DATABASE DESIGN
DBT1103C

Session 1:
An Overview of Database Management System

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Objectives

- Understand definition of database and DBMS
- Distinguish between data and information, and provide examples of each
- Describe and give an example of how data becomes information
- Significance of Database
- Study the application of Database System
- List and explain the three major steps in the database development process
- Understand Modelling for a database

Define the following terms!

- DATA
- INFORMATION
- DATABASE
- DBMS
- DATABASE SYSTEM
- METADATA

Significance of Database

Some of the basic definitions of database concepts are:

- **Data:** Data is known facts that can be recorded and have an implicit meaning.
- **Database:** Database is a collection of related data.
- **Database System:** Database System is the DBMS software together with the data itself. Sometimes, the applications are also included.
- **Database Management System (DBMS):** Database Management System is a software package/system to facilitate the creation and maintenance of a computerized database.
  - Examples for database management systems are MS Access, DB2, ORACLE, SQL Server, SYBASE, INFORMIX etc.

Data vs. Information

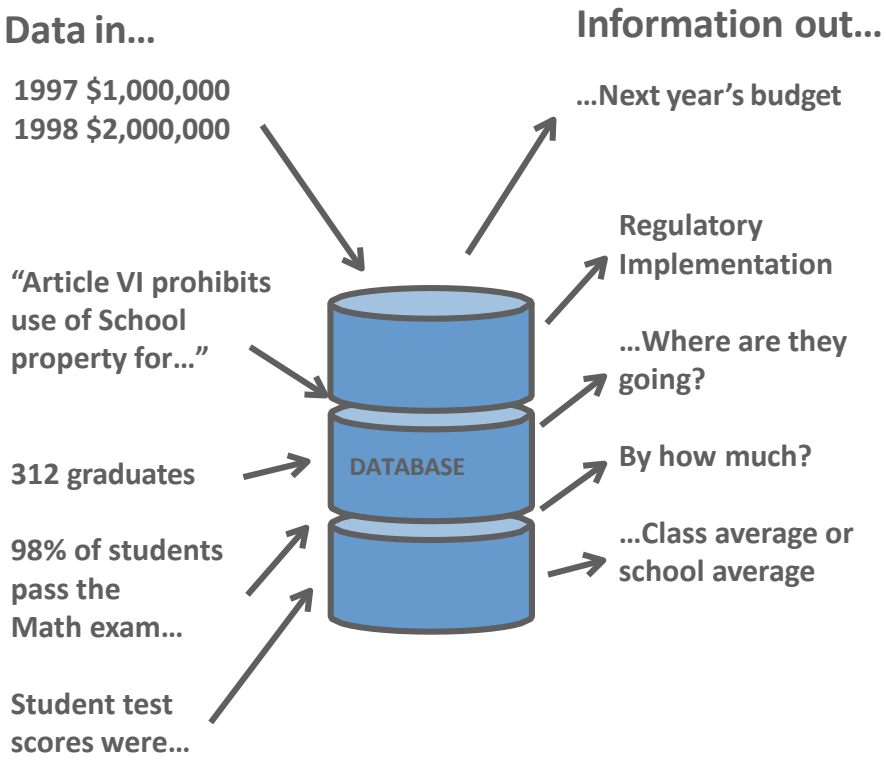
- The words "data" and "information" are often used as if they are synonyms.
- Nevertheless, they have different meanings.
- Data: Raw or unprocessed material
- Information: knowledge, intelligence, a particular piece of data with a special meaning or function.
- Information is often the result of combining, comparing, analyzing or performing calculations on data.
- IPO Concepts

Data vs. Information

- Whenever a student, teacher, administrator (or any person using a computer) interacts with a website, pieces of data are collected.
- The website application may be unique to that school or company, but what happens in the background?

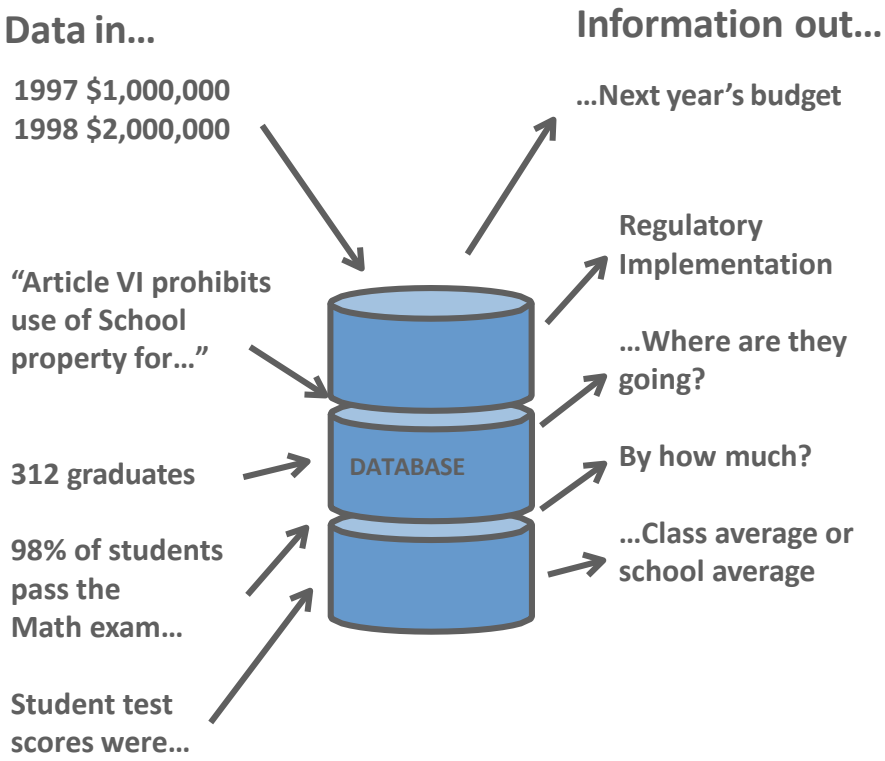
Data vs. Information

- Think about test scores, for example.
- In one class, if every student receives a numbered score, the scores can be calculated to determine a class average.
- The class averages can be calculated to determine the school average.



Data vs. Information

- The Oracle database software will transform recorded/stored data and statistics into useful pieces of information.
- Data: Each student's test score is one piece of data.
- Information: The class's average score or the school's average score.

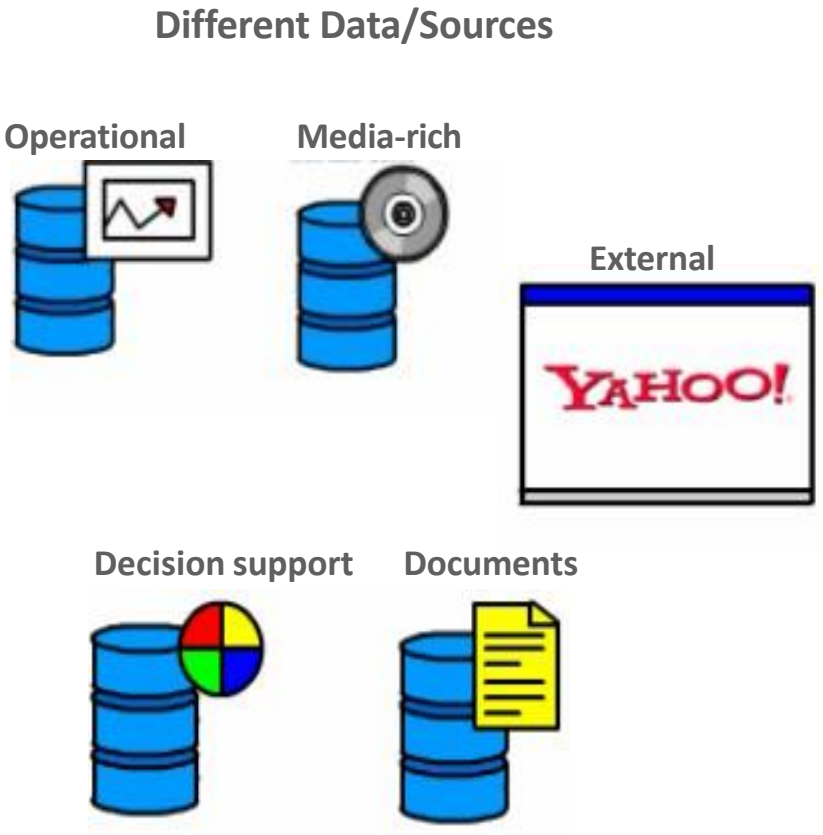


What is a Database?

- A database is a centralized and structured set of data stored on a computer system.
- It provides facilities for retrieving, adding, modifying, and deleting the data when required.
- It also provides facilities for transforming retrieved data into useful information.
- A database is usually managed by a Database Administrator (DBA).

Documents, Pictures, Video, and Sound

- Within most modern databases, you can store and retrieve a wide variety of data and documents.
- Inside the database, data is stored in its “raw” form.
- When this raw data is queried or retrieved, it is transformed into more useful information.

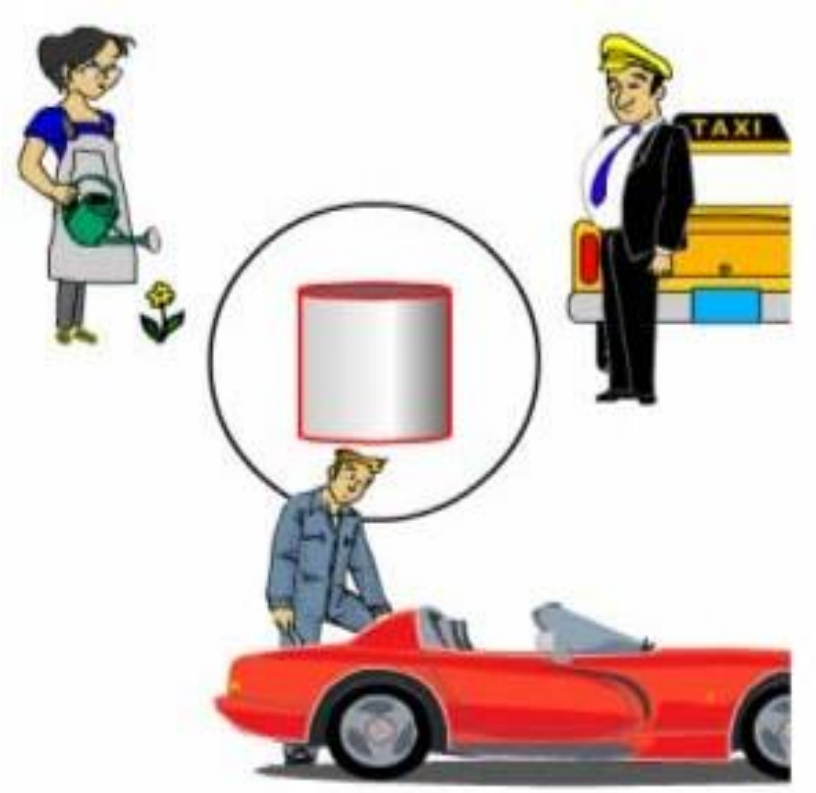


Question: What Does a Database Have to do with My Everyday Life?

