BCA313: Database System

Unit I

- Introduction
- Applications
- Need of DBMS
- Advantages of DBMS
- Views of data
- Instances and schema
- Data independence
- Database Administrator
- Overall System Structure

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Database Management System (DBMS)

- 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.
- The primary goal of a DBMS is to provide an environment to store and retrieve database information that is both convenient and efficient to use.
- Database systems are designed to manage large bodies of information. Management of data involves
  - Defining structures for storage of information
  - Providing mechanisms for the manipulation of information.
  - Ensuring safety of the information stored - despite system crashes or attempts at unauthorized access. If data are to be shared among several users, the system must avoid possible anomalous results.

Some Data

				number
192-83-7465	Arpita	CHB	Jodhpur	A-101
019-28-3746	Abhay	SN	Jaipur	A-215
192-83-7465	Mahesh	PN	Ajmer	A-201
321-12-3123	Vibha	AN	Bikaner	A-217
019-28-3746	Teena	Sardarpura	Jodhpur	A-201

Database Applications

  - Banking: all transactions
  - Airlines: reservations, schedules
  - Universities: registration, grades
  - Sales: customers, products, purchases
  - Manufacturing: production, inventory, orders, supply chain
  - Human resources: employee records, salaries, tax deductions
- Databases touch all aspects of our lives
- Most people are not even aware they are dealing with a database, accessing databases forms an essential part of almost everyone’s life today.

Need of Database System

- In the early days, database applications were built on top of file systems

- This typical file processing system is supported by a conventional operating 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 i.e to manipulate files.

- In FPS different programmers create the files and application programs over a long period, the various files are likely to have different formats and the programs may be written in several programming languages. Moreover, the same information may be duplicated in several files.

Advantages of DBMS over FPS

- Data redundancy and inconsistency
  - Multiple file formats, duplication of information in different files.
  - This redundancy leads to higher storage and access cost.
  - The various copies of the same data may no longer agree

- Difficulty in accessing data
  - Need to write a new program to carry out each new task
  - 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.

- Data isolation
  - multiple files and formats make writing new application programs to retrieve the appropriate data a difficult task.

Cont…

- Integrity problems
  - Integrity constraints (e.g. account balance > 0) become part of program code
  - Hard to add new constraints or change existing ones
- Atomicity of updates
  - Failures may leave database in an inconsistent state with partial updates carried out
  - E.g. transfer of funds from one account to another should either complete or not happen at all

- Concurrent access by multiple users
  - For increase in overall performance of the system and faster response, many systems allow multiple users to update the data simultaneously.
  - Uncontrolled concurrent accesses can lead to inconsistencies
    - E.g. two people reading a balance and updating it at the same time
- Security problems
  - Not every user of the database system should be able to access all the data
  - since application programs are added to the system in an ad hoc manner, enforcing such security constraints is difficult.

