Database System

Introduction

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Course Objectives

- Understand the basic concepts of database systems, data modeling and database design
- Retrieve and manipulate data using T-SQL
- Implement business rules using T-SQL
  (Stored procedure, triggers, functions)
- Understand concepts of transaction and query processing, concurrency control, database recovery and security
- Develop database application using high level language such as JAVA

Course Overview

- Grading

Term project	20%
Assignments	20%
Midterm Exam	30%
Final Exam	30%
quizzes/attendance/participation	10% (bonus)

- Text books and references
  - Database Systems, Models, Languages, Design, and Application Programing, 6th Edition by Ramez Almasri and Shamkant B. Navathe
  - Database systems: the complete book. By Garcia-Molina H. Pearson Education .
  - Database System Concepts by Henry F. Korth , Abraham Silberschatz, S. Sudarshan
  - Practical Database Programming with JAVA by Ying Bai

Course Contents

- Part-1 (Fundamental Concepts)
  - Relational Database
  - E-R Model, database design and implementation
- Part-2 (Business Rules implementation)
  - T-SQL (Data manipulation)
  - Stored programs (Procedures, Functions, Triggers)
- Part-3 (Database Connectivity)
  - JDBC drivers
  - JDBC API
- Part-4 (GUI,Two-Tier Client -Server Model)
  - Java API's,
  - data retrieval and manipulation
- Part-5
  - Transaction and query processing
  - Concurrency control
  - Database recovery and security

Data

- Data
  - Data is the collection of raw facts collected from any specific environment for a specific purpose.
  - Data is a very important resource for an organization.

- Information
  - Once we have processed data using different methods data is converted into meaningful form and that form of the Data is called information

Database

- Def 1: A shared collection of logically related data, designed to meet the information needs of multiple users in an organization.

- Def 2: A collection of data: part numbers, product codes, customer information, etc. It usually refers to data organized and stored on a computer that can be searched and retrieved by a computer program.

- Def 3: A data structure that stores metadata, i.e. data about data. More generally we can say an organized collection of information.

- Def 5: An organized collection of information in computerized format.

- Def 6: A collection of related information about a subject organized in a useful manner that provides a base or foundation for procedures such as retrieving information, drawing conclusions, and making decisions.

- Def 7: A Computerized representation of any organizations flow of information and storage of data.

Database Management System (DBMS)

- The computer programs used to create, manage, and query databases are known as Database Management Systems (DBMS)

- In other words
  - DBMS contains collection of interrelated data and a set of programs to access the data
  - An environment that is both convenient and efficient to use

Database-System Applications

- *Enterprise Information*
  - *Sales*: For customer, product, and purchase information.
  - *Accounting*: For payments, receipts, account balances, assets and other accounting information.
  - *Human resources*: For information about employees, salaries, payroll taxes, and benefits, and for generation of paychecks.
  - *Manufacturing*: For management of the supply chain and for tracking production of items in factories, inventories of items in warehouses and stores, and orders for items.
  - *Online retailers*: For sales data noted above plus online order tracking, generation of recommendation lists, and maintenance of online product evaluations.

- *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; also for storing real-time market data to enable online trading by customers and automated trading by the firm.

Database-System Applications

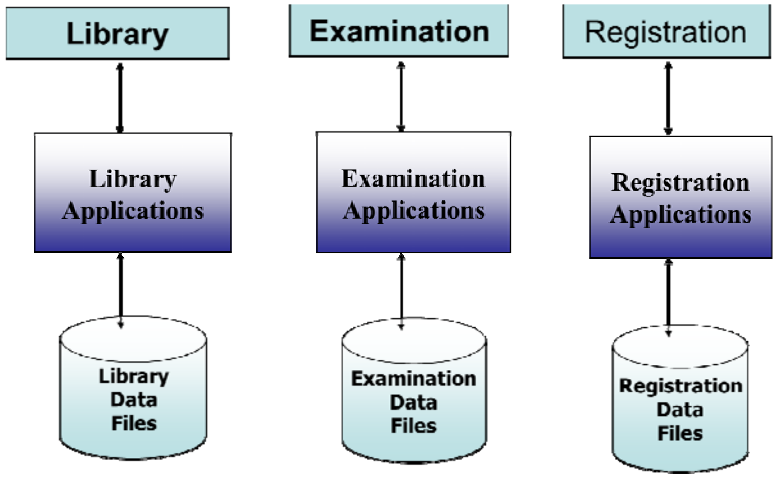
- Universities: For student information, course registrations, and grades (in addition to standard enterprise information such as human resources and accounting).