- Answer: More than you may realize...
- A lot of websites that you visit are driven by a database.

Question: If You Had One of the Jobs Listed Below, How Might You Use a Database?

- Mechanic in a repair shop
- Taxi driver
- Landscaper



Question: Have You Ever Returned an Item to a Store Without a Receipt?

- What information did you have to provide?
- Were you able to return the item?

Significance of Database

The database is a collection of related data.

The basic component of a file in a file system is a *data item, which is the smallest named unit of data that has meaning in the real world*

- *for example, last name, first name, street address, ID number, or political party.*

A group of related data items treated as a single unit by an application is called a record.

- *Examples of types of records are order, salesperson, customer, product, and department.*

A file is a collection of records of a single type.

Significance of Database

A *database is a more complex object;*

- *it is a collection of interrelated stored data that serves the needs of multiple users within one or more organizations, that is, interrelated collections of many different types of tables.*

The motivations for using databases rather than files include:

- *greater availability to a diverse set of users,*
- *integration of data for easier access to and updating of complex transactions*
- *less redundancy of data.*

Significance of Database

- Most database management systems have the following facilities/capabilities:
  - Creating of a file, addition to data, deletion of data, modification of data; creation, addition and deletion of entire files.
  - Retrieving data collectively or selectively.
  - The data stored can be sorted or indexed at the user's discretion and direction.
  - Various reports can be produced from the system. These may be either standardized reports or that may be specifically generated according to specific user definition.
  - Mathematical functions can be performed and the data stored in the database can be manipulated with these functions to perform the desired calculations.

Figure 1-1a Data in Context

Class Roster

Course: MGT 500 Business Policy

Semester: Spring 200X

Section: 2

Large volume of facts, difficult to interpret or make decisions based on

Name	ID	Major	GPA
Baker, Kenneth D.	324917628	MGT	2.9
Doyle, Joan E.	476193248	MKT	3.4
Finkle, Clive R.	548429344	PRM	2.8
Lewis, John C.	551742186	MGT	3.7
McFerran, Debra R.	409723145	IS	2.9
Sisneros, Michael	392416582	ACCT	3.3

Figure 1-1b Summarized data

Useful information that managers can use for decision making and interpretation

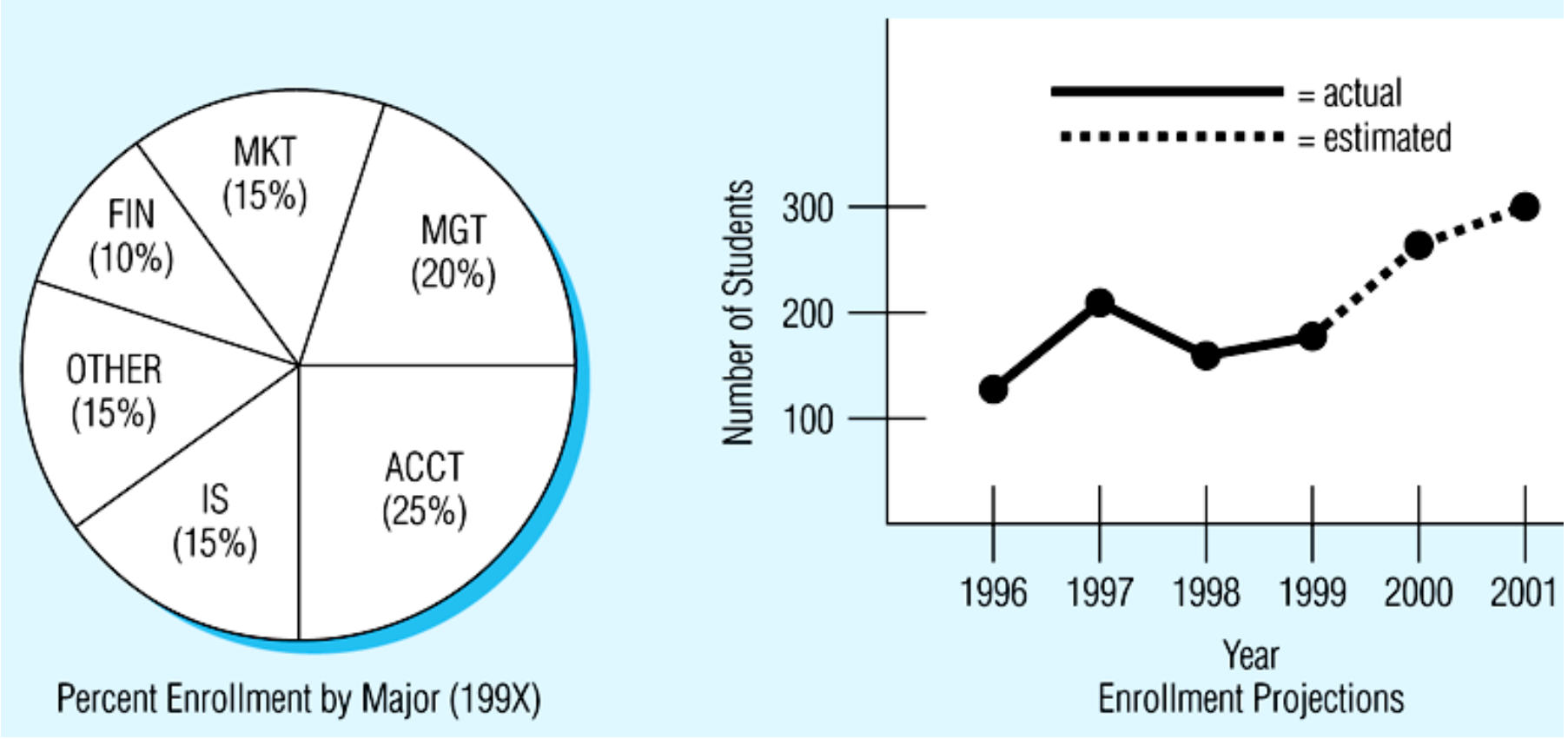


Table 1-1 Metadata

Descriptions of the properties or characteristics of the data, including data types, field sizes, allowable values, and documentation

Table 1-1 Example Metadata for Class Roster

Data Item		*Value*			
Name	**Type**	**Length**	**Min**	**Max**	**Description**
Course	Alphanumeric	30			Course ID and name
Section	Integer	1	1	9	Section number
Semester	Alphanumeric	10			Semester and year
Name	Alphanumeric	30			Student name
ID	Integer	9			Student ID (SSN)
Major	Alphanumeric	4			Student major
GPA	Decimal	3	0.0	4.0	Student grade point average

Database System Applications

Databases are widely used. Here are some representative applications:

- Banking: For customer information, accounts, and loans, and banking transactions.
- Airlines: For reservations and schedule information. Airlines were among the first to use databases in a geographically distributed manner terminals situated around the world accessed the central database system through phone lines and other data networks.
- Universities: For student information, course registrations, and grades.
- Credit card transactions: For purchases on credit cards and generation of monthly statements.

Database System Applications

- Telecommunication: For keeping records of calls made, generating monthly bills, maintaining balances on prepaid calling cards, and storing information about the communication networks.
- Finance: For storing information about holdings, sales, and purchases of financial instruments such as stocks and bonds.
- Sales: For customer, product, and purchase information.
- Manufacturing: For management of supply chain and for tracking production of items in factories, inventories of items in warehouses/ stores, and orders for items.
- Human resources: For information about employees, salaries, payroll taxes and benefits, and for generation of paychecks.

File System

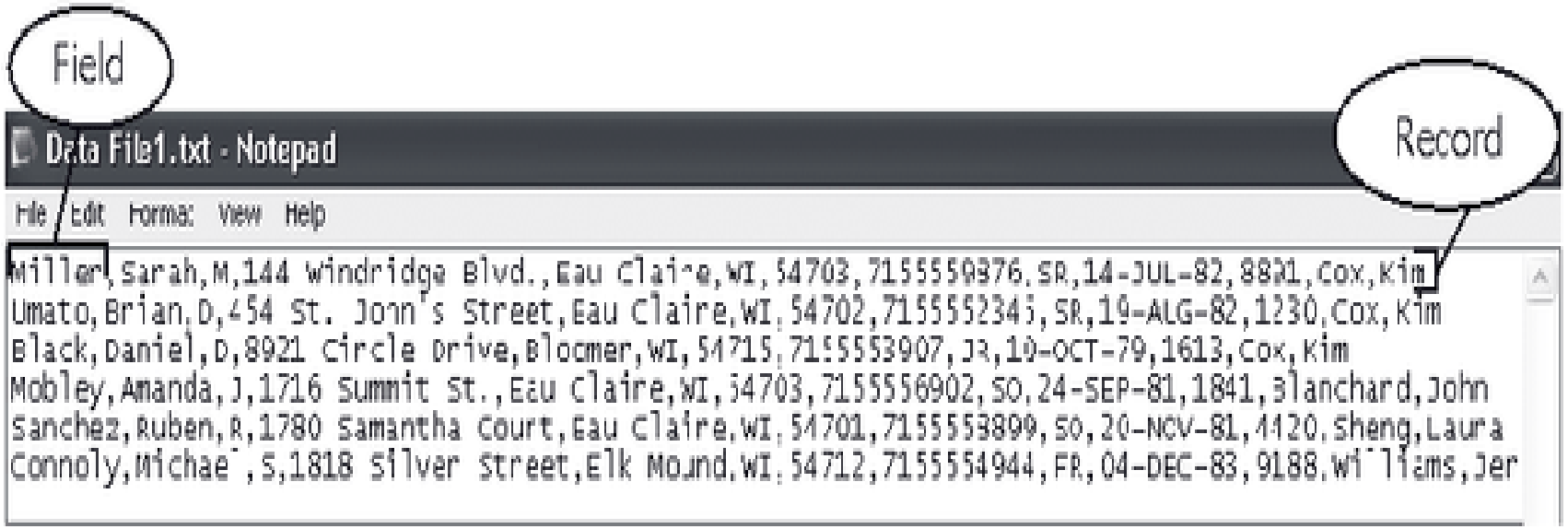


Figure 1-1 Example student data file

Functions of DBMS

It has several functions:

Data storage, retrieval and update

Provide data sharing

Back up and recovery

Data dictionary creation and maintenance

Functions of DBMS

Data Dictionary

- Name, types and sizes of data items
- Relationships
- Integrity Constraints
- Schemas
- Metrics
- Security and Access rights

Data Dictionary helps manage the database in a consistent manner. Helps in recovery and auditing.

Functions of DBMS

Transaction Support

Security: Authorization and access control

Integrity preservation, database instances (snapshot of values) changes as expected.

Data Independence, interlayer logical and physical independence

Utility Services for data conversion, metrics, garbage collection, management & recovery.

