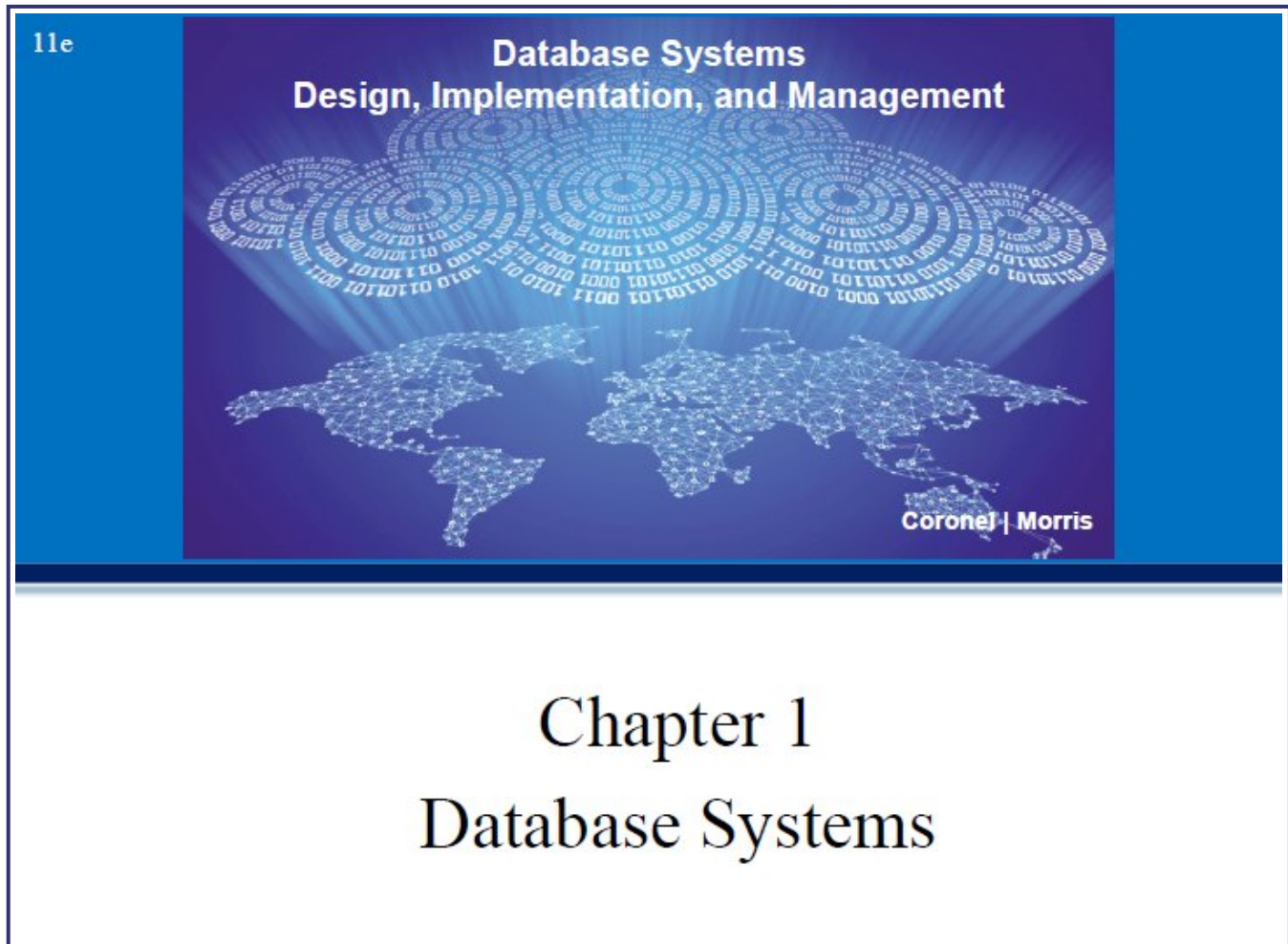


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Introduction

Database systems



What you will learn:

Learning Objectives

- In this chapter, you will learn:
 - The difference between data and information
 - What a database is, the various types of databases, and why they are valuable assets for decision making
 - The importance of database design
 - How modern databases evolved from file systems

What else you will learn:

Learning Objectives

- In this chapter, you will learn:
 - About flaws in file system data management
 - The main components of the database system
 - The main functions of a database management system (DBMS)

Data != information!

