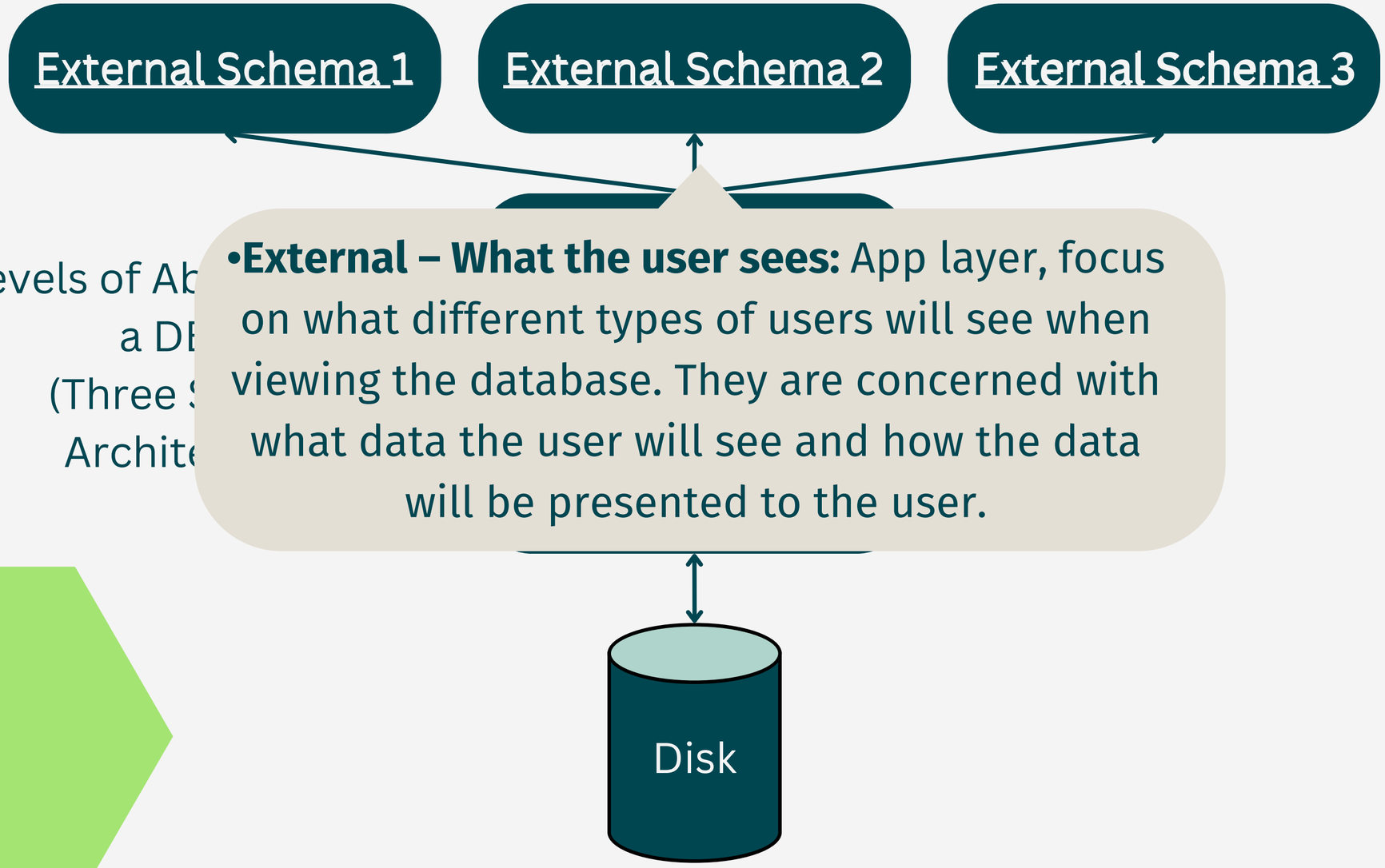
5. End User

DBMS Architecture

Levels of Abstraction in a DBMS (Three Schema Architecture)



