Introduction to Database Management Systems

Neeraj Mishra

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BBA, MBA, B.Com, BMS, M.Com, BCA, MCA

and many more courses for Various Universities

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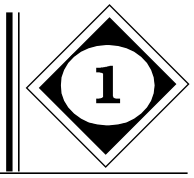
INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS

Basic Concepts



INTRODUCTION

The era in which we are living is called "Information era". In the age of this "Information era" there is need of instant availability of information for dicision making. To make the information instantly available to us, the Databases along with computer, and telecommunications technology play an important role. As computers hence become a part and parcel part of our everyday life so does the databases. The databases and database systems have become an essential part of our everyday life. For example, when we deposit or withdraw money in/from a bank reserve tickets for train or airoplane, get or return books from/to a library, directly or indirectly we have some kinds of interactions with databases. In this case, we interact "customer databases" maintained by banks, "passenger databases" maintained by Railways and Airlines, and "library databases" maintained by libraries. An analogy of a database is a "Telephone Directory" where subscribers names and their relevant numbers are listed in alphabetic order. This "Telephone Directory" can be stored in a computer in the form a database and called "Telephone Directory Database" and then can be arranged by subscribers name for the ease and fast access.

Databases such as "Telephone Directory Database" were only capable to store textual and numeric data *e.g.,* subscribers names and their numbers respectively. These types of databases are called **Traditional databases**. But with the advent of new technologies such as multi-media, you can store pictures, video clips, sound messages along with text and numbers. Such types of databases are called **Multi-media.**

DATABASES

And last, but not least, there is another kind of databases called **Real Time Databases** that can control industrial and manufacturing process.

In this chapter we will discuss

- What a Database is?
- Need for a DBMS;
- Structure of DBMS;
- Three-tier architecture of DBMS; and
- Data Models.

WHAT IS A DATABASE?

A database is a collection of relevant information stored so that it could be available to many users for different purposes. The content of a database called "data" is collected from all the different sources within and outside organization. A computerized database enables the user to got the required information instantly. A database can handle inventory, accounting and filing and use the information in its files to prepare summaries, estimates and reports.

Databases have already a null defined market for specific information for highly selected group of users on almost all the subjects. Such a database is MEDLINE that provides medical information for doctors. Likewise WEST LAW is a computer based information service that catters to the requirements of lawyers.

WHAT IS DBMS?

The key to success of a database is the manner in which information within it is arranged. The management of data in a database system is done by means of a general purpose software package called **Database Management System (DBMS)**. Thus a **Database Management System (DBMS)** is a software that can be used to set up and monitor a database and can manage the updation and retrieval of data that has been stored in it.

ORACLE, SQL Server, dBASE, Foxbase, Foxpro, MS-Access, Ingers etc. are some commercially available DBMS.

Most DBMSs provide following facility to users:

- Create ion, deletion and duplication (copying) of databases.
- Isertion, deletion, modification and preventing duplication of data in a database.
- Arrangement of data in a particular order (either in ascending or descending order) in a database.
- Recovery of data from system failures.
- Retrieval of data from a database.
- Report generation based on data stored in a database.
- Sharing of data stored in a database among users.

NEED OF A DBMS

Any organization be it a Government Department, Bank, University, Hospital or Bank, require a large amount of data to collect, store and process them as and when required in future. This is because they have a need of instant availability of information. This is why there is a need of DBMS.

FILE ORIENTED APPROACH *VS.* DATABASE ORIENTED APPROACH

The convention approach for data process is to store data locally and develop a program (or many programs) for each type of application. In the past, different users had programs that handled their own independent stored data. Consequently, there were more than one data files with the same data used by different applications. This is the factor that resulted in **data redundancy**. An example will clarify it better. Suppose, a payroll application program is used by Accounts department and an Employee record keeping system is used by the Personnel department in an organization.

Both applications have their master files containing common data such as employee names, addresses, designation, department, salary, employee code, etc. Although the data required by the two applications are same, but data will have to be stored in two different places in a computer, because each application suparately stores and maintains data. Is in not a case of data redundancy/duplicacy? Indeed it is.

An organization needs flow of information across the applications and this requires sharing of data, which is significantly lacking in the traditional/convention "File oriented approach" towards data processing. One major limitations of this approach is that the programs become dependent on the files and the files become dependent on the programs.

