

Database Management System

Unit 2: Database Management System

Database Management System

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CE: 2.1

Introduction

CE: Data Vs Information

DATA:

- Data are known as **facts** that can be recorded and that have implicit meaning.
- Data can be numbers, text or objects like documents, photographic image or video, etc.

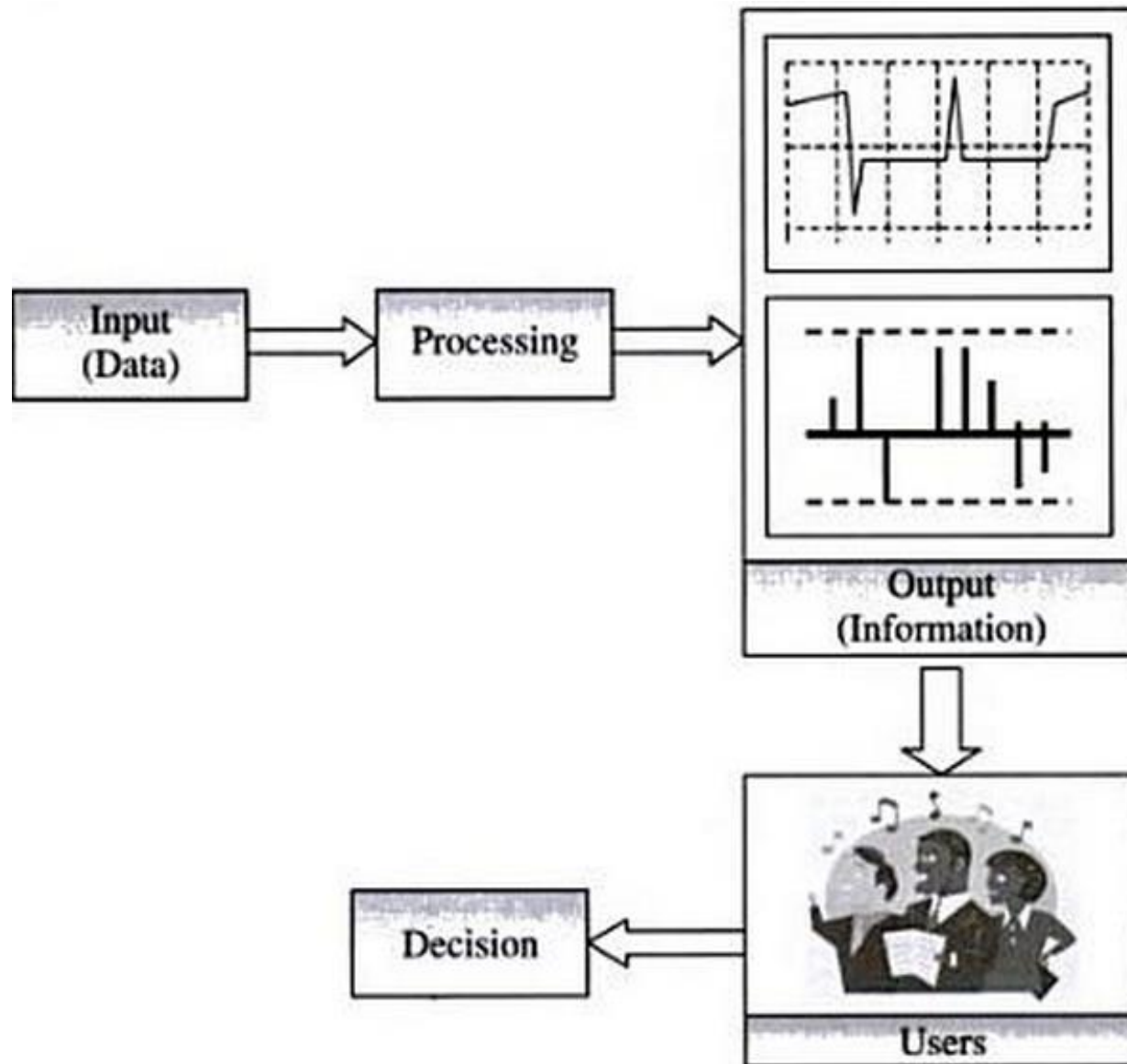
INFORMATION:

- Information is analyzed, organized, processed or summarized data.
- Therefore, Once the data is analyzed, it is considered as information.

CE: Data Vs Information (Conti...)

- Information is a collection of related data, which has some meaningful values for the receiver.
- It is the processed data on which decisions and actions are based.

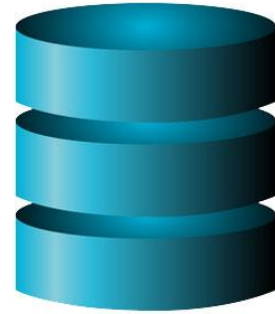
CE: Data Vs Information (Conti...)



CE: Data Vs Information (Conti...)

Data	Information
<ol style="list-style-type: none">1. It is a raw material or unprocessed facts.2. It doesn't depend on Information.3. It may not be meaningful.4. <u>For example:</u><ul style="list-style-type: none">▪ Weights, prices, costs, numbers of items sold, employee names, product names, addresses, tax codes, registration marks, etc.	<ol style="list-style-type: none">1. It is the product, processed from data.2. It relies on Data.3. It is always meaningful.4. <u>For example:</u><ul style="list-style-type: none">▪ Marks obtained by students and their roll numbers form data, the report card/sheet is the information. Other forms of information are pay-slips, schedules, reports, worksheet, bar charts, invoices and account returns etc.

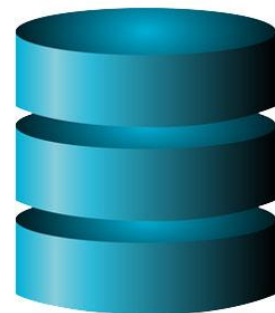
CE: Database



- Database is a systematic collection of data.
- A **database** is a collection of information that is organized, which can easily be accessed, managed and updated.
- The collected information could be in any formats like (electronic, printed, graphic, audio, video).
- A database represents some aspect of the real world.
- For example:
 - ✓ Phone book
 - ✓ Address book
 - ✓ Shopping list

CE: Database (Conti...)

- Let's also consider the **Facebook**.
- ✓ It needs to store, manipulate and present data related to members, their friends, member activities, messages, advertisements, etc.
- Therefore, **Databases make data management easy.**



CE: Database Management System (DBMS)

- A Database Management System is....
 - ✓ a collection of database and
 - ✓ a set of programsthat enable you to store, modify, and access information from a database.

DBMS = Database + Set of Programs

- For example:
Collection of Student ID, Name, Address, Percentage of any student for a particular college.

A random collection of data cannot be considered as a database.

CE: Database Management System (DBMS)

- For example:
Collection of some Vehicle Number, Account Number, Percentage of student and Faculty name do not form database.

CE: Database Management System (DBMS)

- Some Database Software's are:
 - ✓ ADABAS
 - ✓ Microsoft Access
 - ✓ Microsoft Excel
 - ✓ **Oracle (Oracle Corporation)**
 - ✓ SQL Server (Microsoft)
 - ✓ DB2 (IBM)
 - ✓ Microsoft SQL Server
 - ✓ **MySQL**
 - ✓ QuickBase
 - ✓ SAP Sybase ASE
 - ✓ Teradata

Goal of DBMS

- The main goal of DBMS is to provide **efficiency** (good **organization**) and **convenience** (easy) in storing and retrieving database information.
- And also to provide safety of the information against system crashes as well as an unauthorized access.
- For example:
 - ✓ *A bank database*, to withdraw and deposit money.
 - ✓ *A airway or railway reservation database*, for booking of tickets.
 - ✓ *To check for a sufficient credit balance*, while purchasing goods using credit cards.

CE: Database Applications

- **Banking:** transactions
- **Airlines:** reservations, schedules
- **Universities:** registration, grades
- **Sales:** customers, products, purchases
- **Online retailers:** order tracking, customized recommendations
- **Manufacturing:** production, inventory, orders, supply chain
- **Human resources:** employee records, salaries, tax deductions

CE: Database Applications (Conti...)

- For Example:

Consider University Database

- In a database of Application program:
 - ✓ Add: Institutes, Departments, Faculties, Subjects and Students.
 - ✓ Register: Students for Courses and Generate Class Schedules.
 - ✓ Assign: Grades to Students, Compute Grade Point Averages (GPA) and Generate Marksheet.
- In the early days, database applications were built directly on file systems.

CE: 2.2

Purpose of Database

Systems

CE: Purpose of Database Systems

The drawbacks of Conventional File Processing Systems are:

1. Data redundancy and inconsistency
2. Difficulty in accessing data
3. Data Isolation
4. Integrity problems
5. Atomicity problems
6. Concurrent Access anomalies
7. Security problems

CE: Purpose of Database Systems (Conti...)

1. Data redundancy and inconsistency:

- **Data redundancy** means duplication of records.
- Files and application programs are created by different programmers over a long period of time.
- Files have different formats and the programs may be written in several programming language.
- So, same piece of information may be duplicated in several files.

CE: Purpose of Database Systems (Conti...)

1. Data redundancy and inconsistency: (Conti...)

- For Example:

- ✓ The personal information like address and phone number of a customer is maintained in customer records file, that same may appear in a bank saving account records file.
- This redundancy leads to higher storage and access cost.
- It leads to **data inconsistency** that is, the various copies of the same data may no longer agree.
- For Example:
- ✓ If a customer address changes, it may be reflected in a bank saving account records file, but not elsewhere in the system.

CE: Purpose of Database Systems (Conti...)

2. Difficulty in accessing data:

- A conventional file processing environments do not allow needed data to be retrieved in a convenient (suitable) and efficient (well-organized) manner.
- For Example:
 - ✓ Suppose that, if the bank officer needs to find out the names of all customers who live within the city's 395007 zip code.
 - ✓ The bank officer has now two choices:
 - Either get the list of customers and extract the needed information manually, or
 - Ask the data processing department, to have a system programmer to write the necessary application program.
 - ✓ Obviously, both alternatives are unsatisfactory.