DBMS Architecture



Levels of Ab
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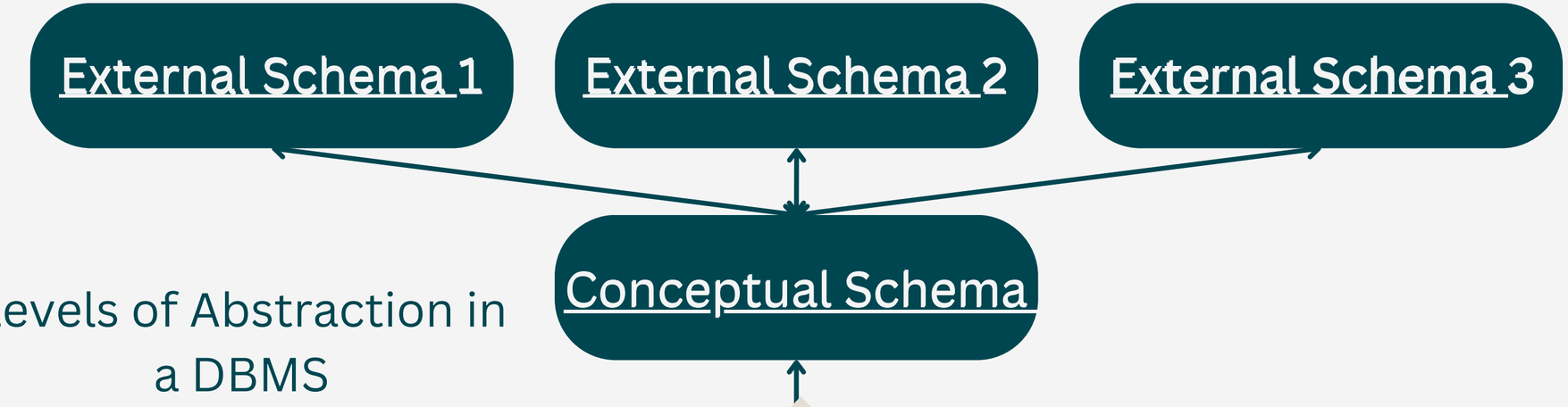
Archite

•**External – What the user sees:** App layer, focus on what different types of users will see when viewing the database. They are concerned with what data the user will see and how the data will be presented to the user.