Data vs. Information

Data

- Raw facts
 - Raw data - Not yet been processed to reveal the meaning
- Building blocks of information
- **Data management**
 - Generation, storage, and retrieval of data

Information

- Produced by processing data
- Reveals the meaning of data
- Enables **knowledge** creation
- Should be accurate, relevant, and timely to enable good decision making

DB, DBMS

Database

- Shared, integrated computer structure that stores a collection of:
 - End-user data - Raw facts of interest to end user
 - **Metadata:** Data about data, which the end-user data are integrated and managed
 - Describe data characteristics and relationships
- **Database management system (DBMS)**
 - Collection of programs
 - Manages the database structure
 - Controls access to data stored in the database

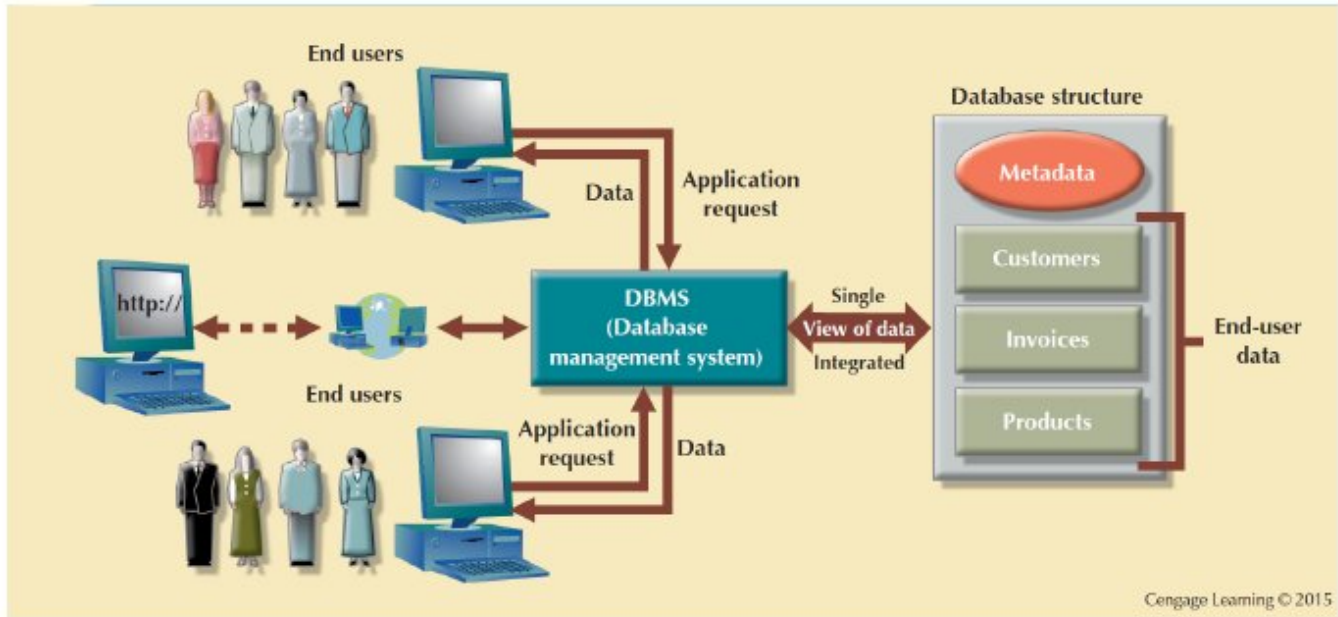
Why DBMS?

