
Introduction to Database Management Systems

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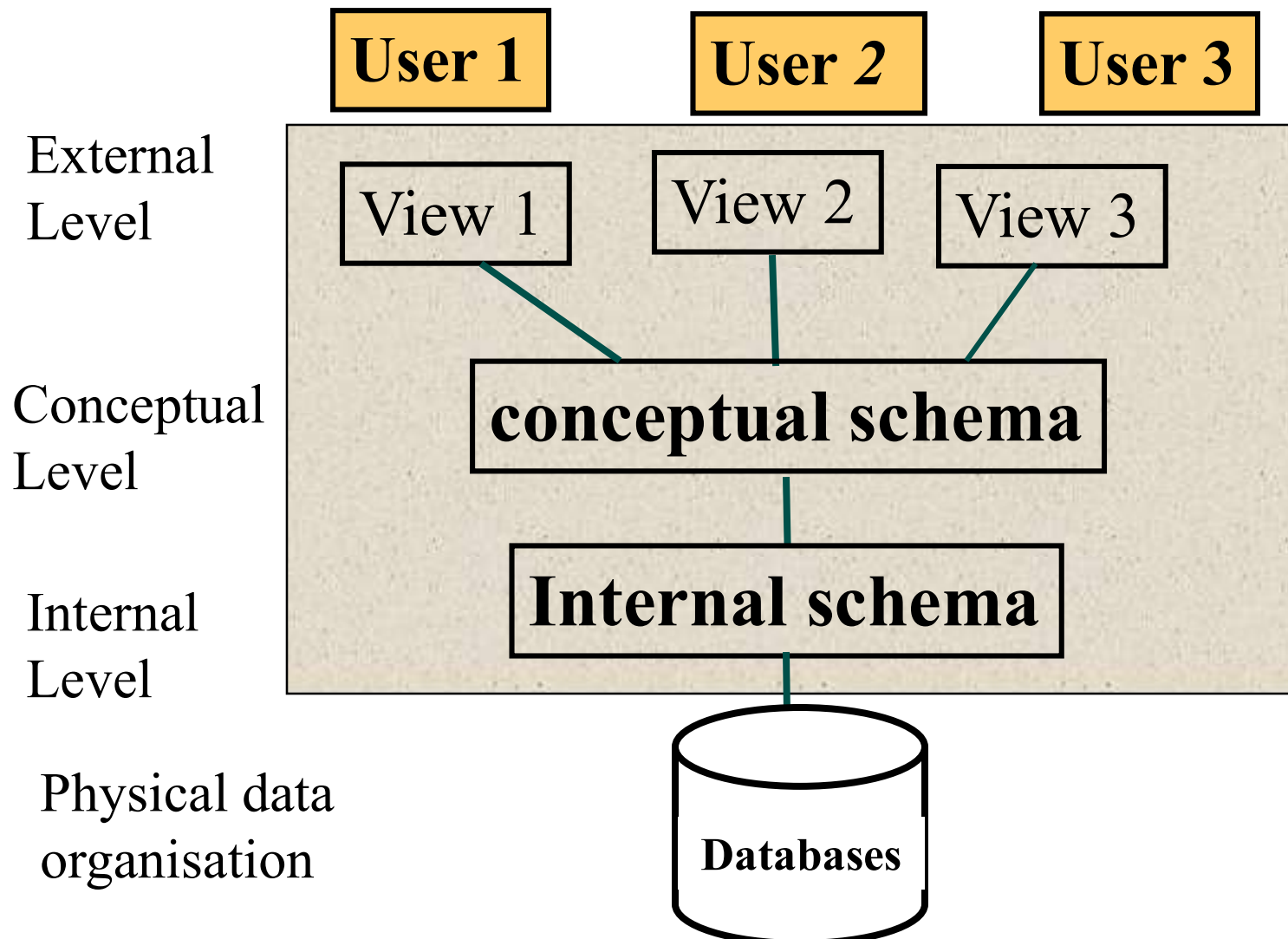
Structure

- ❑ 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.

