
Database Concepts

Database Concepts - 1

Database & Database Management System

Database

= A shared collection of logically related (and a description of this data), designed to meet the information needs of an organization.

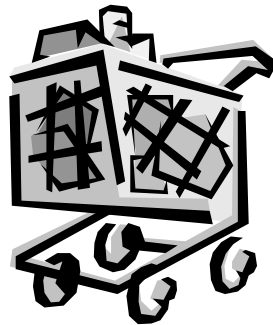
Database Management System (DBMS)

= A software system that enables users to define, create, and maintain the database and provides controlled access to this database.

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Application examples

- o Supermarket



Database Concepts - 3

Application examples

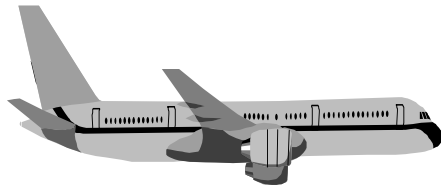
- o Credit Card



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Application examples

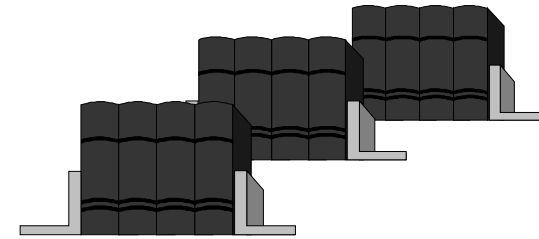
o Travel Agent



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Application examples

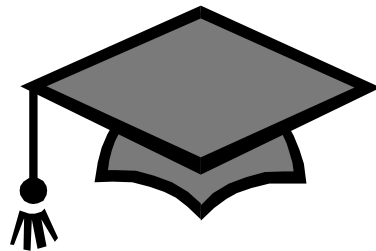
o Library



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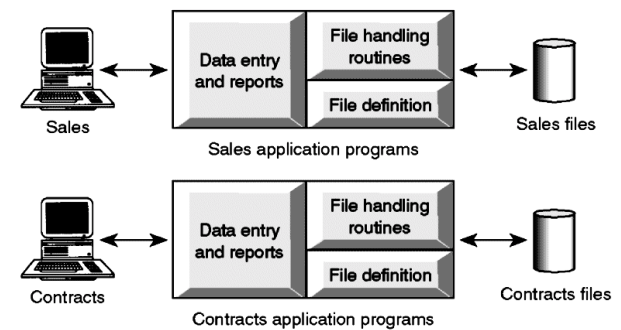
Application examples

o University



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Traditional File-based Processing



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Database Approach

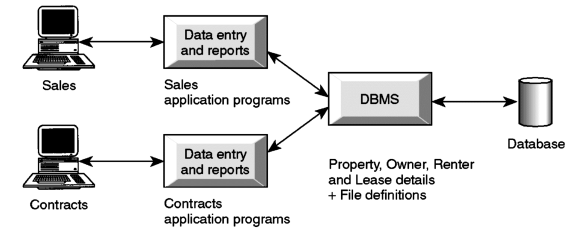
Arose because:

- o Definition of data was embedded in application programs, rather than being stored separately and independently.
- o No control over access and manipulation of data beyond that imposed by application programs.

Result - the database and Database Management System (DBMS).

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DB and DBMS: An example



Property_for_Rent(Property Number, Street, Area, City, Post Code, Property Type, Number of Rooms, Monthly Rent, Owner Number)
Owner(Owner Number, First Name, Last Name, Address, Telephone Number)
Renter(Renter Number, First Name, Last Name, Address, Telephone Number, Preferred Type, Maximum Rent)
Lease(Lease Number, Property Number, Renter Number, Payment Method, Deposit, Paid, Rent Start Date, Rent Finish Date)

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The Paradigm Shift

File-based approach

The work of database design was driven by the application needs of individual departments.

Database approach

To think of the data first and then the application second.

