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# **Database Environment**

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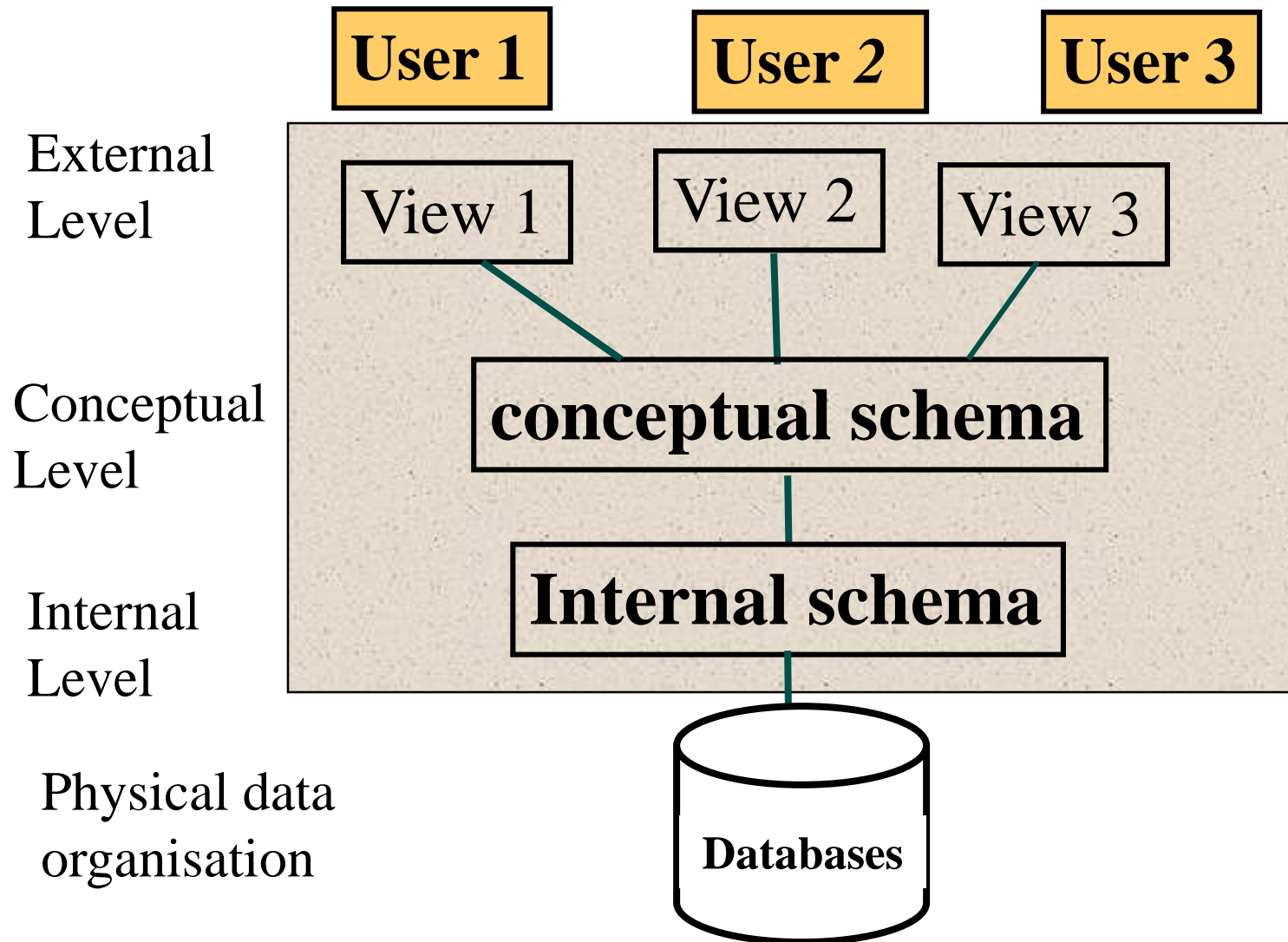
# Structure

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- Three-level database architecture.
- Contents of external, conceptual, and internal levels.
- Purpose of external/conceptual and conceptual/internal mappings.
- Meaning of logical and physical data independence.
- Distinction between DDL and DML.
- Purpose/importance of conceptual modeling.
- Typical functions and services a DBMS should provide.
- Software components of a DB manager.