CE: Purpose of Database Systems (Conti...)

3. Data Isolation:

- All the data are scattered in various files; and these various files may be in different formats, So, it is difficult to write new application programs to retrieve appropriate data.
- For Example:
 - ✓ Suppose, if the bank officer needs to generate a report of the customer, which contains customer personal information, bank information and debit/credit card information. All these information's are stored in different files.
So, how do we get all these details in one report?

CE: Purpose of Database Systems (Conti...)

3. Data Isolation: (Conti...)

- ✓ But before writing the program, the programmer should find out which all files have the needed information, what is the format of each file, how to search data in each file, etc.
- ✓ Once all these analysis is done, he writes a program. If there is 2-3 files involved, programming would be bit simple. But if there are more files involved in it then? It would be require lot of effort from the programmer.

CE: Purpose of Database Systems (Conti...)

4. Integrity problems:

- If we need to check for certain insertion criteria, while entering the data into file it is not possible directly. We can write programs for it.
- For Example:
 - ✓ The balance of a bank account may never fall below Rs.2000. These constraints are enforced in the system by adding appropriate code in the various application programs.
- Thus, the data values stored in the database must satisfy certain types of consistency constraints.

CE: Purpose of Database Systems (Conti...)

5. Atomicity Problems:

- A system failure will lead to an atomicity problem.
- For Example:
 - ✓ If a system fails during transferring fund from system A to B, then it will be debited from A, but not credited to B, which leads to wrong transaction.
 - ✓ It is essential for database consistency that either both the credit and debit occur, or neither occur.
 - ✓ That is, the funds transfer must be **atomic** - it must happen **entirely** or **not at all**.
- Thus, it is difficult to ensure atomicity in a conventional file-processing system.

CE: Purpose of Database Systems (Conti...)

6. Concurrent-access anomalies:

- Concurrent means simultaneous.
- In order to improve the overall performance of the system and obtain a faster response time, many systems allow multiple users to update the data simultaneously.
- In such environment, interaction of concurrent updates may results in inconsistent data.
- For Example:
 - ✓ Consider bank account A, with Rs. 5000.
 - ✓ If two customers withdraw funds (say Rs. 500 and Rs.1000) from account A at the same time, the result of the concurrent executions leads to Rs. 4500 or Rs. 4000 respectively, rather than Rs.3500.

CE: Purpose of Database Systems (Conti...)

7. Security problems:

- Each file can be password protected. But what if we need to give access to only few records in the file?
- For Example:
 - ✓ In a banking system, only payroll staffs should be given authority to see the part of the database, that has information about the various bank employees.
 - ✓ They do not need to access information about customer accounts.
- Thus, not every user of the database system should be able to access all the data.

CE: Purpose of Database Systems (Conti...)

7. Security problems: (Conti...)

- System should be protected using proper security.
- Since application programs are added to the system in an ad-hoc manner, it is difficult to enforce such security constraints.

Class Work

- Write few applications of Database Management System.

International Certification Question

TRUE OR FALSE

1. In DBMS, data files are the files that store the database information. **True**
2. A collection of data designed for use by different users is called database. **True**
3. In a database, data integrity can be maintained. **True**
4. The data in a database cannot be shared. **False**
5. A database cannot avoid data inconsistency. **False**
6. Security restrictions cannot be applied into a database system.
False
7. DBMS manage concurrent databases access and prevents from the problem of loss of information or loss of integrity.
True

International Certification Question

Q8.	Which of the following is the characteristic of data in database?
A.	Independent
B.	Secure
C.	Shared
D.	All of the above

Ans: D

International Certification Question

Q9.	Data is:
A.	a piece of fact
B.	metadata
C.	Knowledge
D.	All of the above

Ans: A

Industry Interview Question

1. What is the difference between Data and Information?
2. How database approach differs from traditional file systems?
3. Why do we need database?

Home Work

1. What is Database? [1 Mark]
2. Differentiate between Data and Information. [2 Marks]
3. State the main goal of DBMS. [2 Marks]
4. What do you mean by redundancy? Explain in brief. [2 Marks]
5. List the advantages of DBMS. [2 Marks]
6. Explain concurrent-access anomalies in File Processing System in detail. [2 Marks]
7. Explain the drawbacks of using Conventional File Processing System. [5 Marks]

or

7. Discuss the limitation of Traditional File Processing System.

or

7. Explain the purpose of database system in details with proper examples.

Home Work

8. Suppose you want to build a video site similar to YouTube. Consider each of the disadvantages of keeping data in a file-processing system. Discuss the relevance of each of these points to the storage of actual video data, and to metadata about the video, such as title, the user who uploaded it, tags, and which users viewed it.

[5 Marks]

CE: Purpose of Database Systems (Conti...)

The drawbacks of Conventional File Processing Systems	Advantages of Database Systems
1. Data redundancy and inconsistency	1. Redundancy can be control 2. Inconsistency can be avoided
2. Difficulty in accessing data	3. Data can be access easily
3. Data Isolation	4. Data can be shared 5. Standards can be enforced
4. Integrity problems	6. Integrity can be maintained
5. Atomicity problems	7. Provides backup and recovery
6. Concurrent Access anomalies	8. Concurrency can be control
7. Security problems	9. Provides Security



CE: Purpose of Database Systems (Conti...)

Advantages of Database Systems:

1. Redundancy can be control/reduced
2. Inconsistency can be avoided
3. Data can be access/search easily
4. Data can be shared
5. Standards can be enforced
6. Integrity can be maintained
7. Provides backup and recovery
8. Concurrency can be control
9. Provides Security/ Security can be enforced

CE: Purpose of Database Systems (Conti...)

1. Redundancy can be control/reduced:

- DBMS controls redundancy by maintaining a single source of data that is defined once and is accessed by many users.
- As there is no or less redundancy, data remains consistent.
- By having a centralized database most of this can be avoided to a great extent, but cannot eliminate.

CE: Purpose of Database Systems (Conti...)

2. Inconsistency can be avoided:

- By controlling the data redundancy, the data consistency is obtained.
- If a data item appears only at once, any update to its value has to be performed only once and the updated value is immediately available to all the users.
- So, if the DBMS has controlled redundancy, then the chances of having inconsistent data are also removed.

CE: Purpose of Database Systems (Conti...)

3. Data can be access/search easily:

- For every search operation on file system, a different application program has to be written.
- While DBMS provides inbuilt searching operations.
- The users have to only write a small query to retrieve data from database.

CE: Purpose of Database Systems (Conti...)

4. Data can be shared:

- In DBMS, data can be shared by authorized users of the organization.
- So, the data of same database can be shared between different applications.
- Therefore, the data can be shared easily due to centralized system.

CE: Purpose of Database Systems (Conti...)

5. Standards can be enforced:

- With the central control of the database, a standard can be applied easily may be at Company level, Department level, National level or International level.
- The standardized data is very helpful during migration or interchanging of data.
- Here, the **DBA** can ensure that all applicable standards are observed in the representation of the data.
- The file system is an independent system, so the standard cannot be easily enforced on multiple independent applications.

CE: Purpose of Database Systems (Conti...)

6. Integrity can be maintained:

- Integrity constraints or consistency rules can be applied to the database, so that the accurate (correct) data can be entered in the database.
- A DBMS should provide capabilities for defining and applying constraints.
- Centralized control of the data helps to permit **DBA** to define integrity constraints.

CE: Purpose of Database Systems (Conti...)

7. Provides backup and recovery:

- In a computer file-based system, the user creates the backup of data regularly to protect the valuable data from damage due to failures to the computer system or application program.
- It is very time consuming method, if amount of data is large.
- DBMS provides the **'backup and recovery' sub-system** that automatically create the backup of data and restore data if required.

CE: Purpose of Database Systems (Conti...)

8. Concurrency can be control:

- Concurrent access to data means more than one user is accessing the same data at the same time.
- Anomalies occur when changes made by one user gets lost, because of changes made by other user.
- File system does not provide any procedure to stop anomalies. Whereas, **DBMS provides a locking system to stop anomalies to occur and provides concurrent access of data to multiple users.**

CE: Purpose of Database Systems (Conti...)

9. Provides Security/ Security can be enforced:

- Data Security is very important object of DBMS.
- When the multiple users share a database, it is likely that some users will not be authorized to access all information in the database.
- Hence, only authorized persons are allowed to access data.
- In addition, some users may be permitted only to retrieve data, whereas other are allowed both to retrieve and to update.
- Hence, the type of access operation retrieval or update must also be controlled.

CE: Purpose of Database Systems (Conti...)

9. Provides Security/ Security can be enforced: (Conti...)

- A DBMS provides a **security and authorization sub-system**, which the DBA uses to create accounts and to specify account restrictions.