Database systems offer solutions to all the above problems

Levels of Abstraction

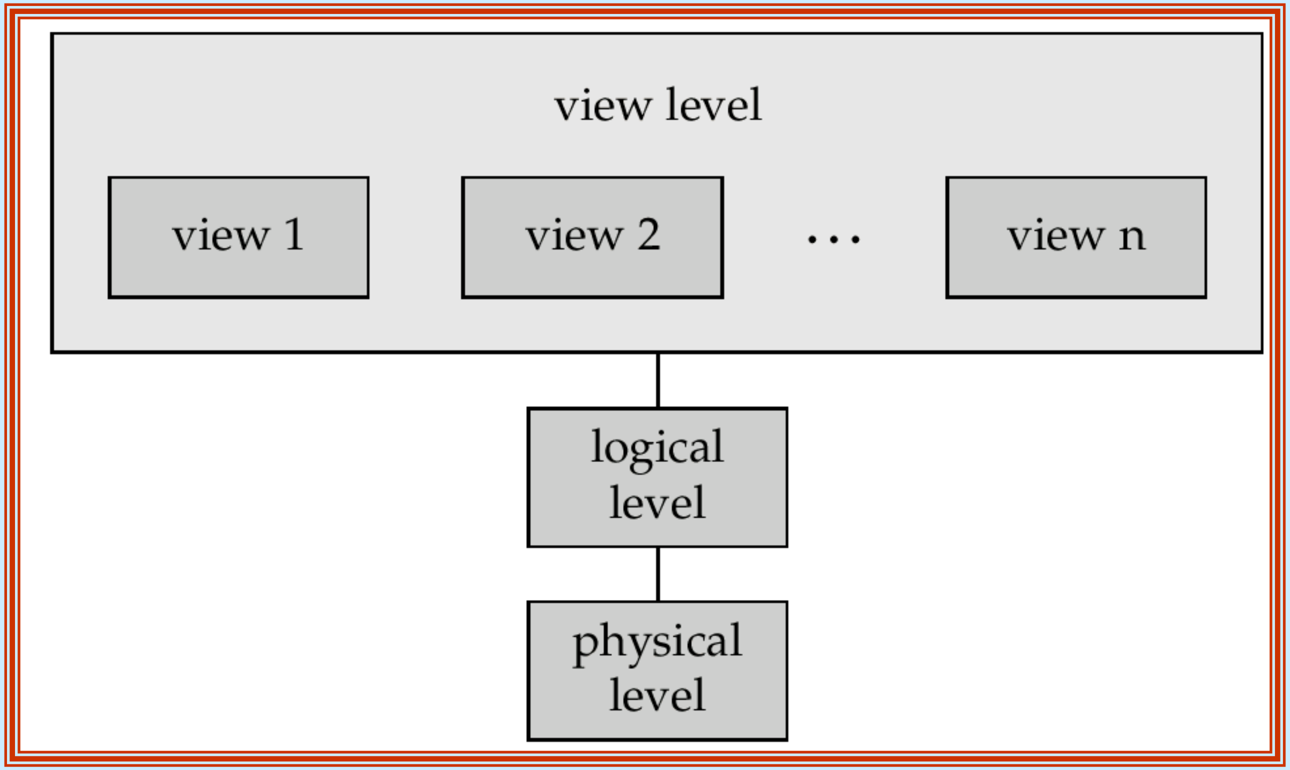
- Physical level describes how a record (e.g., customer) is stored.
- Logical level: describes data stored in database, and the relationships among the data.

```
type customer = record
        name : string;
        street : string;
        city : integer;
    end;
```

- View level: application programs hide details of data types. Views can also hide information (e.g., salary) for security purposes.

View of Data

An architecture for a database system



Instances and Schemas

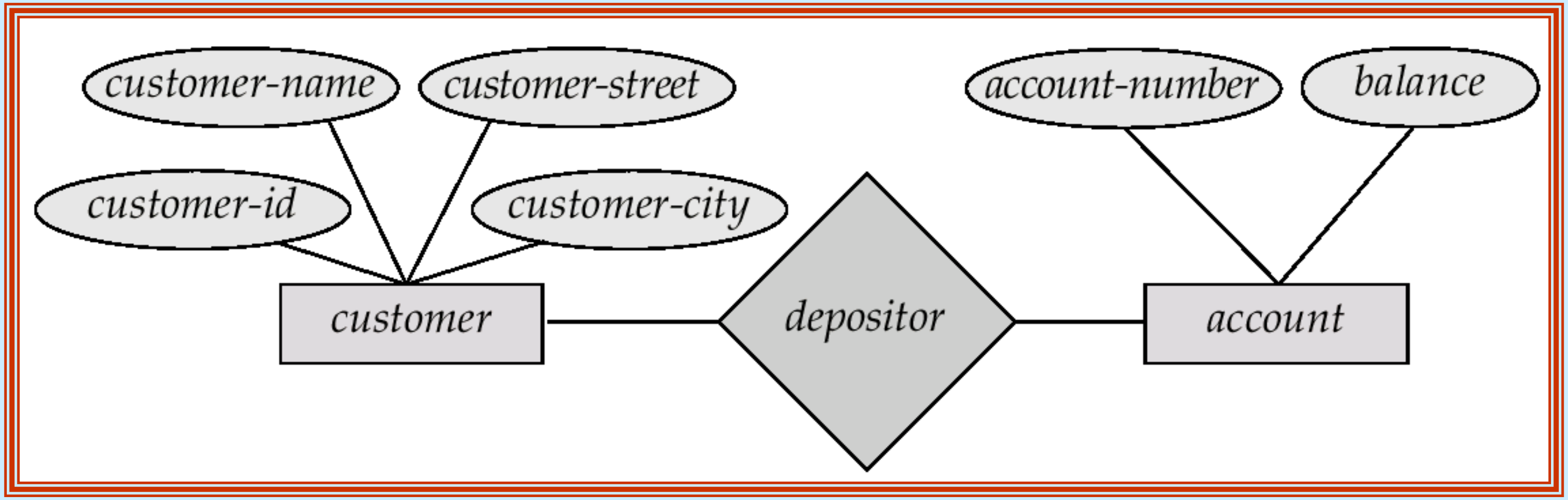
- Similar to types and variables in programming languages
- **Schema** – the logical structure of the database
  - e.g., the database consists of information about a set of customers and accounts and the relationship between them)
  - Analogous to type information of a variable in a program
  - **Physical schema**: database design at the physical level
  - **Logical schema**: database design at the logical level
- **Instance** – the actual content of the database at a particular point in time
  - Analogous to the value of a variable
- **Physical Data Independence** – the ability to modify the physical schema without changing the logical schema
  - Applications depend on the logical schema
  - In general, the interfaces between the various levels and components should be well defined so that changes in some parts do not seriously influence others.