DBMS Architecture

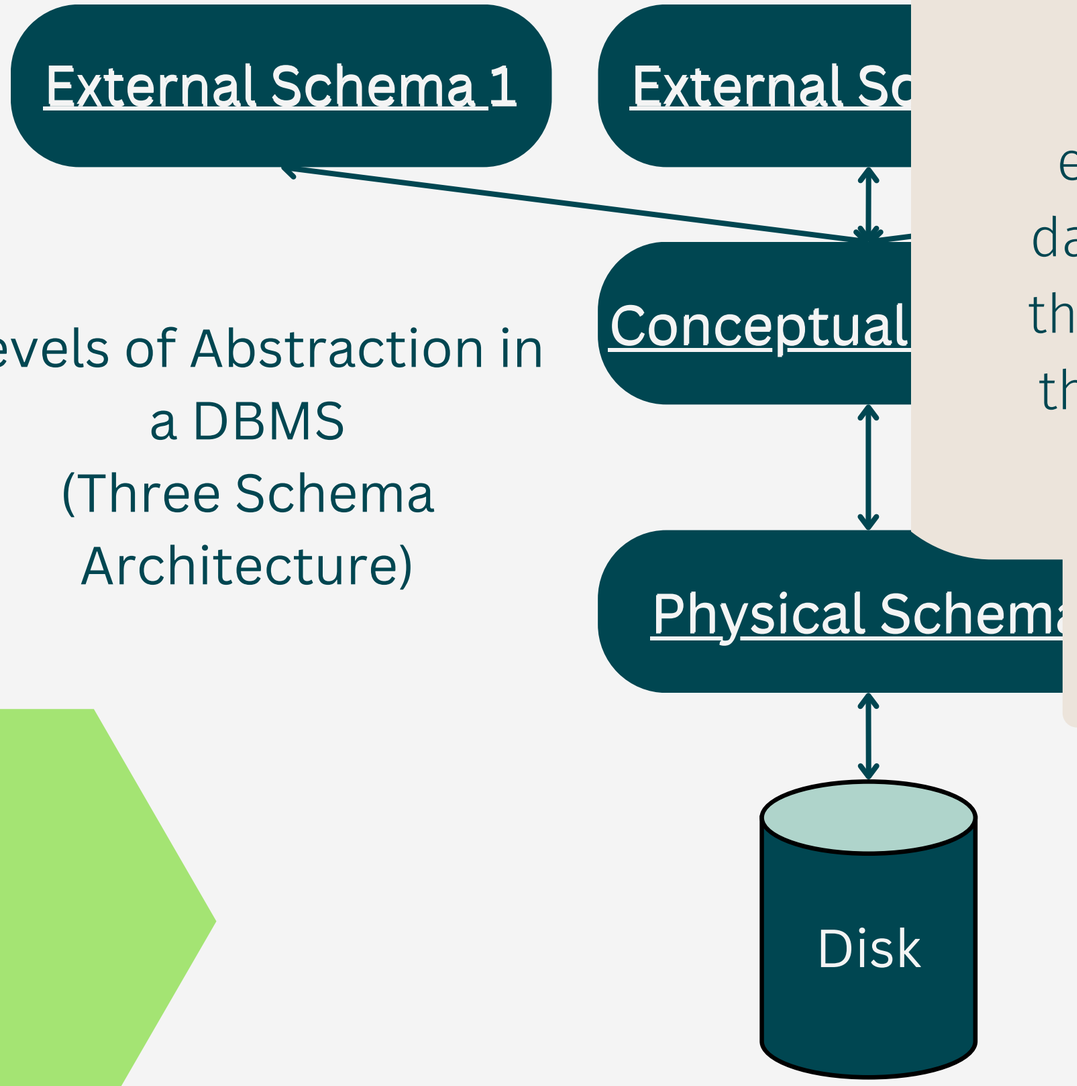


Levels of Abstraction in a DBMS (Three Schema Archite

- **Conceptual – The logical model:** DB tables focus on the logical nature of the data representation. They are concerned with what is represented rather than how it is represented. (define database structures such as tables and constraints)

DBMS Architecture

Levels of Abstraction in a DBMS (Three Schema Architecture)



Internal – The physical model: Conceptual model, place the emphasis on how the data are represented in the database or on how the data structures are implemented.

Mappings:

- **Definition:** It is the processes of transforming requests and results between levels.

- These mappings may be time-consuming. However, a certain amount of mapping between the conceptual and internal levels is necessary.

Data Independence

- Data independence is a fundamental concept in database management.
- It allows for flexibility, maintainability, and scalability in database design.

Benefits

- Simplifies maintenance.
- Enhances flexibility.
- Supports scalability.

1. Logical Data Independence

- **Definition:** Ability to change the logical schema without affecting applications.
- **Importance:** Shields applications from changes in the database structure.
- **Example:** Adding new fields to a customer database.

2. Physical Data Independence

- **Definition:** Ability to change the physical storage without affecting the logical schema.
- **Importance:** Provides flexibility in data storage and management.
- **Example:** Changing data storage from flat files to B-trees.

Data Models

- High Level or Conceptual data models provide concepts that are close to the way many users perceive data, entities, attributes and relationships. (Ex. ERD)

- Physical data models describe how data is stored in the computer and the access path needed to access and search for data.

DBMS Other Functions

Data Mining

Process of discovering patterns, trends, and valuable insights within large datasets.

Spatial Data

Representation and analysis of geographic or location-based information.

Image/ Audio/ Video

Databases can store multimedia data, including images, audio, and video files.

Time Series

Time series data consists of observations recorded at specific time intervals.

Non-relational Database (NoSQL)

- The non-relational database uses a storage model optimized for specific requirements of the type of data being stored.
- Unlike the relational database, there are no tables, rows, primary keys or foreign keys.

Also Known as NoSQL Database.

NoSQL databases stands for Not Only SQL.

NoSQL can use other types of query language rather than SQL.

Non-relational Database (NoSQL)

Document Oriented

Store data in semi-structured JSON or XML documents. Examples include MongoDB and CouchDB.

Columnar Oriented

Organize data into columns instead of rows, ideal for handling large volumes of data. Examples include Apache Cassandra and HBase.