Functions of DBMS

DDL and DML support

Teleprocessing

Data distribution and aggregation

Server architecture, File Server, Client-Server

Improved performance

Scalability

Disadvantages of File Processing

Program-Data Dependence

- All programs maintain metadata for each file they use

Data Redundancy (Duplication of data)

- Different systems/programs have separate copies of the same data

Limited Data Sharing

- No centralized control of data

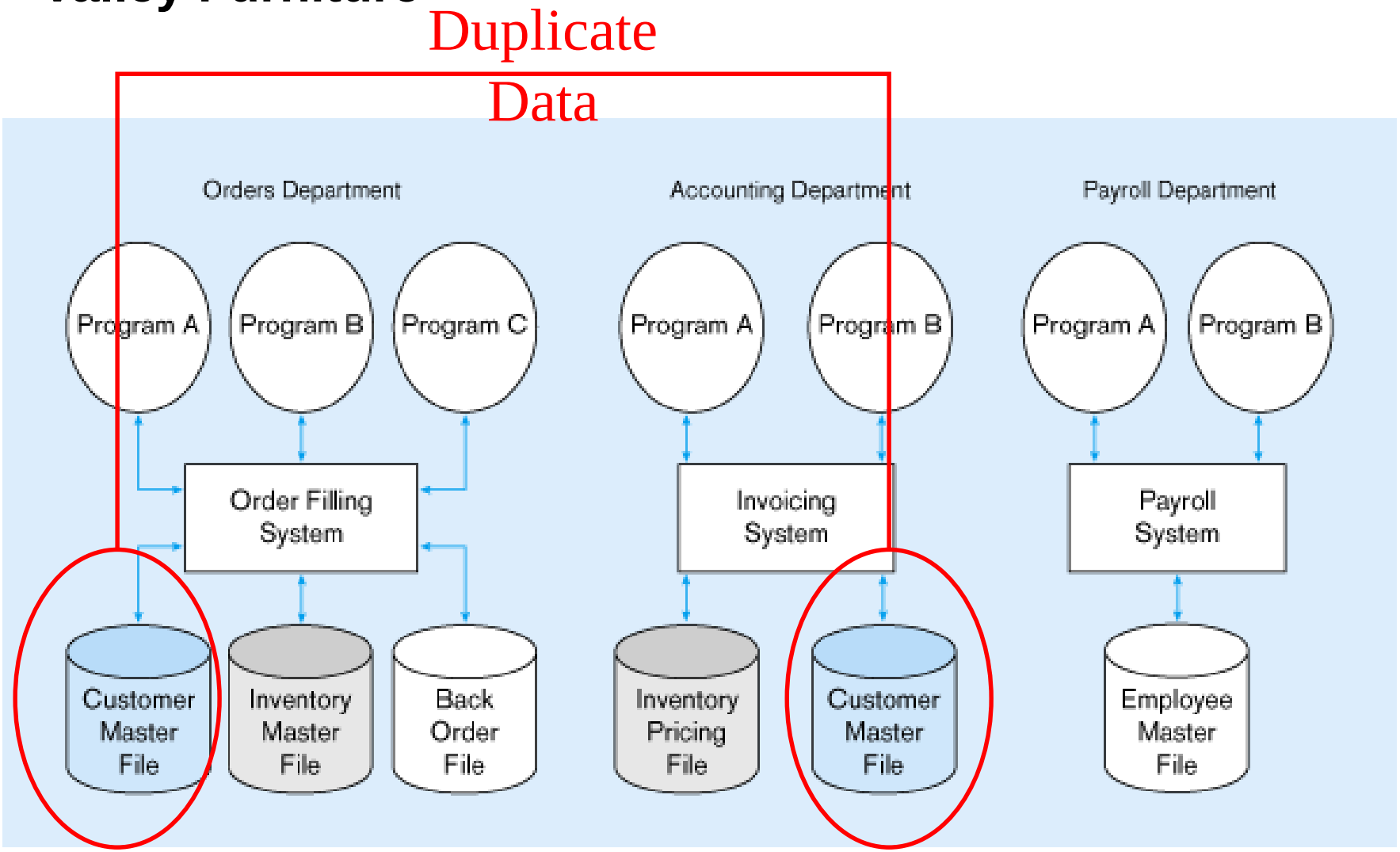
Lengthy Development Times

- Programmers must design their own file formats

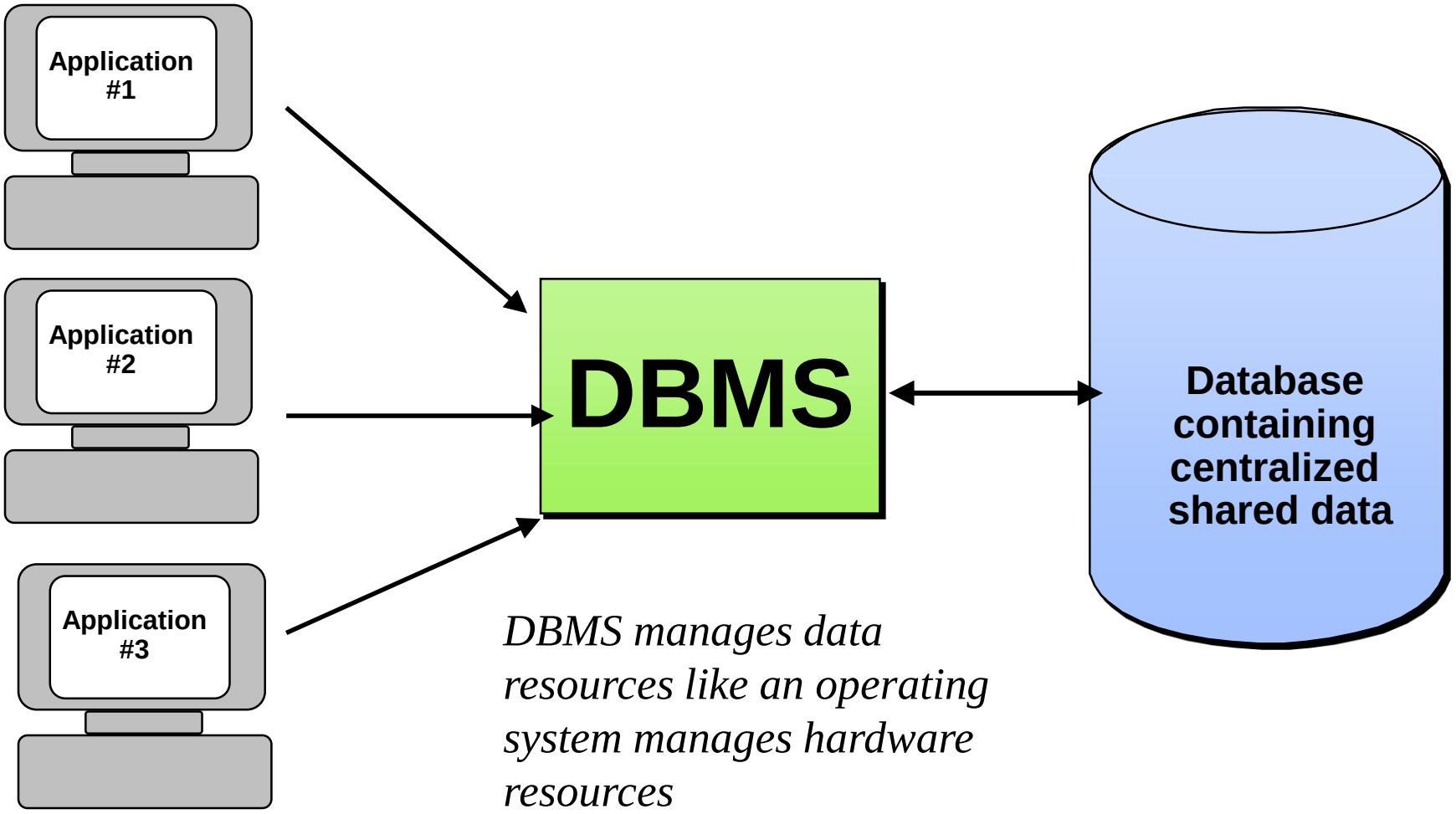
Excessive Program Maintenance

- 80% of of information systems budget

Figure 1-2 Three file processing systems at Pine Valley Furniture



Database Management System



DBMS manages data resources like an operating system manages hardware resources

Advantages of Database Management System

One of the main advantages of using a database system is that the organization can exert, via the DBA, centralized management and control over the data.

The database administrator is the focus of the centralized control.

Any application requiring a change in the structure of a data record requires an arrangement with the DBA, who makes the necessary modifications.

The following are the important advantages of DBMS.

Advantages and Disadvantages of Database Management System

- The following are the important advantages of DBMS.

1. **Reduction of Redundancies**
   - Centralized control of data by the DBA avoids unnecessary duplication of data, and effectively reduces the total amount of data storage required.
   - Another advantage of avoiding duplication is the elimination of the inconsistencies that tend to be present in redundant data files.
   - Any redundancies that exist in the DBMS are controlled and the system ensures that these multiple copies are consistent.

Advantages of Database Management System

2. Sharing Data

- A database allows the sharing of data under its control by any number of application programs or users.

Advantages of Database Management System

3. Data Integrity

- Centralized control can also ensure that adequate checks are incorporated in the DBMS to provide data integrity. Data integrity means that the data contained in the database is both accurate and consistent. Therefore, data values being entered for storage could be checked to ensure that they fall within a specified range and are of the correct format.
  - For example, the value for the age of an employee may be in the range of 16 and 75. Another integrity check that should be incorporated in the database is to ensure that if there is a reference to certain object, that object must exist. In the case of an automatic teller machine, for example, a user is not allowed to transfer funds from a nonexistent saving account to a checking account.

Advantages of Database Management System

4. Data Security

- Data is of vital importance to an organization and may be confidential. Such confidential data must not be accessed by unauthorized persons.
- The DBA, who has the ultimate responsibility for the data in the DBMS, can ensure that proper access procedures are followed, including proper authentication schemas for access to the DBMS, and additional checks before permitting access to sensitive data.
- Different levels of security could be implemented for various types of data and operations. The enforcement of security could be data value dependent (e.g., a manager has access to the salary details of employees in his or her department only), as well as data-type dependent (but the manager cannot access the medical history of any employees, including those in his or her department).

Disadvantages of Database Management System

A significant disadvantage of the DBMS system is cost.

In addition to the cost of purchasing or developing the software, the hardware has to be upgraded to allow for the extensive programs and the work spaces required for their execution and storage.

The processing overhead introduced by the DBMS to implement security, integrity, and sharing of the data causes a degradation of the response and through-put times.

An additional cost is that of migration from a traditionally separate application environment to an integrated one.