=> The Paradigm Shift

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Database

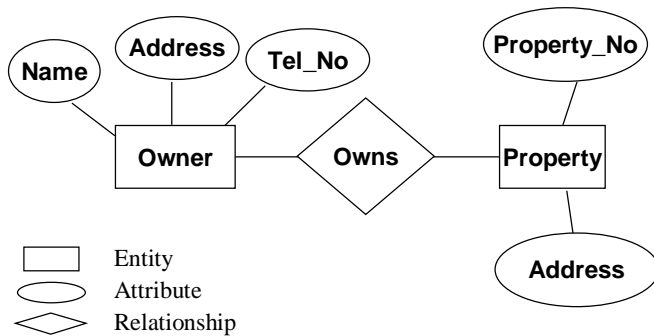
Recall: Database = A shared collection of logically related data (and a description of this data), designed to meet the information needs of an organization.

- o **System catalog (data dictionary or metadata)** provides the description of the data to enable program-data independence.
- o Logically related data comprises **entities**, **attributes**, and **relationships** of an organization's information.

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Logically Related Data

entities, attributes, and relationships



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Functions of a DBMS

- **Data storage, retrieval, and update**
- **User-accessible catalog**
- **Transaction support**
 - Ensure that either all the updates corresponding to a given transaction are made or that none of them are made.
- **Concurrency control services**
 - Ensure that the database is updated correctly when multiple users are updating the database concurrently.

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Functions of a DBMS

The Lost Update Problem:

Time	Transaction ₁	Transaction ₂	bal _x
t1		Read(bal _x)	100
t2	Read(bal _x)	bal _x =bal _x +100	100
t3	bal _x =bal _x -10	Write(bal _x)	200
t4	Write(bal _x)		90
t5			90

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Functions of a DBMS

- **Recovery Services**
- **Authorization Services**
- **Support for data communication**
- **Integrity services**
- **Services to promote data independence**
 - Programs can be written without knowing actual data structure
- **Utility services**
 - Eg. Import data from other formats, monitor database usage and operation, statistical kits, indexing, garbage collection and reallocation.

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Database Languages

Recall: DBMS = A software system that enables users to define, create, and maintain the database and provides controlled access to this database.

Data definition language (DDL)

To express database *schema* (the structure of the database).

Results => System Catalog

Data manipulation language (DML)

To access and manipulate data.

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Database Languages

Procedural & non-procedural DMLs

Procedural DML

What data is needed and exactly *how* to retrieve the data.

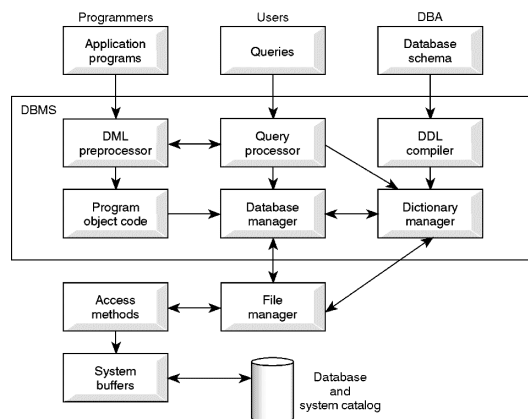
Non-Procedural DML

What data is needed.

Eg. Structured Query Language (SQL)

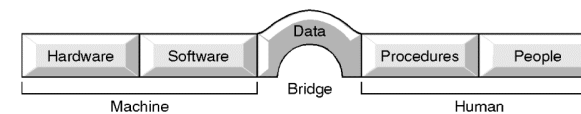
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Components of a DBMS



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Components of DBMS Environment



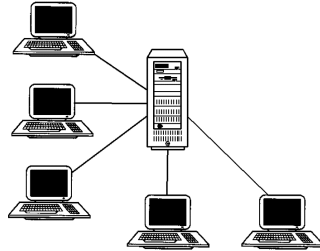
- Hardware
- Software
- Data
- Procedures
- People

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DBMS Environment - *Hardware*

Example:

A Traditional Architecture (Dumb Terminals)