- Airlines: For reservations and schedule information. Airlines were among the first to use databases in a geographically distributed manner.

- Telecommunication: For keeping records of calls made, generating monthly bills, maintaining balances on prepaid calling cards, and storing information about the communication networks.

Why Database Systems?

- File-processing system
  - The system stores permanent records in various files, and it needs different application programs to extract records from, and add records to, the appropriate files.
  - File processing systems are advantageous when data is static and applications are simple; it eliminates the need for an expensive DBMS



Library

Library Applications

Library Data Files

Examination

Examination Applications

Examination Data Files

Registration

Registration Applications

Registration Data Files

Library	Examination	Registration
Reg_Number	Reg_Number	Reg_Number
Name	Name	Name
Father Name	Address	Father Name
Books Issued	Department	Phone
Fine	Semester	Address
	Grade	Department

Disadvantages of File Processing System

- Data redundancy (duplication)
- Inconsistency
- Difficulty in accessing data
- Data isolation
- Integrity problems
- Atomicity problems

Why Database Systems?

- Database System
  - A better alternative to a file processing system is an integrated database approach.
  - All data belonging to an organization is stored in a single database.
  - A user may interact either directly with the DBMS or via a program written in a specific programming language such as C++, C#, Java or Visual Basic.
  - Integration implies a logical relationship, usually provided through a common column in the tables.

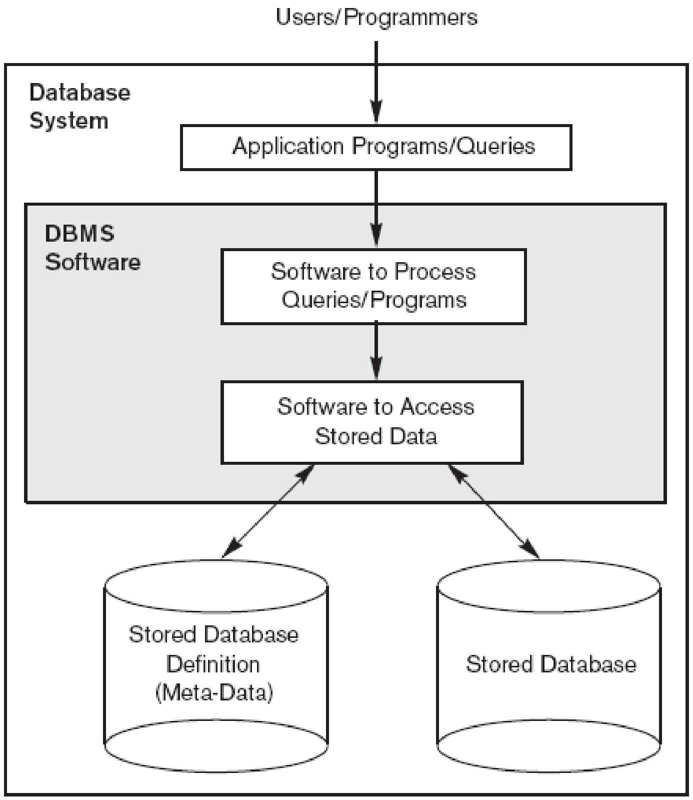
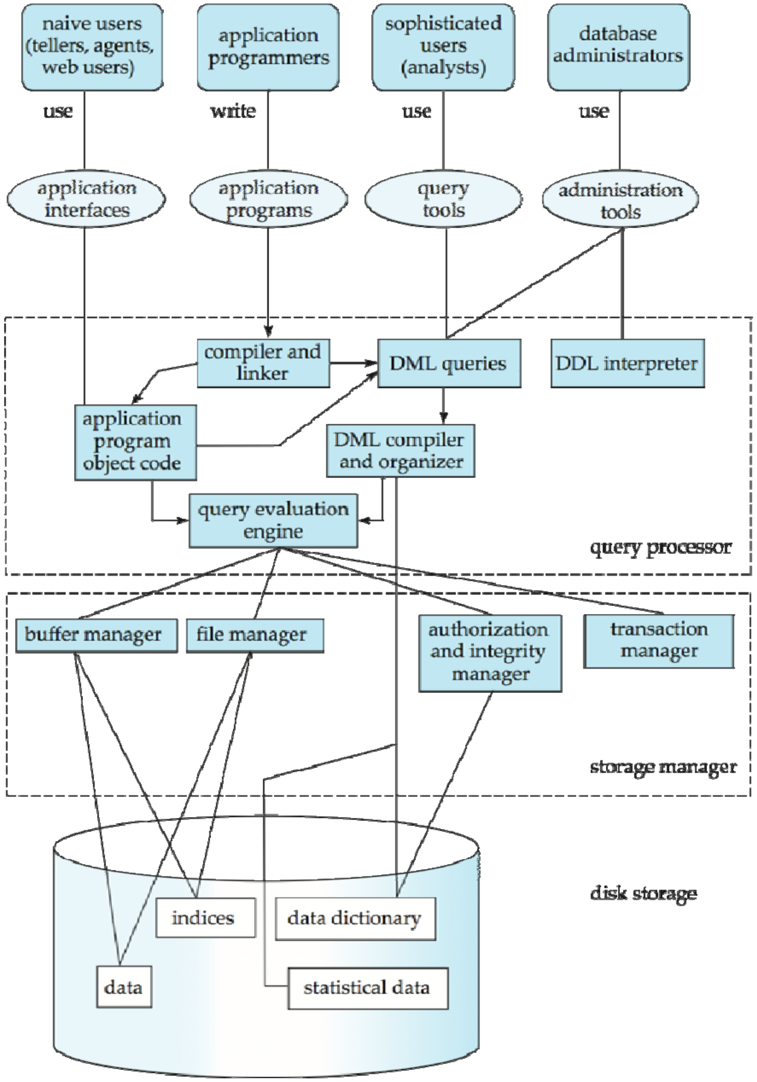

