Chapter 1:
The Database Environment

Modern Database Management
8th Edition

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Objectives

- Definition of terms
- Explain growth and importance of databases
- Name limitations of conventional file processing
- Identify five categories of databases
- Explain advantages of databases
- Identify costs and risks of databases
- List components of database environment
- Describe evolution of database systems

Definitions

- **Database**: organized collection of logically related data

- **Data**: stored representations of meaningful objects and events
  - Structured: numbers, text, dates
  - Unstructured: images, video, documents

- **Information**: data processed to increase knowledge in the person using the data

- **Metadata**: data that describes the properties and context of user data

Figure 1-1a Data in context

```
                        Class Roster

Course:    MGT 500              Semester: Spring 200X
           Business Policy

Section:   2

         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
```

Context helps users understand data

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Figure 1-1b Summarized data

Percent Enrollment by Major (200X)

Enrollment Projections
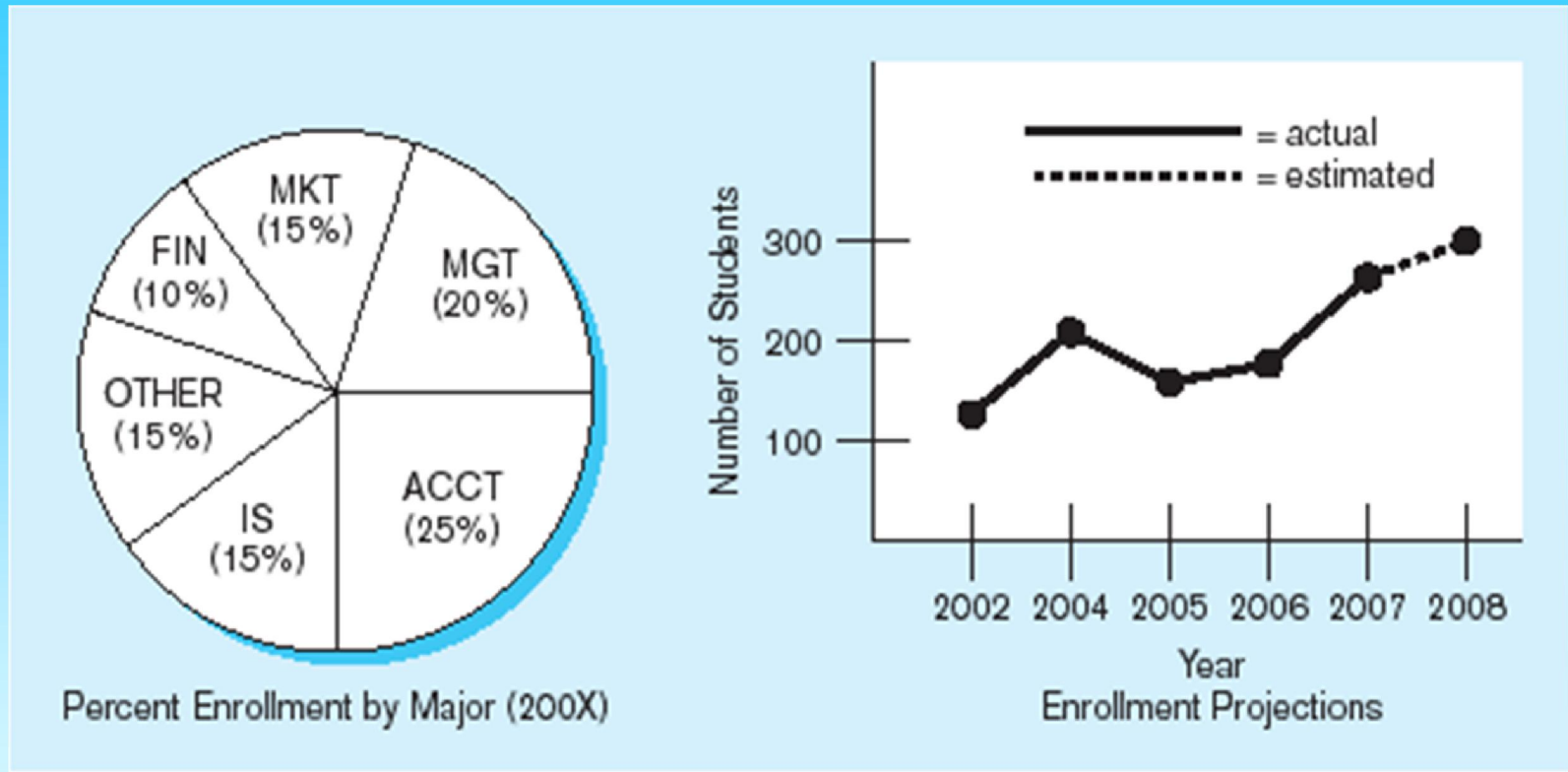
Graphical displays turn data into useful information that managers can use for decision making and interpretation

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Table 1-1 Example Metadata for Class Roster

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

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

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Disadvantages of File Processing

- **Program-Data Dependence**
  - All programs maintain metadata for each file they use

