IT2201 / IT2601 / IT2564 / IT2621 / IT2521 / IT2323

Database Management Systems

Unit 1
Introduction to
Database Systems

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Unit Objectives

□ At the end of this unit, you should be able to

- Identify the differences between the traditional file-based processing and the database approach.
- Explain the architecture of the DBMS.
- Describe the functions and major components of a DBMS.
- Describe the advantages and disadvantages of the database approach.
- Identify the DBMS products available in the market.

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File-based Systems

- ❑ What is File-Based System?
  - A collection of application programs that perform services for the end users such as the production of reports. Each program defines and manages its own data.
- ❑ Characteristics
  - Focuses on data processing needs of individuals.
  - Implements for a specific application.
  - Each application is designed with its own set of data file.
  - Program-data dependence.

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Example of a file based processing
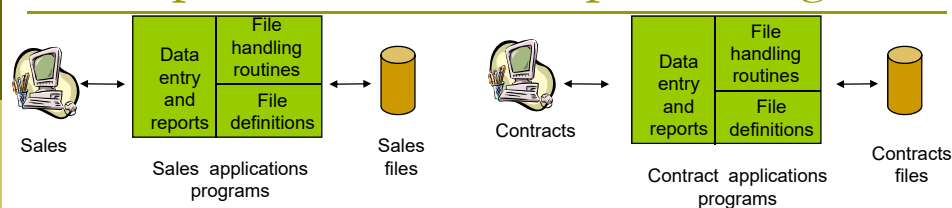
Sales Files

PropertyForRent (propertyNo, street, city, postcode, type, rooms, rent, ownerNo)
PrivateOwner (ownerNo, fName, lName, address, telNo)
Client (clientNo, fName, lName, address, telNo, prefType, maxRent)

Contract Files

Lease (leaseNo, propertyNo, clientNo, rent, paymentMethod, deposit, paid, rentStart, rentFinish, duration)
PropertyForRent (propertyNo, street, city, postcode, rent)
Client (clientNo, fName, lName, address, telNo)

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Limitations of File-based Systems (1)

- Separation and isolation of data
  - Each program maintains its own set of data
  - More difficult to process data

- Duplication of data
  - Same data is held by different programs
  - Wasted storage space
  - Loss of data integrity

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Limitations of File-based Systems(2)

- Data dependence
  - File structure is defined in the program code.
  - Changes to an existing file structure are difficult.

- Incompatible file formats
  - Files formats created by different programming language (eg COBOL and C) are incompatible. Difficult to process these files jointly.
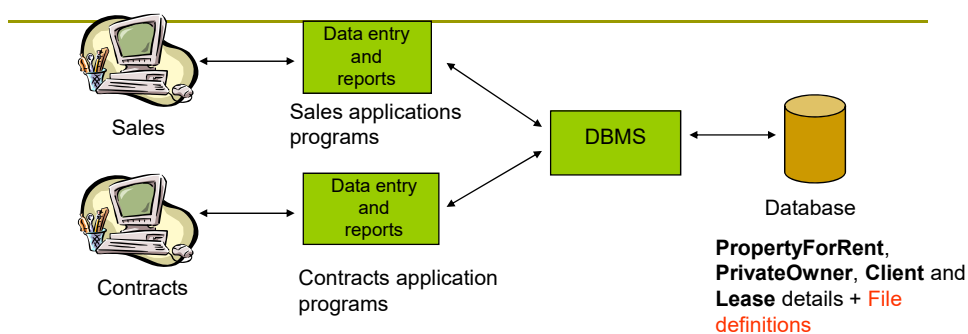
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Database Approach

- ❑ Database Approach:
  - ▪ Description of data is stored separately and independently.
  - ▪ Sharing of data by different programs.

- ❑ Requirement:
  - ▪ A Database Management System (DBMS) to manage database environment.

