

Introduction to Database Systems

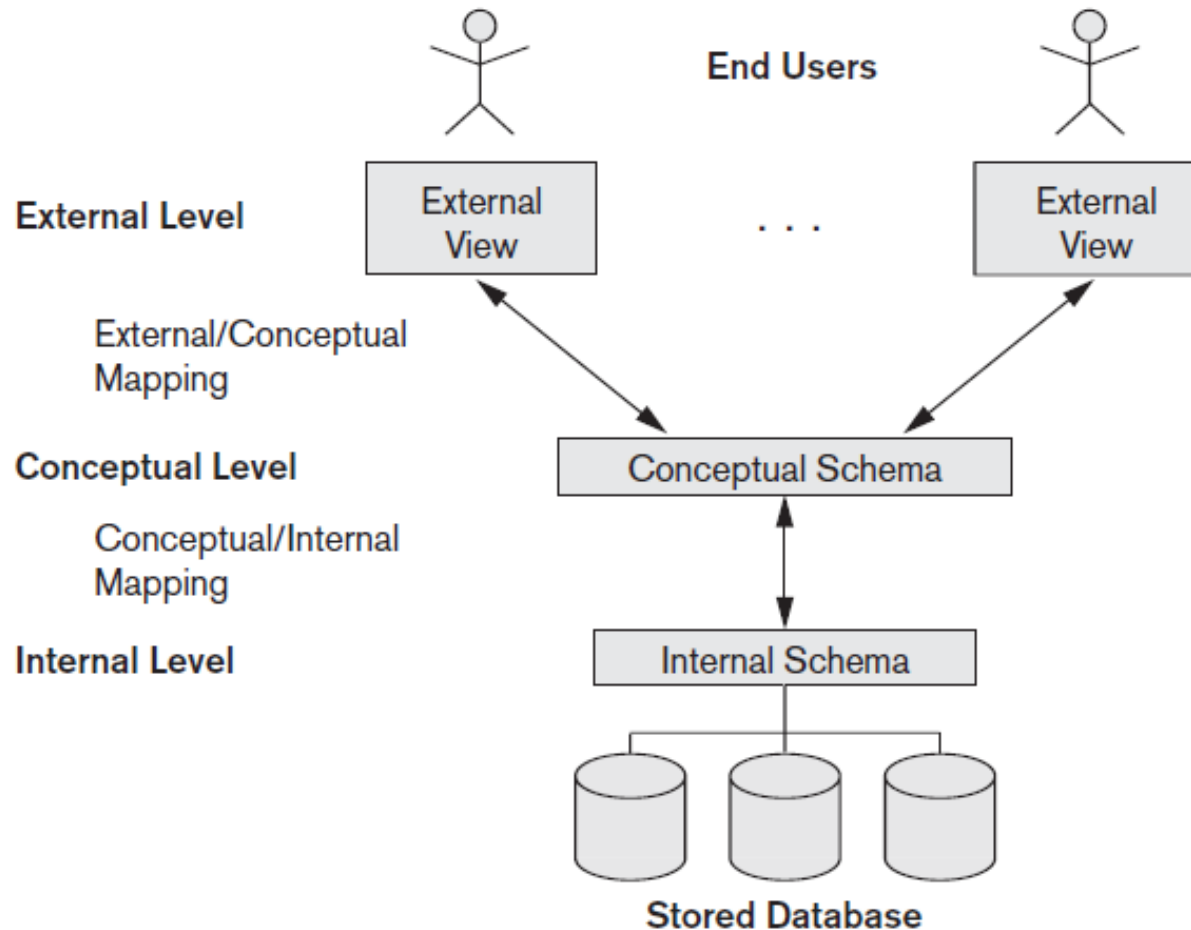
Lecture 2

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Database Architecture

- Database has three level architecture.
- It is a basis for understanding DBMS functionalities.
- There are three levels at which data can be described.
 - External Level
 - Conceptual Level
 - Internal Level

Database Architecture



External Level

- The way users think about data.
- Each user has a view of the database limited to the appropriate portion of the user's perspective of reality.
- Users may have different views of the same data e.g. date, time etc.
- Virtual/calculated data: that is not actually stored in the database but is created when needed e.g. age, statistical data etc.

External Level

- DBMS uses external views to create user interface for different users which is both the facility and barrier.
- User's external view is created after considering data access, reports, and the transactions needs.
- External schema evolves as user needs are modified over time.