Data Models

- A collection of tools for describing
  - data
  - data relationships
  - data semantics
  - data constraints
- Entity-Relationship model
- Relational model
- Other models:
  - object-oriented model
  - semi-structured data models
  - Older models: network model and hierarchical model

Entity-Relationship Model

Example of schema in the entity-relationship model



Entity Relationship Model (Cont.)

- E-R model of real world
  - Entities (objects)
    - E.g. customers, accounts, bank branch
  - Relationships between entities
    - E.g. Account A-101 is held by customer Johnson
    - Relationship set *depositor* associates customers with accounts
- Widely used for database design
  - Database design in E-R model usually converted to design in the relational model (coming up next) which is used for storage and processing

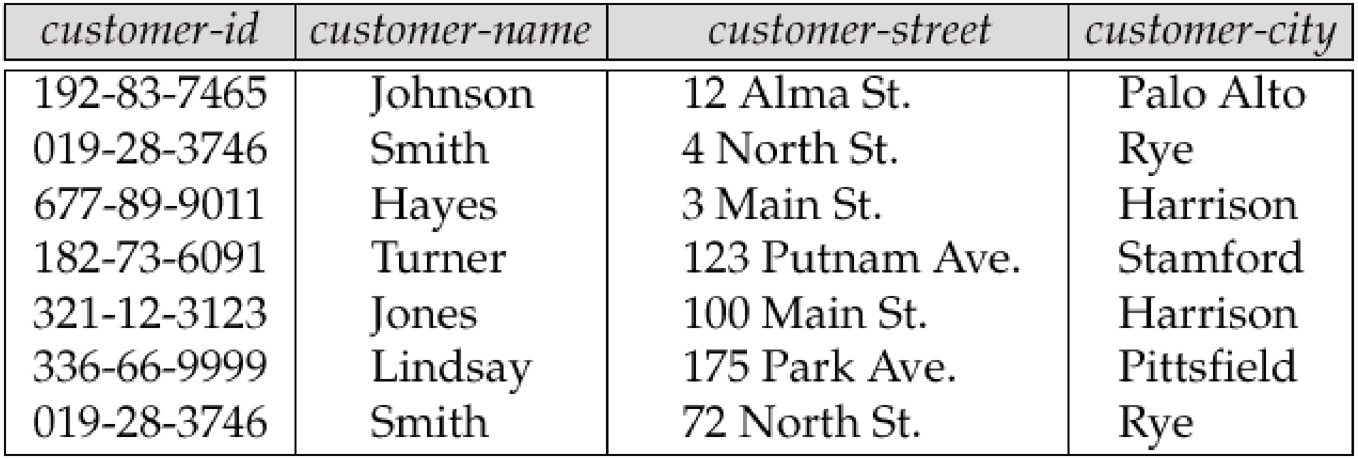
Relational Model

Attributes

- Example of tabular data in the relational model

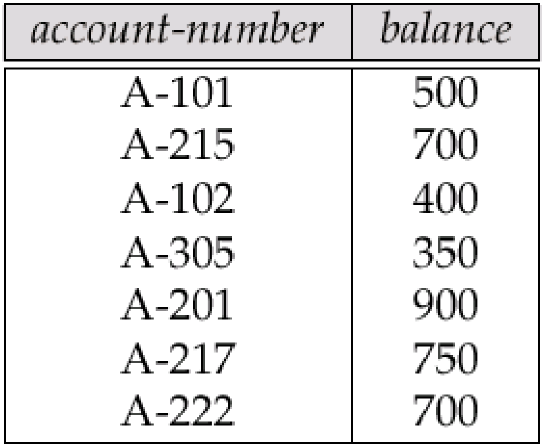
Customer-id	*customer-name*	*customer-street*	*customer-city*	*account-number*
192-83-7465	Johnson	Alma	Palo Alto	A-101
019-28-3746	Smith	North	Rye	A-215
192-83-7465	Johnson	Alma	Palo Alto	A-201
321-12-3123	Jones	Main	Harrison	A-217
019-28-3746	Smith	North	Rye	A-201

A Sample Relational Database



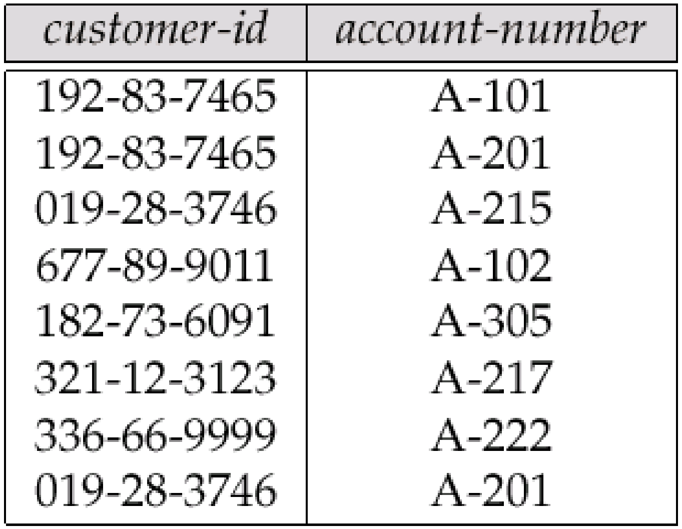
customer-id	*customer-name*	*customer-street*	*customer-city*
192-83-7465	Johnson	12 Alma St.	Palo Alto
019-28-3746	Smith	4 North St.	Rye
677-89-9011	Hayes	3 Main St.	Harrison
182-73-6091	Turner	123 Putnam Ave.	Stamford