Key-Value Stores

Use a simple key-value data model. Examples include Redis and Amazon DynamoDB.

Graph Stores

Designed for managing relationships in data. Examples include Neo4j and Amazon Neptune.

NoSQL Vendors

mongoDB®

redis

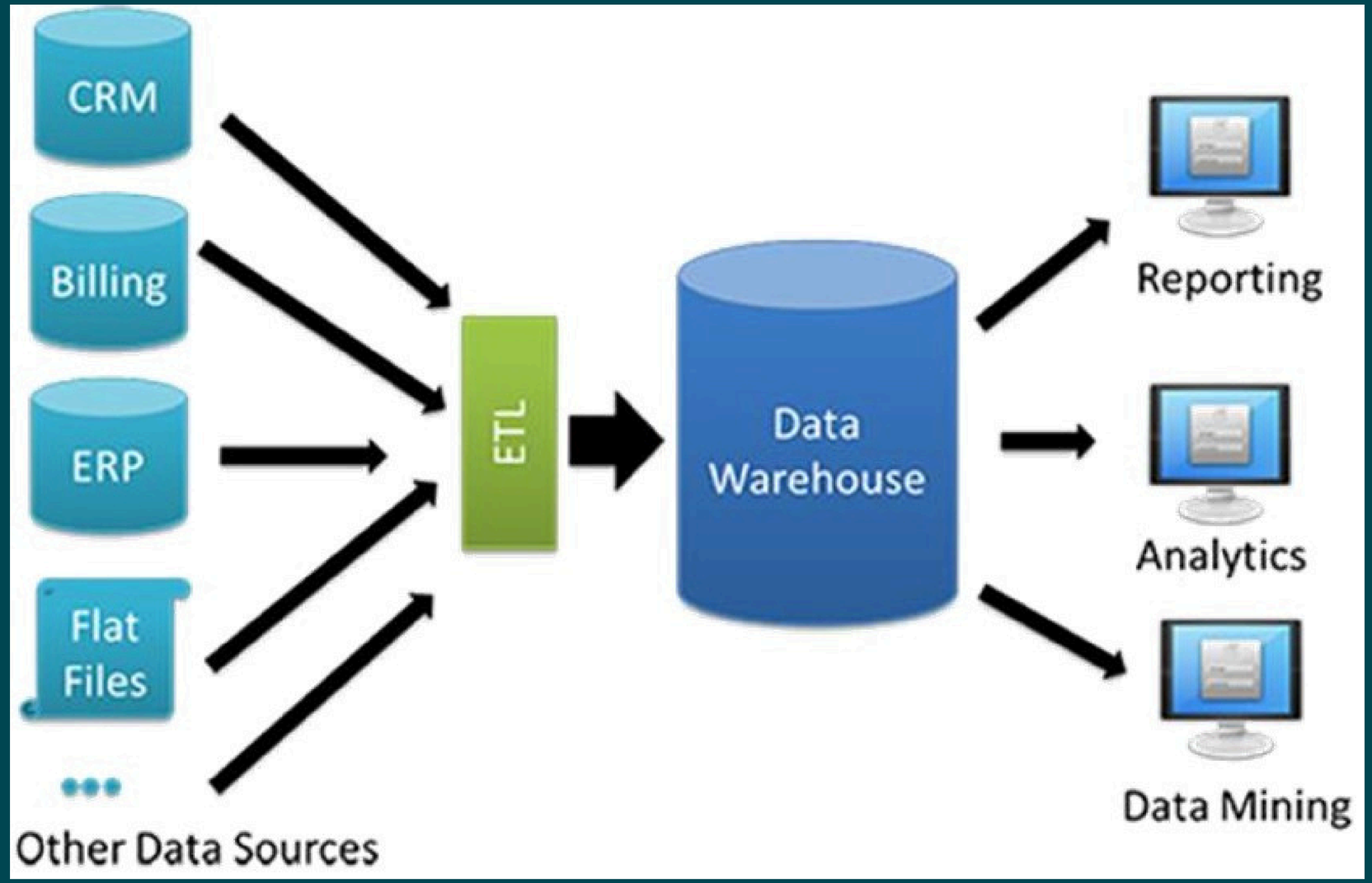
cassandra

APACHE HBASE

ORACLE®
NOSQL DATABASE

Data Warehouse

Centralized repository that collects, stores, and manages data from various sources within an organization. It is designed to support complex queries and analysis, enabling businesses to make informed decisions based on historical and current data.