Structure

- Purpose/importance of conceptual modeling.
- Typical functions and services a DBMS should provide.
- Software components of a DB manager.

Three-level ANSI/SPARC architecture



3 Level ANSI/SPARC Architecture

- **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

- 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

- 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

- 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

□ 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

□ 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

- 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).

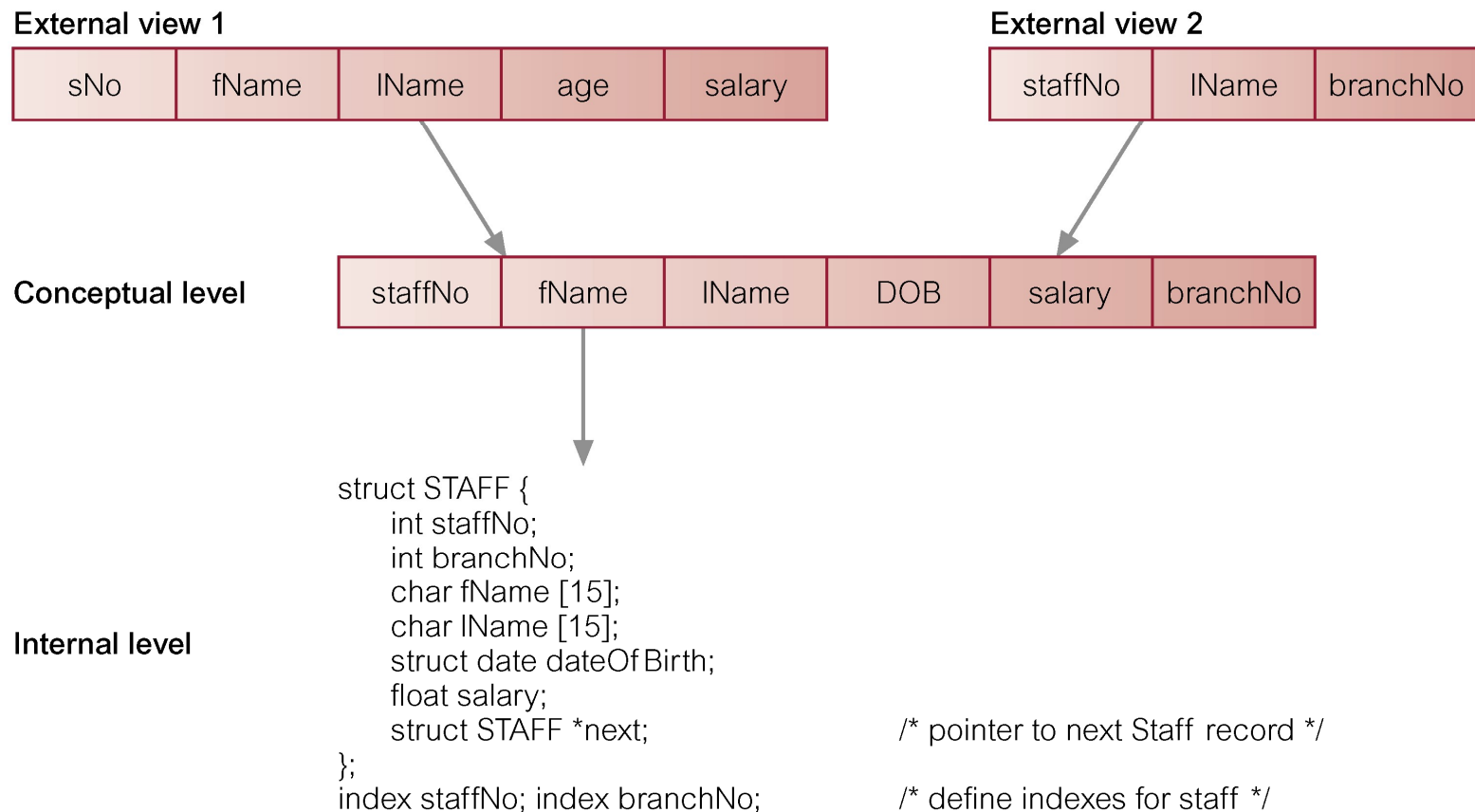
Objectives of Three-Level Architecture

- 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

- 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



Database Schema

- 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

- 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

□ Logical Data Independence

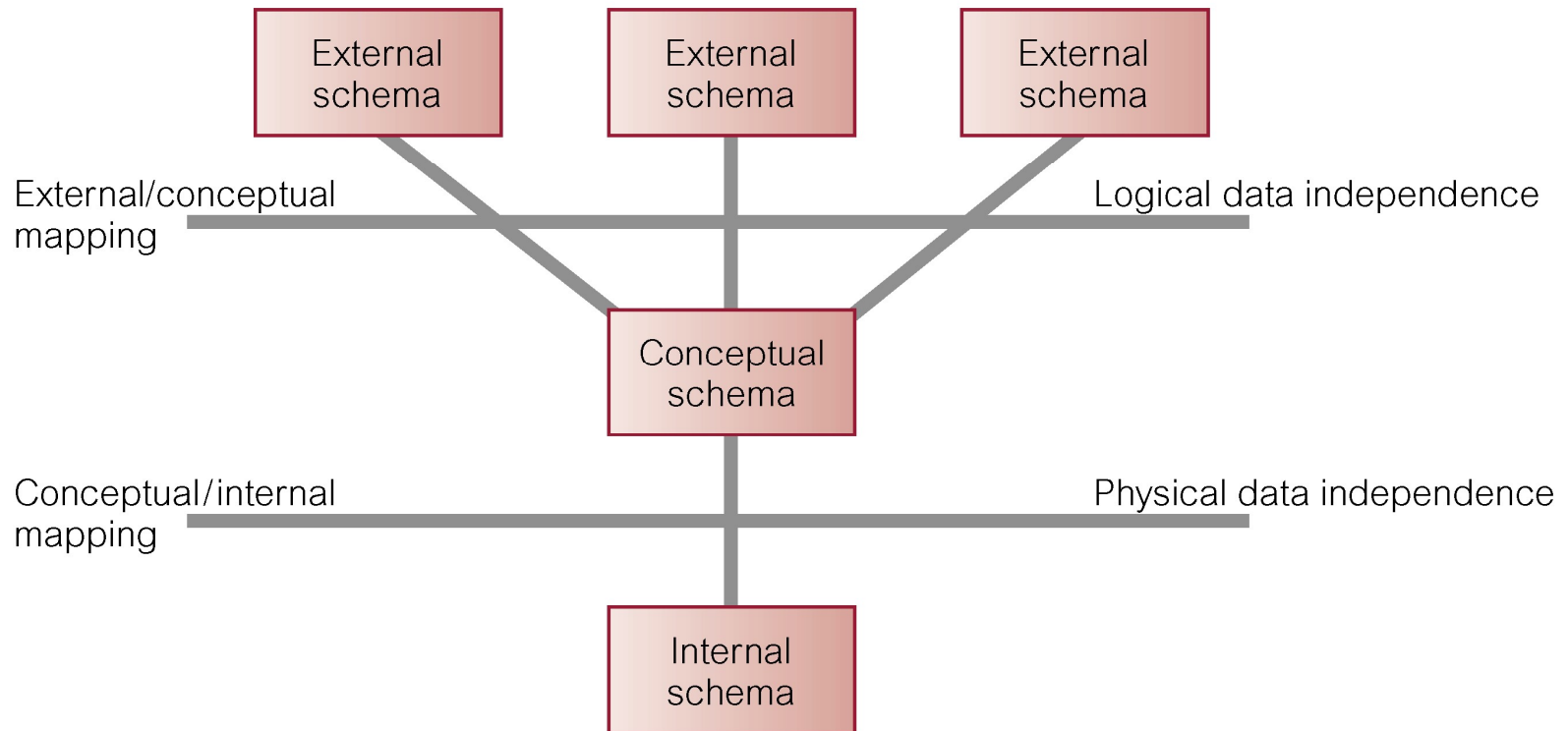
- Refers to immunity of external schemas to changes in conceptual schema.
- Conceptual schema changes (e.g. addition/removal of entities).
- Should not require changes to external schema or rewrites of application programs.