Role of the DBMS

- Intermediary between the user and the database
- Enables data to be shared
- Presents the end user with an integrated view of the data
- Receives and translates application requests into operations required to fulfill the requests
- Hides database's internal complexity from the application programs and users

DBMS is a go-between

Figure 1.2 - The DBMS Manages the Interaction between the End User and the Database



DBMS: advantages

Advantages of the DBMS

- Better data integration and less data inconsistency
 - **Data inconsistency:** Different versions of the same data appear in different places
- Increased end-user productivity
- Improved:
 - Data sharing
 - Data security
 - Data access
 - Decision making
 - **Data quality:** Promoting accuracy, validity, and timeliness of data

Types of DBs: based on user count

Types of Databases

- **Single-user database:** Supports one user at a time
 - **Desktop database:** Runs on PC
- **Multiuser database:** Supports multiple users at the same time
 - **Workgroup databases:** Supports a small number of users or a specific department
 - **Enterprise database:** Supports many users across many departments

Types of DBs: based on location

Types of Databases

- **Centralized database:** Data is located at a single site
- **Distributed database:** Data is distributed across different sites
- **Cloud database:** Created and maintained using cloud data services that provide defined performance measures for the database

Types of DBs: based on content

Types of Databases

- **General-purpose databases:** Contains a wide variety of data used in multiple disciplines
- **Discipline-specific databases:** Contains data focused on specific subject areas

Types of DBs: based on data currency

Types of Databases

- **Operational database:** Designed to support a company's day-to-day operations
- **Analytical database:** Stores historical data and business metrics used exclusively for tactical or strategic decision making
 - **Data warehouse:** Stores data in a format optimized for decision support

Types of DBs [cont'd]

Types of Databases

- **Online analytical processing (OLAP)**
 - Enable retrieving, processing, and modeling data from the data warehouse
- **Business intelligence:** Captures and processes business data to generate information that support decision making

Types of DBs: based on the structure of contained data

Types of Databases

- **Unstructured data:** It exists in their original state
- **Structured data:** It results from formatting
 - Structure is applied based on type of processing to be performed
- **Semistructured data:** Processed to some extent
- **Extensible Markup Language (XML)**
 - Represents data elements in textual format

Early DBs: file systems

Evolution of File System Data Processing

Manual File Systems

Accomplished through a system of file folders and filing cabinets



Computerized File Systems

Data processing (DP) specialist: Created a computer-based system that would track data and produce required reports