- **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**
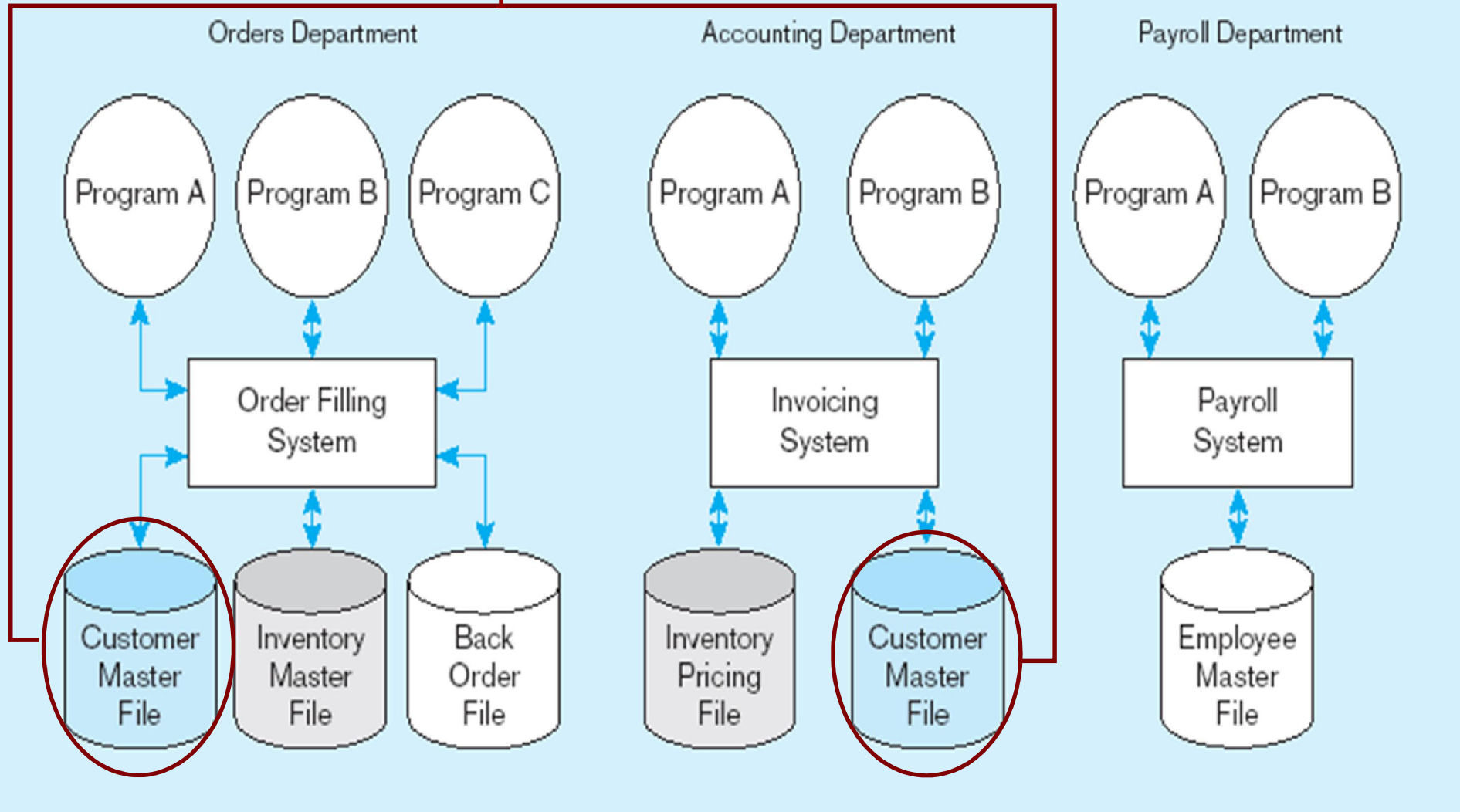 - 80% of information systems budget

Problems with Data Dependency

- Each application programmer must maintain his/her own data

- Each application program needs to include code for the metadata of each file

- Each application program must have its own processing routines for reading, inserting, updating, and deleting data

- Lack of coordination and central control

- Non-standard file formats

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Figure 1-3 Old file processing systems at Pine Valley Furniture Company

Duplicate Data

Orders Department

Accounting Department

Payroll Department

Program A Program B Program C

Program A Program B

Program A Program B

Order Filling System

Invoicing System

Payroll System

Customer Master File

Inventory Master File

Back Order File

Inventory Pricing File

Customer Master File

Employee Master File

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Problems with Data Redundancy

- Waste of space to have duplicate data

- Causes more maintenance headaches

- The biggest problem:

  - **Data changes in one file could cause inconsistencies**

  - Compromises in *data integrity*

    تنازلات في سلامة البيانات
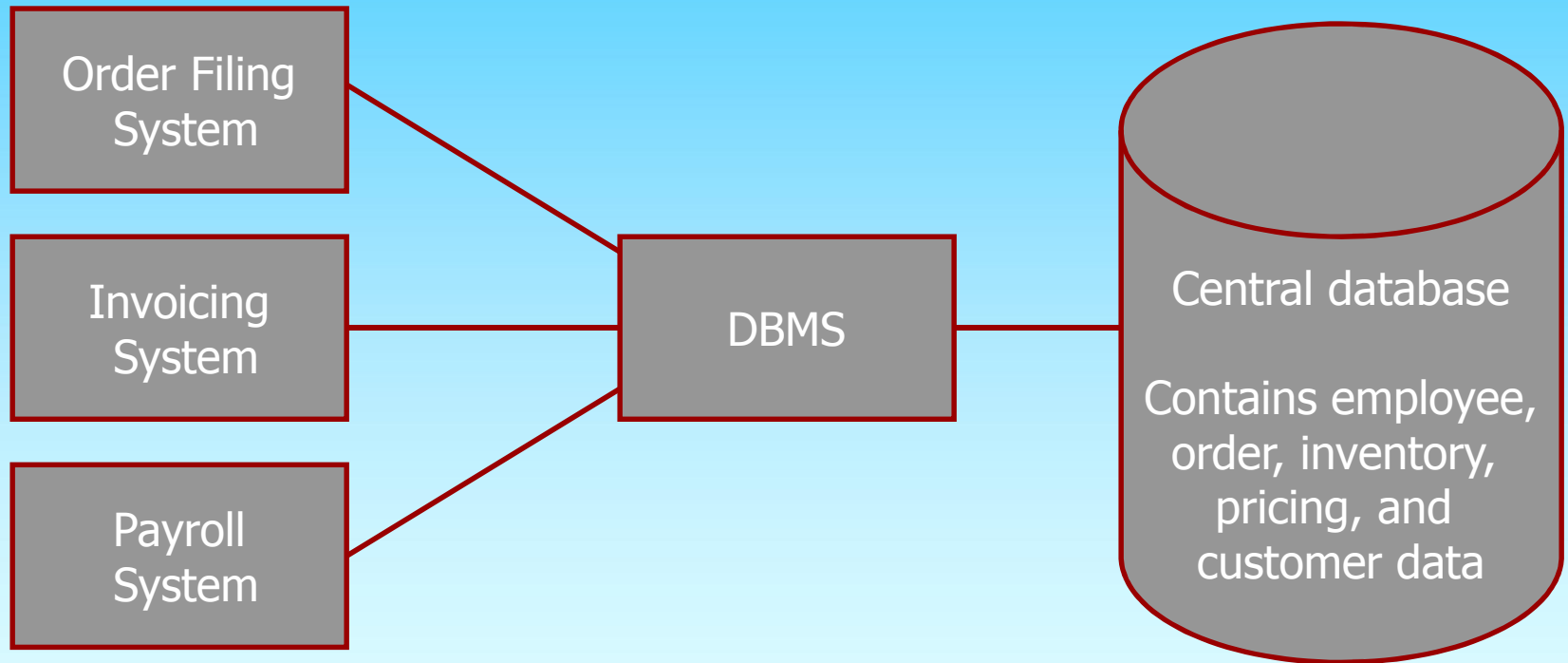
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SOLUTION:
The DATABASE Approach

- <mark>Central repository</mark> of shared data

- Data is managed by a controlling agent

- Stored in a <mark>standardized</mark>, convenient form

<mark>Requires a Database Management System (DBMS)</mark>

Database Management System

- A software system that is used to create, maintain, and provide controlled access to user databases

```
┌──────────────────┐
│  Order Filing    │──────┐
│     System       │       \
└──────────────────┘        \
                             \
┌──────────────────┐    ┌──────────┐        ╭─────────────────╮
│    Invoicing     │────│   DBMS   │────────│ Central database │
│     System       │    └──────────┘        │                  │
└──────────────────┘        /               │ Contains employee,│
                           /                │ order, inventory,  │
┌──────────────────┐      /                 │  pricing, and      │
│     Payroll      │─────┘                  │  customer data     │
│     System       │                        ╰─────────────────╯
└──────────────────┘
```

DBMS manages data resources like an operating system manages hardware resources

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Advantages of the Database Approach

- Program-data independence
- Planned data redundancy
- Improved data consistency
- Improved data sharing
- Increased application development productivity
- Enforcement of standards
- Improved data quality
- Improved data accessibility and responsiveness
- Reduced program maintenance
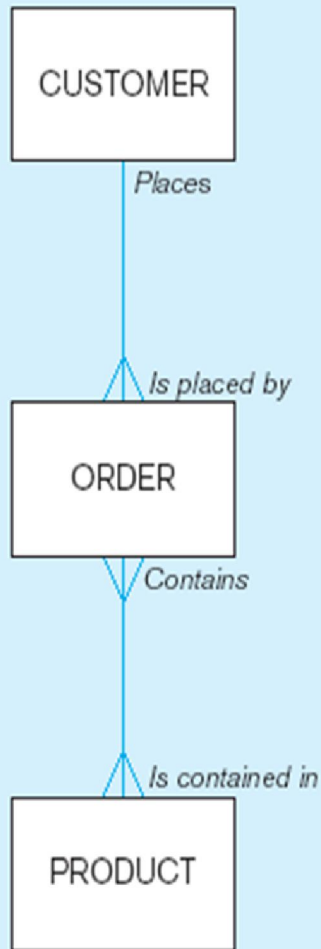- Improved decision support

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Costs and Risks of the Database Approach

- New, specialized personnel

- Installation and management cost and complexity

- Conversion costs

- Need for explicit backup and recovery

- Organizational conflict

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Elements of the Database Approach