# Three-level ANSI/SPARC architecture

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# 3 Level ANSI/SPARC Architecture

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- **External level**
  - User's view of the database.
- **Conceptual level**
  - Describes what data is stored in the database and the relationships among the data.
- **Internal level**
  - Describes how the data is stored in the database.

# Internal Level

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- The physical representation of the database on the computer to achieve optimal runtime performance and storage space utilization.
  - Covers data structures and file organisations used to store data on the storage device.
  - Storage space allocation for data and indexes.

# Conceptual Level

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- This level contains the logical structure of the entire database. Provides a complete view of the data requirements of the organisation that is independent of any storage considerations.
- The conceptual level represents:
  - All entities, their attributes and their relationships
  - The constraints on the data
  - Security and integrity information

# External Level

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- Describes the part of the database that is relevant to the user.
- The external view includes only the entities, attributes or relationships in the ‘real world’ that the user is interested in.
- Different views have different representations of the same data.

# External Level

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- **External Views Allow to**

- **hide unauthorised data**

- ◆ e.g. *salary, dob*

- **provide user view**

- ◆ e.g. view employee *name, designation, department* data taken from *employee* and *department* files

- **derive new attributes**

- ◆ e.g. *age* derived from *dob* or *nid*



# External Level

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- **External Views Allow to**
  - **change unit of measurement**
    - ◆ e.g. show *age* in years or months
  - **define security levels**
    - ◆ e.g. update access to *employee* file  
read-only to *department* file

# Three-Level Architecture

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- All users should be able to access same data but have a customized view of the data.
- A user's view is immune to changes made in other views.
- Users should not need to know physical database storage details (e.g. indexing or hashing).

# Objectives of Three-Level Architecture

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- DBA should be able to change database storage structures without affecting the users' views.
- DBA should be able to change conceptual structure of database without affecting all users.

# Physical Level

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- Managed by the operating system under the direction of the DBMS.
- Consist of items only the OS knows.

# Differences between Three Levels of ANSI-SPARC Architecture

External view 1

sNo	fName	lName	age	salary
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External view 2

staffNo	lName	branchNo
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Conceptual level

staffNo	fName	lName	DOB	salary	branchNo
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Internal level

```
struct STAFF {  
    int staffNo;  
    int branchNo;  
    char fName [15];  
    char lName [15];  
    struct date dateOfBirth;  
    float salary;  
    struct STAFF *next;  
};  
index staffNo; index branchNo;
```

/\* pointer to next Staff record \*/  
/\* define indexes for staff \*/

# Database Schema

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- Overall description of the database is called the database schema.
- There are three different types of schema
  - External (Sub) Schema
    - ◆ defines the external view of data  
*as seen by a user or program*
  - Conceptual Schema
    - ◆ defines the logical view of data  
*as seen by all users and programs*
  - Internal Schema
    - ◆ defines the physical view of data  
*as seen by a DBMS*

# Mapping between Levels

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- DBMS map or translate from one level to another.

- External  $\Leftrightarrow$  Conceptual

External schema is related to the conceptual schema

- Conceptual  $\Leftrightarrow$  Internal

Conceptual schema is related to the internal schema.

# Data Independence

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- **Logical Data Independence**

- Refers to immunity of external schemas to changes in conceptual schema.
- Conceptual schema changes (e.g. addition/removal of entities).
- Should not require changes to external schema or rewrites of application programs.