CE: 2.3

View of Data

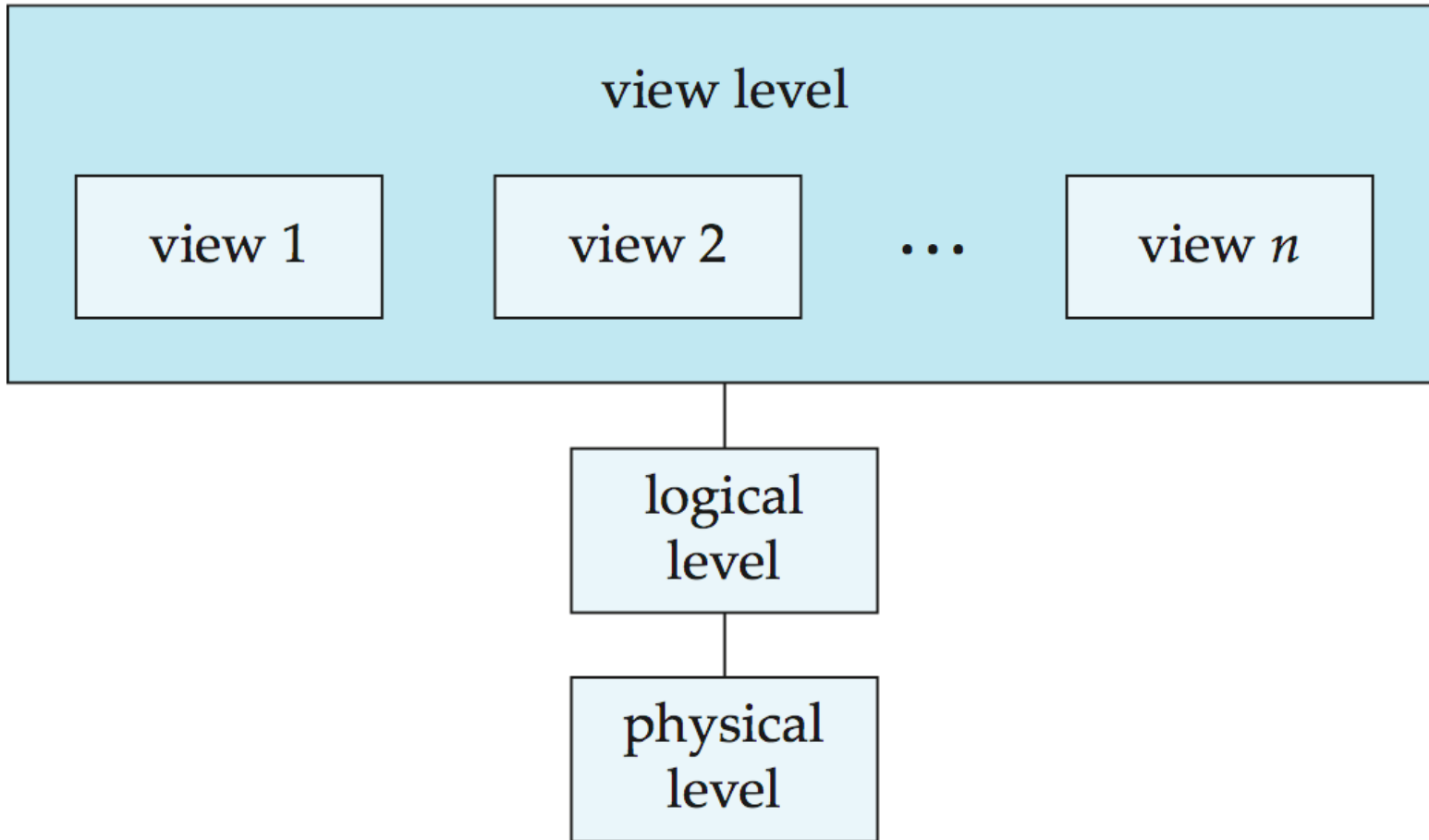
CE: 2.3 View of Data

- A *database system* is a collection of interrelated data and a set of programs that allow users to access and modify these data.
- A **major purpose** of a database system is to provide users with an *abstract view of the data*.
 - ✓ That means, the system hides certain details of how the data are stored and maintained.
- Since many of the database-system users are not computer trained, developers hide the complexity from users through several levels of abstraction, to simplify the users interactions with the system.
- This process of hiding irrelevant (unrelated) details from the user is called **data abstraction**.

CE: 2.3.1 Data Abstraction

- There are three levels of data abstraction. They are:
 1. Physical Level
 2. Logical Level
 3. View Level

CE: 2.3.1 Data Abstraction (Conti...)



Relationship among the three levels of abstraction.

CE: 2.3.1 Data Abstraction (Conti...)

1. Physical level (Internal level):

- It is the lowest level of data abstraction.
- It describes how the data are actually stored.
- It describes the complex low-level data structures in detail.
- **For Example:**
 - ✓ If we want to store the details of employees, then the blocks of storage and the amount of memory used for these purposes is kept hidden from the user.

CE: 2.3.1 Data Abstraction (Conti...)

2. Logical level (Conceptual level):

- It is the next higher level of data abstraction.
- It describes what data are stored in database, and the relationships among that data.
- It is a level of Database administrators(DBA), who must decide what information is to be keep in the database.
- **For Example:**
 - ✓ The manager can store the various attributes of an employee and relationships.

CE: 2.3.1 Data Abstraction (Conti...)

3. View level (External level):

- It is the highest level of data abstraction.
- Here the application programs hide details of data types.
- It describes only a part of the entire database. (because many users of the database system do not need all the information.)
- This level exists to simplify their interaction with the system; and the system may provide many views for the same database.
- Views can also hide information for security purposes.
- **For Example:** Employee's salary

CE: 2.3.2 Schemas and Instances

Schemas:

- The overall design of the database is called database **schema**.
- It is the logical structure of the entire database.
- It defines how the data is organized and how the relations among them are associated.
- It includes table names, column names, data-types and size of columns, various constraints at logical level.
- *It is similar like **variables** in programming language.*

CE: 2.3.2 Schemas and Instances (Conti...)

Schemas: (Conti..)

- **For Example:**

STUDENT			
ROLL_NO	NAME	SEMESTER	COURSE

Database schema of STUDENT

CE: 2.3.2 Schemas and Instances (Conti...)

Schemas: (Conti..)

- Database systems have several schemas, divided according to the levels of abstraction:
 1. **Physical schema:** describes the database design at the physical level.
 2. **Logical schema:** describes the database design at the logical level.
 3. **Sub-schemas:** describe different views of the database design at the view level.

CE: 2.3.2 Schemas and Instances (Conti...)

Instance:

- The collection of information stored in the database at a particular moment is called an **instance** of the database.
- *It is similar to the value of a variable in programming language.*

CE: 2.3.2 Schemas and Instances (Conti...)

Instance: (Conti..)

- **For Example:**

ROLL_NO	NAME	SEMESTER	COURSE
1	Hiral	2	MSC IT
2	Krishna	2	Int. MSC IT
3	Deep	2	MSC IT
4	Shivang	4	BCA
5	Nirmal	6	MSC IT

Instances of the database STUDENT

CE: 2.3.3 Data Independence

- *Data Independence* means the capacity to change the schema at one level without effecting the schema at the next higher level of a database system.
- Data independence are of two types:
 1. Physical Data Independence
 2. Logical Data Independence

CE: 2.3.3 Data Independence (Conti...)

1. Physical Data Independence:

- It is the ability to modify the physical schema without effecting any change in application programs.
- **For Example:**
 - ✓ Physical storage structures or devices used for storing the data could be changed without effecting any change in conceptual view or any of the external view, like...
 - ✓ Suppose if we want to replace hard-disks with SSD, it should not have any impact on the logical data or schemas.

CE: 2.3.3 Data Independence (Conti...)

2. Logical Data Independence:

- It is also the ability to modify the logical schema without effecting any change in application programs.
- It is difficult to achieve logical data independence.
- **For Example:**
 - ✓ Whenever a new column in table or a new table in database is added, the logical structure changes.

International Certification Question

Q1.	The external level defines how and where the data are organized in a physical data storage.
A.	True
B.	False

Ans: B

International Certification Question

Q2.	Which of the following is the advantage of using database system?
A.	Security enforcement
B.	Avoidance of redundancy
C.	Reduced inconsistency
D.	All of the above

Ans: D

International Certification Question

Q3.	The system hides certain details of how the data are stored and maintained through _____.
A.	Data Abstraction
B.	Physical Data Independence
C.	Logical Data Independence
D.	All of the above

Ans: A

International Certification Question

Q4.	The physical level is concerned with using the data structures offered by a DBMS in order to make the schema understable to the computer.
A.	True
B.	False

Ans: A

International Certification Question

Q5.	The logical schema, deals with the manner in which the conceptual database shall get represented in the computer as stored database.
A.	True
B.	False

Ans: A

International Certification Question

Q6.	What schema defines how and where the data are organized in a physical data storage?
A.	Physical schema
B.	Logical Ischema
C.	None of both

Ans: A

Class Work

- Design a database schema for a university.

[Hint: Institute, Department, Faculty, Students]

Industry Interview Question

1. What is Database Schema?
2. What is Data Abstraction?

Home Work

1. What is Data Abstraction? [1 Mark]
2. Define: Database Schema. [1 Mark]
3. State the difference between Schema and Instance with example. [2 Marks]
4. Differentiate Physical Schema and Logical Schema. [2 Marks]
5. What is Data Independence? [2 Marks]
6. How Physical Data Independence is easy to achieve as compared to Logical Data Independence? [2 Marks]
7. Write a note on data abstraction. [5 Marks]

or

7. Explain the difference between Physical, Logical and View level of data abstraction.

or

7. Discuss data abstraction in detail with examples.

CE: 2.4

Database Languages

CE: Database Languages

- A database system provides a **data-definition language**, to specify the database schema.
- A **data-manipulation language**, to express database queries and updates.
- Data definition and data manipulation languages are not two separate languages, but are the part of a single database language, which is widely use as SQL language.

CE: Data Definition Language (DDL)

- DDL provides a set of definitions, to describe logical schema of a database.
- The data values stored in the database must satisfy certain **consistency constraints**.
- For Example:
 - ✓ A bank balance of any customer must never be negative.
Hence, DDL provides such facilities to specify such constraints.
- DDL compiler generates a set of table templates which is stored in a data dictionary. Therefore, the output of the DDL is placed in the **data dictionary**.

CE: Data Definition Language (DDL) (Conti...)

What is data dictionary?

- A data dictionary is a file or a set of files that contains a database's metadata.
- *Metadata* is a data about data, which means the information about the database, attribute names and definitions for each table in the database.
- DBMS keeps the data dictionary hidden from the users, to prevent them from an accidental destroying content.
- **Without a data dictionary, a DBMS cannot access data from the database.**

CE: Data Definition Language (DDL) (Conti...)

DDL includes following commands:

1. **CREATE** – For creating tables.
2. **DESC** – To view the table structure.
3. **ALTER** – For modifying table structure.
4. **RENAME** – To change the name of the table.
5. **DROP** – For removing an existing table.

CE: Data Definition Language (DDL) (Conti...)