File System Redux: Modern End-User Productivity Tools

Includes spreadsheet programs such as Microsoft Excel

File systems

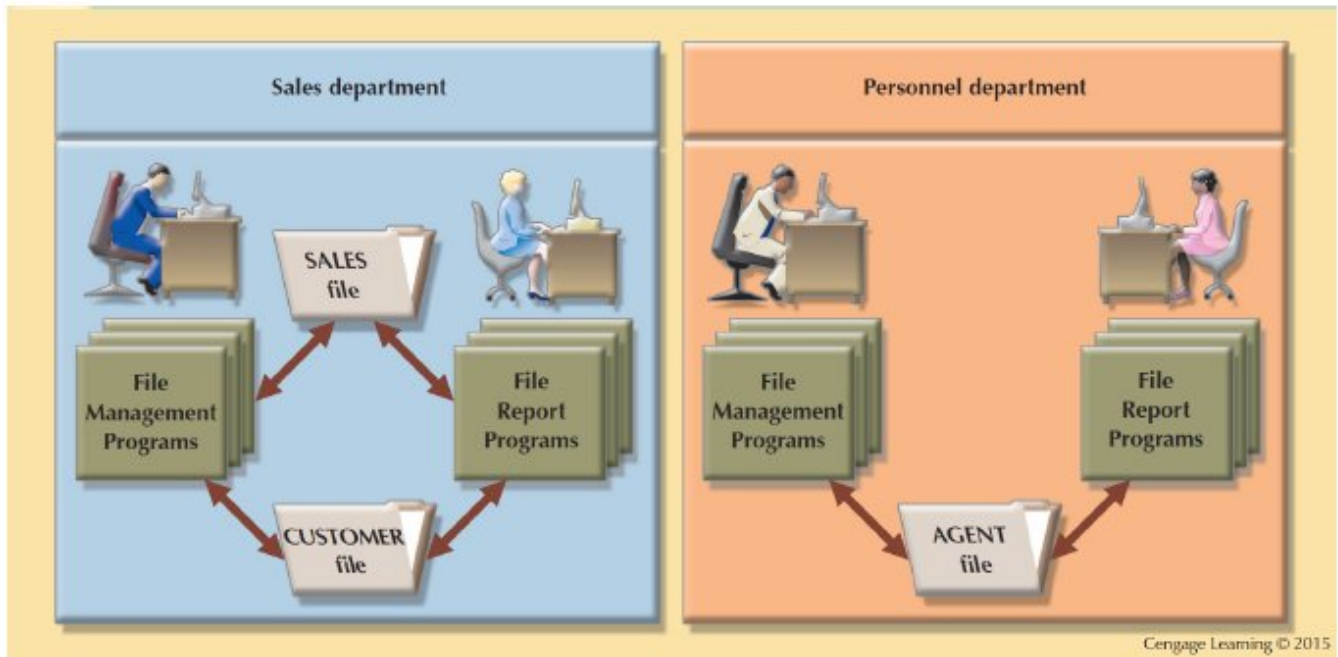
Table 1.2 - Basic File Terminology

TERM	DEFINITION
Data	Raw facts, such as a telephone number, a birth date, a customer name, and a year-to-date (YTD) sales value. Data have little meaning unless they have been organized in some logical manner.
Field	A character or group of characters (alphabetic or numeric) that has a specific meaning. A field is used to define and store data.
Record	A logically connected set of one or more fields that describes a person, place, or thing. For example, the fields that constitute a record for a customer might consist of the customer's name, address, phone number, date of birth, credit limit, and unpaid balance.
File	A collection of related records. For example, a file might contain data about the students currently enrolled at Gigantic University.

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File system

Figure 1.6 - A Simple File System



File systems: problems

Problems with File System Data Processing

Lengthy development times

Difficulty of getting quick answers

Complex system administration

Lack of security and limited data sharing

Extensive programming

'Structural' dependence (not a good thing!)

Structural and Data Dependence

- **Structural dependence:** Access to a file is dependent on its own structure
 - All file system programs are modified to conform to a new file structure
- **Structural independence:** File structure is changed without affecting the application's ability to access the data

Structural dependence [cont'd]

Structural and Data Dependence

- Data dependence
 - Data access changes when data storage characteristics change
- Data independence
 - Data storage characteristics is changed without affecting the program's ability to access the data
- Practical significance of data dependence is difference between logical and physical format

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Redundancy of data (again, not a good thing!)

Data Redundancy

- Unnecessarily storing same data at different places
- **Islands of information:** Scattered data locations
 - Increases the probability of having different versions of the same data

Why is redundancy not a good thing?

Data Redundancy Implications

- Poor data security
- Data inconsistency
- Increased likelihood of data-entry errors when complex entries are made in different files
- **Data anomaly:** Develops when not all of the required changes in the redundant data are made successfully

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The three types of data anomalies