- Data models
  - Graphical system capturing nature and relationship of data
  - Enterprise Data Model–high-level entities and relationships for the organization
  - Project Data Model–more detailed view, matching data structure in database or data warehouse
- Relational Databases
  - Database technology involving tables (relations) representing entities and primary/foreign keys representing relationships
- Use of Internet Technology
  - Networks and telecommunications, distributed databases, client-server, and 3-tier architectures
- Database Applications
  - Application programs used to perform database activities (create, read, update, and delete) for database users
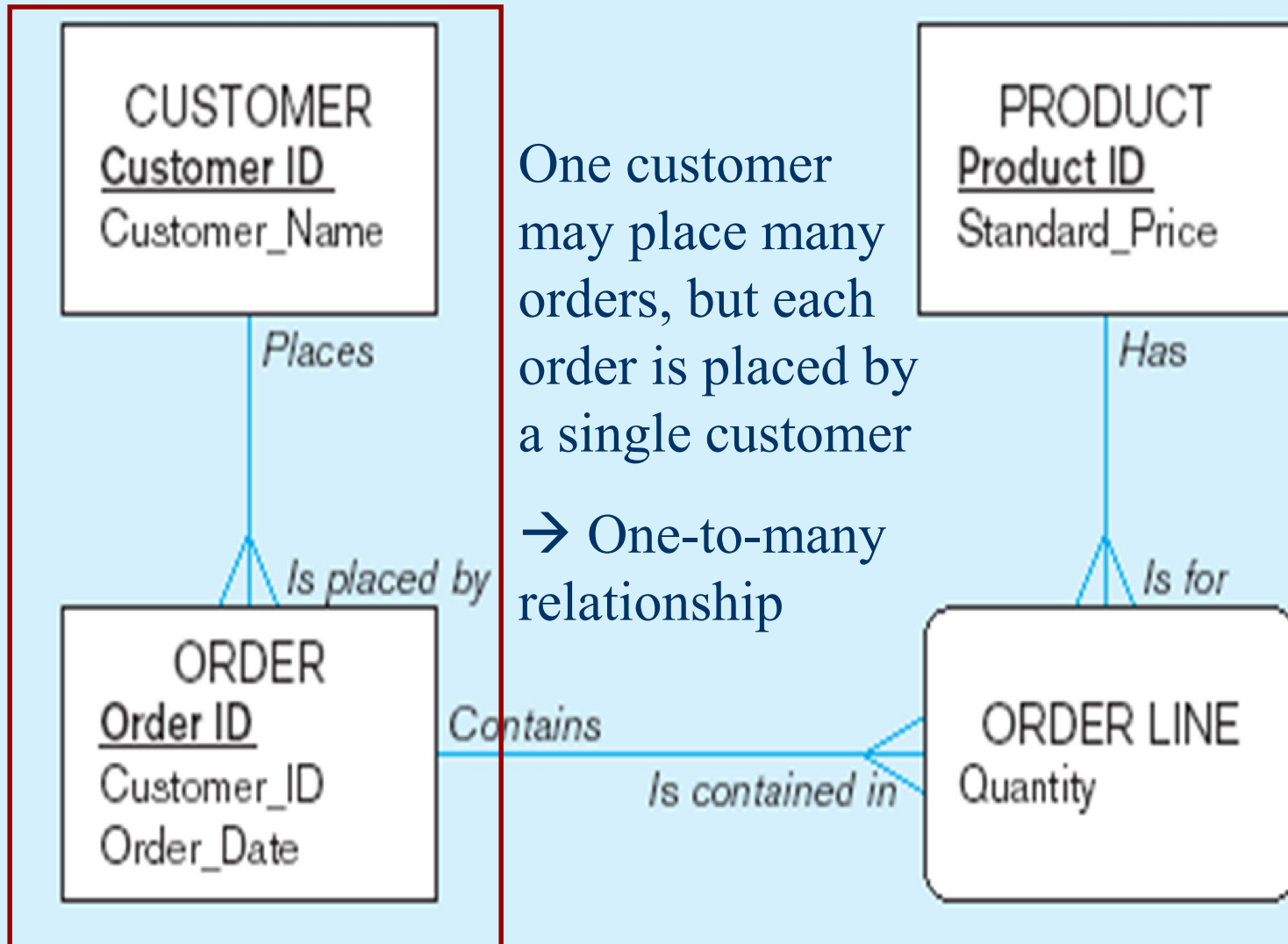
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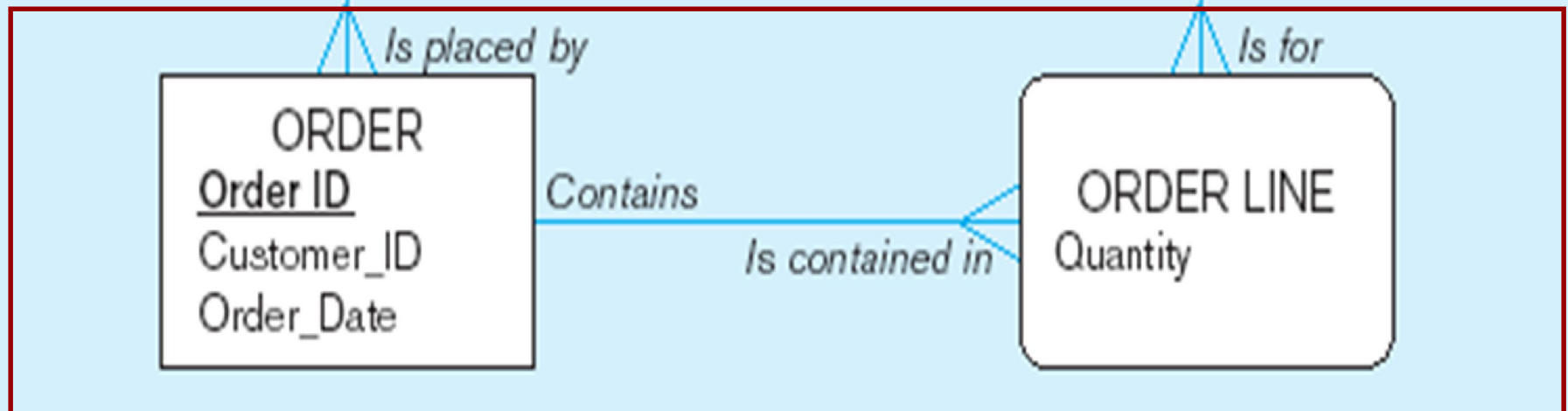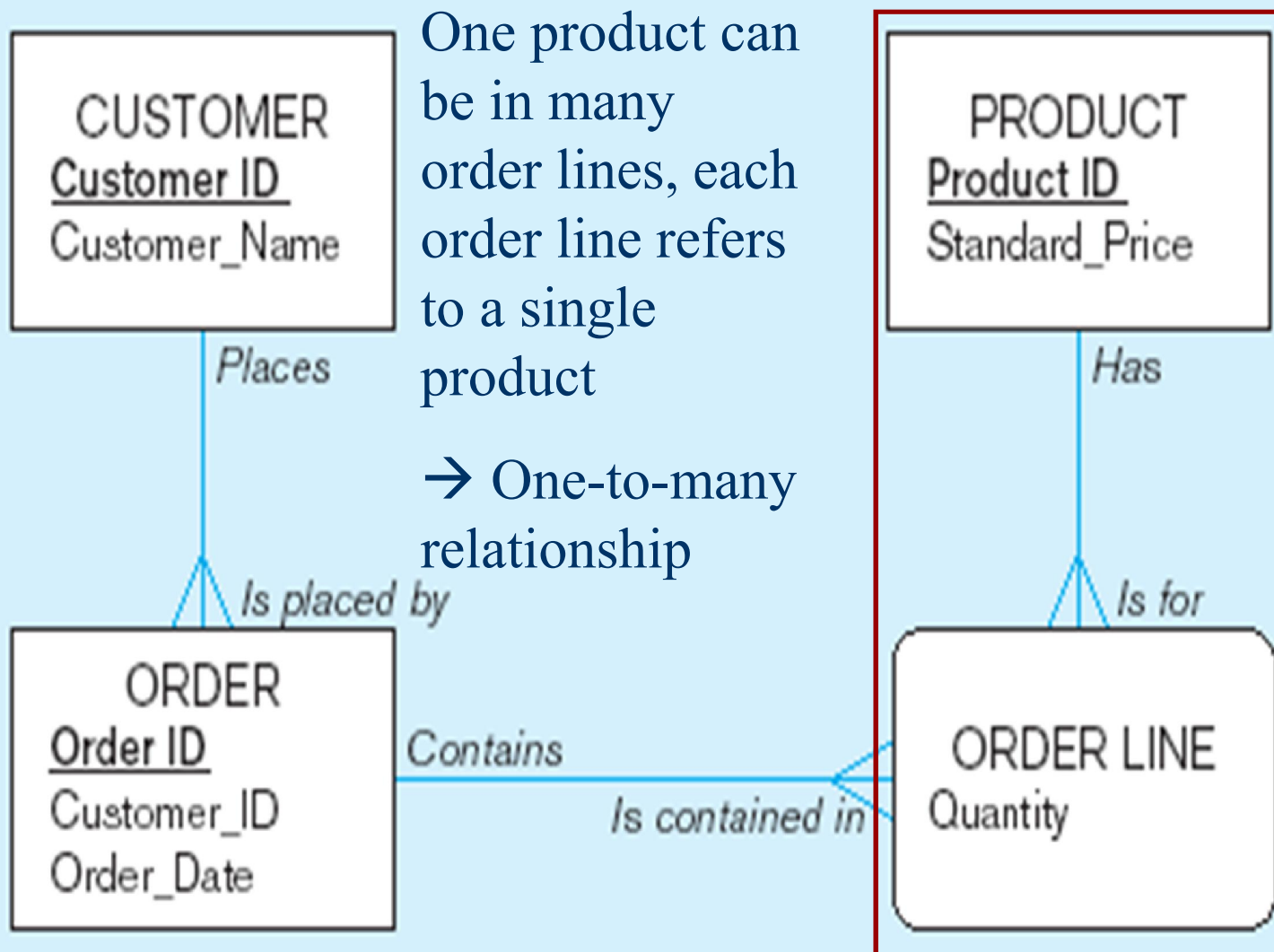
Segment of an Enterprise Data Model