- For Example:

```
create table tblStudent(  
  enro int,  
  firstname varchar(20),  
  lastname varchar(20),  
  contactno bigint(10));
```

```
create table tblEmployee(  
  empid int,  
  empname varchar(20),  
  city varchar(20),  
  contactno numeric(10,0));
```

CE: Data Manipulation Language (DML)

- It is used for accessing and manipulating the data organized by an appropriate **data model**.
- Basically there are two types of DMLs:
 1. Procedural DMLs: which specifies *what data is required* and *how to get those data*.
 2. Declarative (nonprocedural) DMLs: which specifies *what data is required* **without specifying** *how to get those data*.
- DML is also known as **query language**.

CE: Data Manipulation Language (DML) (Conti...)

What is query?

- A *query* is a statement, requesting to retrieve the information.
- And the portion of a DML that involves information to retrieve is called a **query language**.
- Thus, **SQL** is the most widely used query language.

CE: Data Manipulation Language (DML) (Conti...)

DML includes following commands:

1. **INSERT** – To insert one or more number of rows.
2. **SELECT** – To display one or more rows.
3. **UPDATE** – To modify the column values in a table.
4. **DELETE** – To remove one or more rows from the table.

CE: Data Manipulation Language (DML) (Conti...)

- For Example:

insert into tblStudent **values**(120, 'Bhavik', 'Sarang', 9725158632);

select * from tblStudent;

update tblStudent **set** contactno=9632587410 **where** enro=120;

delete from tblStudent **where** enro=120;

Industry Interview Question

1. What data dictionary stores?
2. What is DDL and DML?
3. What is the main difference between DDL and DML?
4. Are DDL and DML two different database languages?
5. What is query in SQL?

Home Work

1. Which is the language of database? [1 Mark]
2. What is data dictionary? [1 Mark]
3. Define: Metadata. [1 Mark]
4. What is query language? [1 Mark]
5. Give the difference between DDL and DML statement. [2 Marks]
6. Explain DDL and DML with its commends and examples. [5 Marks]

CE: 2.5

Data Models

CE: 2.5 Data Models

- **Data Models** are the collection of conceptual tools for describing...
 - Data
 - Data relationships
 - Data semantics and
 - Consistency (Stability) constraints.
- A *data model* provides a way to describe the design of database at the Physical, Logical and View level.
- That means, data models define how data is connected to each other and; how they are processed and stored inside the system.
- Ultimately, **Data models define how the logical structure of a database is modeled.**

CE: 2.5 Data Models (Conti...)

- The data models can be classified into four different categories:
 1. Relational Model
 2. Entity-Relationship Data Model
 3. Object-based Data Models
 4. Semi-structured Data Model (XML)

1. Relational Model

- A **relational model** is a collection of tables to represent both data and the relationship among those data.
- Each table has multiple columns and each column has a unique name. and tables are also known as **relations**.
- Software such as **Oracle**, **Microsoft SQL Server** and **Sybase** are based on the relational model.

1. Relational Model (Conti...)

■ For Example:

✓ Relational Database for the Bank Customer Account.

tblCustomer		
<u>Cid</u>	Name	City
C01	Riya	Surat
C02	Jiya	Bardoli
C03	Diya	Navsri

tblAccount	
<u>Ano</u>	Balance
A01	5000
A02	6000
A03	7000

Rows

tblAccount_Holder	
<u>Cid</u>	<u>Ano</u>
C01	A03
C02	A01
C03	A02

Columns

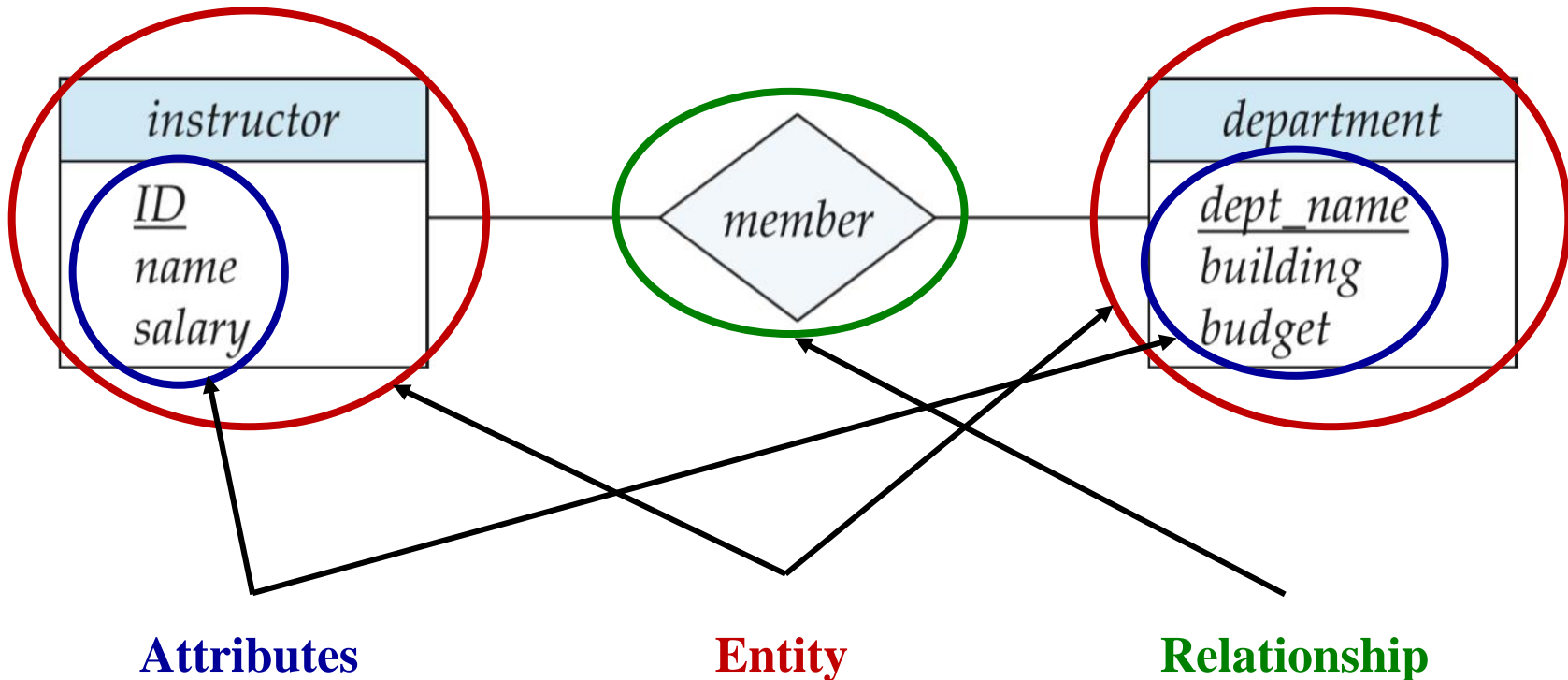
2. Entity-Relationship Data Model

- **E-R Model** is a collection of entities and relationships.
- An **entity** is a “thing” or an “object” in the real world that is distinguishable from other objects.
- **For Example:**
 - ✓ “Each person” is an entity, “bank account” is an entity, etc.
- **The Entity-Relationship Model is widely used in database design.**

2. Entity-Relationship Data Model (Conti...)

■ For Example:

- ✓ E-R Model for a university which has *department* and *instructor*.



3. Object-Based Data Model

- In this model, the information is represented in the form of **objects**.
- Object-oriented programming like C++, Java, or C# has become the dominant software-development methodology.
- An object-oriented data model can be seen as extending E-R model with the notation of **variables**, **methods** and **objects**.

3. Object-Based Data Model (Conti...)

■ For Example:

```
int getsalary();
string getname();
string getdept_name();
string setname(string new_name);
```

```
class instructor {
```

```
    /*Variables*/
```

```
    int id;
```

```
    string name;
```

```
    string dept_name;
```

```
    int salary;
```

```
};
```

```
/*Methods*/
```

```
string getname()
```

```
{
```

```
    return address;
```

```
}
```

```
string setname(string new_name)
```

```
{
```

```
    name = new_name;
```

```
}
```

```
void main() {
```

```
    instructor i; // “i” is an Object
```

```
    i.getname();
```

```
    i.setname(Bhavik);
```

```
}
```

3. Object-Based Data Model (Conti...)

- **Object-Based Data Model** or Object-Relational Data Model is the combination features of the object-oriented data model and relational data model.

4. Semi-structured Data Model

- The semi-structured data model plays a special role in database systems:
 1. It serves as a model suitable for mixing databases, i.e., two or more databases, that contain similar data with different schemas.
 2. It also serves as the fundamental model with XML notation, that are being used to share information on the web.
- The **Extensible Markup Language (XML)** is widely used to represent semi-structured data.

