Database Management Systems

Part I: Basic Concepts

Lecture 2

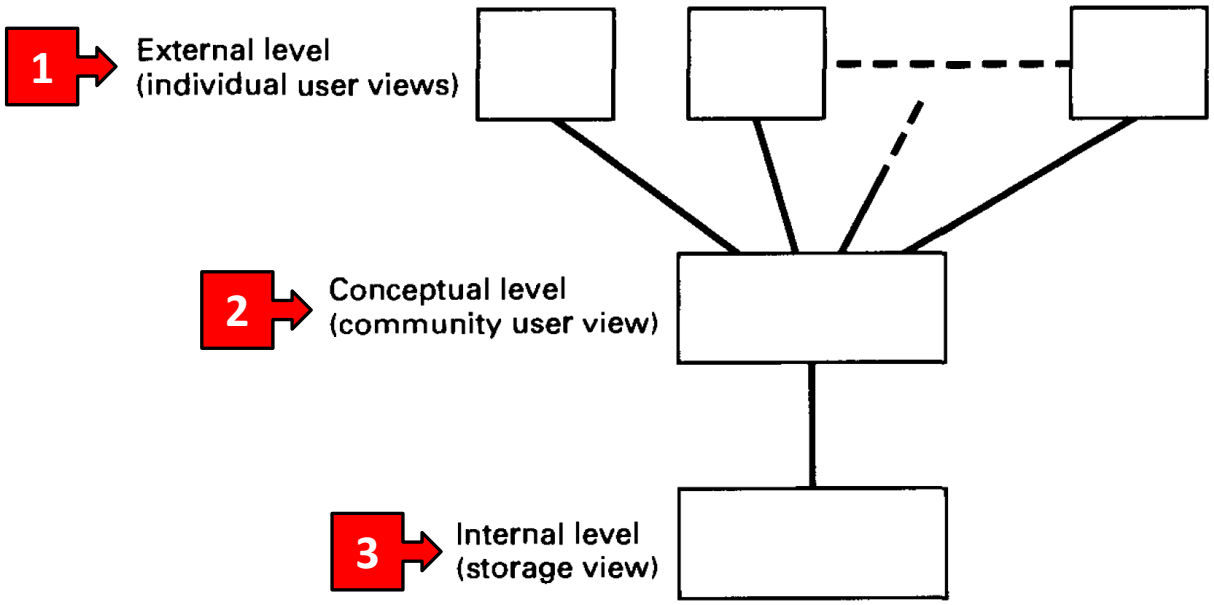
An Architecture for a Database System

Contents

- Three Levels of the Architecture
- Mappings
- Client/Server Architecture
- Distributed Processing

Three Levels of the Architecture

- The goal of the three levels architecture is to separate the user applications from the physical database.
- In ANSI/SPARC architecture, it is divided into three levels:



The three levels of the architecture

Three Levels of the Architecture (Cont.)

- The external level is the one closest to the users, that is, it is concerned with the way the data is viewed by individual users.
- The internal level is the one closest to physical storage, that is, it is the one concerned with the way the data is physically stored.
- The conceptual level is a level of indirection between the other two.

External Level

- The external level is the individual user level.
- Each user can be either an application programmer or an end user.
- Each user has a language at his or her disposal: C or COBOL for the application programmer and query language for the end user.

External Level (Cont.)

- This level illustrates the users how the data is stored in terms of tables and relations and the users see the data in the form of rows and columns.
- The users will have different views based on their levels of access rights.
- For example, student will not have access to see Lecturers' salary details.

External Level (Cont.)

- At this level, the data from database can be accessed and some calculations are performed based on the data.
- However, any changes or computations done at this level will not affect other levels of data.
- This level of data is based on the below levels but it will not alter the data at below levels.

Conceptual Level

- This logical level comes between the user level and physical storage view.
- The conceptual view is a representation of the entire information content of the database.
- It describes the database structure of the whole database for the community of users.

Conceptual Level (Cont.)

- It defines all database entities, their attributes, and their relationships.
- It also defines security and integrity information.
- In the conceptual level, the data available to a user must be contained in or derivable from the physical level.

Conceptual Level (Cont.)

- This schema hides information about the physical storage structures and focuses on describing data types, entities, relationships, etc.
- It describes the actual data stored in the database in the form of tables and relates them by means of mapping.
- Any changes done in this level will not affect the external or physical levels of data.

Internal Level

- The third level of the architecture is the internal level.
- The internal view is a low-level representation of the entire database.
- It describes the physical storage structure of the database.
- This level uses a physical data model and describes the complete details of data storage and access paths for the database.
- In the ANSI term, it is also called stored record.

Internal Level (Cont.)