CUSTOMER

| Places

Is placed by

ORDER

Contains

Is contained in

PRODUCT

Segment of a Project-Level Data Model

CUSTOMER
Customer ID
Customer_Name

Places

Is placed by

ORDER
Order ID
Customer_ID
Order_Date

Contains
Is contained in

PRODUCT
Product ID
Standard_Price

Has

Is for

ORDER LINE
Quantity

*

One customer may place many orders, but each order is placed by a single customer

→ One-to-many relationship

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CUSTOMER
Customer ID
Customer_Name
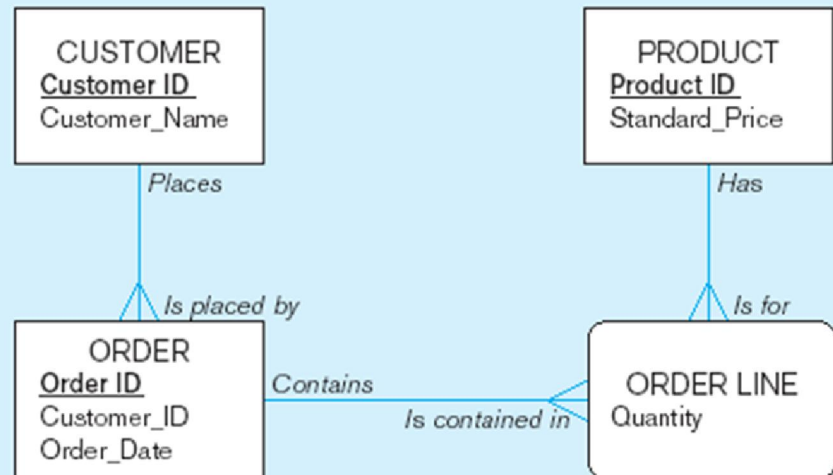
One order has many order lines; each order line is associated with a single order

PRODUCT
Product ID
Standard_Price

→ One-to-many relationship
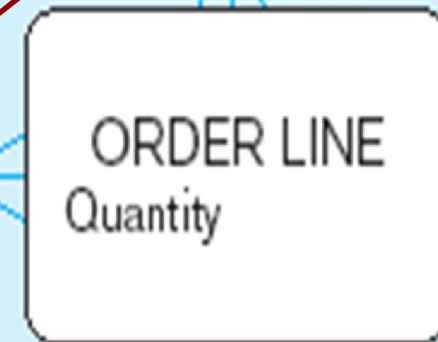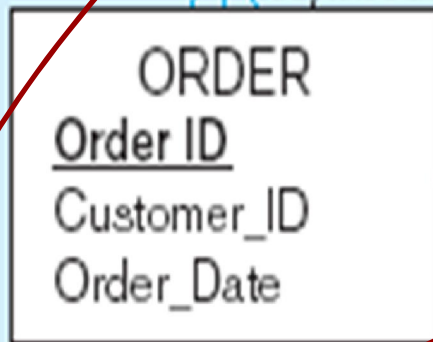
Places

Has

Is placed by

Is for

ORDER
Order ID
Customer_ID
Order_Date

Contains

Is contained in

ORDER LINE
Quantity

*

One product can be in many order lines, each order line refers to a single product