Types of databases

Centralised databases

Distributed databases

Centralised databases

Data located at a single site

Users access using telecomm.s facilities

Greater control over accessing & updating

More vulnerable to failure

Distributed databases

Organisations spread over various locations- cities, states ... centralised DB impractical

- Distributed database : A single logical database spread physically across computers in multiple locations

Two generic categories :

- Homogeneous databases
- Heterogeneous databases

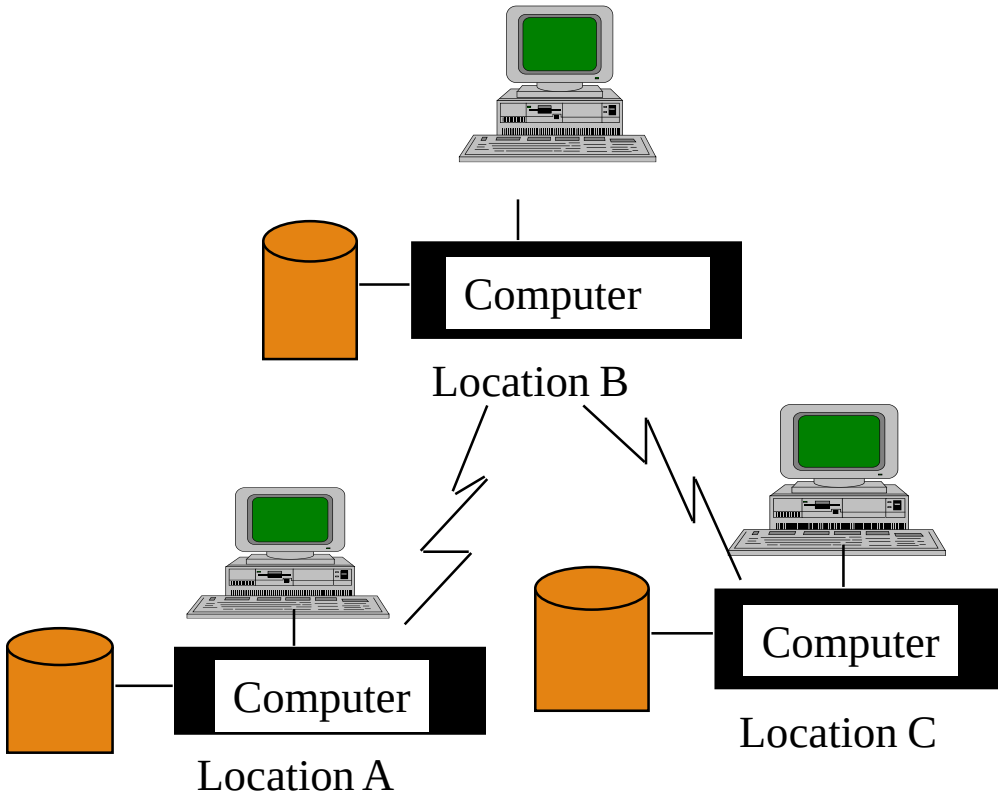
Homogeneous databases

Database technology same/compatible at each of the locations

- O/S same/compatible
- Data models same
- DBMS same/compatible

Simplify data sharing

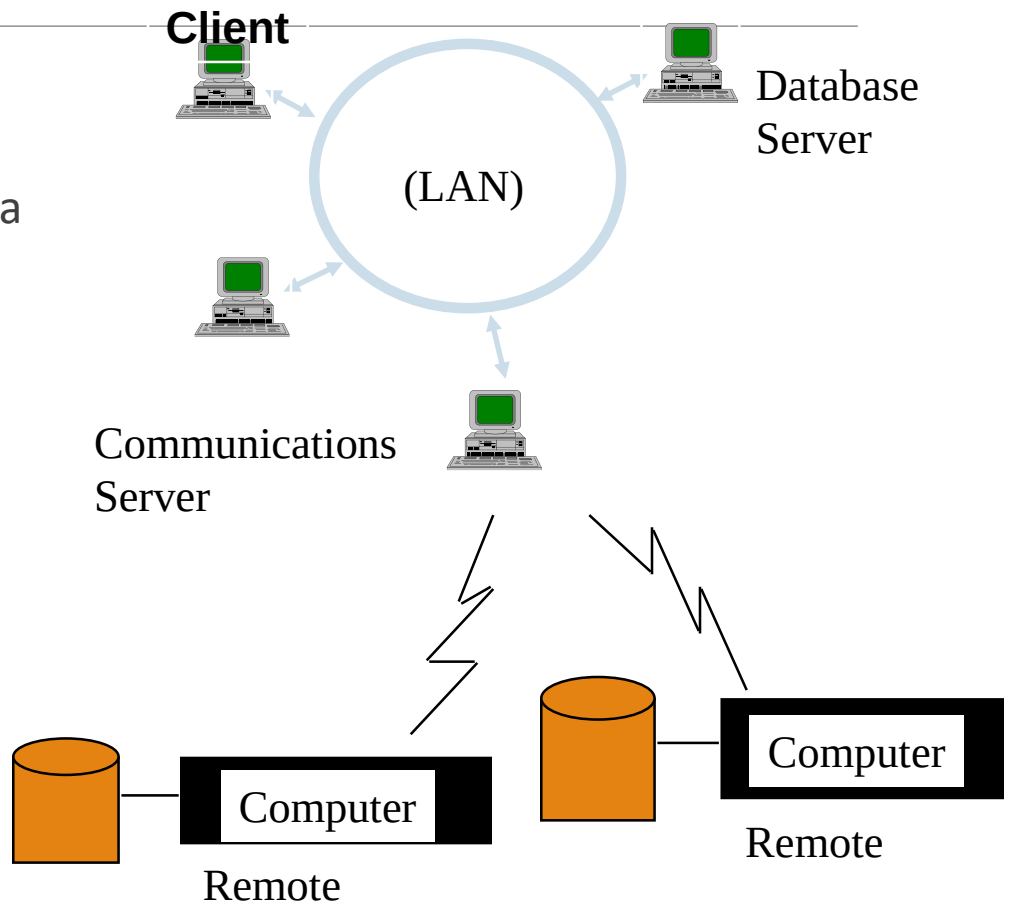
High level of planning required



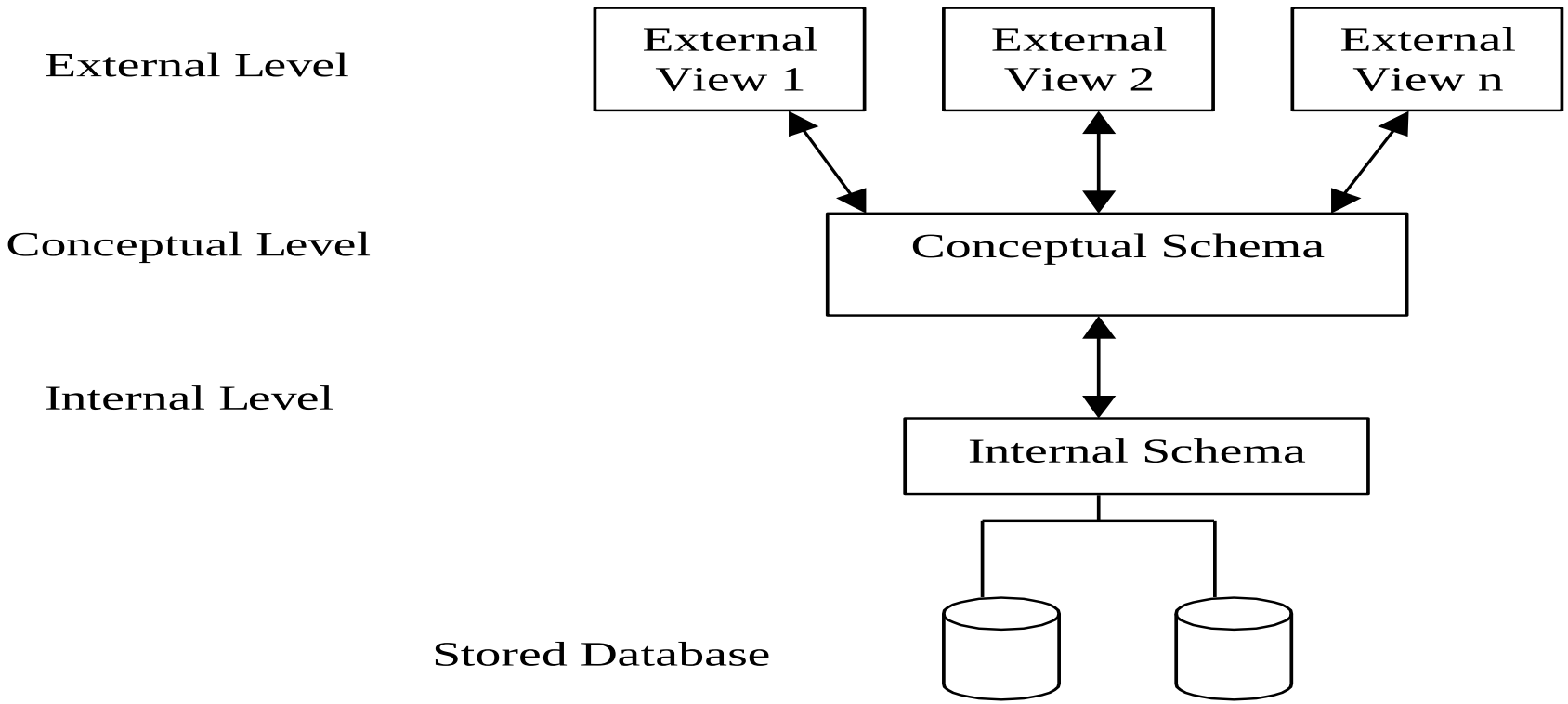
Heterogeneous databases

Databases evolve over time

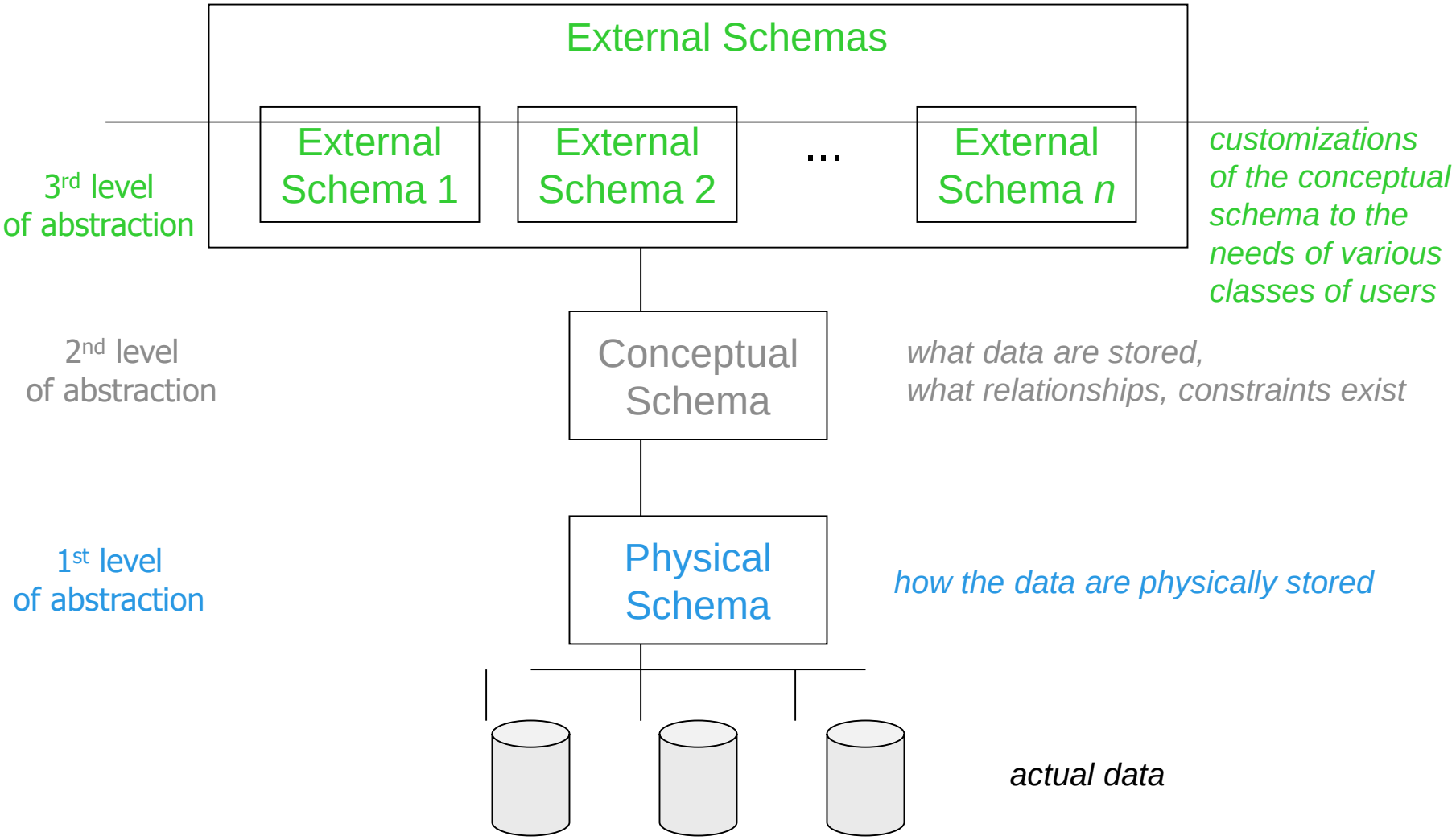
- without planning
- different OSs
- different data models (e.g. files)
- Syntactic differences (e.g. different data field representations)
- Semantic differences