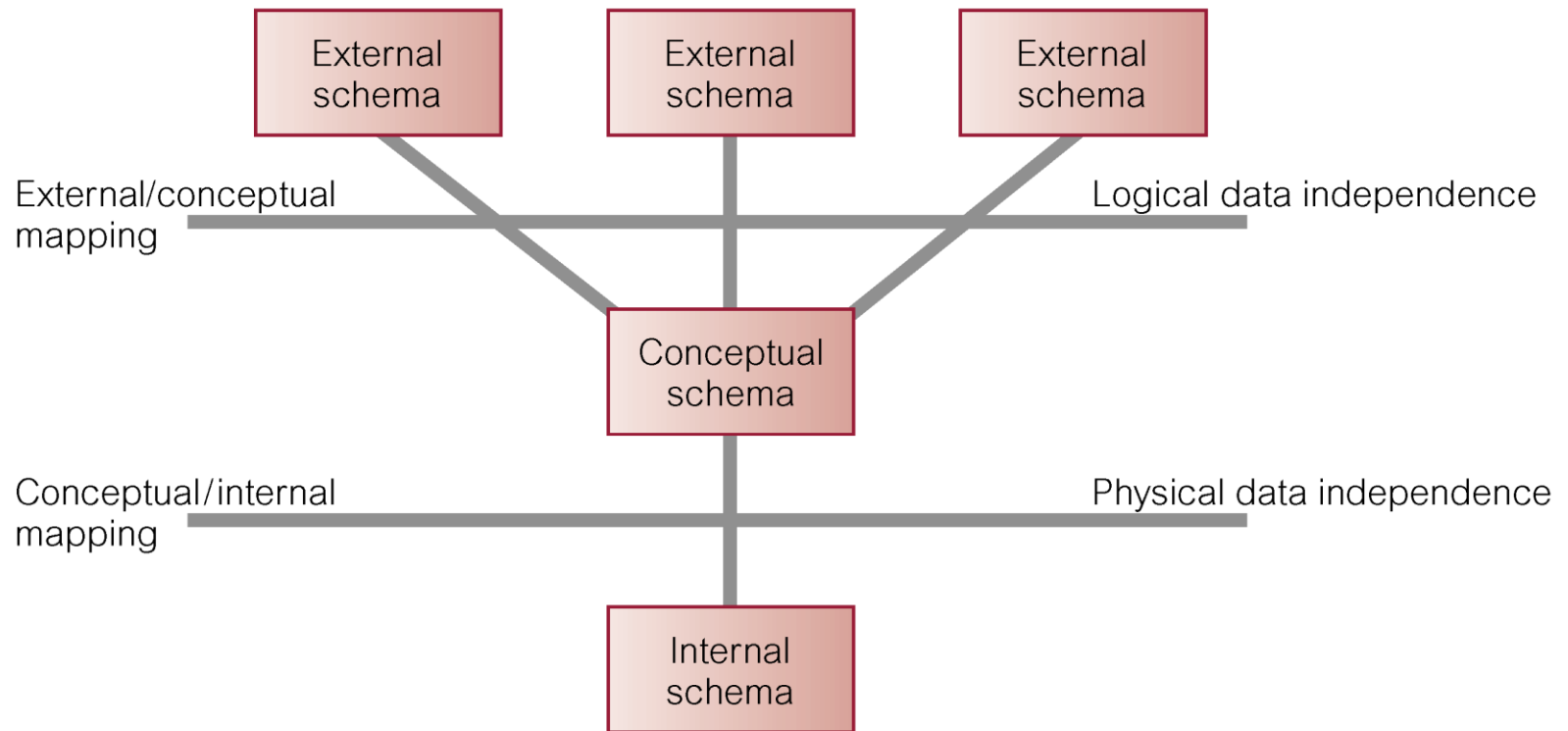


# Data Independence

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- **Physical Data Independence**
  - Refers to immunity of conceptual schema to changes in the internal schema.
  - Internal schema changes (e.g. using different file organizations, storage structures/devices).
  - Should not require change to conceptual or external schemas.

# Data Independence and the ANSI-SPARC Three-Level Architecture



# Database Languages

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- **Data Definition Language (DDL)**
  - Allows the DBA or user to describe and name entities, attributes, and relationships required for the application
  - Plus any associated integrity and security constraints.

# Database Languages

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- **Data Manipulation Language (DML)**
  - Provides basic data manipulation operations on data held in the database.
- **Non-Procedural DML**
  - Allows user to state what data is needed rather than how it is to be retrieved.
- **Procedural DML**
  - Allows user to tell system exactly how to manipulate data.