- It keeps information about the actual representation of the entire database like the actual storage of the data on the disk in the form of records.
- The internal view tells us what data is stored in the database and how.
- It never deals with the physical devices.
- Instead, internal schema views a physical device as a collection of physical pages.

Mappings

- There are two levels of mapping in the architecture;
  - ✓ external/conceptual mapping which is from the external level to the conceptual level, and
  - ✓ conceptual/internal mapping which is from the conceptual level to the internal level.

Mappings (Cont.)

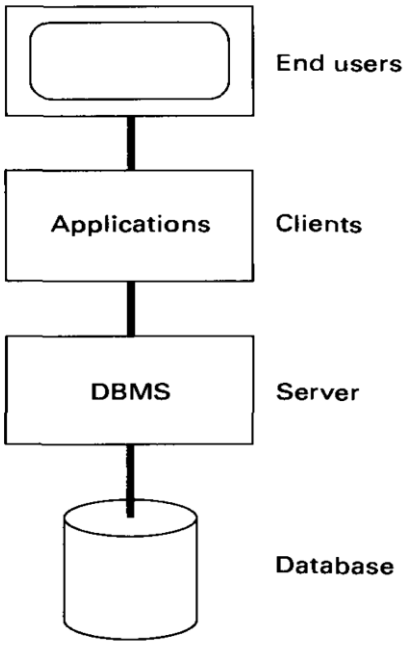
- External/conceptual mapping defines the correspondence between a particular external view and the conceptual view.
- Conceptual/internal mapping defines the correspondence between the conceptual view and the stored database; it specifies how conceptual records and fields are represented at the internal level.

Database Administrator (DBA)

- The functions of DBA will include the followings.
  - ✓ Defining the conceptual schema
  - ✓ Defining the internal schema
  - ✓ Liaising with users
  - ✓ Defining security and integrity rules
  - ✓ Defining backup and recovery procedures
  - ✓ Monitoring performance and responding to changing requirements

Client/Server Architecture

- A database system can be regarded as having a very simple two-part structure, consisting of a server (called backend) and a set of clients (called frontends) as shown in figure.



Client/server architecture

Client/Server Architecture (Cont.)

- The server is the DBMS itself.
- It supports all the basic DBMS functions:
  - ✓ data definition,
  - ✓ data manipulation,
  - ✓ data security and integrity, and so on.
- It provides all of the external, conceptual, and internal level support.

Client/Server Architecture (Cont.)

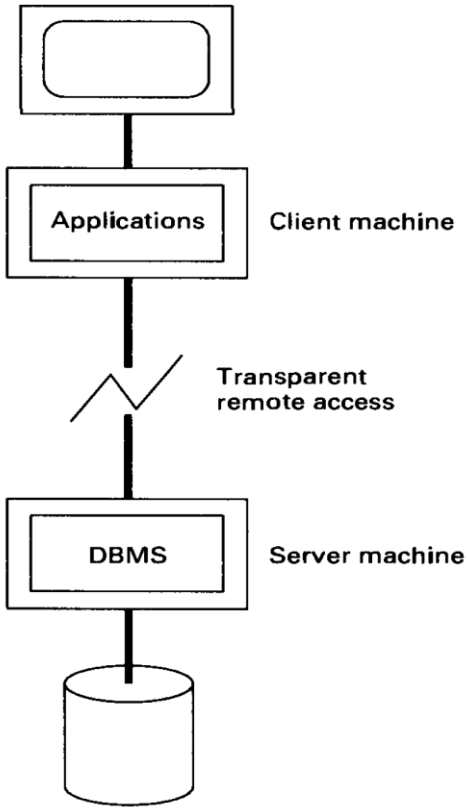
- The clients are the various applications that run on top of the DBMS – both user-written and built-in applications.
- User-written applications are basically regular application programs.
- Built-in applications are often called tools and they are used to assist in the process of creating and executing other applications.

Distributed Processing

- Distributed processing means that distinct machines can be connected together into a communications network such that a single data processing task can span several machines in the network.
- Many levels or varieties of distributed processing are possible.

Distributed Processing (Cont.)