Database Architecture
The ANSI/SPARC Model



Three-Tier Architecture



Data Modeling for a Database

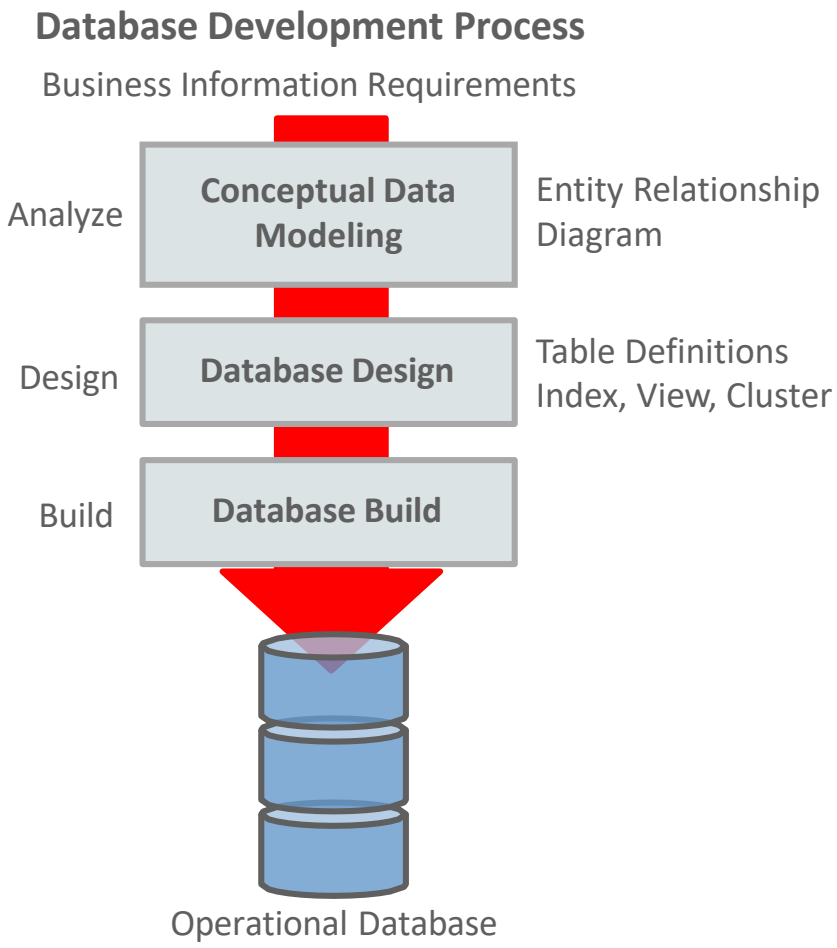
The data model is one part of the conceptual design process. The other is the function model.

The data model focuses on what data should be stored in the database while the function model deals with how the data is processed.

To put this in the context of the relational database, the data model is used to design the relational tables. The functional model is used to design the queries that will access and perform operations on those tables.

Question: What Does Data Modeling Have to do with a Database?

- Data modeling is the first step in the database development process.
- It involves collecting and analyzing the data that a business needs to track, and then diagramming the organization of that data in an Entity Relationship Diagram.



Database Development Process

- Data modeling begins by researching the information requirements of a business.
- Example: Here is a set of information requirements.
  - I manage the Human Resources Department for a large company. We need to store data about each of our company's employees. We need to track each employee's first name, last name, job or position, hire date and salary. For each employee on commission, we also need to track his/her potential commission. Each employee is assigned a unique employee number.

Database Development Process

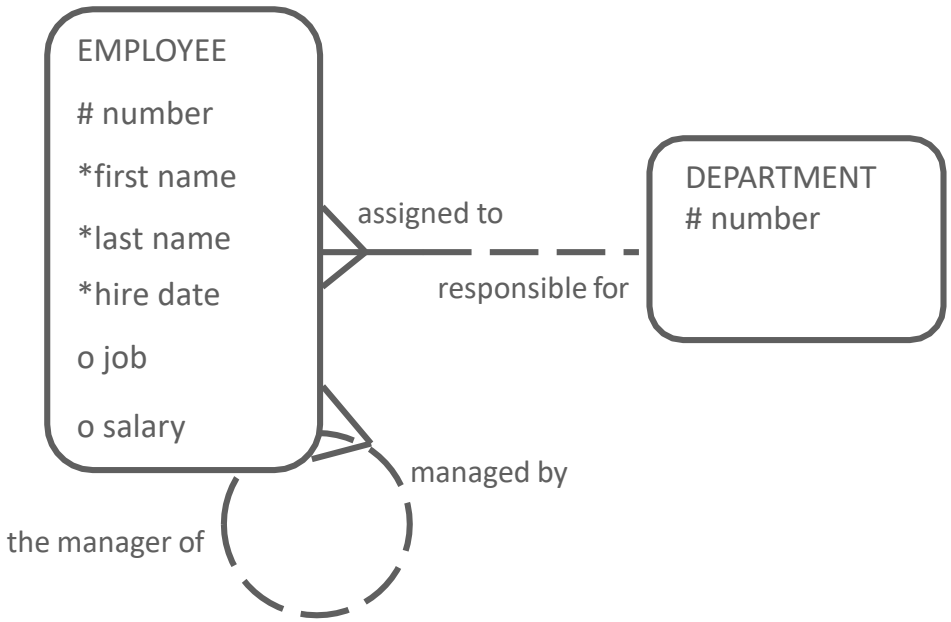
- Example: Here is a set of information requirements.
  - Our company is divided into departments. Each employee is assigned to a department -- for example, accounting, sales, or development. We need to know the department responsible for each employee and the department location. Each department has a unique number.
  - Some of the employees are managers. We need to know each employee's manager and all of the employees that are managed by each manager.

Database Development Process

- An entity relationship diagram should completely capture and accurately model the organization's information needs and support the functions of the business.

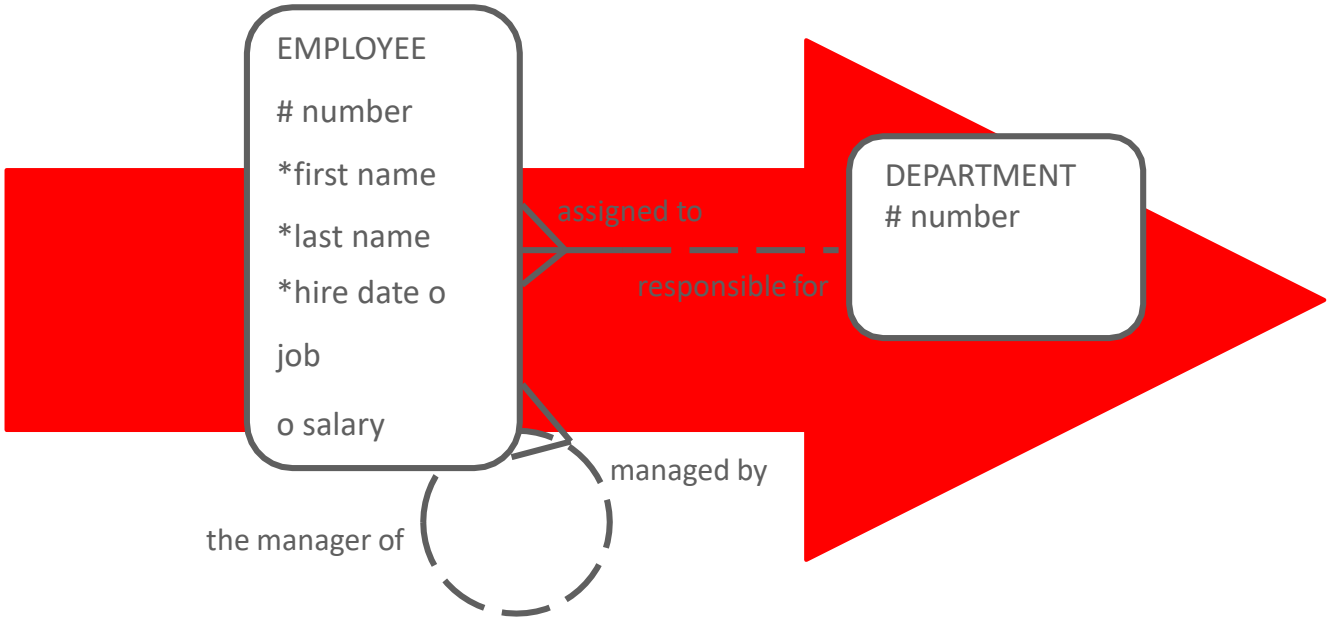
EXAMPLE

The following entity relationship diagram represents the information requirements of the Human Resources Department.



Database Development Process

- Step two, the database design phase of the development process, translates the information modeled on the entity relationship diagram to a table instance chart.



Database Development Process

The table instance chart lists the design specifications of the information and has the following components:

- Table name
- Column names
- Keys: a primary key (PK) is the unique identifier for each row of data; a foreign key (FK) links data in one table to the data in a second table by referring to the PK column in the second table
- Nulls: indicates if a column must contain a value (mandatory)

Database Development Process

- Unique: indicates if the value contained in a column is unique within the table
- Data type: identifies the definition and format of the data stored in each column

Database Development Process

- Structured Query Language (SQL) commands are used to build the physical structure of the database.