Users/Programmers
Database System
Application Programs/Queries
DBMS Software
Software to Process Queries/Programs
Software to Access Stored Data
Stored Database Definition (Meta-Data)
Stored Database

Figure 1.1
A simplified database system environment.

Database System Internals



Advantages of Database System

- Data Sharing
- Data Independence
- Controlled Redundancy
- Better Data Integrity
- Faster Application Development
- Economy of Scale
- Better Backup and Recovery Facility
- Better Concurrency Control

Database Users

- **Naïve Users**
  - They are unsophisticated users who interact with the system by invoking one of the application programs that have been written previously.
  - The typical user interface for naive users is a **forms** interface, where the user can fill in appropriate **fields** of the form.
  - Naive users may also simply read reports generated from the database.

- **Application programmers**
  - They are computer professionals who write application programs.
  - They can choose from many **tools** to develop user interfaces.
  - **Rapid application development (RAD)** tools are tools that enable an application programmer to construct forms and reports with minimal programming effort.

Database Users

- **Sophisticated users**
  - They interact with the system without writing programs.
  - Instead, they form their requests either using a database query language or by using tools such as data analysis software.
  - Analysts who submit queries to explore data in the database fall in this category.

- **Specialized users**
  - They are sophisticated users who write specialized database applications that do not fit into the traditional data-processing framework.
  - Among these applications are computer-aided design systems, knowledge base and expert systems, systems that store data with complex data types (for example, graphics data and audio data), and environment-modeling systems

Database Users

- Database Administrator
  - **Schema definition.** The DBA creates the original database schema by executing a set of data definition statements in the DDL.
  - **Storage structure and access-method definition.**
  - **Schema and physical-organization modification.** The DBA carries out changes to the schema and physical organization to reflect the changing needs of the organization, or to alter the physical organization to improve performance.
  - **Granting of authorization for data access.**
    - The database administrator can regulate which parts of the database various users can access.
    - The authorization information is kept in a special system structure that the database system consults whenever someone attempts to access the data in the system.