Big Data

"**Big Data**" is data whose scale, distribution, diversity, and/or timeliness require the use of new technical architectures and analytics to enable insights that unlock new sources of business value.

Source: McKinsey May 2011 article Big Data: The next frontier for innovation, competition, and productivity

Characteristics

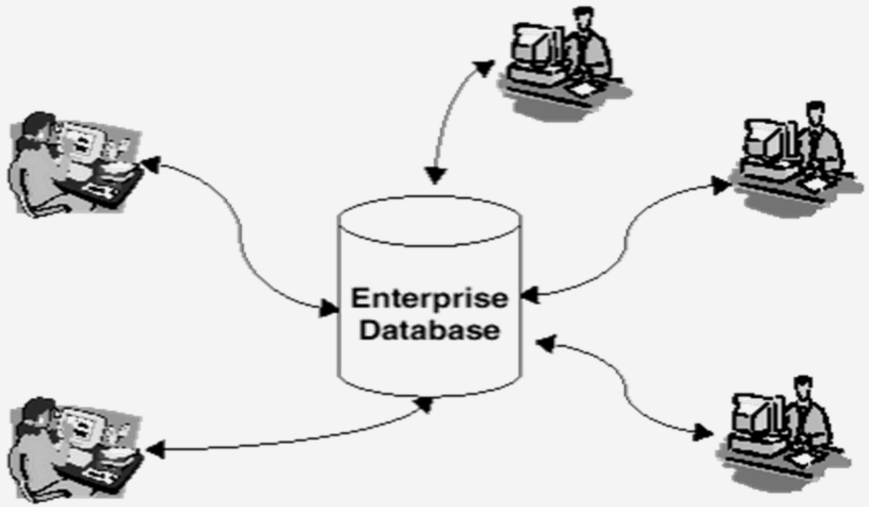
Volume

Velocity

Variety

Database Environment

Centralized Database



All data at a single site.

Data access from remote sites through communication links.

Easy to administer.

Uncertain data availability.

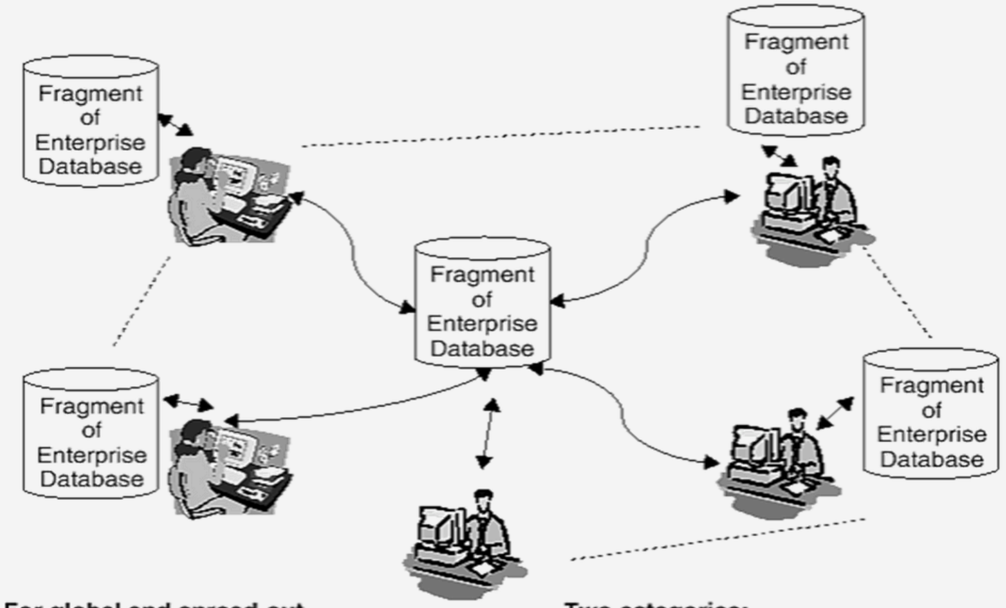
Common Examples:

Personal Database

Central Computer Database

Client/Server Database

Distributed Database



For global and spread-out organizations, centralized databases not economical.