DATABASE BUILD—Step Three

```
CREATE TABLE departments
(deptno NUMBER(5) CONSTRAINT depts_deptno_PK PRIMARY KEY,
name VARCHAR2(25) CONSTRAINT depts_name_NN NOT NULL,
loc VARCHAR2(30) CONSTRAINT depts_loc_NN NOT NULL);
```

```
CREATE TABLE employees
(empno NUMBER(9) CONSTRAINT emps_empno_PK PRIMARY KEY,
fname VARCHAR2(15) CONSTRAINT emps_fname_NN NOT NULL,
lname VARCHAR2(20) CONSTRAINT emps_lname_NN NOT NULL,
hiredate DATE CONSTRAINT emps_hiredt_NN NOT NULL, salary
NUMBER(9,2),
commission NUMBER(9,2),
mgr NUMBER(9) CONSTRAINT emps_mgr_FK REFERENCES
employees(empno),
deptno NUMBER(5) CONSTRAINT emps_deptno_FK REFERENCES
departments(deptno));
```

Database Development Process

- SQL is also used to populate, access, and manipulate the data within the relational database.

DATABASE BUILD—Step Three

```
INSERT INTO departments
   (deptno,name,loc)
VALUES
(123,'Accounts','US');
```

```
SELECT fname, lname, deptno FROM
employees
WHERE deptno = 123;
```

```
UPDATE departments
SET name = 'marketing' WHERE
deptno=123
```

Data Modeling for a Database

Entities and their Attributes

- Entities are the principal data objects about which information is to be collected; they usually denote a person, place, thing, or event of informational interest.
- A particular occurrence of an entity is called an entity instance or sometimes an entity occurrence.
- Identify some of the entities that will be used in the following database application:
  - UNIVERSITY
  - RETAIL SHOP (NIKE SHOP)
  - CAR RENTAL SYSTEM

Data Modeling for a Database

Entities and their Attributes

- Attributes are characteristics of entities that provide descriptive details about them.
- A particular occurrence of an attribute within an entity or relationship is called an attribute value.
- Identify some of the attributes for the following Entities:
  - CUSTOMER
  - ORDER
  - PRODUCT

Data Modeling for a Database

Relationships and Relationship Types

- Relationships represent real-world associations among one or more entities, and, as such, have no physical or conceptual existence, other than that which depends upon their entity associations.
- Relationships are described in terms of degree, connectivity, and existence. The most common meaning associated with the term *relationship is indicated by the connectivity between entity occurrences: one-to-one, one-to-many, and many-to-many.*

Data Modeling for a Database

- **Relationship Types**
- For a binary relationship set R between entity sets A and B, the mapping cardinality must be one of the following:
  - One-to-one (1:1): An entity in A is associated with at most one entity in B, and an entity B is associated with at most one entity in A.
  - One-to-many (1:N): An entity in A is associated with any number of entities in B. An entity in B, however can be associated with at most one entity in A.
  - Many-to-many: An entity in A is associated with any number of entities in B. An entity in B, is associated with any number of entities in A.
- Identify the types of relationship we have between these entities:
  - CUSTOMER, ORDER, PRODUCT

Figure 1-3 Segment from enterprise data model

Figure 3

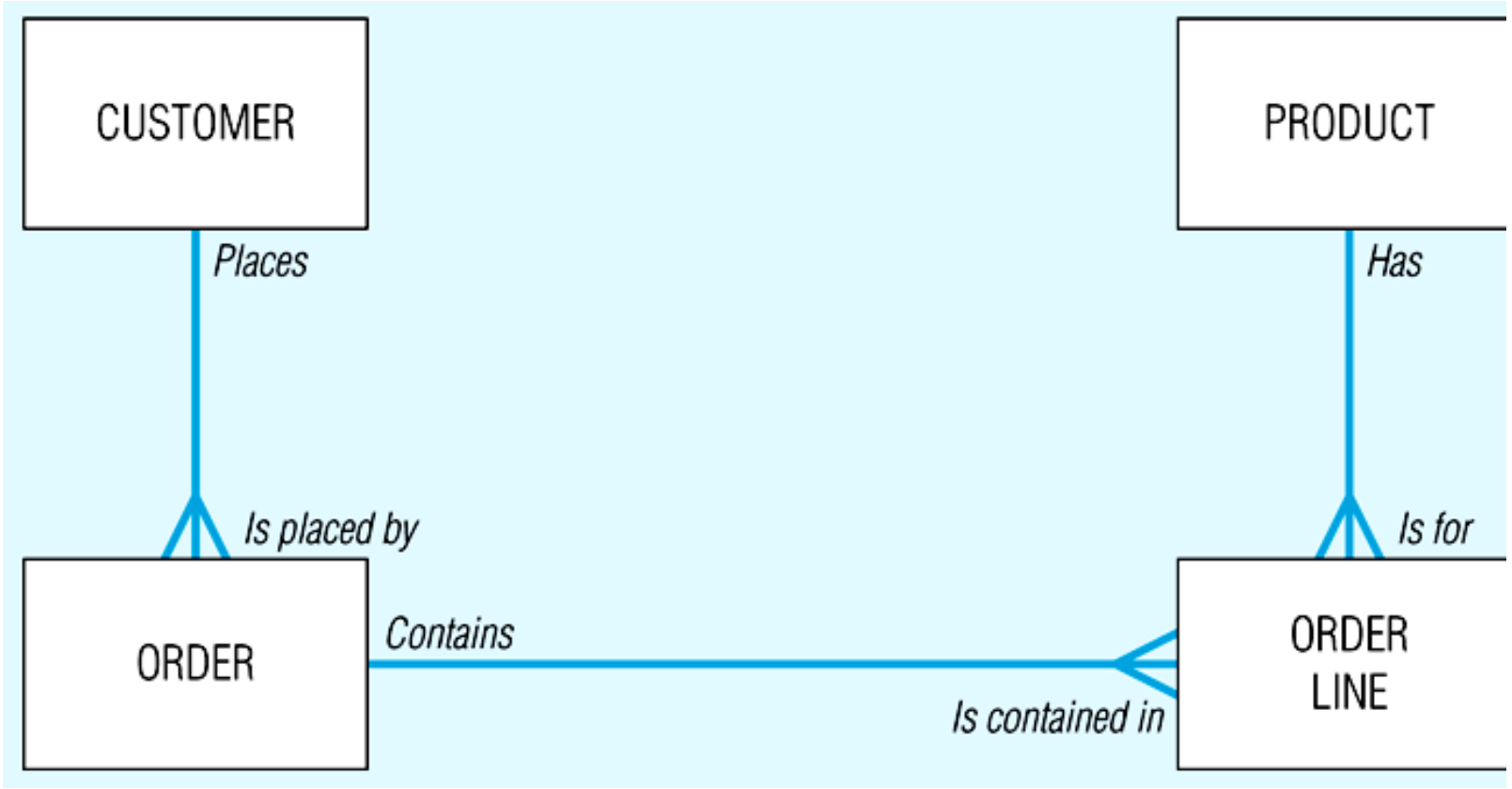


Figure 1-3 Segment from enterprise data model

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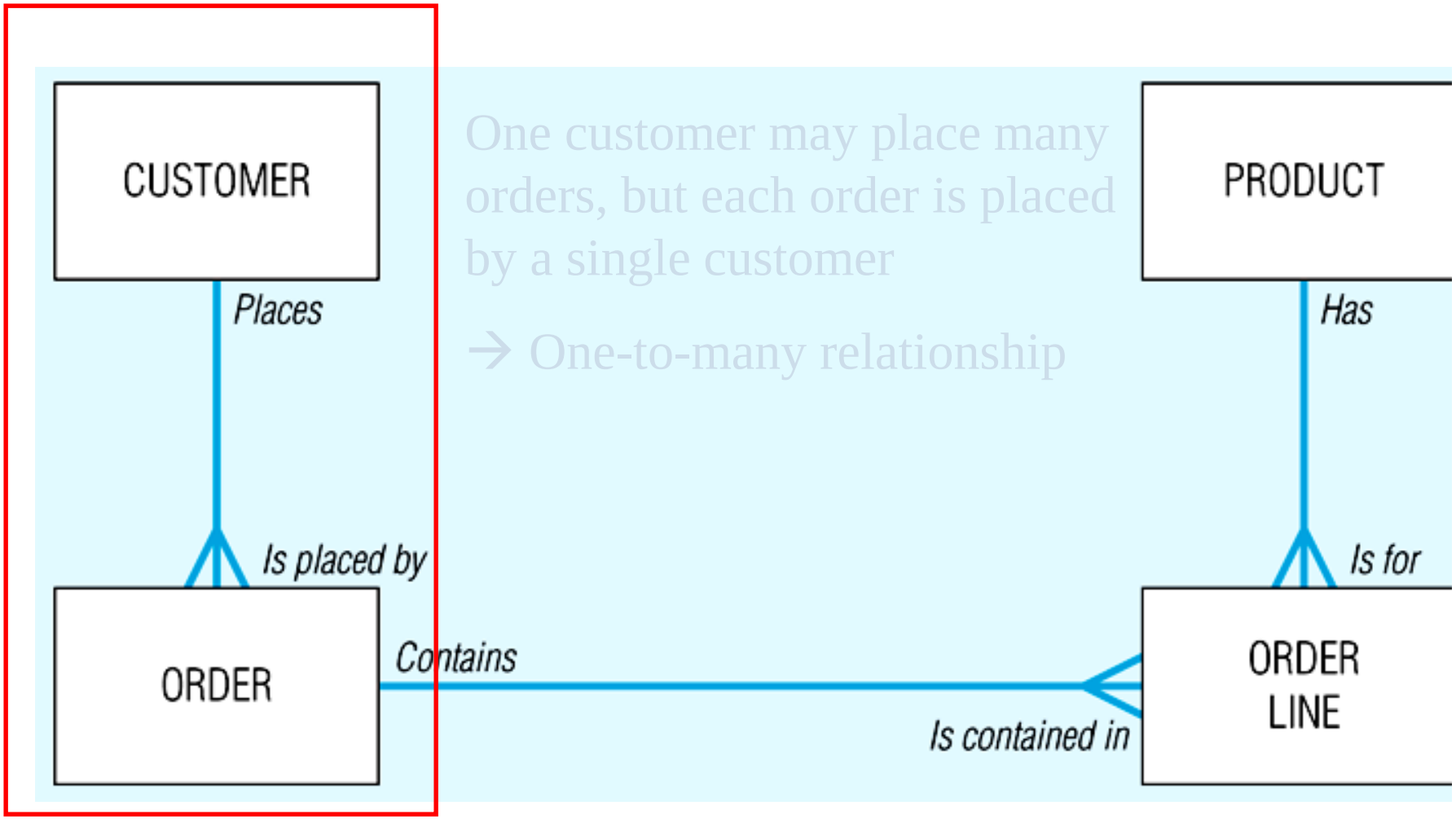