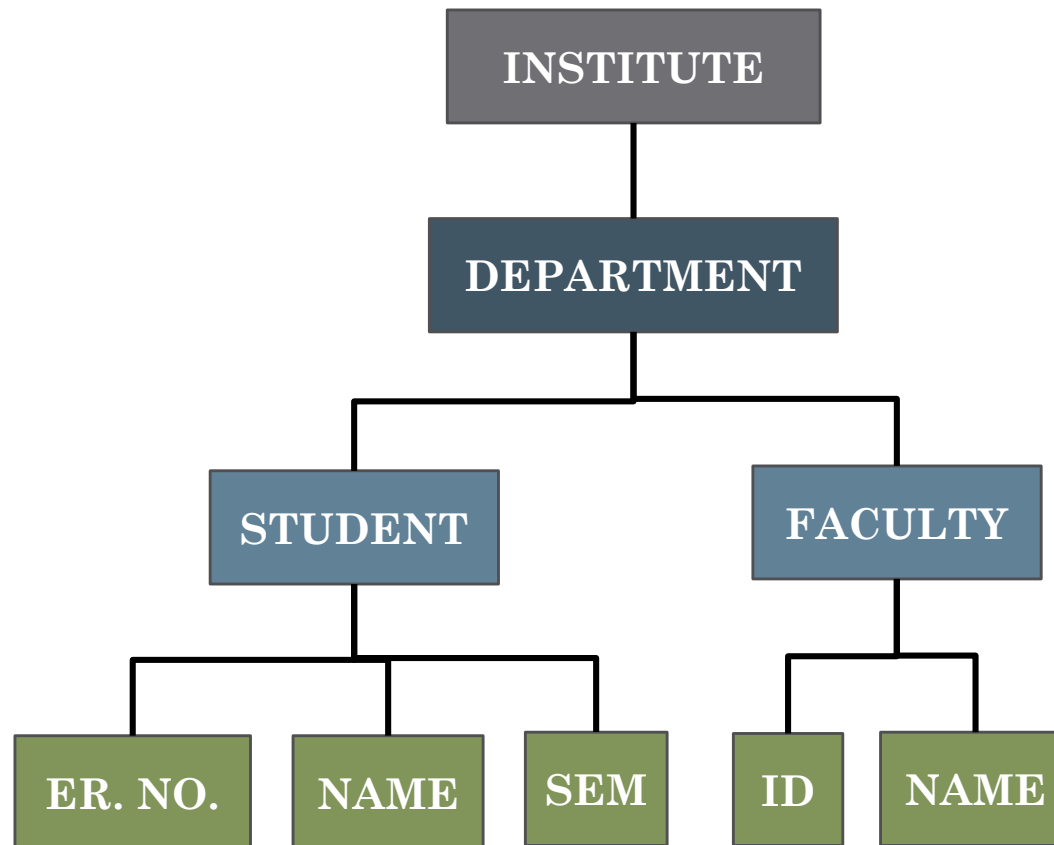
4. Semi-structured Data Model (Conti...)

- **XML** has the ability to specify new tags, and to create nested tag structures.
- It is not just a document, but its a great way to exchange data.
- The semi-structured data model is often referred to as self describing model also.
- **It is a tree-structured (hierarchical) data model.**

4. Semi-structured Data Model (Conti...)

- **For Example:**

- ✓ The database for a university in hierarchical structure.



4. Semi-structured Data Model (Conti...)

- **For Example:**

- ✓ The database for a university using XML.

```
<?xml version="1.0" encoding="UTF-8"?>
<institute name="BMIT">
  <department name="INT. MSC IT">
    <student enro="1050">
      <name>Aesha</name>
      <sem>I</sem>
    </student>
    <student enro="1051">
      <name>Kush</name>
      <sem>I</sem>
    </student>
    <faculty id="999">
      <name>Bhavik Sarang</name>
    </faculty>
  </department>
  <department name="MSC IT">
    <student enro="2001">
```

```
<name>Dhruvi</name>
      <sem>7</sem>
    </student>
  </department>
</institute>
```


CE: 2.5 Data Models (Conti...)

- Other data models like **the network data model** and **the hierarchical data model** controlled with the relational data model.
- These models were tightly closed, as their implementation was quit complex to perform the task of modeling data.

International Certification Question

Q1.	A feature of relational database is that a single database can be spread across several tables.
A.	True
B.	False

Ans: A

International Certification Question

Q2.	The primary difference between the different data models lies in the methods of expressing relationships and constraints among the data elements.
A.	True
B.	False

Ans: A

International Certification Question

Q3.	The object-oriented data models are used to...
A.	Specify overall logical structure of the database.
B.	Describe data and its relationship.
C.	Higher level description of storage structure and access mechanism.
D.	All of these

Ans: B

International Certification Question

Q4.	The _____ data model represents an entity as a class.
A.	Relational
B.	Entity Relationship
C.	Object-oriented
D.	Semi-structured

Ans: C

International Certification Question

Q5.	Tables are also known as _____.
A.	Relation
B.	Entity
C.	Database
D.	All of Above

Ans: A

Class Work

1. Consider the following relational database, that keeps a track of the business trips for salespersons in a sales office:

SALESPERSON(Ssn, Name, Start_year, Dept_no)

TRIP(Trip_id, From_city, To_city, Departure_date,
Return_date, Ssn)

EXPENSE(Trip_id, Account, Amount)

- A trip can be charged to one or more accounts.
- Specify the primary keys and foreign keys for the given schema.

Class Work

2. Consider the bank database:

branch (branch_name, branch_city, assets)

customer (cust_name, cust_street, cust_city)

loan (loan_number, amount, branch_name)

borrower (customer_name, loan_number)

account (account_number, balance, branch_name)

depositor (customer_name, account_number)

- Identify and give primary keys and foreign keys to an appropriate field, using relational model.

Industry Interview Question

1. Which data models were used for maintaining database?
2. How data definition language used in a database is differ from Java or C++?

Home Work

1. What are Data Models? [1 mark]
2. Briefly explain relational model by giving example. [2 marks]
3. Explain entity-relationship model. [2 marks]
4. List and explain all the various types of data models with proper example. [5 marks]

CE: 2.6

Database Architecture

CE: 2.6 Database Architecture

- A Database Management system is not always directly available for users; and applications to access and store data in it.
- A Database Management system can be **centralized** (all the data stored at one location), **decentralized** (multiple copies of database at different locations) or **hierarchical**, depending upon its architecture.

CE: 2.6 Database Architecture (Conti...)

- Most users of a database system today are not present at the site of the database system, but they connected through a network.
- Therefore, there is a difference between **client machines** (on which remote database users work) and **server machines** (on which the database system runs).

CE: 2.6 Database Architecture (Conti...)

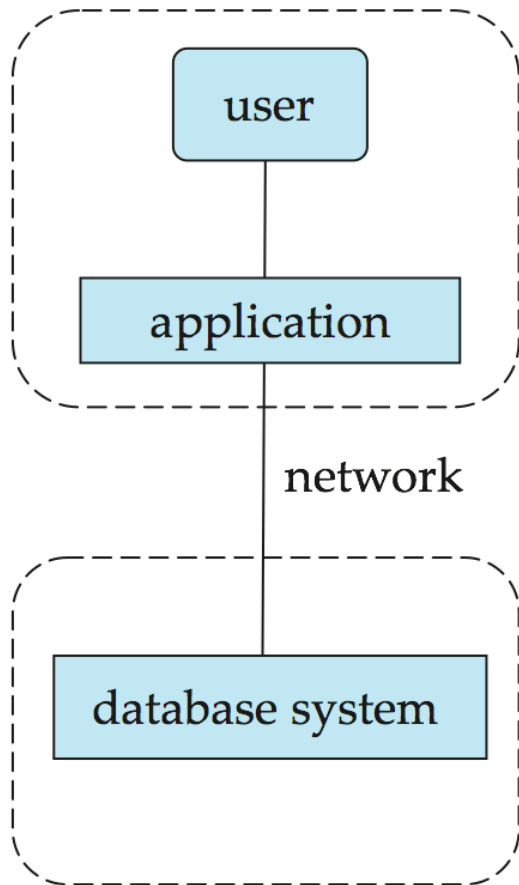
- Database Architecture is logically of two types:

1. Two-tier architecture
2. Three-tier architecture

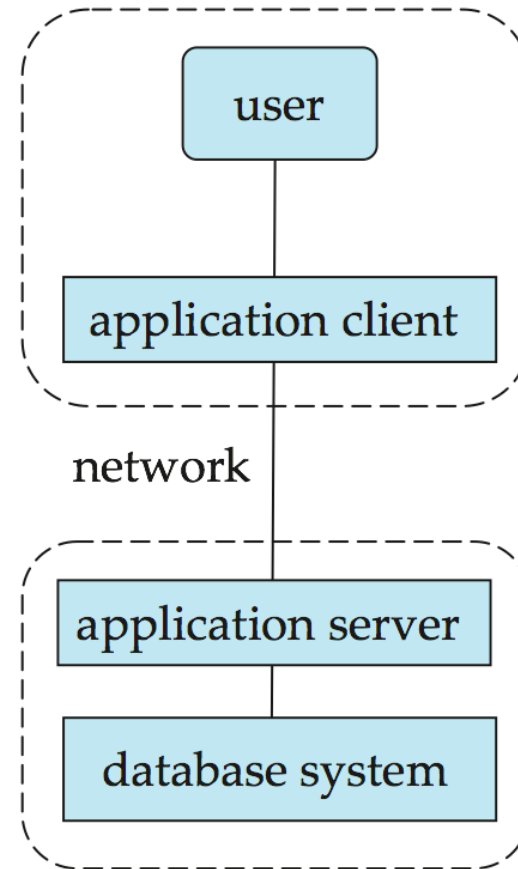
❖ **One-tier architecture:**

- One-tier DBMS architecture also exist, when the database is directly available to the user for using it to store data.
- Generally such a setup is used for local application development, where programmers communicate directly with the database for quick response.

CE: 2.6 Database Architecture (Conti...)