The problem pointed out with the File-oriented approach to data processing can be solved using **Database approach.** A **database** is a persistent collection of logically related data. Databases are self-describing in nature. A database contains not only the data but also the complete definition of database structure and constraints, which are stored in a system catalog. A DBMS manages this data and allows data sharing and integration of data of an organization within a single database. A DBMS facilitates user to create databases, modify the structure of a database and its data value stored in it, insert data in a database, retrieve data from a database inforce the data integrity within a database, etc. In brief, database, approach to data processing reduces data redundancy, makes the data sharable and independent, provides data integrity and provides improved security and backup and recovery, which will be discussed under the subheading "Advantages of Database Approach".

Limitations of File Oriented Approach

The file based system and file oriented approach to data processing has some limitation or disadvantage, which are as follows:

- **Data redundancy/duplication:** Due to decentralization of data, the file oriented system leads to uncontrolled duplication of data, which results in a wastage of a lot of storage space. It also costs time and money to enter data more than once.
- **Separation and isolation of data and programs:** Data is stored in separate files and each data file requires separate processing program. It becomes complex when the data is required to be retrieved from more than two files as a large amount of data has to be search. Each department needs to keep its files updated separately.
- **Program/Data Dependency:** In the file oriented approach if a data field is to be added to a master data file, all such programs that access the master file would have to be modified to allow for this new field which would have been added to the master record. In this way, programs become dependent on the data files and data files become dependent on programs.

- **File formats incompatibility:** Since the structure of data files are embedded (defined) in application programs, the structure is dependent on application programming languages. The file structure created with one language differs to other. For example, the structure of a file created with COBOL differs from one created with PASCAL and so they are incompatible to each other. This incompatibility makes them difficult to process combinedly. To convert them into some common format there will be need of software to be developed, which is a time consuming and expensive job.
- **Supports predefined queries and reports:** In file-oriented system queries and reports are defined by the application programmer during the development of application program. This is the fact, that in any business organization the type and the requirement number of queries and reports increases as the time passes by. Again any new query or report needed by organization have to be developed by the application program; otherwise no new query or report of the data could be generated.

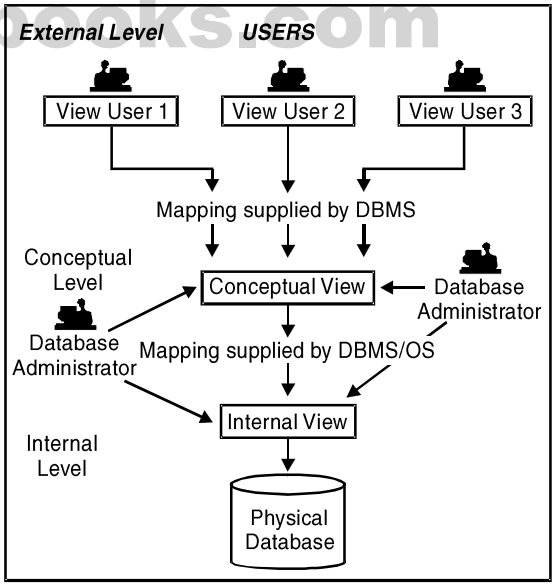
Advantages of Database Approach

The database approach to data processing has many advantage over file-based on file-oriented approach, which are as follows:

- **Reduction of redundancies:** The main reason of data redundancy in file oriented system to data processing is that each group of users maintains its own files. Maintaining separate copies of similar data, results in not only wastage of storage space but may also results in data inconsistencies. The files that represents same day may become inconsistent as some may be updated whereas others may not be.
  In database approach data can be stored centrally at a single storage location with controlled redundancy under DBMS, which saves space, thus elimanes redundancy and does not permit inconsistency.
- **Data Sharing:** A DBMS allows any number of users or application programs to share a database under its control. A database belonging to an organization can be shared by all authorized users according to the permissions granted to them by the DBA (Database Administrator).
- **Data Independence:** In file-oriented approach data files depend on the programs and programs depend on data file. This is why modification in either, requires modification in another one. Database Management Systems database structure and its data from application programs; however application program manipulates data stored in the database. This is called **Data Independence,** where details of data are not exposed. DBMS provides an abstract view of database and hide its details, because it isolates data descriptions from data.
- **Improved Integrity:** Data integrity refers to validity and consistency of data. Data integrity means that data should be accurate and consistent. This is achieved by providing some validation checks or constraints on the database. There are some integrity rules almost provided by all the DBMS that the database is not allowed to violate. Constraints may be applied to data items (fields) within a record and/or on records too for validation of data at the entry time. For example, the basic salary of an employee must be between 5000 and 20000. While entering the data for basic salary in the database, say Employee database, the database must check against this rule (constraint).
- **Efficient data access:** A DBMS is capable to provide services to end users, where they can retrieve the from a database immediately. For this DBMS utilizes techniques to store and retrieve data efficiently at least for unseen queries.
- **Multiple user interface:** A DBMS provides various level of interfaces to different levels of users to work with databases. A DBMS such as Visual Foxpro (6.0) provides:
- query language such as SQL as an interface for casual users.
- programming language such as Xbase as an interface for application programmer.
- Menu and wizards as an interface for novice users.

  Besides these interfaces, a DBMS should also provide natural language interfaces for stand alone users, which are still not available in standard form.
- **Representation of complex relationship among data:** Since a database may have data that needs to be interrelated with each other in many ways, a DBMS must facilitate the user to establish the relationships among databases and retrieve and update the related data easily and efficiently. For example a "student" database and a "student-course" database may need to be related, where a student may have opted many courses. This is the case of "one-to-many" relationship.

- **Security of Database:** Data is not only a vital resource of any organization, but it is confedential too. In a shared system where multiple users access the data, data is a subjected to security. All data/information may be accessed by all users; but with restricted permissions. For example, some users may view, delete, modify data records whereas some can only view data records and even some users can not view all the data-fields stored in a database. For examples some users may not be able to see the salary of employees in the "Empolyee"database, whereas the users of Accounts department can. These permissions to the database are granted by the DBA (Database Administrator) to the users. In this way unauthorized access to the database is prohibited by a DBMS. For security and authorization the DBA assigns usernames and passwords to the authorized users and grants permissions/previleges as will for accessing a database. DBA implements it using security and authorization subsystem of the DBMS.
- **Improved Backup and Recovery:** A file-based system usually fails to provide measures to protect data from system failure and it left this responsibility solely on user. So the user of a file-based system is required to the take the backup of the database periodically. But, a DBMS provides facilities for recovering the hardware and software failures. Each and every DBMS has a Backup and Recovery subsystem, which is responsible for recover the database from system failure. In case of system failure this subsystem restores the database to a state in which it was before the failure event occurred.
- **Support concorrency control:** A DBMS supports multiple transactions to occur simultaneously.
- **Logical or Three-Level Architecutre of DBMS** : There are two different views to look at the architecturs of a DBMS : the logical DBMS architecture and physical DBMS architecture. The logical architecture deals with the way data is stored and presented to the users. It describes how data in a database is perceived by users. It is not concerned with the subject that how data is handled and processed by the DBMS. The physical architetures concerned with the software components that make up a DBMS. The method of data storage on the underlying file system is not revealed by the DBMS to the users and it facilitates users to manipulate data without worring about where it (data) is stored and how it is actually stoned. This results in the database having different levels of abstraction. A majority of DBMS's are based on the ANSI/ SPARC generalised DBMS architecture. The generalized architecture of a database system is called ANSI/SPARC model. This model divides a DBMS into three levels of abstraction.
  - ✦ Internal level or physical level
  - ✦ Conceptual level
  - ✦ External level or view level. The figures below shows the logical architecture of a typical DBMS as per ANSI/SPARC model
- **The Extenral Level or View Subheading Level :** The external or view level is the highest level of abstraction of database. It is the level of the architecture of a DBMS closest to the users. This is the level which is concerned with the way. which data are viewed/observed by the users. They can be either an application program or an end user. There can be many external views of a database as any number of external **schema** can be defined and they can overlap each other. It consists of the definition of logical records and relationships in the external view. It also contains the methods for deriving the objects such as entities, attributes and relationships in the external view from the conceptual view.



The three-level (logical) architecture for a DBMS as per ANSI/SPARC model