321-12-3123	Jones	100 Main St.	Harrison
336-66-9999	Lindsay	175 Park Ave.	Pittsfield
019-28-3746	Smith	72 North St.	Rye

(a) The *customer* table



account-number	*balance*
A-101	500
A-215	700
A-102	400
A-305	350
A-201	900
A-217	750
A-222	700

(b) The *account* table



customer-id	*account-number*
192-83-7465	A-101
192-83-7465	A-201
019-28-3746	A-215
677-89-9011	A-102
182-73-6091	A-305
321-12-3123	A-217
336-66-9999	A-222
019-28-3746	A-201

(c) The *depositor* table

Data Definition Language (DDL)

- Specification notation for defining the database schema
  - E.g.
    create table *account* (
    account-number **char**(10),
    balance **integer**)
- DDL compiler generates a set of tables stored in a *data dictionary*
- Data dictionary contains metadata (i.e., data about data)
  - database schema
  - Data *storage and definition* language
    - language in which the storage structure and access methods used by the database system are specified
    - Usually an extension of the data definition language

Data Manipulation Language (DML)

- Language for accessing and manipulating the data organized by the appropriate data model
  - DML also known as query language
- Two classes of languages
  - Procedural – user specifies what data is required and how to get those data
  - Nonprocedural – user specifies what data is required without specifying how to get those data
- SQL is the most widely used query language

SQL

- SQL: widely used non-procedural language
  - E.g. find the name of the customer with customer-id 192-83-7465