Database Users

- **Routine maintenance.**
  - Periodically backing up the database, either onto tapes or onto remote servers, to prevent loss of data in case of disasters such as flooding.
  - Ensuring that enough free disk space is available for normal operations, and upgrading disk space as required.
  - Monitoring jobs running on the database and ensuring that performance is not degraded by very expensive tasks submitted by some users.

Database Architecture

- The architecture of a database systems is greatly influenced by the underlying computer system on which the database is running:
  - Centralized
  - Client-server
  - Parallel (multi-processor)
  - Distributed

Database Architecture

- Centralized DBMSs Architecture
  - All DBMS functionality, application program execution, and user interface processing carried out on one machine

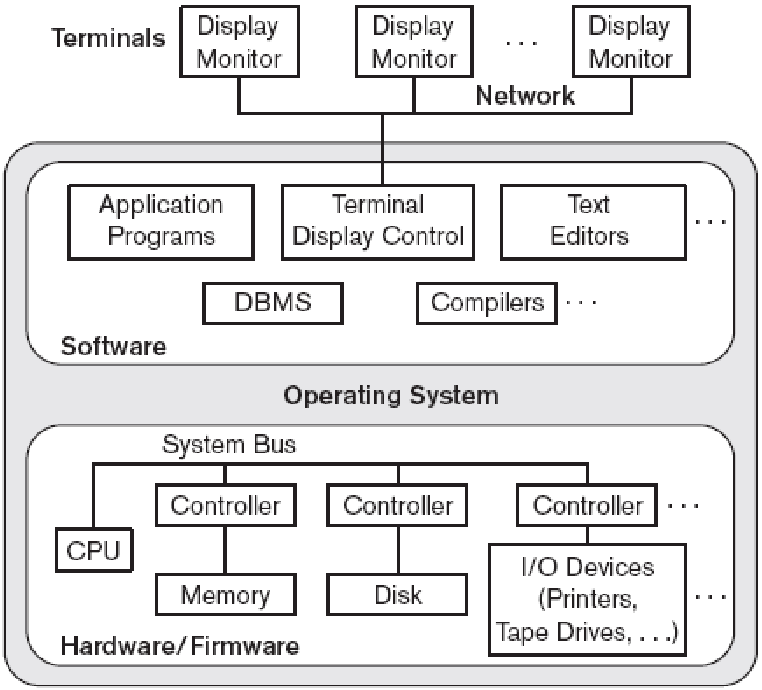


Figure 2.4
A physical centralized architecture.

Database Architecture

- Client/Server Architecture
- Servers with specific functionalities
  - **File server**
    - Maintains the files of the client machines.
  - **Printer server**
    - Connected to various printers; all print requests by the clients are forwarded to this machine
  - **Web servers** or **e-mail servers**

- **Client machines**
  - Provide user with:
    - Appropriate interfaces to utilize these servers
    - Local processing power to run local applications

Database Architecture

- Two-Tier Client/Server

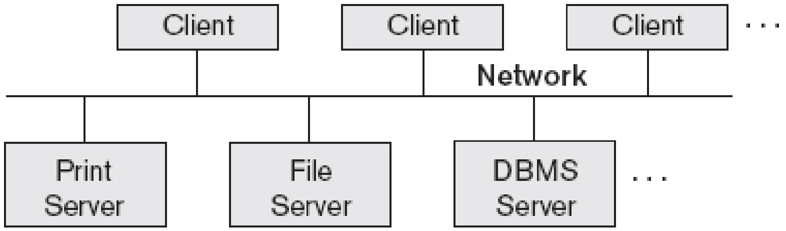


Figure 2.5
Logical two-tier client/server architecture.