Figure 1-3 Segment from enterprise data model

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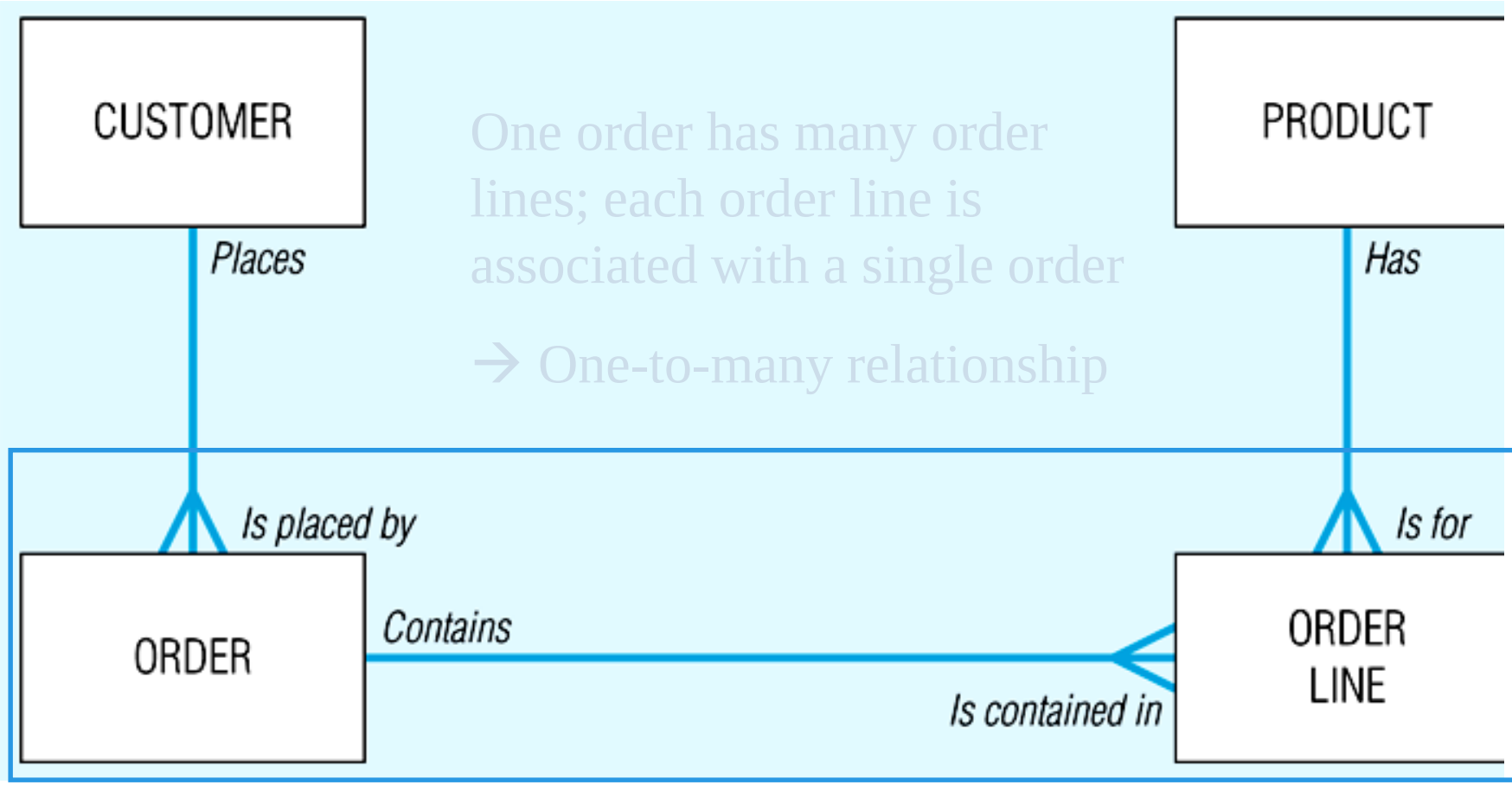

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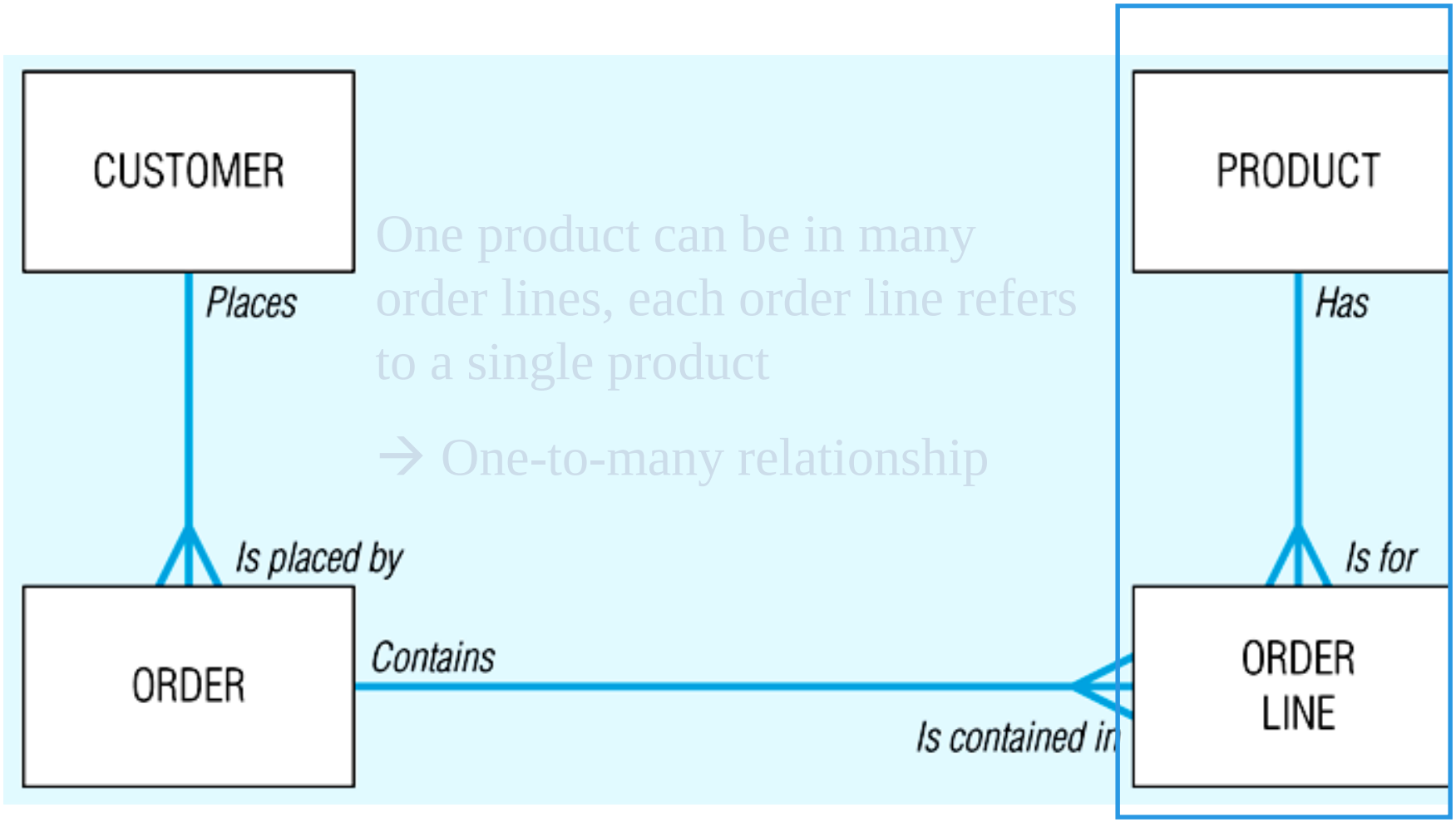

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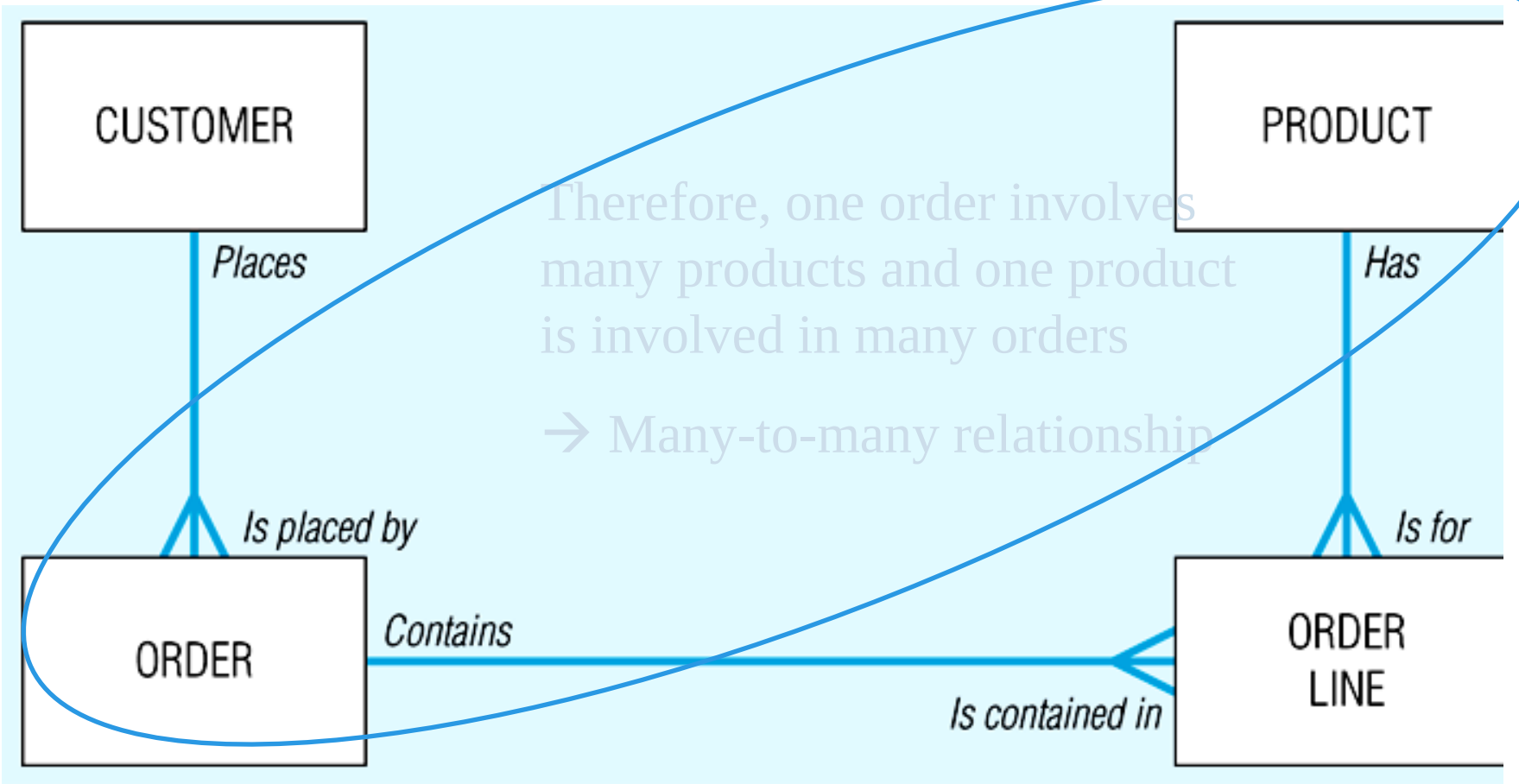