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Database Approach

Data entry and reports

Sales

Sales applications programs

Data entry and reports

Contracts

Contracts application programs

DBMS

Database

PropertyForRent, **PrivateOwner**, **Client** and **Lease** details + File definitions

PropForRent (propertyNo, street, city, postcode, type, rooms, rent, ownerNo)

PrivateOwner (ownerNo, fName, lName, address, telNo)

Client (clientNo, fName, lName, address, telNo, preType, maxRent)

Lease (leaseNo, propertyNo, clientNo, paymentMethod, deposit, paid, rentStart, rentFinish)

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Database Definition

- Database
  - It's a shared collection of logically related data and a description of this data, designed to meet the information needs of an organization.
- Shared collection – can be used simultaneously by many departments and users.
- Logically related - comprises the important objects and the relationships between these objects.
- Description of the data – the system catalog (meta-data) provides description of data to enable data independence.

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Database Management System (DBMS)

- Definition
  - A software system that enables users to define, create, and maintain the database and provides controlled access to this database.
- Database Languages
  - Data Definition Language (DDL) is used to define and create the database.
  - Data Manipulation Language (DML) is used to manipulate its data.
- Controlled access is provided through its various subsystems such as security, integrity, concurrency control, recovery control and user-accessible system catalog.

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The difference between Text file and Database file

Text file - Used in file-based system. Only data is stored.

```
100,"June Tan","F",1-4-1978 0:00:00,$5000.00,"S1"
200,"Ong Ah Hwee","M",25-5-1955 0:00:00,$7000.00,"S1"
300,"Jimmy Chia","M",6-6-1980 0:00:00,$3000.00,"S2"
```

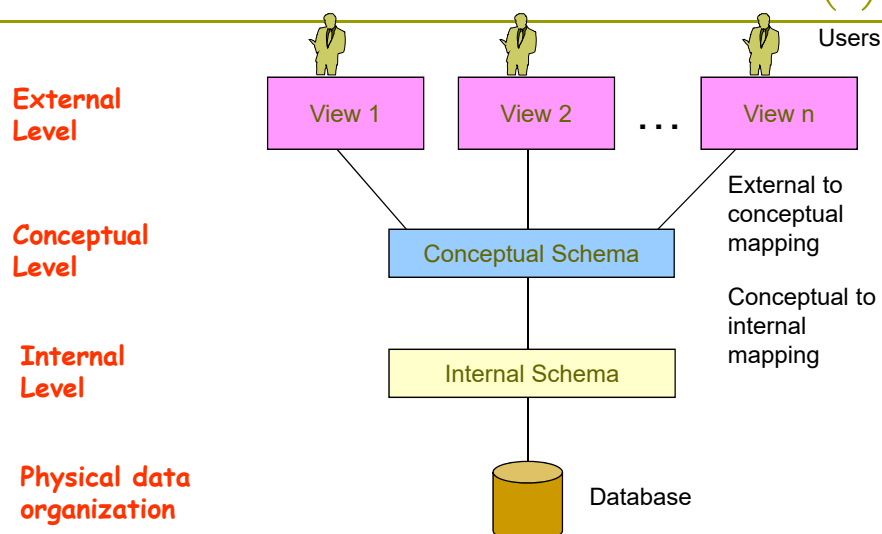**Database file – It stores both meta-data and data.**

Meta-data

Field Name	Data Type
empNo	Number
name	Text
gender	Text
birthdate	Date/Time
salary	Currency
grade	Text

Data

empNo	name	gender	birthdate	salary	grade
100	June Tan	F	01/04/1978	$5,000.00	S1
200	Ong Ah Hwee	M	25/05/1955	$7,000.00	S1
300	Jimmy Chia	M	06/06/1980	$3,000.00	S2
0				$0.00	

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Three-Level Architecture of DBMS(1)