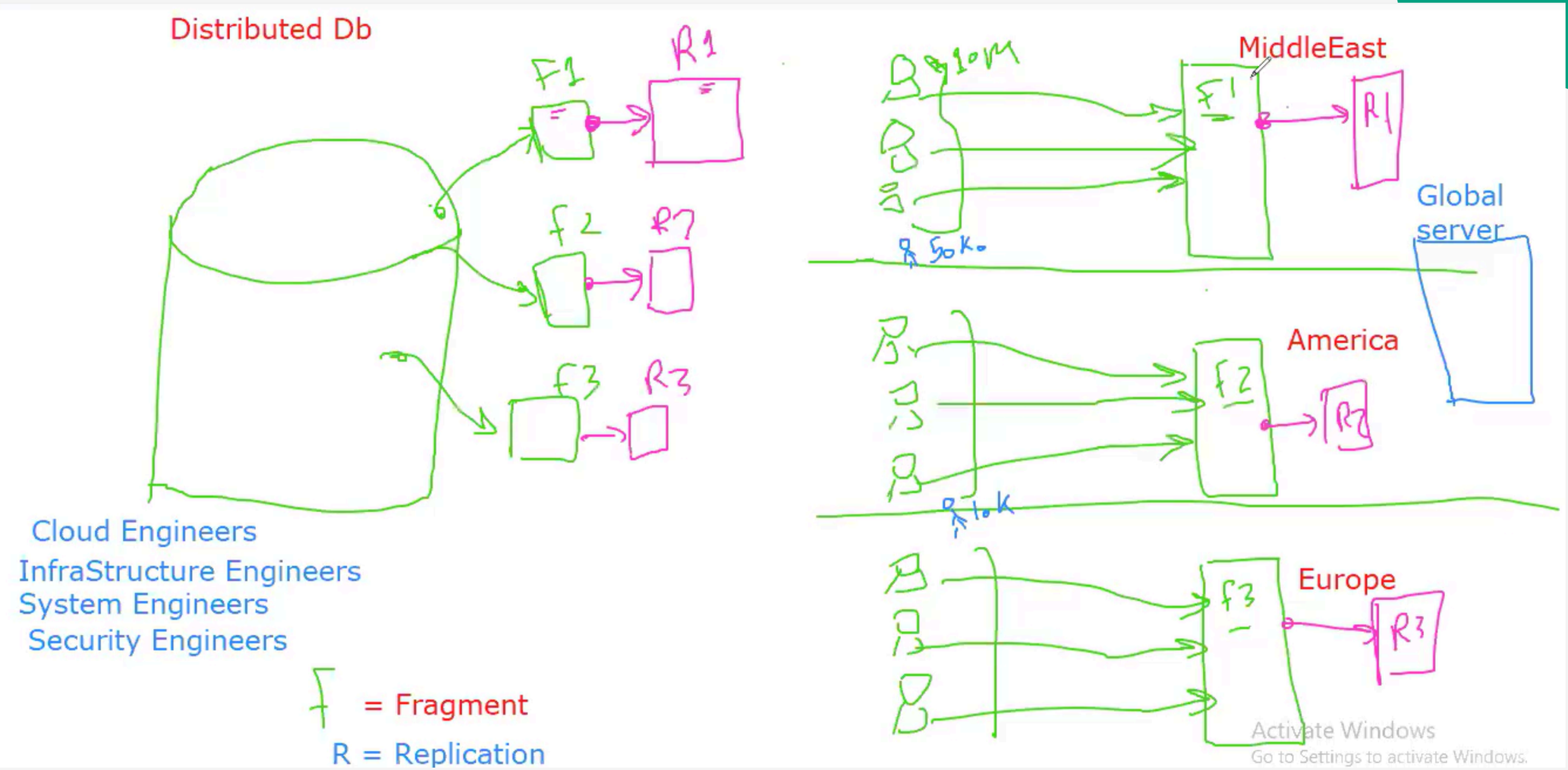
Enterprise data distributed across multiple computer systems.

