Database Environment

The Three-Level ANSI-SPARC Architecture

- From a DBMS viewpoint there are 3 distinct levels at which data items can be described.
- These levels form a three-level architecture comprising an *external*, a *conceptual*, and an *internal* level.
- The way users perceive the data is called the *external level*.
- The way the DBMS and the operating system perceive the data is called the *internal level*.
- The *conceptual level* provides both the mapping and the desired independence between the external and internal levels.

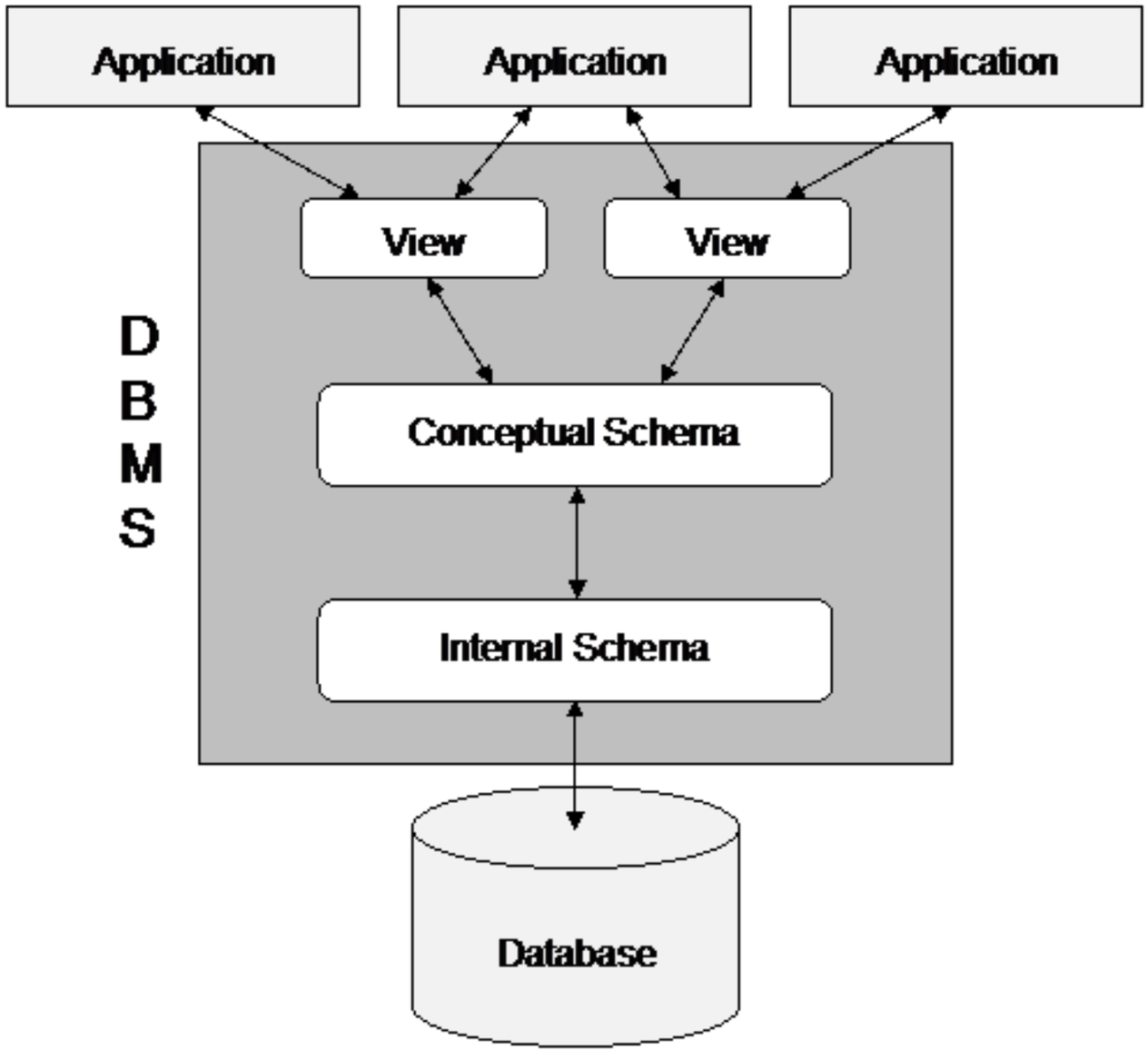
Objectives of Three-Level Architecture

- All users should be able to access the same data.
- A user’s view is immune to changes made in other views.
- Users should not need to know physical database storage details.