Data Independence

□ 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

□ 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

□ **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.

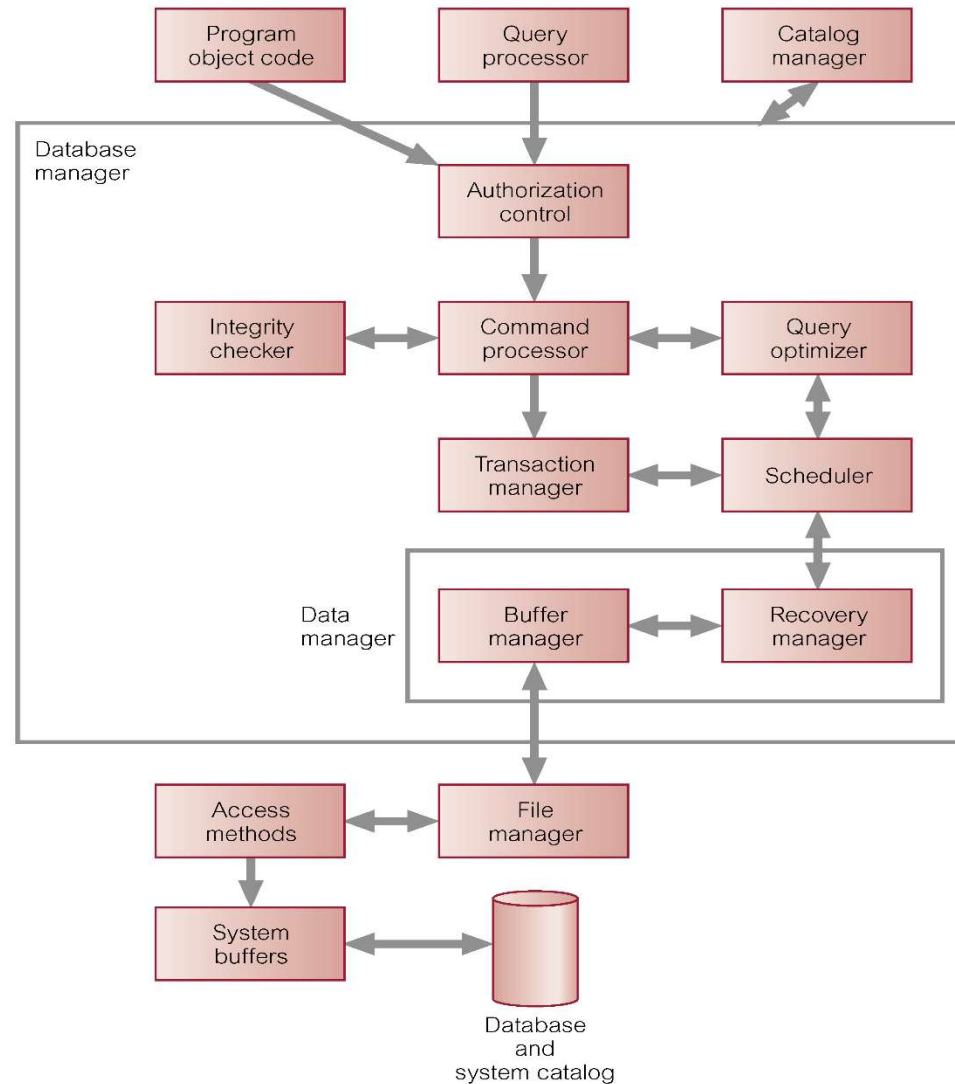
Functions of a DBMS

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

Functions of a DBMS

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

Components of Database Management System



Catalog Manager

- 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

- 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

- ❑ 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

□ 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

□ 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.