External Level

Employee Data

First Name: Rana
Last Name: Aslam
Date of Birth:
12 Sep, 1970



Saleema

Saleem

Workers

Name: R. Aslam
Age: 25y,10d
Dept: Sales

External Layer

Lower Layers

Conceptual Level

- A complete description of the information content of the database.
- The entire information structure of the database, as seen by the DBA.
- The conceptual level hides the details of physical storage structures constraints.
- All entities, attributes and their relationships are represented here.

Conceptual Level

- Contains record types representing entities, data item types with their attributes, relationships and constraints on data.
- Contains Semantic information about the data meaning, security and integrity information.
- Relatively constant: designed with the present as well as future needs of an organization.

Employee Data

First Name: Rana
Last Name: Aslam
Date of Birth:
12 Sep, 1970

Saleema



Workers

Name: R. Aslam
Age: 24y,10d
Dept: Sales



Saleem

External Layer

Logical Record Interface

Conceptual Layer

Name

DoB

Deps

Depld

Rana Aslam

12/09/70

5

D001

Marya Wasti

29/02/80

0

D005

Internal Level

- Concerns about the physical implementation of the database.
- DBMS chooses type of data structures.
- Lays out data on storage devices with operating system access methods.

Internal Level

- Internal record: a single stored record.
- Does not just contain what we see at the conceptual level.
- DBMS adds other data.

Inter-Schema Mappings

- It is also a part of 3-level architecture.
- External to conceptual mapping
 - Specifies mapping between objects in the external view to those in the logical model.
- Conceptual to Internal
 - Specifies mapping between objects in the logical model to those in the physical model-data independence.

First Name: Rana
Last Name: Aslam
Date of Birth:
12 Sep, 1970

Saleema



Name: R. Aslam
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Saleem

<u>Name</u>	<u>DoB</u>	<u>Deps</u>	<u>Depld</u>
Rana Aslam	12/09/70	5	D001
Marya Wasti	29/02/80	0	D005

BH RH Rana Aslam 120970 5 D001 RH Marya Wasti...

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Data Independence

- A major advantage of 3-Layered Architecture is data independence.
- The immunity of applications to change in storage structure and access strategy.
- Changes in lower level do not affect the upper levels.
- Data Independence Types
 - Logical Data Independence
 - Physical Data Independence