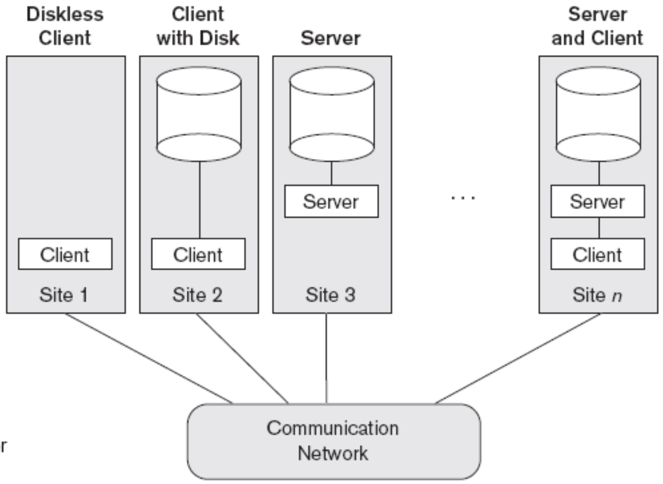


Figure 2.6
Physical two-tier client/server architecture.

Database Architecture

- Three-Tier Client/Server

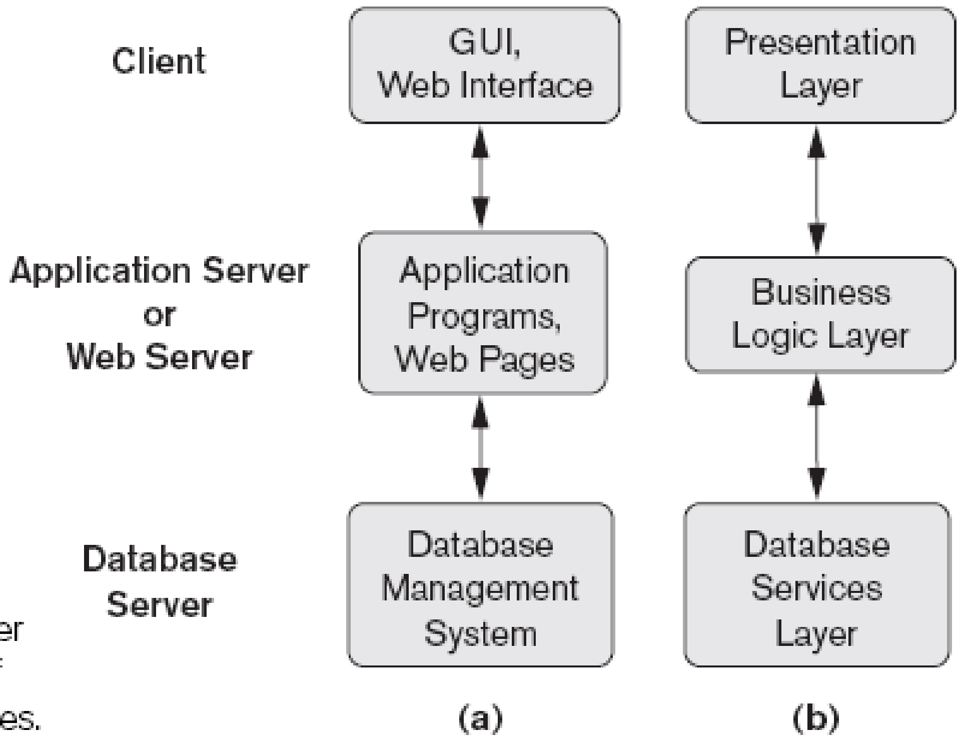


Figure 2.7
Logical three-tier client/server architecture, with a couple of commonly used nomenclatures.

Systems Development Life Cycle Approach

- **Problem Identification –** identify user requirements
- **Project Planning –** Establish scope of the project.
- **Problem Analysis –** Specify detailed requirements
- **Logical Design –** Determine screen designs, report layout designs, data models etc.
- **Physical Design –** Develop physical data structures
- **Implementation –** Code programs; perform testing.

Database Development

- Planning and Analysis
  - includes requirement specifications, evaluating alternatives, determining input, output, and reports
- Conceptual Design
  - develop a conceptual schema based on the requirement specification
- Logical Design
  - Define the tables (entities) and fields (attributes). Identify primary and foreign key for each table. Define relationships between the tables.
- Physical Design
  - Develop physical data structures; specify file organization, and data storage etc.
  -
- Implementation
  - Implement the physical design. Perform testing. Modify if necessary