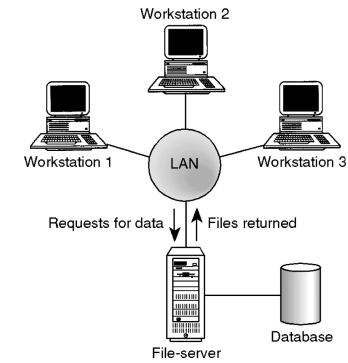


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DBMS Environment - *Hardware*

Example:

A File-Server Architecture

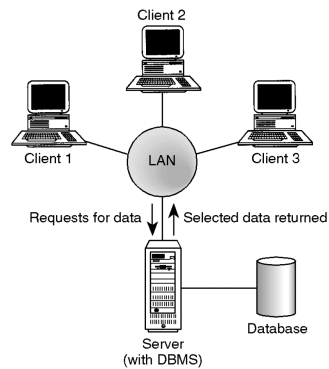


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DBMS Environment - *Hardware*

Example:

A Client-Server Architecture



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DBMS Environment - *Software*

- **DBMS + Application Programs + Operating Systems**
- **A typical application program embeds SQL statements in C or Cobol codes to access data**
- **DBMS Tools: reports generators, forms generators, application generators etc.**

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DBMS Environment - *Data*

- o **Data (Operational data)**
- o **System Catalog**
 - Examples:
 - Names, types, sizes of data items
 - Relationships
 - Integrity constraints on the data
 - Names of authorized users
 - Types of indexes and storage structures
 - Usage statistics

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DBMS Environment - *Procedures*

- Procedures refer to the instructions and rules of the design and use of the database, eg.,
- o **Logon**
 - o **Run some programs**
 - o **Start and stop the DBMS**
 - o **Backup**
 - o **Failure handling**
 - o **Changes on the data structures or physical storage**

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DBMS Environment - *People*

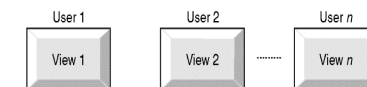
- o **Data Administrator**
 - Management of the data resource
- o **Database Administrators**
 - Responsible for physical aspects such as physical database design and implementation, security, performance
- o **Database Designer**
- o **Application Programmers**
- o **End-Users**

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DB Architecture: 3 Levels of Abstraction

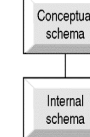
External (User Views)

Each user concerns with only his specific portion of data



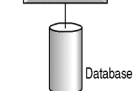
Conceptual (Logical)

What data are stored and the relationships exist among data



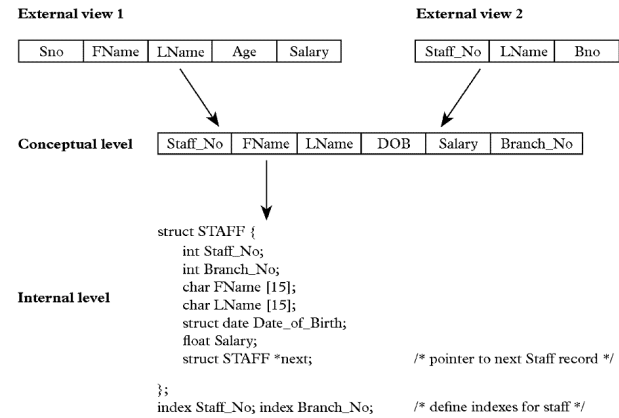
Internal (Physical)

The lowest level, describes how data are actually stored



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DB Architecture: 3 Levels of Abstraction



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View Mechanism

View mechanism

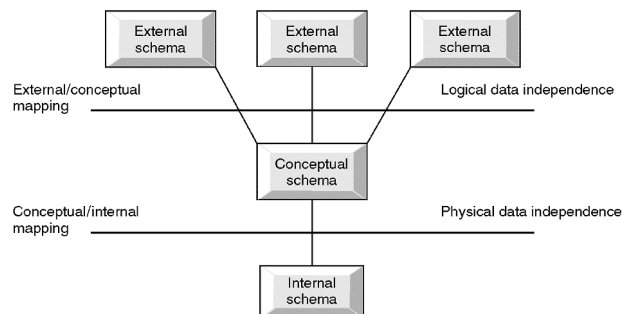
- Provides users with only the data they want or need to use.