Users

External Level   View 1   View 2   . . .   View n

External to conceptual mapping

Conceptual Level   Conceptual Schema

Conceptual to internal mapping

Internal Level   Internal Schema
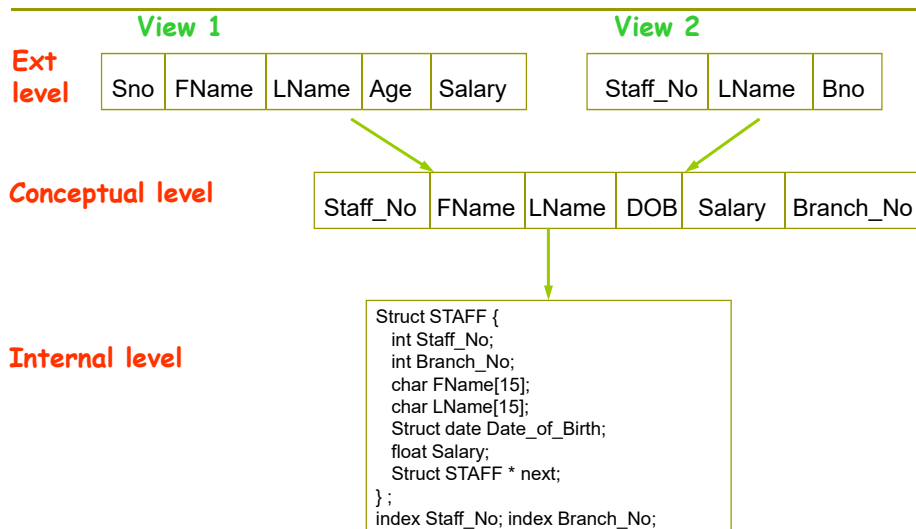
Physical data organization   Database

Three-Level Architecture of DBMS(2)

- Proposed by ANSI-SPARC (The American National Standards Institute, Standards Planning and Requirements Committee).
- **External level** – The users' view of the database. This level describes that part of the database that is relevant to each user.
- **Conceptual level** – The community view of the database. This level describes what data is stored in the database and the relationships among the data.
- **Internal level** – The physical representation of the database on the computer. This level describes how the data is stored in the database.
- At each level, we have **schema** to describe the data in that level. The 3 schemas are only **descriptions of data**; the only data that actually exists is at the ***physical level***.

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Database Schema in 3 Levels

View 1						**View 2**		

Ext level

Sno	FName	LName	Age	Salary

Staff_No	LName	Bno

Conceptual level

Staff_No	FName	LName	DOB	Salary	Branch_No

Internal level

```
Struct STAFF {
    int Staff_No;
    int Branch_No;
    char FName[15];
    char LName[15];
    Struct date Date_of_Birth;
    float Salary;
    Struct STAFF * next;
} ;
index Staff_No; index Branch_No;
```

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Data Independence

◻ Objective of the 3-level architecture
- To provide **Data Independence** which means that upper levels are unaffected by changes to lower levels.

◻ Example(refer to previous slide)
- When there is a new information of staff, say handphone number, is added at the conceptual level, it will not affect the existing external level (view1 & view 2). That means program using these two external views *will not* be affected.

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Review Questions (Part I)

1. A set of programs supporting the creation, maintenance and operation of a database is called _____.

2. A database schema is _____.
   a) the content of the database
   b) a description of the database using a specific data model
   c) the collection of related data
   d) the state of a database

3. Which of the following is NOT a level of the three-level architecture of DBMS ?
   a) Conceptual
   b) External
   c) Internal
   d) Application

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Functions of a DBMS(1)

- Data storage, retrieval and update
  - Allow user to store, retrieve, and update data in the database.
- A user-accessible system catalog
  - Provide a catalog in which descriptions of data items are stored and which is accessible to users.
- Transaction support
  - A mechanism to ensure that either all the updates corresponding to a given transaction are made or that none of them are made.

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Functions of a DBMS(2)

- Concurrency control services
  - A mechanism to ensure that the database is updated correctly when multiple users are updating the database concurrently.
- Recovery services
  - A mechanism for recovering the database in the event that the database is damaged in any way.
- Authorization services
  - A mechanism to ensure that only authorized users can access the database.

