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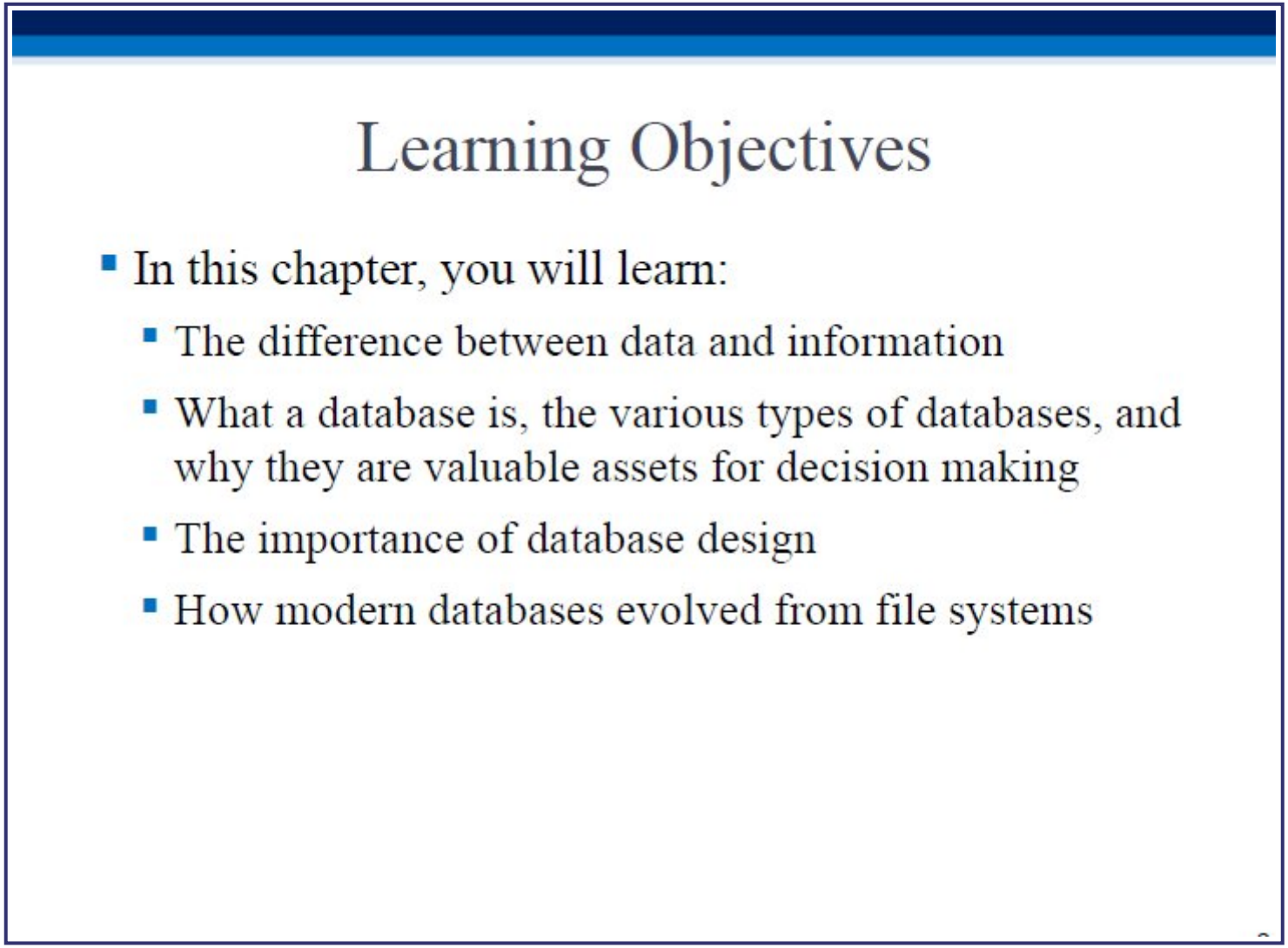
Introduction

Database systems

Chapter 1

Database Systems

What you will learn:

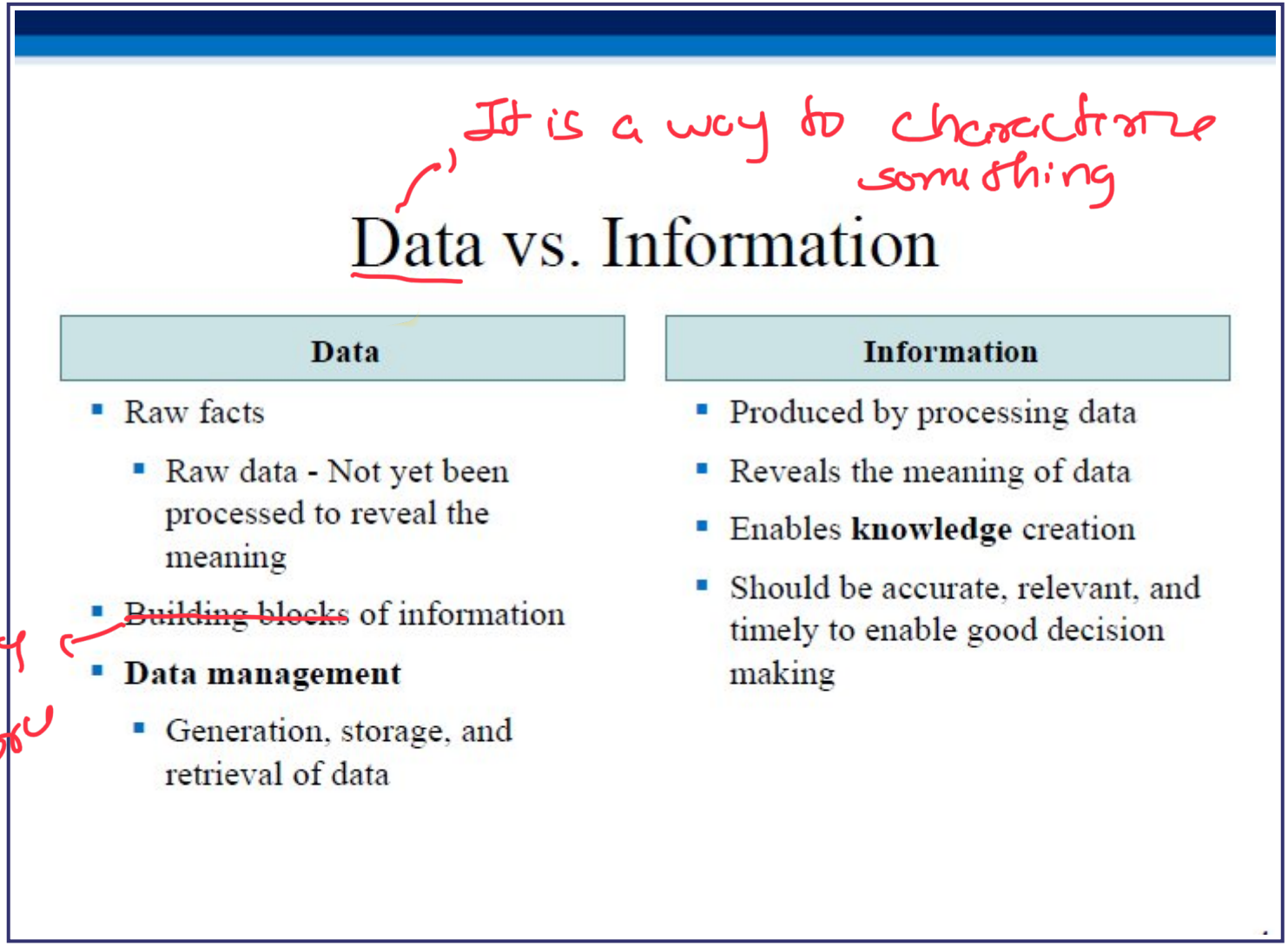


What else you will learn:

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!



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

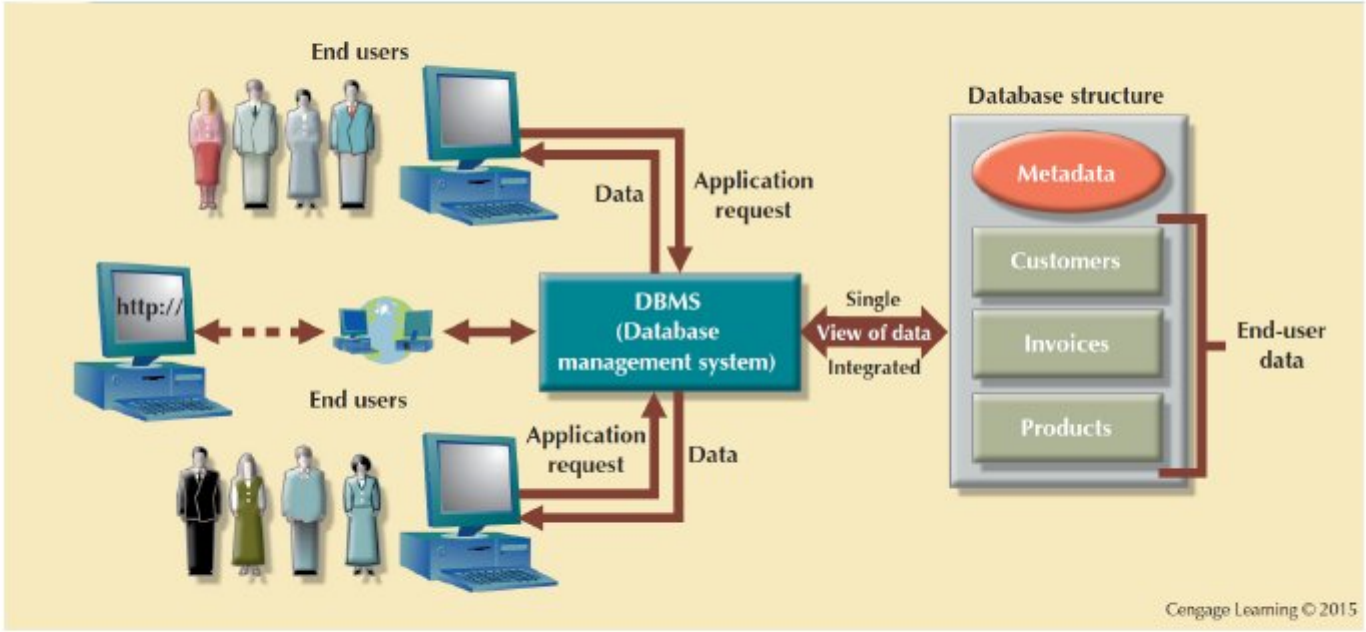
Why DBMS?