Objectives of Three-Level Architecture

- DBA should be able to change database storage structures without affecting the users' views.
- Internal structure of database should be unaffected by changes to physical aspects of storage.
- DBA should be able to change conceptual structure of database without affecting all users.

ANSI-SPARC Three-Level Architecture



ANSI-SPARC Three-Level Architecture

- **External Level**
  - Users' view of the database.
  - Describes that part of the database that is relevant to a particular user.
  - Includes only the entities, attributes, and relationships in the 'real world' that the user is interested in.
  - Different views may have different representations of the same data.

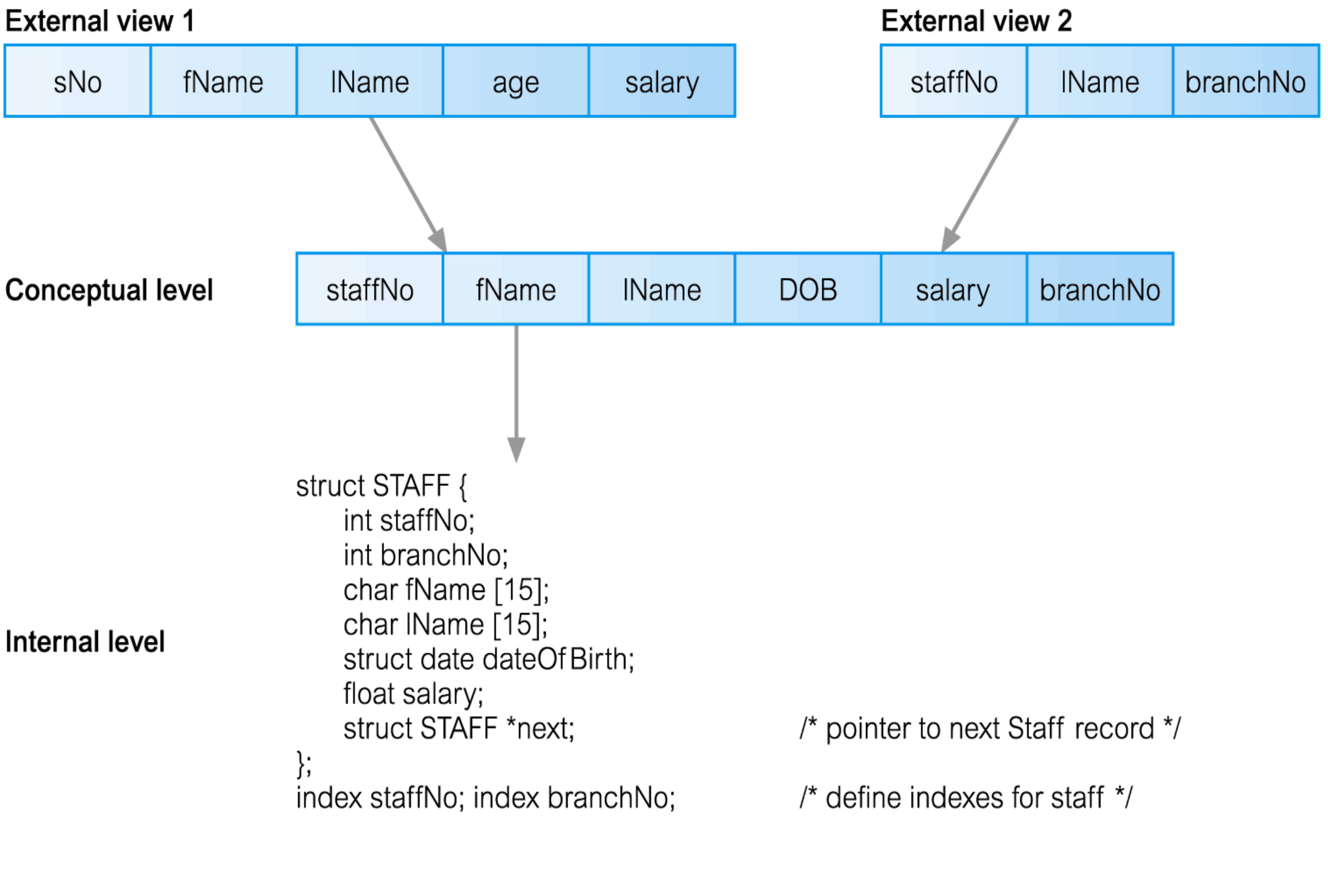
ANSI-SPARC Three-Level Architecture

- **Conceptual Level**
  - Community view of the database.
  - Describes what data is stored in the database and relationships among the data.
  - Logical structure as seen by the Database Administrator.
  - Complete view of the data requirements independent of any storage considerations.
  - Conceptual model represents:
    - Entities, attributes, and their relationships,
    - Data constraints,
    - Semantic information,
    - Security and integrity information.

ANSI-SPARC Three-Level Architecture

- **Internal Level**
  - Physical representation of the database on the computer.
  - How the data is stored in the database.
  - The internal level is concerned with:
    - Storage space allocation for data and indexes,
    - Record description for storage,
    - Record placement,
    - Data compression, encryption techniques.