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Functions of a DBMS(3)

- □ Support for data communication
  - ■ A DBMS must be capable of integrating with communication software.
- □ Integrity services
  - ■ A mechanism to ensure that both the data in the database and changes to the data follow certain rules.
- □ Services to promote data independence
  - ■ Include facilities to support the independence of programs from the actual structure of the database.
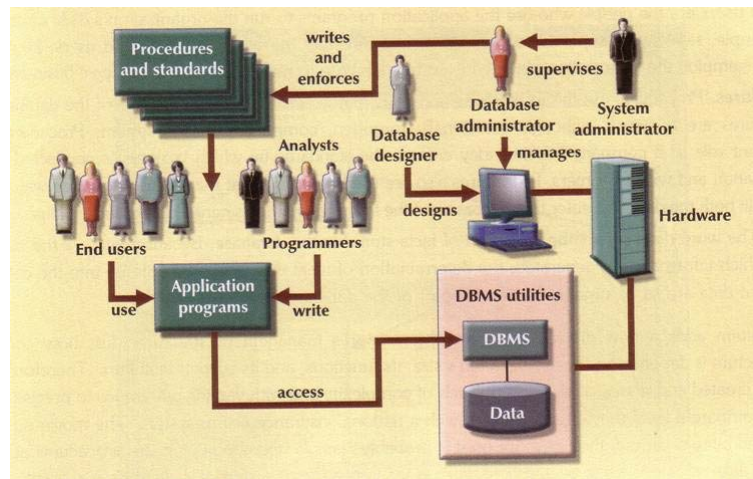
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Functions of a DBMS(4)

- □ Utility services
  - ■ A DBMS should provide a set of utility services like
    - □ Import facilities
    - □ Monitoring facilities
    - □ Statistical analysis programs
    - □ Index reorganization facilities
    - □ Garbage collection and reallocation

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Components of DBMS Environment

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Components of DBMS Environment

Hardware – The DBMS and the applications require hardware to run.

Software – The software components comprises the DBMS, operating system, network software (if necessary) and also the application programs.

Data –The data acts as a bridge between the machine components and the human components. The database contains both the operational data and the meta-data, the 'data about data'.

Procedures – Procedures refer to the instructions and rules that govern the design and use of the database. Eg instructions on how to logon to the DBMS, how to use a particular DBMS facility, start and stop the DBMS.

People – The people involved with the system such as Database Administrator, Database Designers, end-users etc.

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Advantages of Database Approach

❑ Some of the advantages are:
- Control of data redundancy
- Improved data consistency
- Improved data sharing
- Improve data integrity
- Improve data security
- Enforcement of standards

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Disadvantages of Database Approach

❑ Disadvantages
- Complexity - DBMS is an extremely complex piece of software
- Size - Requires large amount of disk space and substantial amount of memory to run efficiently.
- Cost of DBMS – costly in term of licenses and maintenance cost
- Additional hardware costs – require to purchase a large machine
- Cost of conversion - efforts required to convert the existing applications to run on DBMS and cost of training staff to use the new systems.

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DBMS Industry Trend (Marketplace)

- Small Scale
  - Microsoft Access – commonly used desktop database
- Medium Scale
  - Microsoft SQL Server – Popular in Windows environment
  - MySQL – Popular Open Source database
- Enterprise Scale
  - Oracle – Popular enterprise database
  - DB2 - Popular in mainframe environment

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Review Questions (Part II)

1. Which of the following DBMS functions ensure that the database is updated correctly when multiple users are updating the database concurrently?
   a) Recovery Services
   b) Authorization Services
   c) Concurrency Services
   d) Integrity Services

2. A system catalog stores
   a) program codes
   b) descriptions of database structure and constraints
   c) data from various databases
   d) the list of various DBMSs

3. Which of the following DBMS is more suitable for an enterprise application system?
   a) MS Access
   b) SQL Server
   c) Oracle
   d) MySQL

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Summary

◻ Limitation of traditional file-based systems.

◻ Definitions of database and database management systems.

◻ How DBMS achieves data independence.

◻ The typical functions of a DBMS.

◻ The major components of the DBMS environment.

◻ The advantages and disadvantages of the database approach.

◻ The DBMS software available in the market.

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Reference Materials

1. Database Systems, Connolly, Ch 1 & 2

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