Types of Data Anomaly

Update Anomalies

Insertion Anomalies

Deletion Anomalies

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DB systems

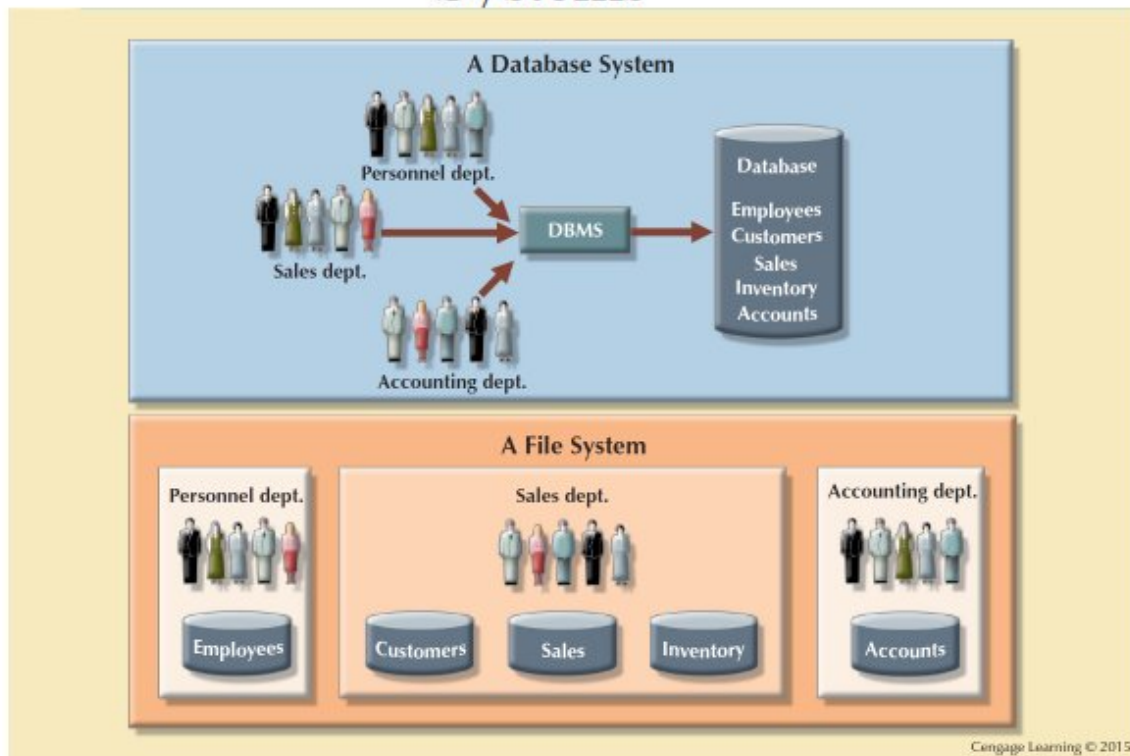
Database Systems

- Logically related data stored in a single logical data repository
 - Physically distributed among multiple storage facilities
 - DBMS eliminates most of file system's problems
- Current generation DBMS software:
 - Stores data structures, relationships between structures, and access paths
 - Defines, stores, and manages all access paths and components

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DB vs file system

Figure 1.8 - Contrasting Database and File Systems



DBMS

DBMS Functions

Data dictionary management

- **Data dictionary:** Stores definitions of the data elements and their relationships

Data storage management

- **Performance tuning:** Ensures efficient performance of the database in terms of storage and access speed

Data transformation and presentation

- Transforms entered data to conform to required data structures

Security management

- Enforces user security and data privacy

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DBMS [cont'd]

DBMS Functions

Multiuser access control

- Sophisticated algorithms ensure that multiple users can access the database concurrently without compromising its integrity

Backup and recovery management

- Enables recovery of the database after a failure

Data integrity management

- Minimizes redundancy and maximizes consistency

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DBMS [cont'd]

DBMS Functions

Database access languages and application programming interfaces

- **Query language:** Lets the user specify what must be done without having to specify how
- **Structured Query Language (SQL):** De facto query language and data access standard supported by the majority of DBMS vendors

Database communication interfaces

- Accept end-user requests via multiple, different network environments

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How DBs could be "bad"

Disadvantages of Database Systems

Increased costs

Management complexity

Maintaining currency

Vendor dependence

Frequent upgrade/replacement cycles

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