Two categories:

Homogeneous databases

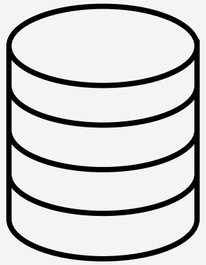
Heterogeneous databases

Database Environment

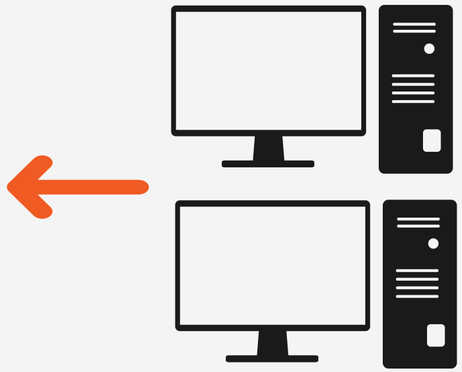


Centralized Database Enviroment

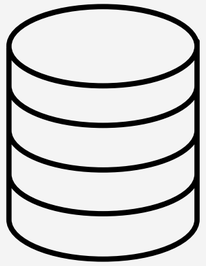
Mainframe



DB server



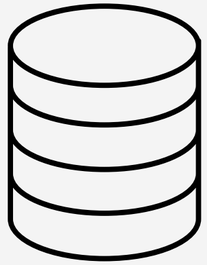
Client/ Server



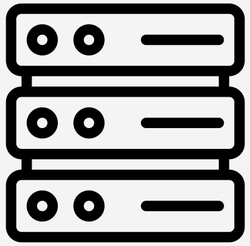
DB server

Thick Client Application locally installed

Inernet Computing



DB server

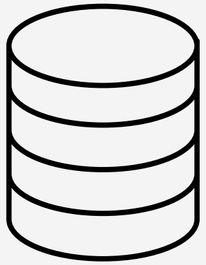


App server

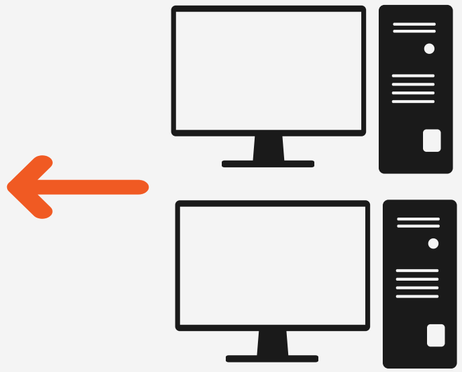
Thin Client Applet

Centralized Database Enviroment

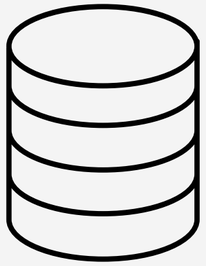
Mainframe



DB server



Client/ Server



DB server

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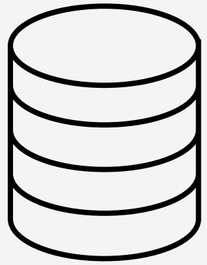
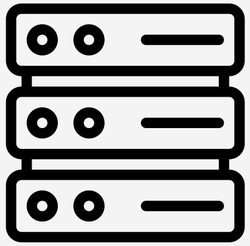


DB server



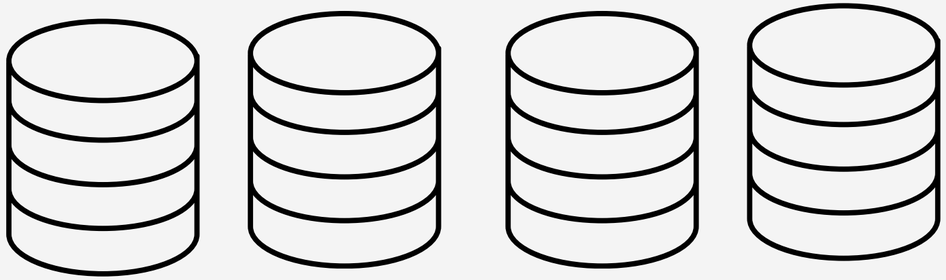
App server

Thin Client Applet

Distributed Database Enviroment

Partial Replication

Full Replication



Fragmantation

Questions?