(a) Two-tier architecture



(b) Three-tier architecture

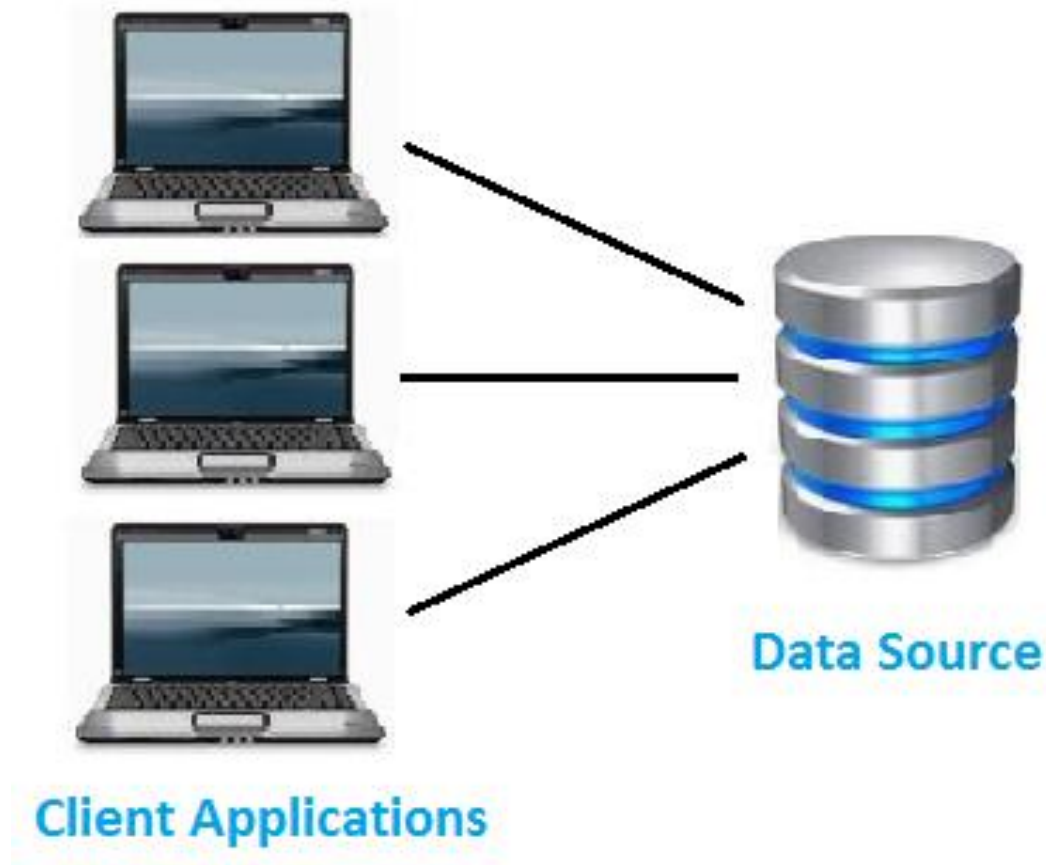
CE: 2.6 Database Architecture (Conti...)

1. Two-tier architecture:

- Two-tier DBMS architecture includes an Application program between **the user** and **the DBMS**, which is responsible to communicate the user's request to the DBMS; and then send the response from the DBMS to the user.
- Application program interface standards like ODBC (Open Database Connectivity) and JDBC (Java Database Connectivity) are used for interaction between the *client* and the *server*.

CE: 2.6 Database Architecture (Conti...)

1. Two-tier architecture: (Conti...)



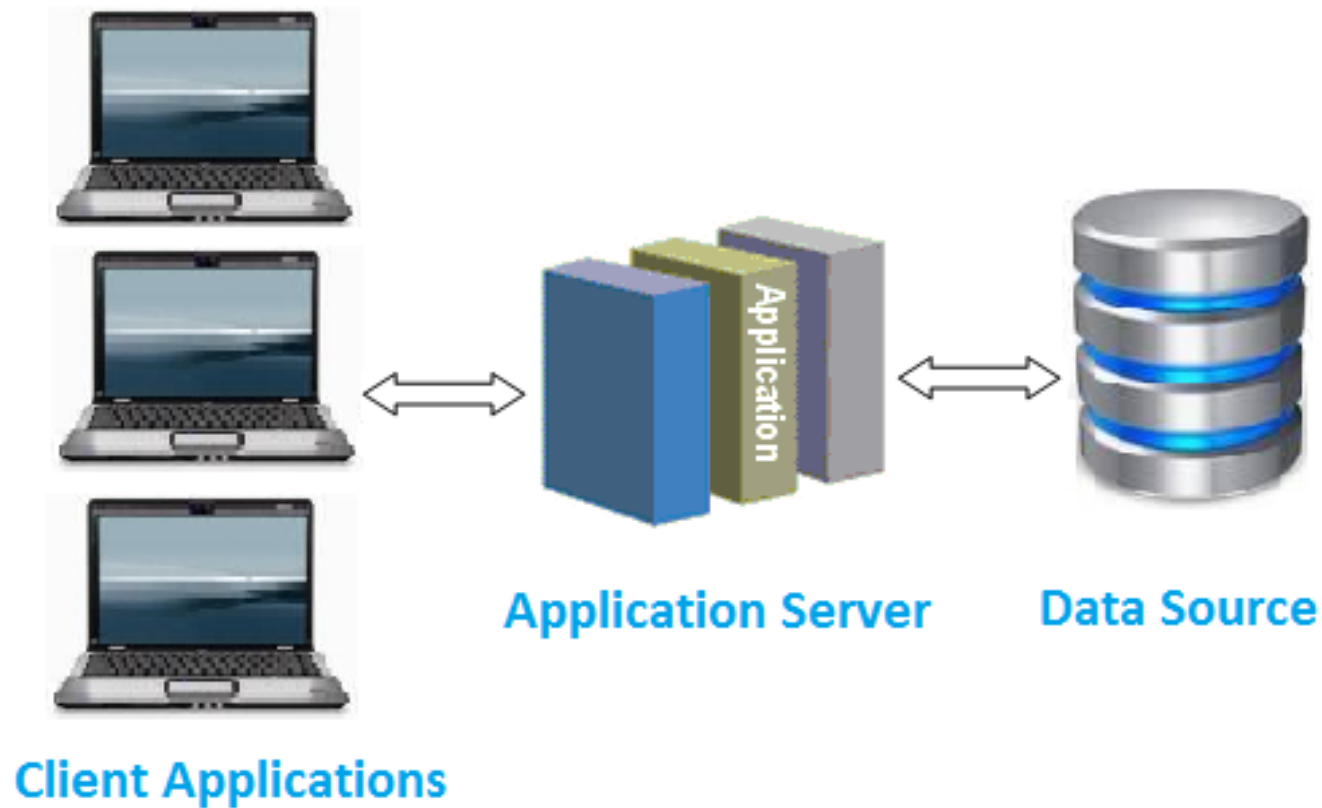
CE: 2.6 Database Architecture (Conti...)

2. Three-tier architecture:

- Three-tier DBMS architecture is the most commonly used architecture for web applications.
- The *client machines* act as a front end and do not contain any direct database calls.
- A client communicates with the *application servers* through GUI form interface and interacts with database system to access data.
- The *business logic* of application says what actions to be carried out under what condition.

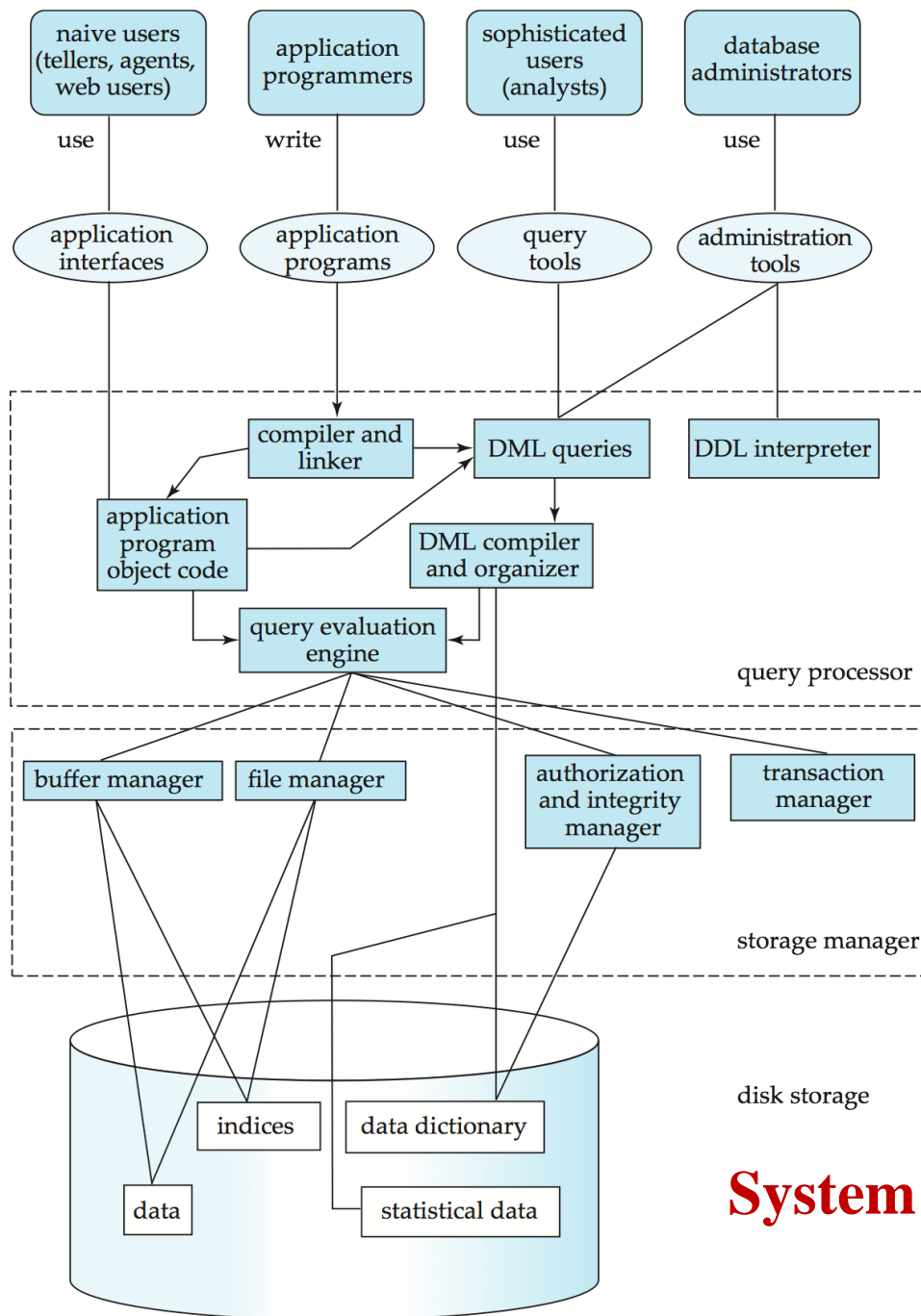
CE: 2.6 Database Architecture (Conti...)

2. Three-tier architecture: (Conti...)



CE: 2.6 Database Architecture (Conti...)

- The *database system architecture* has various components of a database system and the connections among them.