Differences between Three Levels of ANSI-SPARC Architecture



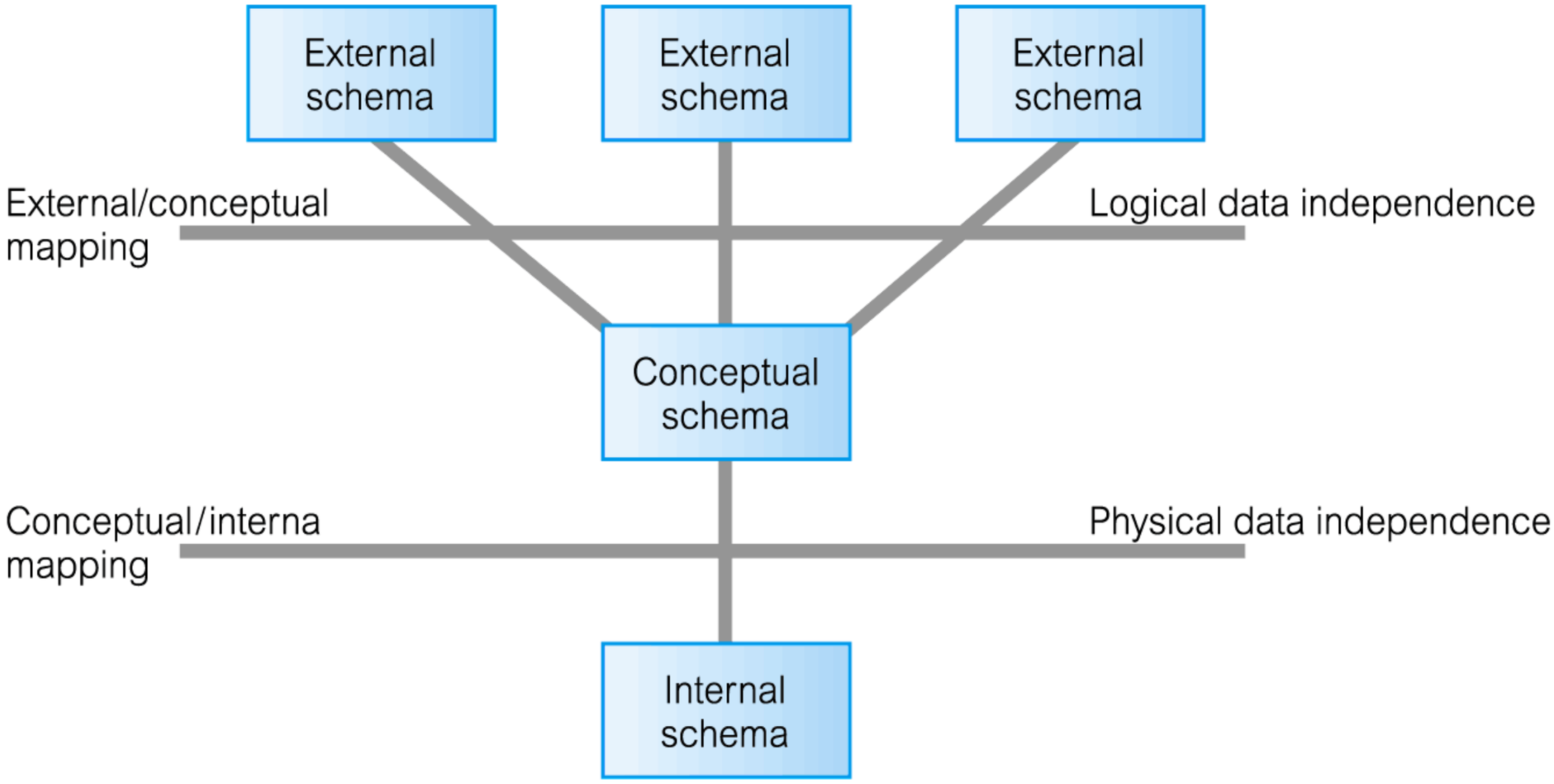
Data Independence

- **Logical Data Independence**
  - Refers to immunity of external schemas to changes in conceptual schema.
  - Conceptual schema changes (e.g. addition/removal of attributes, etc…).
  - 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 organisations, 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.

Data Definition Language (DDL)

- The result of the compilation of the DDL statements is a set of tables stored in special files collectively called the *system catalog*. The system catalog integrates the *metadata*, which is data that describes the objects in the database and makes it easier for those objects to be accessed or manipulated.

- The metadata contains definitions of records, data items, and other objects that are of interest to users or are required by the DBMS.

- The DBMS normally consults the system catalog before the actual data is accessed in the database.

Data Manipulation Language (DML)

- Provides basic data manipulation operations on data held in the database.
- Data manipulation operations usually include the following:
  - insertion of new data into the database;
  - modification of data stored in the database;
  - retrieval of data contained in the database;
  - deletion of data from the database.

Data Manipulation Language (DML)

- **Procedural DML**
  - allows user to tell system exactly how to manipulate data. For example Relational Algebra.
- **Non-Procedural DML**
  - allows user to state what data is needed rather than how it is to be retrieved. For example Relational Calculus, SQL.

