Chapter 1: Introduction

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Content Outline

Database Management Systems (DBMS)

Definition

A database-management system (DBMS) is a :
-collection of **interrelated data**
-and **a set of programs to access those data**.

The collection of data, usually referred to as the database, contains information relevant to an enterprise.
Goal: The primary goal of a DBMS is to provide a way to store and retrieve database information that is both convenient and efficient.

Database-System Applications

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- are highly **valuable**
- are relatively **large**, and
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Database-System Applications (Cont.)

- **Enterprise Information.**
  - ✓ **Sales:** For customer, product, and purchase information.
  - ✓ **Accounting:** For payments, receipts, account balances, assets, and other ac- counting information.
  - ✓ **Human resources:** For information about employees, salaries, payroll taxes, and benefits, and for generation of paychecks.
- **Banking and Finance**.
  - ✓ **Banking:** For customer information, accounts, loans, and banking transactions.
  - ✓ **Credit card transactions:** For purchases on credit cards and generation of monthly statements.
  - ✓ **Finance:** For storing information about holdings, sales, and purchases of financial instruments such as stocks and bonds.
- **Universities:** Result Processing System (RPS), Pay Role
- **Airlines:** For reservations and schedule information. Airlines were among the first to use databases in a **geographically distributed** manner.

Database-System Applications (Cont.)

- **Telecommunication:** For keeping records of calls, texts, and data usage, generating monthly bills, maintaining balances on prepaid calling cards.
- **Social-media and Online detail.** For keeping records of users, connections between users. For keeping records of sales data and orders as for any retailer, but also for tracking a users product views, search terms.
- **Document databases:** For maintaining collections of new articles, patents, published research papers, etc.
- **Navigation systems:** For maintaining the locations of varies places of interest along with the exact routes of roads, train systems, buses, etc.

Two Modes of operation in Database

In general there are two modes in which databases are used:

1. The first mode is to support **online transaction processing (OLTP)**, where a large number of users use the database, with each user retrieving relatively small amounts of data, and performing small updates.
   Example: Banking System
2. The second mode is to support **data analytics (OLAP)**, that is, the processing of data to draw conclusions, and infer rules or decision procedures, which are then used to drive business decisions.
   Example: An automated system to predict the profit/loss of a particular product based on past transaction and other prediction techniques.

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Purpose/Necessity of Database Systems

Before Database Systems application programs were written using File Processing System which highly lacks abstraction. But it has a number of major disadvantages:

- **Data redundancy and inconsistency.** Data duplication incurs higher storage and access time. More importantly it leads to data inconsistency.
  Example: A customer has multiple accounts. If his phone number is changed then it must be changed to all places.
- **Difficulty in accessing data.** For each request a new program must be written or modified which is very hard to maintain.
  Example: Need the result of CSE and EEE departments who has scored more than 3.5. File processing system will give you much pain this such request. (One assignment will be posted in this regard)
  - ✓ conventional file-processing environments do not allow needed data to be retrieved in a convenient and efficient manner. More responsive data-retrieval systems are required for general use.

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Purpose/Necessity of Database Systems (Cont.)

- **Data isolation.** Because data are scattered in various files, and files may be **in different formats**, writing new application programs to retrieve the appropriate data is difficult.
- **Integrity problems.** The data values stored in the database must satisfy certain types of **consistency constraints**.
  Example: Balance of a customer can not be negative. Appropriate application program will ensure this restriction using file processing system. **But whenever any constraint is added**, the application program code must be added or revised which makes the system hard to maintain.
- **Atomicity problems.** All or nothing property. It is due to multiple users access at the same time.
  Example: Transfer money from account A to B.
- **Security problems.** Not every user of the database system should be able to access all the data. It is hard to ensure such restriction in file systems.

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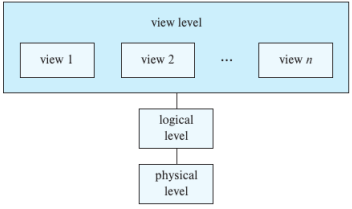
Data Abstraction

Abstraction refers to hiding details and providing a simple environment for the application developers.
Broadly 3 levels:

1. **Physical level.** The lowest level of abstraction describes how the data are actually stored. The physical level describes complex low-level data structures in detail.
2. **Logical level.** The next-higher level of abstraction describes what data are stored in the database, and what relationships exist among those data. ✓
3. **View level.** Highest level. It describes only part of the entire database. ✓



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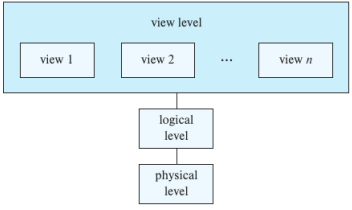

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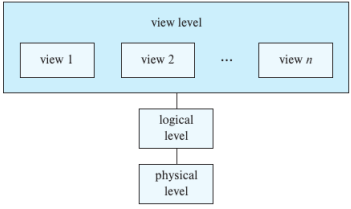
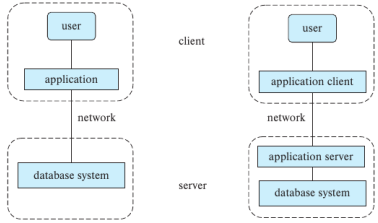


Database Application Architecture

- Earlier-generation database applications used a two-tier architecture, where the application resides at the client machine, and invokes database system functionality at the server machine through query language statements.
- In contrast, modern database applications use a three-tier architecture, where the client machine acts as merely a front end and does not contain any direct database calls; web browsers and mobile applications are the most commonly used application clients today. The front end communicates with an application server.



(a) Two-tier architecture (b) Three-tier architecture

History

- 1950s and early 1960s:
  - ✓ Data processing using magnetic tapes for storage, punched cards for input.
- Late 1960s and 1970s:
  Ted Codd defines the relational data model
  - ✓ ACM Turing Award for this work
  - ✓ IBM Research begins System R prototype
  - ✓ Oracle releases first commercial relational database
- 1980s:
  - ✓ **SQL** becomes **industrial standard**
  - ✓ Parallel and distributed database systems,Object-oriented database systems
- 1990s:
  - ✓ Large scale **data warehouse and data-mining** applications
  - ✓ Emergence of Web commerce

History (Cont.)

- 2000s:
  - ✓ Google BigTable, **NoSQL** systems
  - ✓ **Big data analysis**: beyond SQL. Map Reduce
- 2010s:
  - ✓ Support high scalability and availability for NoSQL
  - ✓ **Cloud service** instead of local hosting of database which improves maintenance issues

Database in Use

Broadly there are 2 types of Database based on licensing:

1. Proprietary: Oracle Enterprise Edition, MS SQL Server, IBM DB2
2. Open Source: MySQL, MongoDB, PostGRE