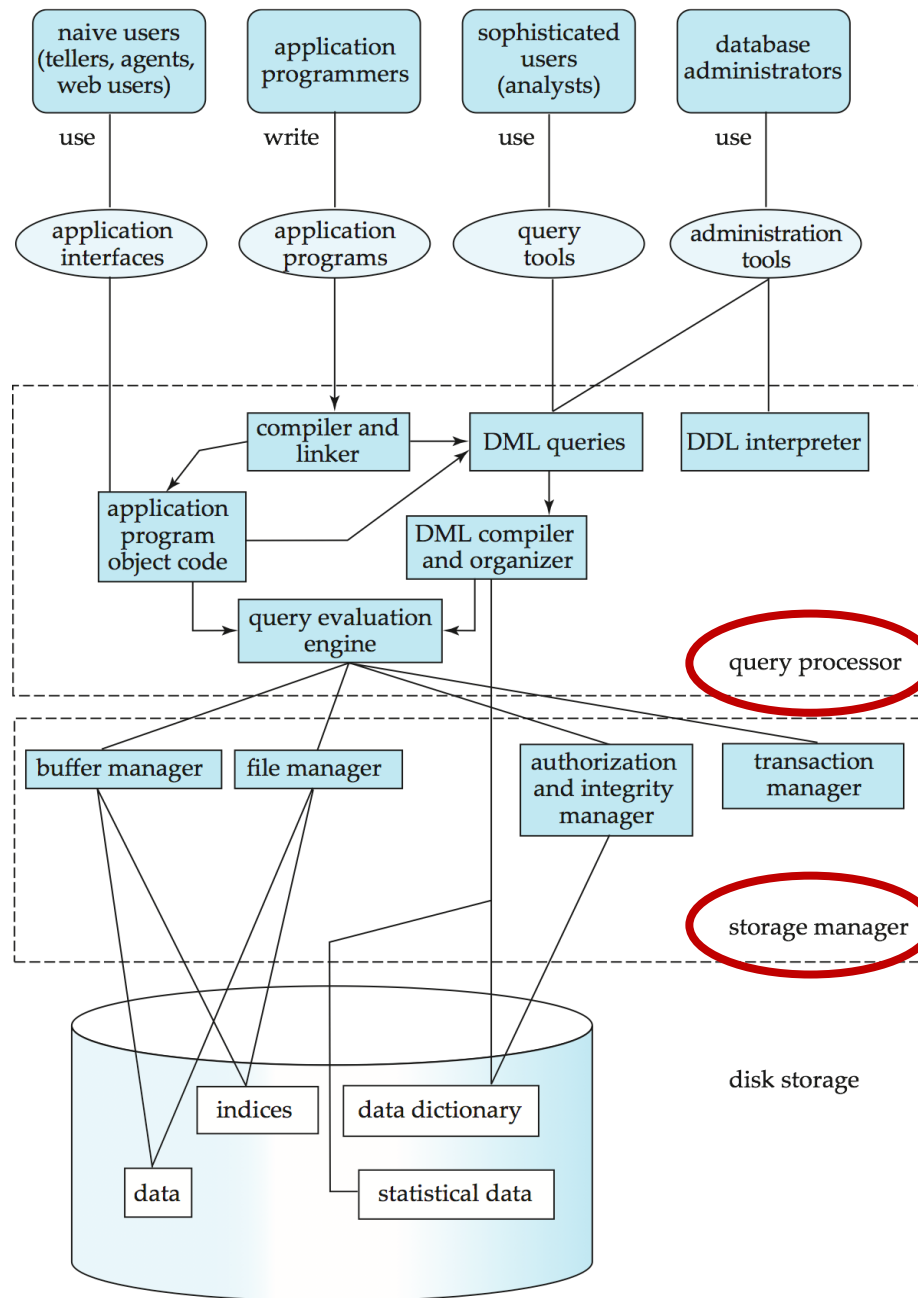
System Structure

CE: 2.7

Data Storage and Querying

CE: 2.7 Data Storage and Querying

- A database system is divided into modules that deal with each of the responsibilities of the overall system.
- The functional modules/components of a database system can be broadly divided into:
 1. The storage manager and
 2. The query processor



1. Storage Manager:

- The **storage manager** is the component of a database system which is responsible for storing, retrieving, and updating data in the database.
- The storage manager translates various DML statements into low-level file-system commands.
- It provides the interface between the low-level data stored in the database; and the application programs and queries submitted to the database system.

1. Storage Manager: (Conti...)

- The storage manager is only responsible for the interaction with the **file manager**.
- The raw data are stored on the disk using the file system, which is provided by the operating system.

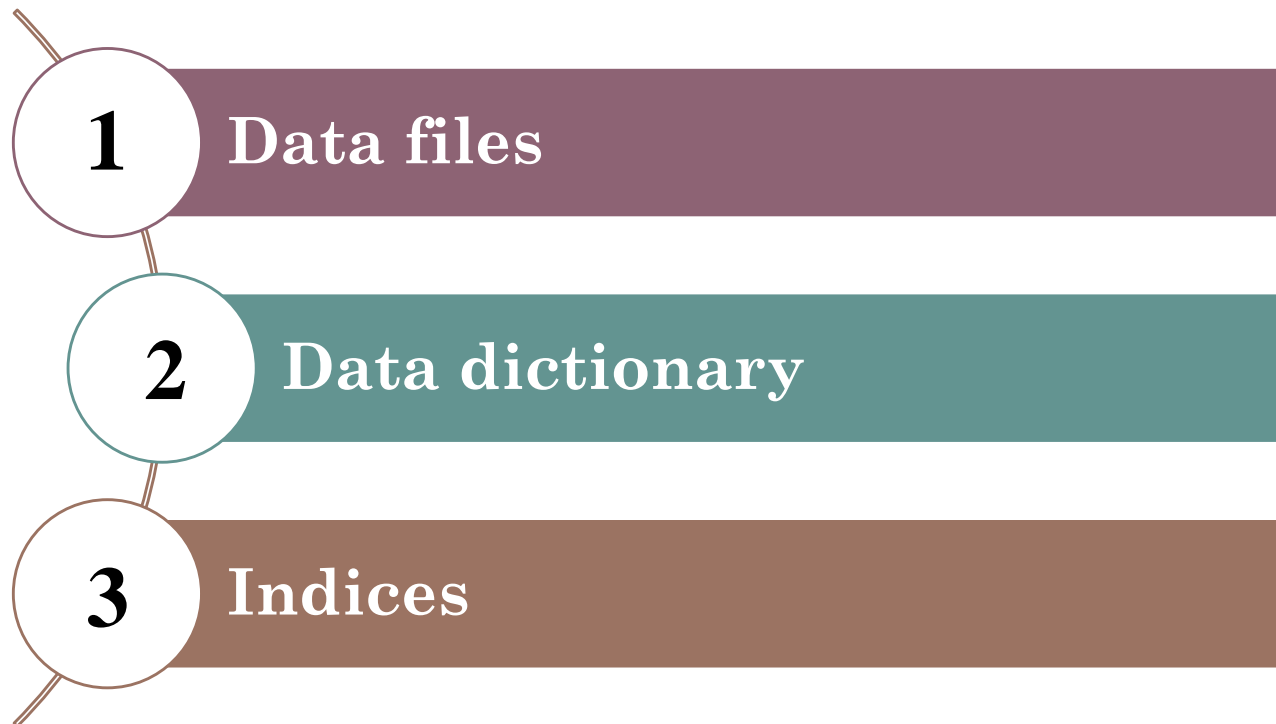
1. Storage Manager: (Conti...)

The storage manager components include:

- 1 Authorization Manager
- 2 Integrity Manager
- 3 Transaction Manager
- 4 File Manager
- 5 Buffer Manager

1. Storage Manager: (Conti...)

The storage manager implements several data structures as part of the physical system implementation:



2. Query Processor:

- The **query processor** is the database system to simplify and facilitate access to data.
- It deals with the execution of DDL and DML statements.

2. Query Processor: (Conti...)

The query processor components include:

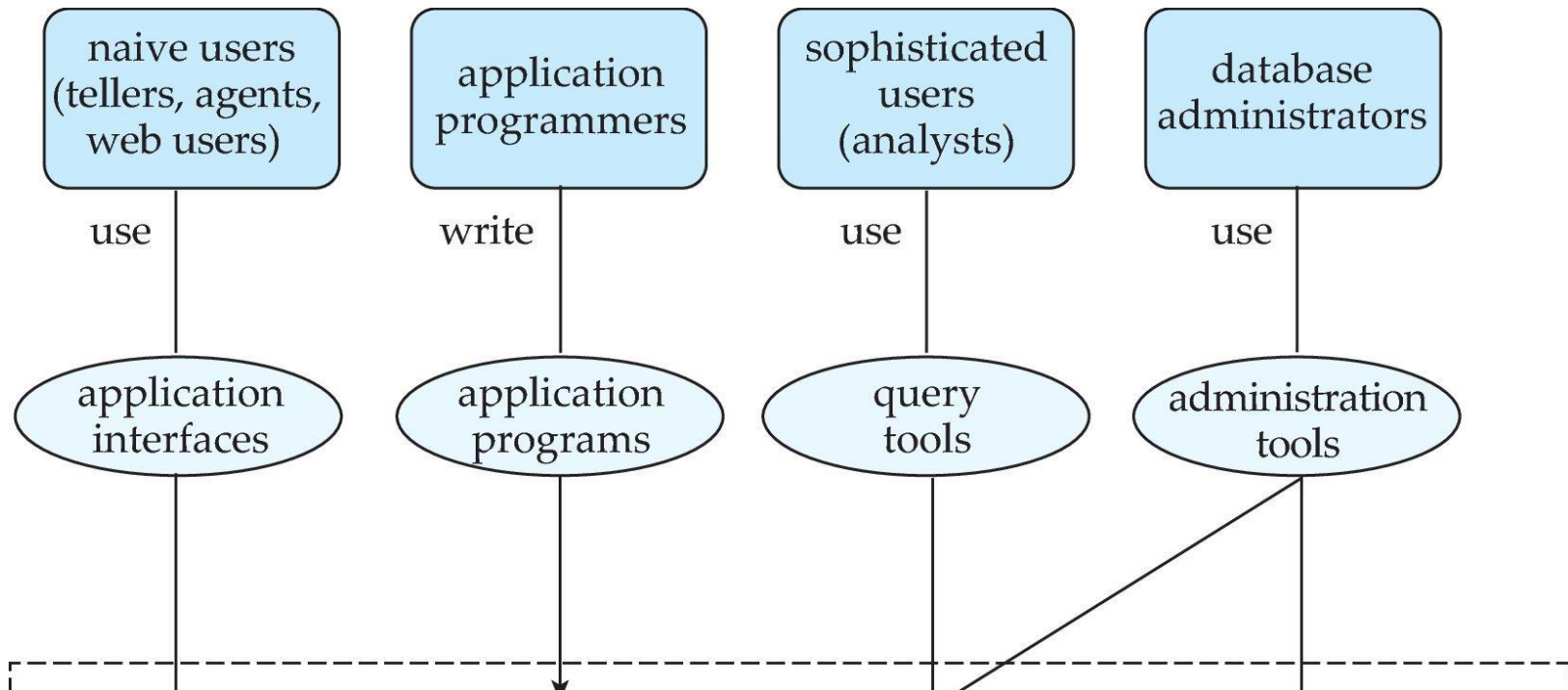
- 1 DDL interpreter
- 2 DML compiler
- 3 Query evaluation engine