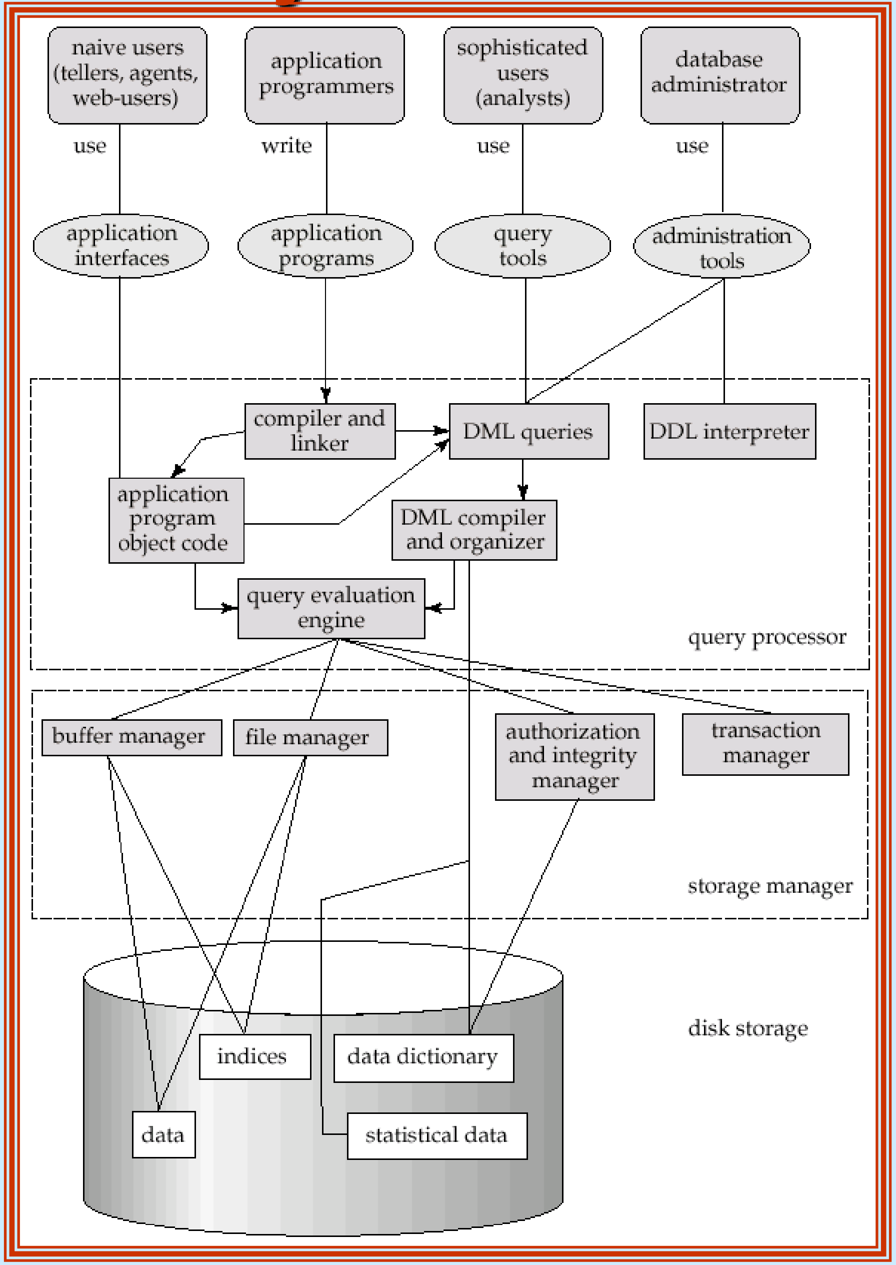
    select *customer.customer-name*
    from *customer*
    where *customer.customer-id* = ‘192-83-7465’

  - E.g. find the balances of all accounts held by the customer with customer-id 192-83-7465

    select *account.balance*
    from *depositor*, *account*
    where *depositor.customer-id* = ‘192-83-7465’ **and**
    depositor.account-number = *account.account-number*

- Application programs generally access databases through one of
  - Language extensions to allow embedded SQL
  - Application program interface (e.g. ODBC/JDBC) which allow SQL queries to be sent to a database

Overall System Structure



Database Users

- Users are differentiated by the way they expect to interact with the system
- Application programmers – interact with system through DML calls
- Sophisticated users – form requests in a database query language
- Specialized users – write specialized database applications that do not fit into the traditional data processing framework
- Naïve users – invoke one of the permanent application programs that have been written previously
  - E.g. people accessing database over the web, bank tellers, clerical staff

Database Administrator

- Coordinates all the activities of the database system; the database administrator has a good understanding of the enterprise's information resources and needs.
- Database administrator's duties include:
  - Schema definition
  - Storage structure and access method definition
  - Schema and physical organization modification
  - Granting user authority to access the database
  - Specifying integrity constraints
  - Acting as liaison with users
  - Monitoring performance and responding to changes in requirements
- Database Manager is a software, or a set of computer programs, that provide basic database management functionalities including creation and maintenance of databases. Database managers have several capabilities including the ability to back up and restore, attach and detach, create, clone, delete and rename the databases.