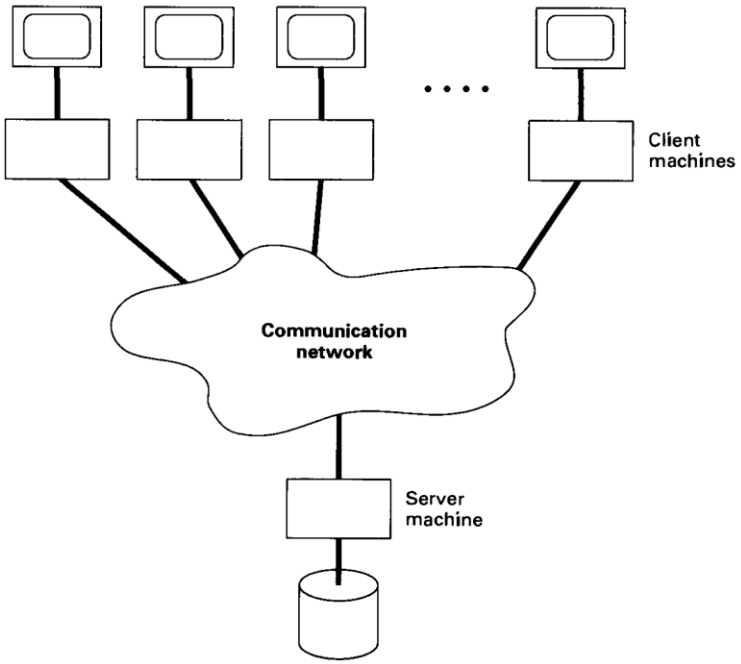
- One simple case involves running the DBMS backend (the server) on one machine and the application frontends (the clients) on another.
- Figure shows the client and server running on different machines.



Client and server running on different machines

Distributed Processing (Cont.)

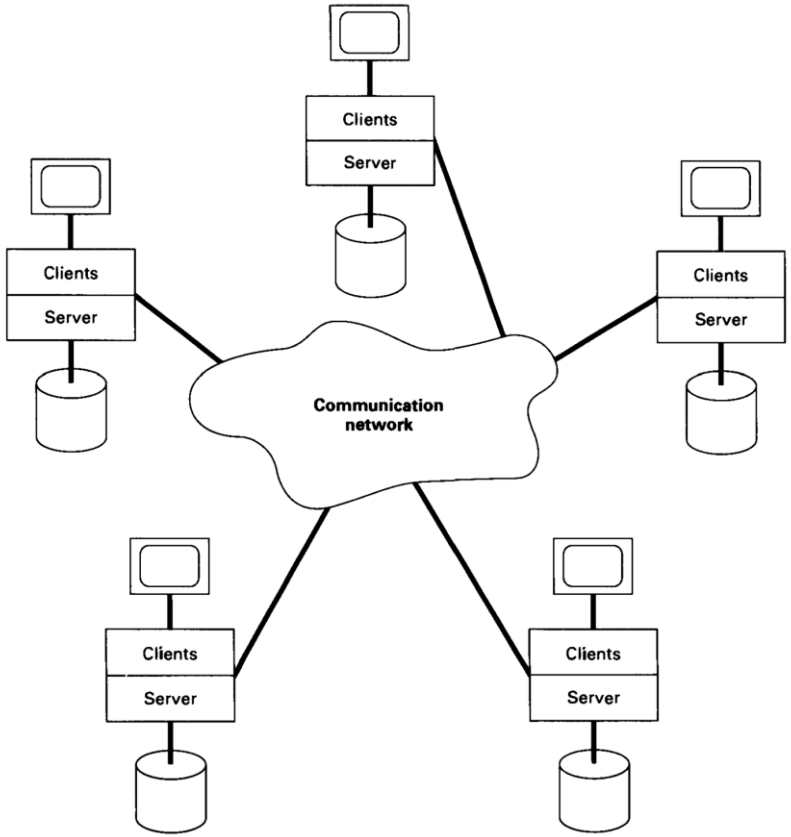
- In this figure, several different client machines might be able to access the same server machine.
- Thus, a single database might be shared across several distinct client systems.



One server, many clients

Distributed Processing (Cont.)

- In this figure, each machine will act as a server for some users and a client for others.
- In other words, each machine will support an entire database system.



Each machine is both client and server

Distributed Processing (Cont.)

- Enterprises do typically operate in distributed processing.
- Their total data collection is not stored on one single machine but rather is spread across many distinct machines.
- Therefore, applications will need the ability to access data from more than one machine.

Distributed Processing (Cont.)

- Access can basically be provided in two ways:
  - ✓ a given client might be able to access any number of servers, but only one at a time, or
  - ✓ the client might be able to access many servers simultaneously.

Summary

- ANSI/SPARC architecture divides a database system into three levels; internal, external and conceptual level.
- Mappings describe the correspondence between (a) the external and conceptual level, and (b) conceptual and internal level.
- Client and server can run on separate machines, thus providing distributed processing.

Next Lecture

Part I: Basic Concepts

An Introduction to Relational Databases

- Relational Systems
- Relational Model
- The SQL Language

Textbook and References

Textbook

- C. J. Date, “An Introduction to Database Systems”, 6th Edition, 1994.

Additional References

- Abraham Silberschatz, Henry F. Korth, S. Sudarshan, “Database System Concepts”, 6th Edition, 2011.
- Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, 6th Edition, 2010.
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