→ One-to-many relationship

CUSTOMER
Customer ID
Customer_Name

Places

PRODUCT
Product ID
Standard_Price

Has

Is placed by

ORDER
Order ID
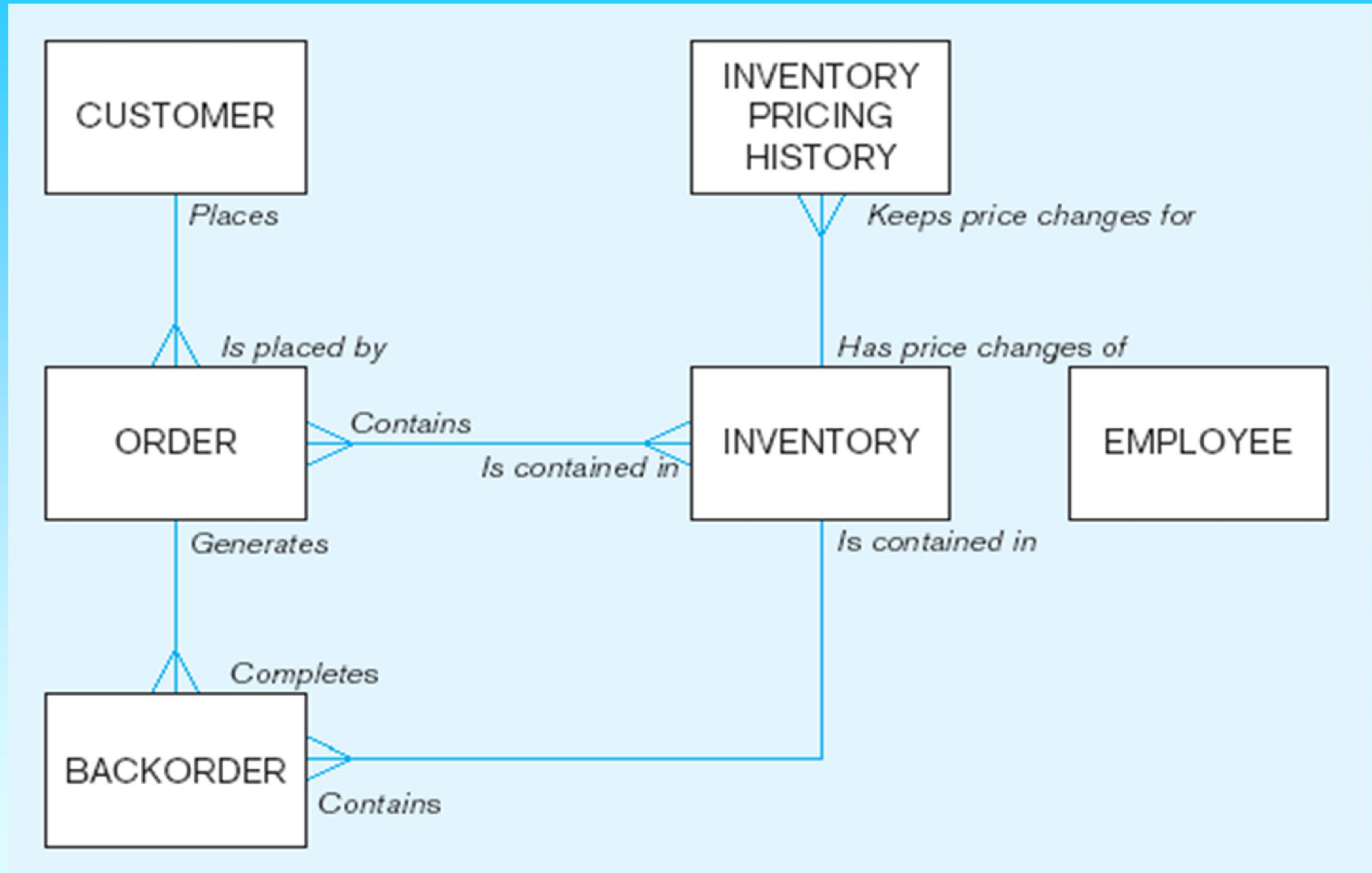Customer_ID
Order_Date

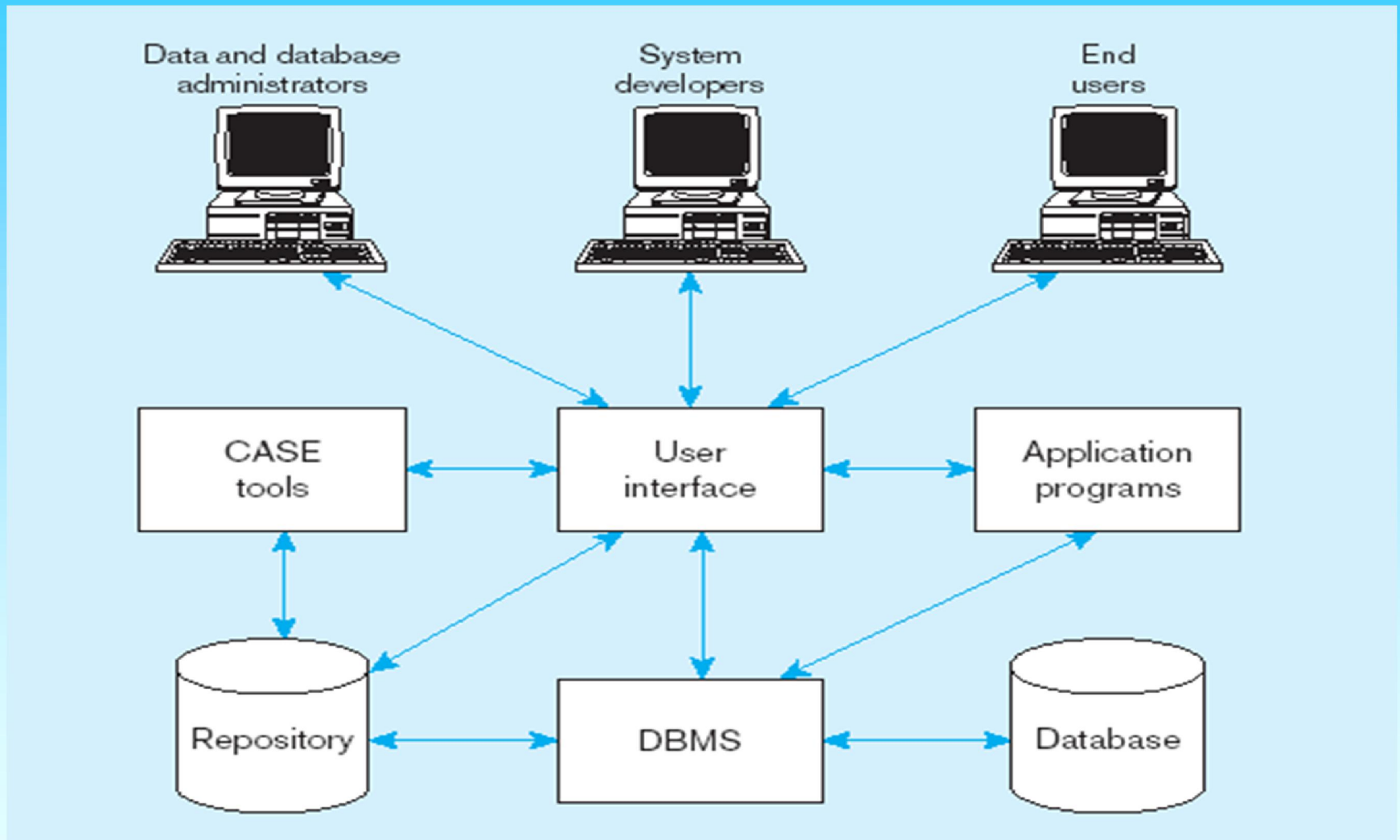*Contains*

Is contained in

Is for

ORDER LINE
Quantity

*

Therefore, one order involves many products and one product is involved in many orders

→ Many-to-many relationship

Figure 1-4 Enterprise data model for Figure 1-3 segments

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Figure 1-5 Components of the Database Environment

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Components of the Database Environment

- **CASE Tools**–computer-aided software engineering
- **Repository**–centralized storehouse of metadata
- **Database Management System (DBMS)** –software for managing the database
- **Database**–storehouse of the data
- **Application Programs**–software using the data
- **User Interface**–text and graphical displays to users
- **Data/Database Administrators**–personnel responsible for maintaining the database
- **System Developers**–personnel responsible for designing databases and software
- **End Users**–people who use the applications and databases

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The Range of Database Applications