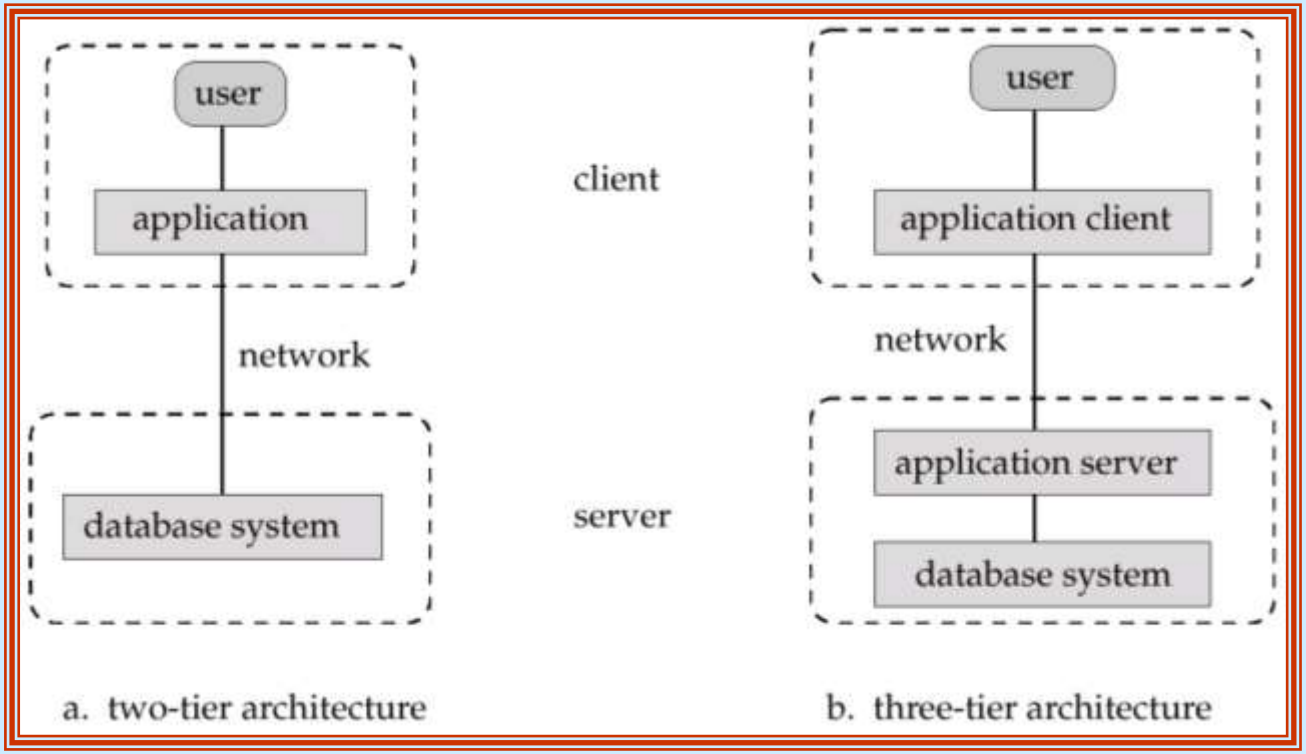
Transaction Management

- A *transaction* is a collection of operations that performs a single logical function in a database application
- Transaction-management component ensures that the database remains in a consistent (correct) state despite system failures (e.g., power failures and operating system crashes) and transaction failures.
- Concurrency-control manager controls the interaction among the concurrent transactions, to ensure the consistency of the database.

Storage Management

- Storage manager is a program module that provides the interface between the low-level data stored in the database and the application programs and queries submitted to the system.
- The storage manager is responsible to the following tasks:
  - interaction with the file manager
  - efficient storing, retrieving and updating of data

Application Architectures



a. two-tier architecture

b. three-tier architecture

- **Two-tier architecture**: E.g. client programs using ODBC/JDBC to communicate with a database
- **Three-tier architecture**: E.g. web-based applications, and applications built using "middleware"

Thank you