Functions of a DBMS

- **Data Storage, Retrieval, and Update.**
  - A DBMS must furnish users with the ability to store, retrieve, and update data in the database.
- **A User-Accessible Catalog**
  - A catalog will describe the data in the database. Typically stores:
    - names, types, and sizes of data items;
    - constraints on the data;
    - names of authorized users;
    - data items accessible by a user and the type of access;
    - usage statistics.

Functions of a DBMS

- **Transaction Support**
  - Transactions must be completed entirely or not at all.

- **Concurrency Control Services**
  - Provide a mechanism to ensure that the database is updated correctly when multiple users are updating the database concurrently.

- **Recovery Services**
  - Provide a facility to recover the database if the database crashes.

Functions of a DBMS

- **Authorisation Services**
  - Only authorised users will have access to certain tables, data items, etc…
- **Support for Data Communication**
  - Be capable of integrating with communication software.
- **Integrity Services**
  - Correctness and consistency of stored data.
- **Services to Promote Data Independence**
  - Facilities to support the independence of programs from the actual structure of the database.

Functions of a DBMS

- **Utility Services**
  - Utility programs aid the DBA to administer the database effectively. Examples include:
    - Import and export facilities,
    - monitoring facilities,
    - statistical analysis programs,
    - index reorganisation facilities, and
    - garbage collection.