- Personal databases

- Workgroup databases

- Departmental/divisional databases

- Enterprise database

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Table 1-6 Summary of Database Applications (adapted from White, 1995)

| Type of Database	Typical Number of Users	Typical Architecture	Typical Size of Database
Personal	1	Desktop/laptop computer, PDA	Megabytes
Workgroup	5–25	Client/server (two-tier)	Megabytes–gigabytes
Department/Division	25–100	Client/server (three-tier)	Gigabytes
Enterprise	>100	Client/server (distributed or parallel server)	Gigabytes–terabytes
Web-enabled	>1000	Web server and application servers	Megabytes–gigabytes

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Figure 1-6 Typical data from a personal database

Customer

Customer Name:	Multi Media, Inc.
Address:	1000 River Road
City:	San Antonio
State:	TX
Zip:	76235
Phone:	(219) 864-2000
Next Contact Date: 10/17/2006	Time: 10:30 AM

Contact History for Customer

Date	Time	Contact	Comments
08/04/2006	10:00 AM	Roberts	Review proposal
08/19/2006	08:00 AM	Roberts	Revise schedule
09/10/2006	09:00 AM	Pearson	Sign contract
09/21/2006	02:00 PM	Roberts	Follow up

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Figure 1-7 Workgroup database with wireless local area network

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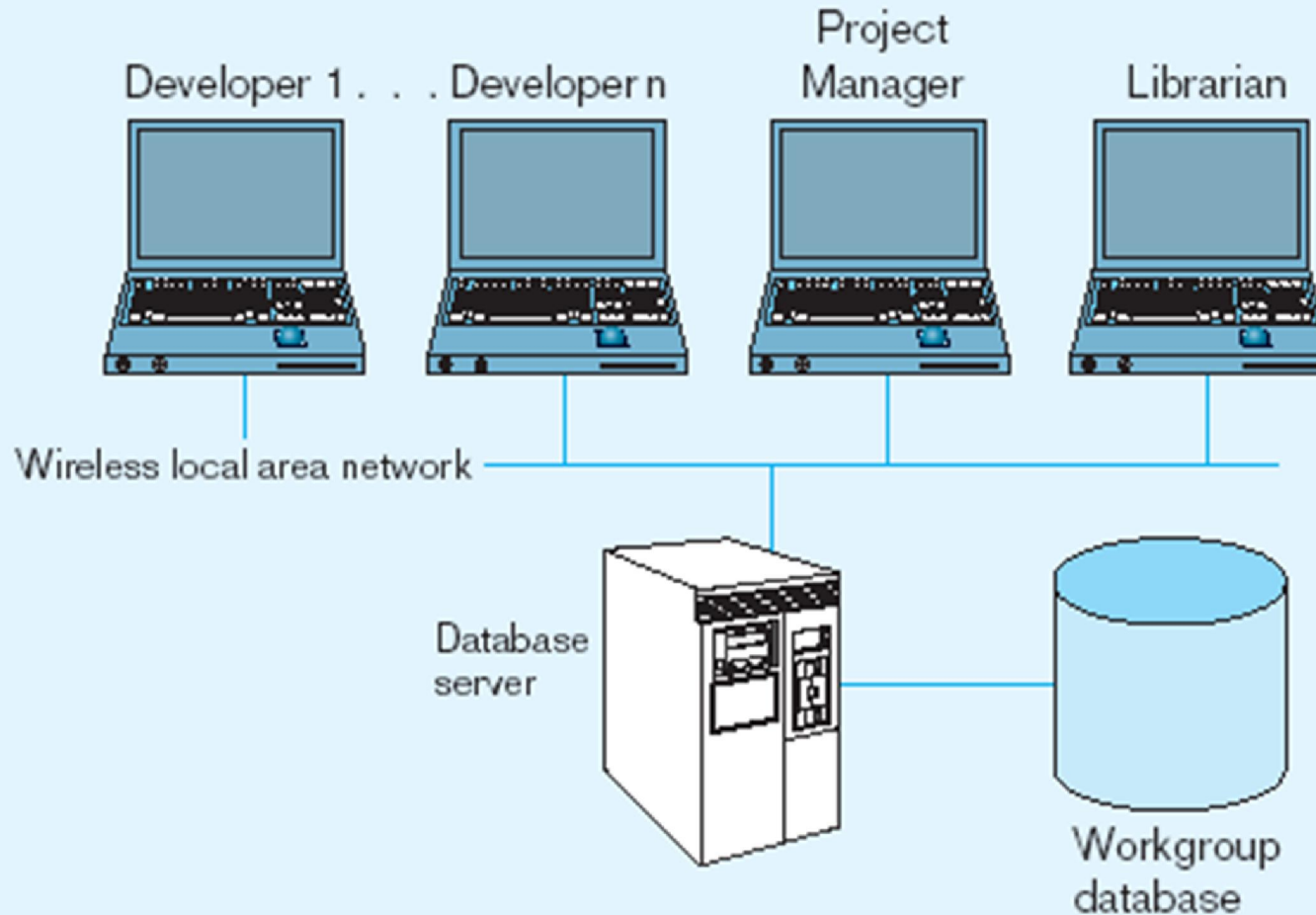
Enterprise Database Applications

- ## Enterprise Resource Planning (ERP)
  - ### Integrate all enterprise functions (manufacturing, finance, sales, marketing, inventory, accounting, human resources)

- ## Data Warehouse
  - ### Integrated decision support system derived from various operational databases

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Figure 1-8 An enterprise data warehouse

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Evolution of DB Systems

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