Figure 1-4 Order, Order_Line, Customer, and Product tables

Relationships established in special columns that provide links between tables

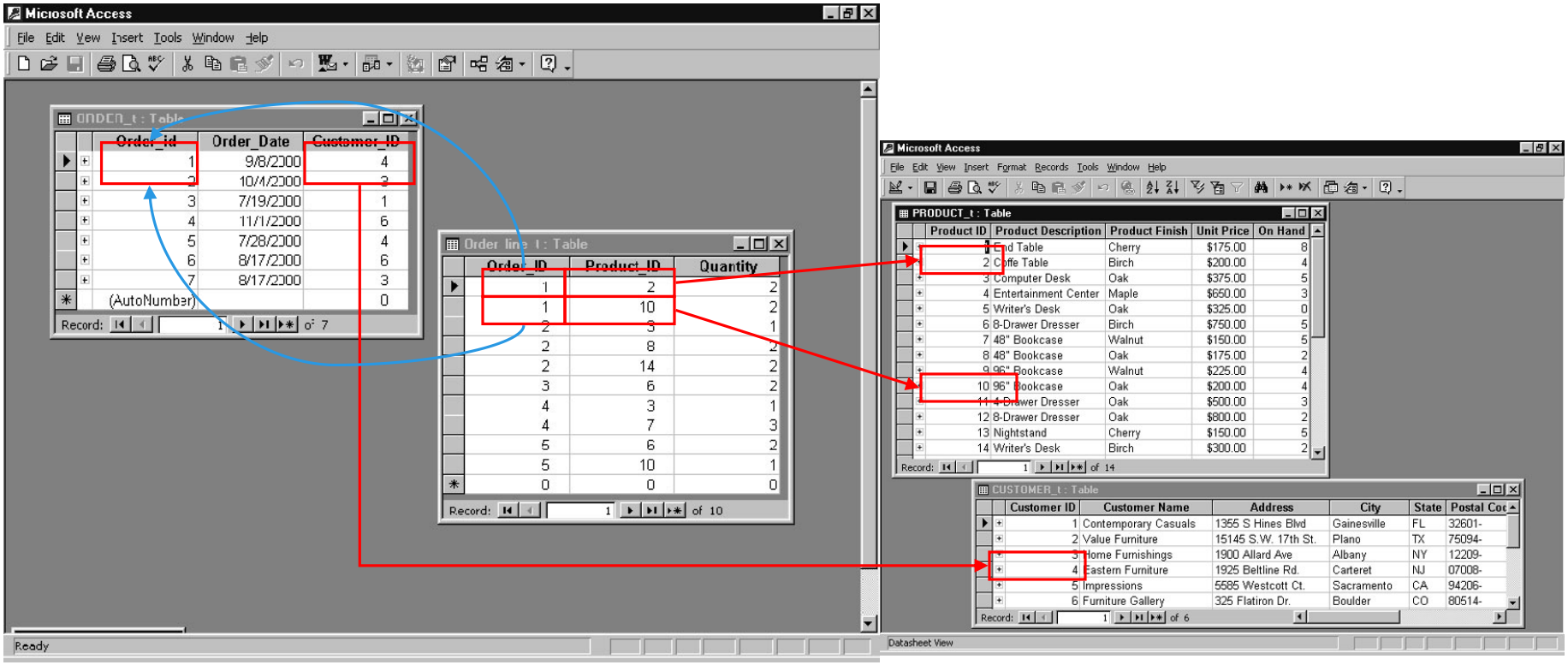


Figure 1-5
Client/server system

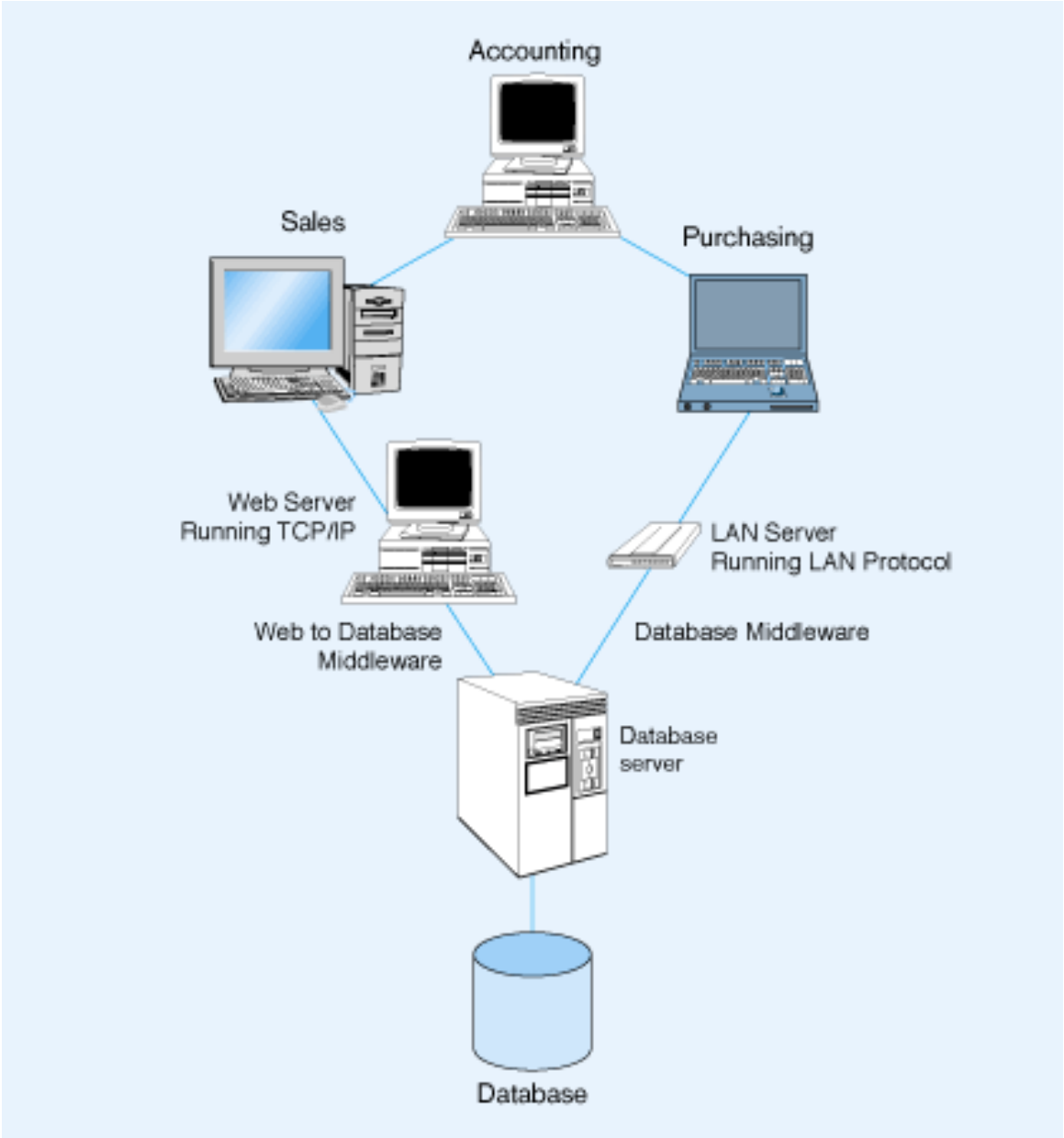
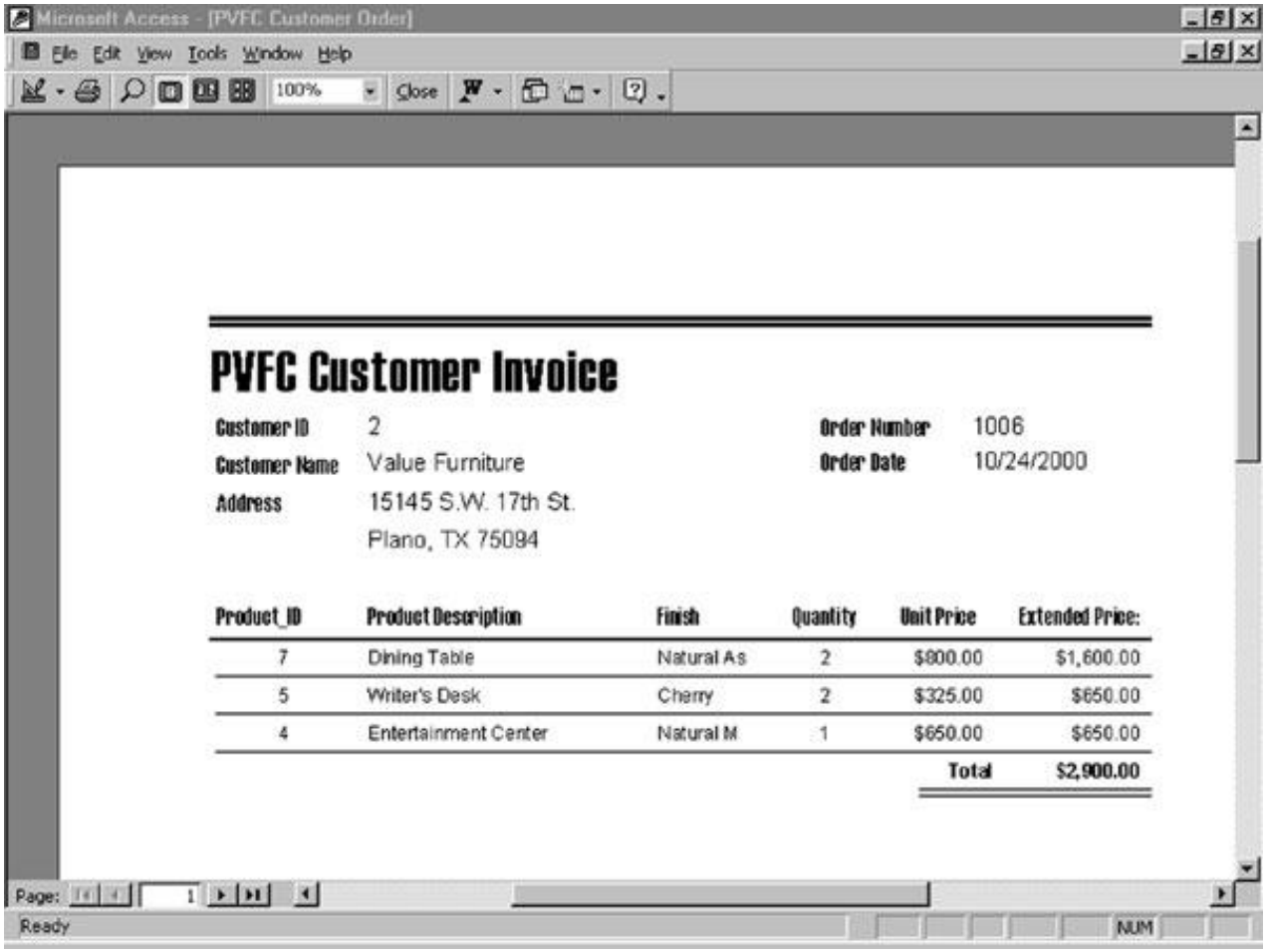


Figure 1-6 Customer invoice (Pine Valley Furniture Company)

Application program functions:

inserting new data, updating existing data,
deleting existing data, reading data for display



Summary

- Understand definition of database and DBMS
- Distinguish between data and information, and provide examples of each
- Describe and give an example of how data becomes information
- Significance of Database
- Study the application of Database System
- List and explain the three major steps in the database development process
- Understand Modelling for a database