Advantages:

- Provides a level of security
- Allows to customize the appearance of the database
- Presents a consistent, unchanging picture of the structure of the database

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Data Independence



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Data Independence

Data Independence : Upper levels are unaffected by changes to lower levels.

Physical Data Independence

- the ability to modify the physical scheme without causing application programs to be rewritten

Logical Data Independence

- the ability to modify the conceptual scheme without causing application programs to be rewritten

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Data Models

Data Model = an integrated collection of concepts for describing data, relationships and constraints on the data in an organization.

3 types of Data Models:

- **Record-Based Data Models**
 - Relational (tables)
 - Network (graphs)
 - Hierarchical (trees)
- **Object-Based Data Models**
 - Entity-Relationship
 - Object-Oriented
- **Physical Data Models (few in use)**
 - Unifying Model; Frame memory

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Database Design

The process of database design involves 3 steps:

- **Conceptual Database Design => Conceptual Model**
Modelling of the information used in an enterprise, independent of all physical considerations (the DBMS, application programs and languages, hardware platform etc.)
- **Logical Database Design => Logical Model**
Refine and map the conceptual model into a logical model according to the target data model for the database (eg. Relational data model)
- **Physical Database Design=> How to implement on secondary storage (structures and access methods)**

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Don't be confused

Database Architecture (3 Levels of abstraction):

External / Conceptual / Internal (Physical) Levels
External / Conceptual / Internal Schemas

Data Independence:

Logical / Physical Data Independences

Types of data models:

Record-Based / Object-Based / Physical Data Models

Database Design Steps:

- Conceptual Database Design => Conceptual Model
- Logical Database Design => Logical Model
- Physical Database Design => Physical implementation plan

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Advantages of DBMS

- **Sharing of Data (& Data Access)**
- **Control of Redundancy**
- **Data Consistency**
- **Improved Data Standard**
- **Better Data Security**
- **Higher Data Integrity**
- **Balance of Conflicting Requirements**
- **Faster Development of New Applications**
- **Control over concurrency**
- **Backup & Recovery**

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Disadvantages of DBMS

- o High cost of DBMS
- o May involve more expensive hardware
- o Specific programming skill
- o Database files conversion
- o Slower processing of less critical applications
- o Increased vulnerability as resources are centralized
- o More sophisticated recovery required when concurrent updates allowed

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Case Study - DreamHome

Organization:

- o Branches
- o Staff of each branch:
 - One Manager
 - Supervisors
 - 5-10 General Staff + 1 secretary under a supervisor

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Case Study – DreamHome (Forms)

Staff Details Form

DreamHome		Staff Number: SL21	
Staff Details			
Personal Details			
First Name	John	Last Name	White
Address	19 Taylor St, Cranford, London	Sex	Male
Tel No	0171-884-5112	Date of Birth	1-Oct-45
		NIN	WK442011B
Next-of-Kin Details			
Full Name	Mary White	Address	19 Taylor St, Cranford, London
Relationship	Wife		
Tel No	0171-884-5112		
General Work Details		Managerial Staff	
Position	Manager	Date Start	19-Sep-89
Allocated to Branch Office	London	Salary	30,000
Branch Number	B5	Car Allowance	2,000
Joined Company	24-Oct-88	Bonus Payment	340
Secretarial Staff		Typing Speed	

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Case Study - DreamHome

Services provided by DreamHome:

- o Advertising the property (Flat or House)
- o Interview prospective renters
- o Organize visits
- o Negotiate lease agreement
- o Inspect the property regularly (6 months)

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Case Study – DreamHome (Forms)