CE: 2.8

Database Users and

Administrators

CE: 2.8.1 Database Users



CE: 2.8.1 Database Users (Conti...)

- **There are four types of users:**
 1. Naive users
 2. Application Programmers
 3. Sophisticated users
 4. Specialized users

CE: 2.8.1 Database Users (Conti...)

1. Naive users:

- An unsophisticated users who interact with the system by using permanent application programs are called **naive users**.
- **For example:**
 - ✓ Automated Teller Machine

OR

- Any user who does not have any knowledge about database can be called as naive users.
- There task is just to use the developed application and get the desired results.

CE: 2.8.1 Database Users (Conti...)

1. Naive users: (Conti...)

- **For example:**

- ✓ Clerical staff in any bank is a naive user.
 - They don't have any knowledge about DBMS, but they still use the database and perform their given task.

CE: 2.8.1 Database Users (Conti...)

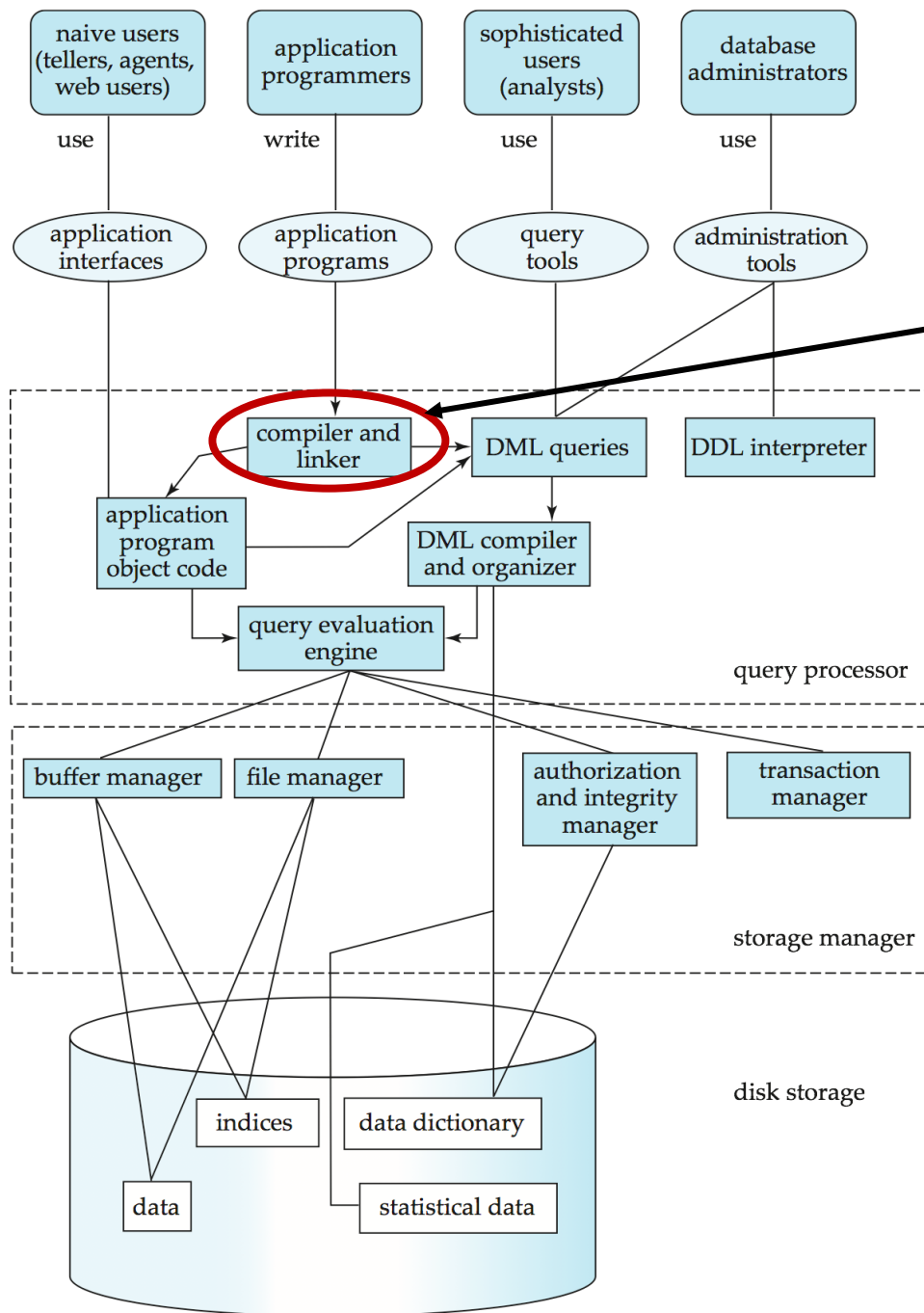
2. Application Programmers:

- The computer professionals who write application programs that uses the database are called **application programmers**.
- These application programs are written in programming languages like COBOL, C, PL/1, Pascal, C++, JAVA, C#, etc.
- Retrieving information, creating new information and changing existing information is done by these application programs.

CE: 2.8.1 Database Users (Conti...)

2. Application Programmers: (Conti...)

- They interact with DBMS through DML calls. And all these functions are performed by generating a request to the DBMS.
- If application programmers are not there, then there will be no creativity in the whole team of Database.



It is the host language compiler, which generates the object code.

CE: 2.8.1 Database Users (Conti...)

3. Sophisticated users:

- The users who interact with the system without writing programs are called **sophisticated users**.
- These users have great knowledge of database query language.
- They do not write programs, but they can interact with the system by writing queries (through database query language) in the form requests.
- These users access data by entering different queries from the terminal end.

CE: 2.8.1 Database Users (Conti...)

4. Specialized users:

- These users are sophisticated users who write special database application programs.
- That may be a CADD (Computer aided design and drafting) systems, knowledge-based and expert systems, complex data systems (audio/video), etc.
- These application programs do not fit into the traditional data-processing framework.

CE: 2.8.2 Database Administrator

- A person who has central control over the data and the programs that can access those data system is called **Database Administrator (DBA)**.

- **Functions of a DBA:**
 - 1) Schema definition.
 - 2) Storage structure and access-method definition.
 - 3) Schema and physical-organization modification.
 - 4) Granting of authorization for data access.
 - 5) Routine maintenance.

International Certification Question

Q1.	A client communicates with the _____ through GUI form interface and interacts with database system to access data.
A.	Application servers
B.	Application Clients
C.	Database system
D.	None of these

Ans: A

International Certification Question

Q2.	Duty of Integrity manager is to apply integrity and _____ checks.
A.	Concurrency
B.	Multiplicity
C.	Security
D.	None of these

Ans: C

International Certification Question

Q3.	Term that says what actions to carry out under what conditions, is known as the
A.	Data logic
B.	Business logic
C.	Computing logic
D.	File logic

Ans: B

International Certification Question

Q4.	Application resides at client machine and invokes database system functionality at server machine through query statement, is type known as
A.	One-tier architecture
B.	Two-tier architecture
C.	Three-tier architecture
D.	N-tier architecture

Ans: B

International Certification Question

Q5.	Query processor translates different DML commands to lower level commands.
A.	True
B.	False

Ans: A

International Certification Question

Q6.	Who detects the failure of the system and restore the database to consistent state?
A.	Naive Users
B.	Application Programmer
C.	Storage manager
D.	Database Administrator

Ans: C

International Certification Question

Q7.	Which of the following is a database administrator's function?
A.	database design
B.	backing up the database
C.	performance monitoring
D.	user coordination
E.	All of the above

Ans: E

Industry Interview Question

1. What is the difference between Two-tier and Three-tier architecture?
2. What is the significance of Indices in database?
3. How many types of database users are there? Which are they?
4. What are the responsibilities of Database Administrator?

Home Work

1. What is the role of Transaction Manager in Storage Manager?
[1 Mark]
2. Which are several data structures used as part of the physical system implementation in a disk storage?
[1 Mark]
3. List all the components of Query Processor.
[1 Mark]
4. State the use of Query Evaluation Engine.
[1 Mark]
5. Give the difference between Two-tier and Three-tier architecture.
[2 Marks]
6. List all the components of Storage Manager.
[2 Marks]
7. Differentiate between Naive users and Sophisticated users.
[2 Marks]
8. Who is a DBA? What are the responsibilities of DBA?
[2 Marks]
9. Briefly explain the purpose of Storage Manager and Query Processor with its components.
[5 Marks]

Home Work

10. List and briefly explain all database users. [5 Marks]
11. Draw the labeled diagram of Database Architecture. [5 Marks]

Thank
you