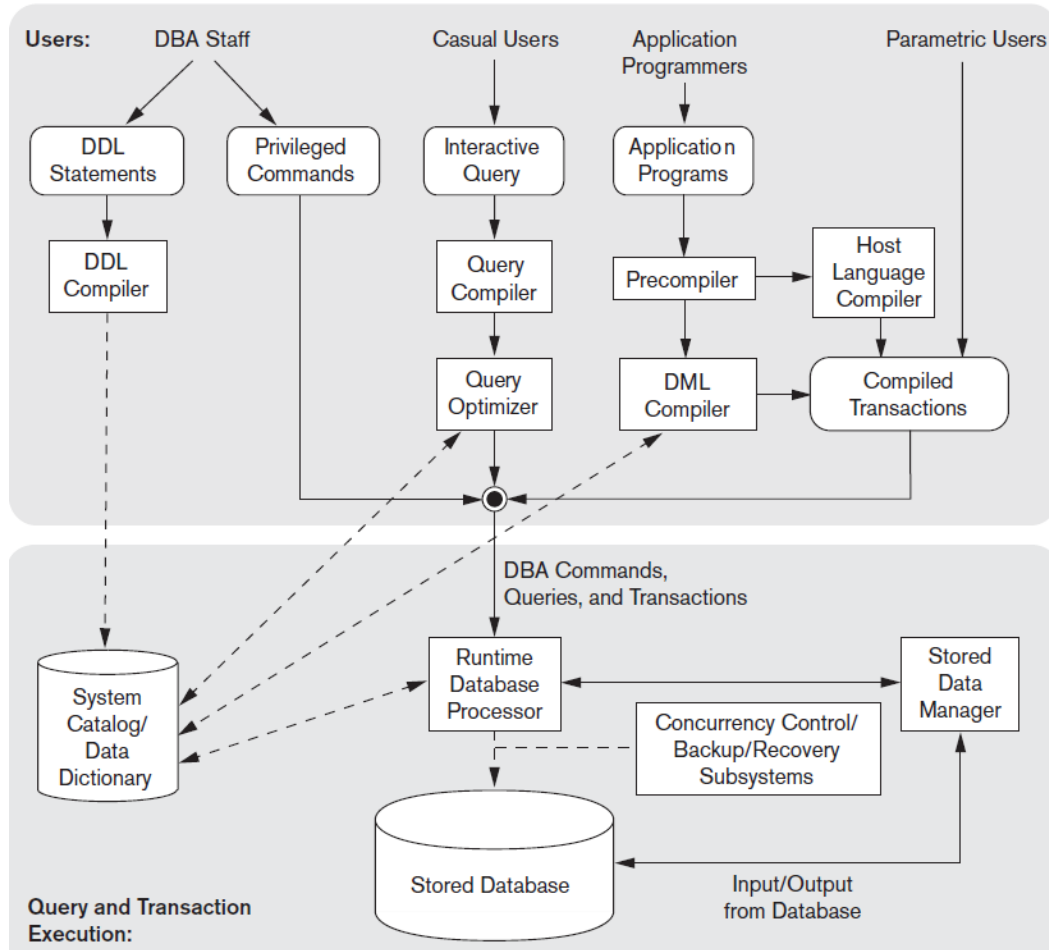
Data Independence Types

- Logical Data Independence
 - Changes in conceptual model do not affect the external views.
 - Immunity of external level from changes at conceptual level
 - Types of Changes
 - Adding a new file/index etc.
 - Adding a new field in a file
 - Changing type/size
 - Deleting an attribute

Data Independence Types

- Physical Data Independence
 - Changes in the internal model do not affect the conceptual model.
 - Immunity of Conceptual level from changes at Internal level.
 - Types of changes
 - Changing file organization
 - Index implementation, hash, tree etc.
 - Changing storage medium

DBMS Component Modules



DBMS Component Modules

- Figure above illustrates, in a simplified form, the typical DBMS components.
- The figure is divided into two parts.
- The top part of the figure refers to the various users of the database environment and their interfaces.
- The lower part shows the internals of the DBMS responsible for storage of data and processing of transactions.

DBMS Component Modules

- A stored data manager module of the DBMS controls access to DBMS information that is stored on disk, whether it is part of the database or the catalog.
- The DBA staff works on defining the database and tuning it by making changes to its definition using the DDL and other privileged commands.
- The DDL compiler processes schema definitions, specified in the DDL, and stores descriptions of the schemas (meta-data) in the DBMS catalog.

DBMS Component Modules

- Casual users and persons with occasional need for information from the database interact using some form of interface, which we call the interactive query interface.
- A query compiler compiles the queries into an internal form. This internal query is subjected to query optimization.

DBMS Component Modules

- Among other things, the query optimizer is concerned with the rearrangement and possible reordering of operations, elimination of redundancies, and use of correct algorithms and indexes during execution.
- We have shown the concurrency control and backup and recovery systems separately as a module in this figure.
- They are integrated into the working of the runtime database processor for purposes of transaction management.

Database System Utilities

- In addition to possessing the software modules just described, most DBMS have database utilities that help the DBA manage the database system.
- Common utilities have the following types of functions:
- Loading
 - A loading utility is used to load existing data files—such as text files or sequential files—into the database.

Database System Utilities

- Backup
 - A backup utility creates a backup copy of the database, usually by dumping the entire database onto tape or other mass storage medium.
 - The backup copy can be used to restore the database in case of catastrophic disk failure.
- Database storage reorganization
 - This utility can be used to reorganize a set of database files into different file organizations, and create new access paths to improve performance.

Database System Utilities

- Performance monitoring
 - Such a utility monitors database usage and provides statistics to the DBA.
 - The DBA uses the statistics in making decisions such as whether or not to reorganize files or whether to add or drop indexes to improve performance.

Classification of Database Management Systems

- Several criteria are normally used to classify DBMSs.
- The first is the data model on which the DBMS is based.
 - The main data model used in many current commercial DBMSs is the relational data model.
 - The object data model has been implemented in some commercial systems but has not had widespread use.

Classification of DBMS

- The second criterion used to classify DBMSs is the number of users supported by the system.
- Single-user systems support only one user at a time and are mostly used with PCs.
- Multiuser systems, which include the majority of DBMSs, support concurrent multiple users.

Classification of DBMS

- The third criterion is the number of sites over which the database is distributed.
- A DBMS is centralized if the data is stored at a single computer site.
- A distributed DBMS (DDBMS) can have the actual database and DBMS software distributed over many sites, connected by a computer network.
- Homogeneous DDBMSs use the same DBMS software at all the sites, whereas heterogeneous DDBMSs can use different DBMS software at each site.

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