Forms used by the Sales Department

DreamHome Property for Rent Details		Property Number: PG21
Address	18 Dale Rd	Allocated to Branch: 163 Main St, Partick, Glasgow
Area	Hyndland	
City	Glasgow	Branch No B3
Postcode	G12	
Type	House	Staff Responsible Ann Beech
Rent	600	
No of Rooms	5	
Owner's Details		
Name	Carol Farrel	Business Name
Address	6 Achray St, Glasgow G32 9DX	Address
Tel No.	0141-357-7419	Tel No.
Owner No.	CO87	Owner No.
		Contact Name
		Business Type

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Case Study – DreamHome (Forms)

Forms used by the Sales Department

DreamHome Renter Details		Renter Number: CR74	
First Name	Mike	Last Name	Ritchie
Address	18 Tain St, Gourock PA1G 1YQ	Tel No.	01475-392178
Property Requirement Details			
Preferred Property Type	House	Maximum Monthly Rent	750
General Comments	Currently living at home with parents Getting married in August		
Seen By	Ann Beech	Date	24-Mar-98
Branch No	B3	Branch City	Glasgow

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Case Study – DreamHome (Reports)

Properties for Rent Report

Page 1		DreamHome Property for Rent		Date 12-May-98			
Branch Number B3		Telephone Number 0141-339-2178					
Branch Office Address 163 Main St, Partick, Glasgow G11 9QX		Fax Number 0141-339-4439					
Property Number	Street	Area	City	Postcode	Type	No of Rooms	Monthly Rent
PG4	6 Lawrence St	Partick	Glasgow	G11 9QX	Flat	3	350
PG36	2 Manor Rd		Glasgow	G32 4QX	Flat	3	375
PG21	18 Dale Rd	Hyndland	Glasgow	G12	House	5	600
PG16	5 Novar Dr	Hyndland	Glasgow	G12 9AX	Flat	4	450

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Case Study – DreamHome (Forms)

Forms used by the Contracts Department

DreamHome Lease Details		Lease Number: 10012	
Renter No.	CR74	Property No.	PG21
Full Name	Mike Ritchie	Address	18 Dale Rd, Hyndland, Glasgow G12
Address (previous)	18 Tain St, Gourock PA1G 1YQ	Tel No.	01475-392178
Payment Details			
Monthly Rent	600	Rent Start Date	1-Jul-97
Payment Method	Cheque	Rent Finish Date	30-Jun-98
Deposit	1200	Paid (Y or N)	<input checked="" type="checkbox"/> Y
		Duration	1 Year

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Case Study – DreamHome (Reports)

Property Inspection Report

Page 1	DreamHome Property Inspection Report		Date 18-Jan-98
Property Number PG21	Address 18 Dale Rd, Hyndland, Glasgow G12	Allocated to Branch	163 Main St, Partick, Glasgow
Property Type	House	No of Rooms	5
	Branch Number	B3	
Staff Name	Inspection Date	Comments	
Susan Brand	12-Apr-95	No problems	
Susan Brand	30-Sep-96	Cracked ceiling in living room Requires urgent repair	
Ann Beech	01-Jul-97	Crockery needs to be replaced	

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Case Study - DreamHome

Other data:

- o Advertisement details
- o Appropriate newspapers

Policies:

- o Retain information of withdrawn properties: 3 years
- o Retain information of expired leases: 3 years
- o Lease period: 3 months – 1 year
- o Each staff manages not more than 10 properties

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Case Study - DreamHome

Transaction Requirements:

- o Maintain records of staff details, properties, prospective renters, viewing by prospective renters, adverts, lease agreements, property inspections
- o Produce staff details listing at a branch
- o Produce listing of staff under a supervisor
- o Produce listing of supervisors at a branch
- o Produce listing of properties at a branch
- o Produce listing of properties managed by a staff

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Case Study - DreamHome

- o Produce listing of prospective renters at a branch
- o Search for properties satisfying a prospective renter
- o Produce a report of viewing comments of a property
- o Produce listing of adverts for a property
- o Produce listing of adverts placed in a newspaper
- o Produce report of lease agreement for a property
- o Produce listing of inspections of a property

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