# Functions of a DBMS

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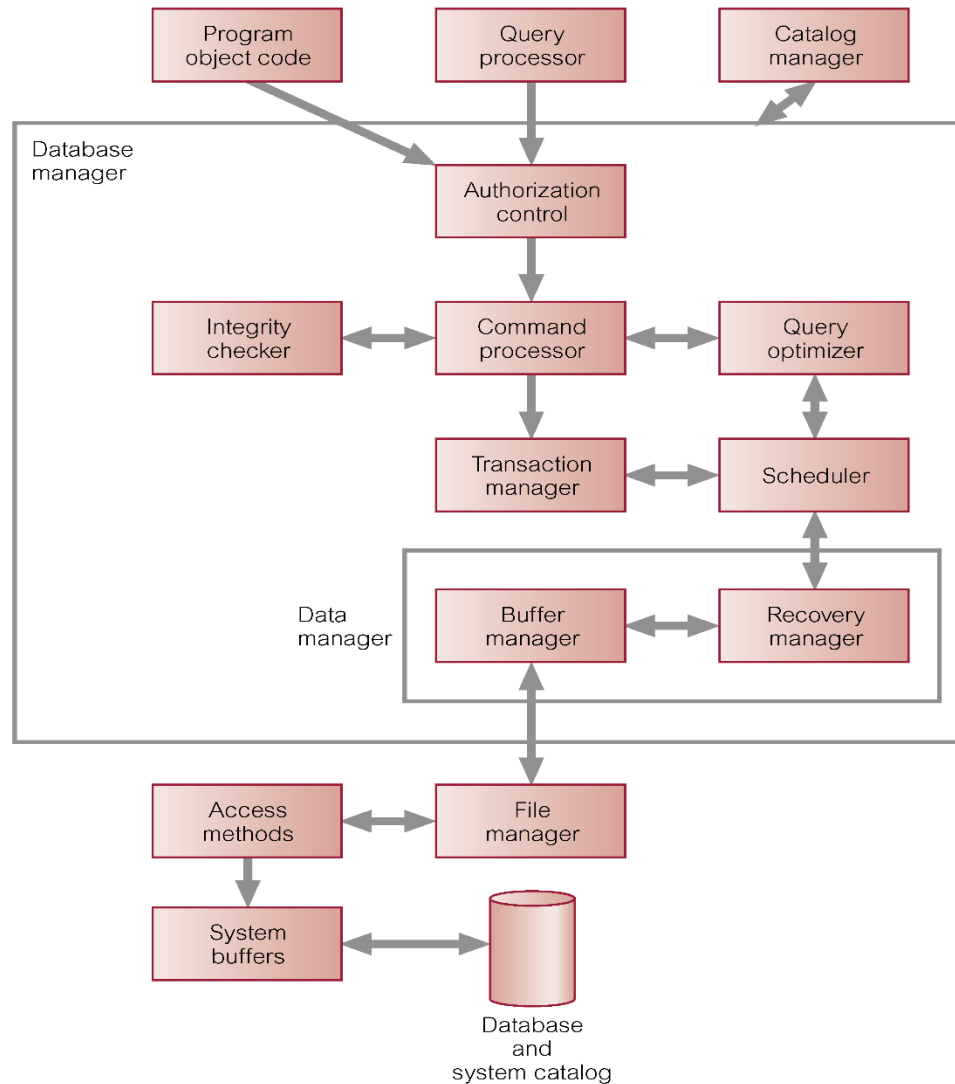
- Data Storage, Retrieval, and Update.
- A User-Accessible Catalog.
- Transaction Support.
- Concurrency Control Services.
- Recovery Services.

# Functions of a DBMS

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- Authorization Services.
- Integrity Services.
- Utility Services.

# Components of Database Management System



# Catalog Manager

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- The catalog manager manages access to and maintain the system catalog.

## System Catalog

- Repository of information (metadata) describing the data in the database.
- Typically stores:
  - Names of authorized users;
  - Names, types, and sizes of data items in the database;
  - Names of relationships
  - Constraints on each data item;



# System Catalog

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- Data items accessible by a user and the type of access allowed (e.g. insert, delete, update or read access).
- External, conceptual and internal schemas and the mappings between the schemas.
- Used by modules such as Authorization Control and Integrity Checker.

# System Catalog - Advantages

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- Maintains control over the data as a resource.
- Helps other users understand the purpose of the data.
- Communication is simplified.
- Identifies the user/s who own or access the data.
- Security can be enforced.
- Integrity can be ensured

# Components of DB Manager

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- **Authorization Control**

This module checks that the user has the necessary authorization to carry out the required operation.

- **Integrity Checker**

For an operation that changes the database, the integrity checker checks that the requested operation satisfies all necessary integrity constraints.

# Components of DB Manager

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- **Scheduler**

Responsible for ensuring that concurrent operations on the database proceed without conflicting with one another. It controls the relative order in which the transaction operations are executed.

- **Recovery Manager**

Ensures that the database remains in a consistent state in the presence of failure.



**END**