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

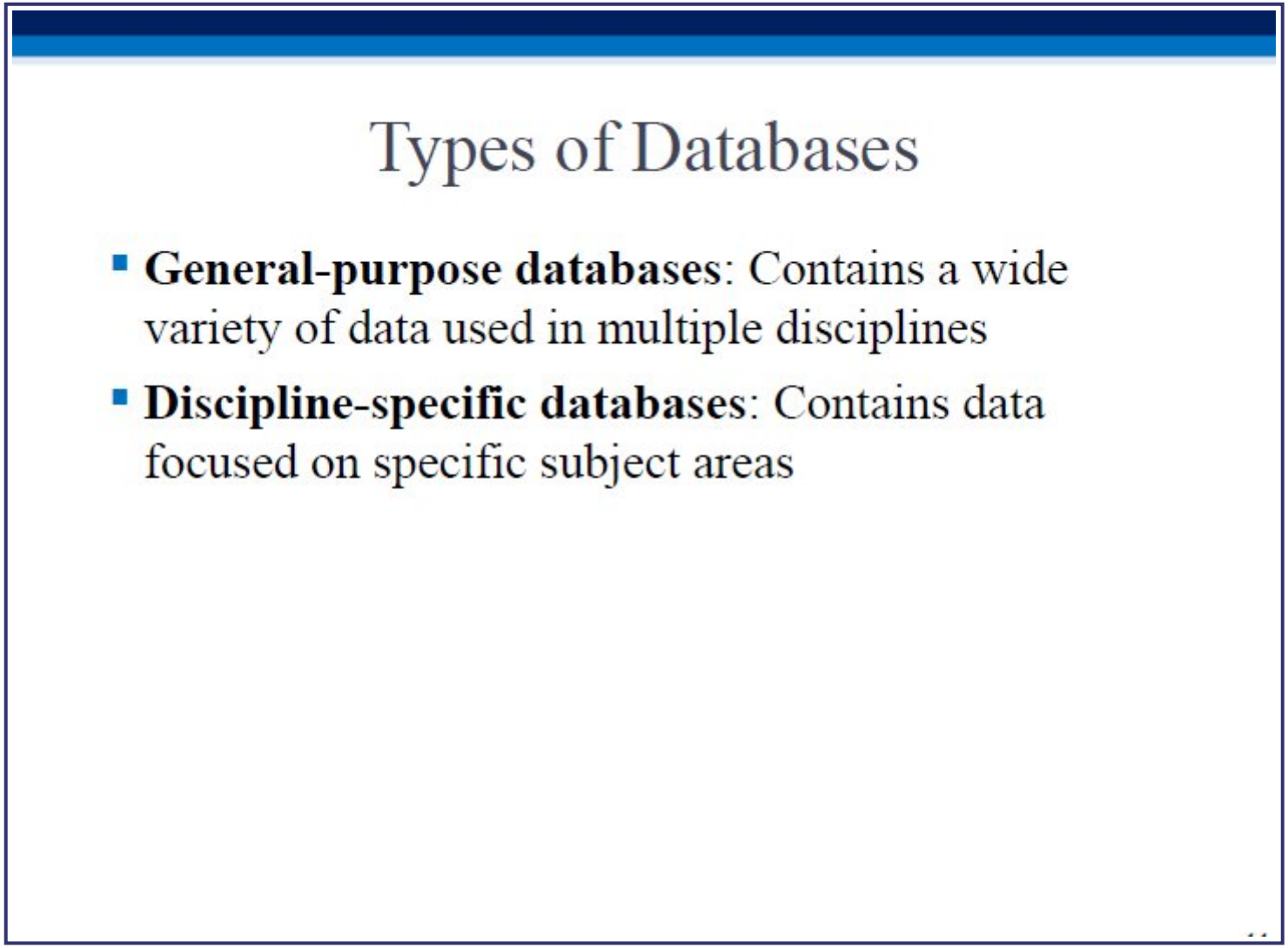
- **Single-user database**: Supports one user at a time
  - **Desktop database**: Runs on PC
- **Multiuser database**: Supports multiple users at the same time
  - **Workgroup databases**: Supports a small number of users or a specific department
  - **Enterprise database**: Supports many users across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

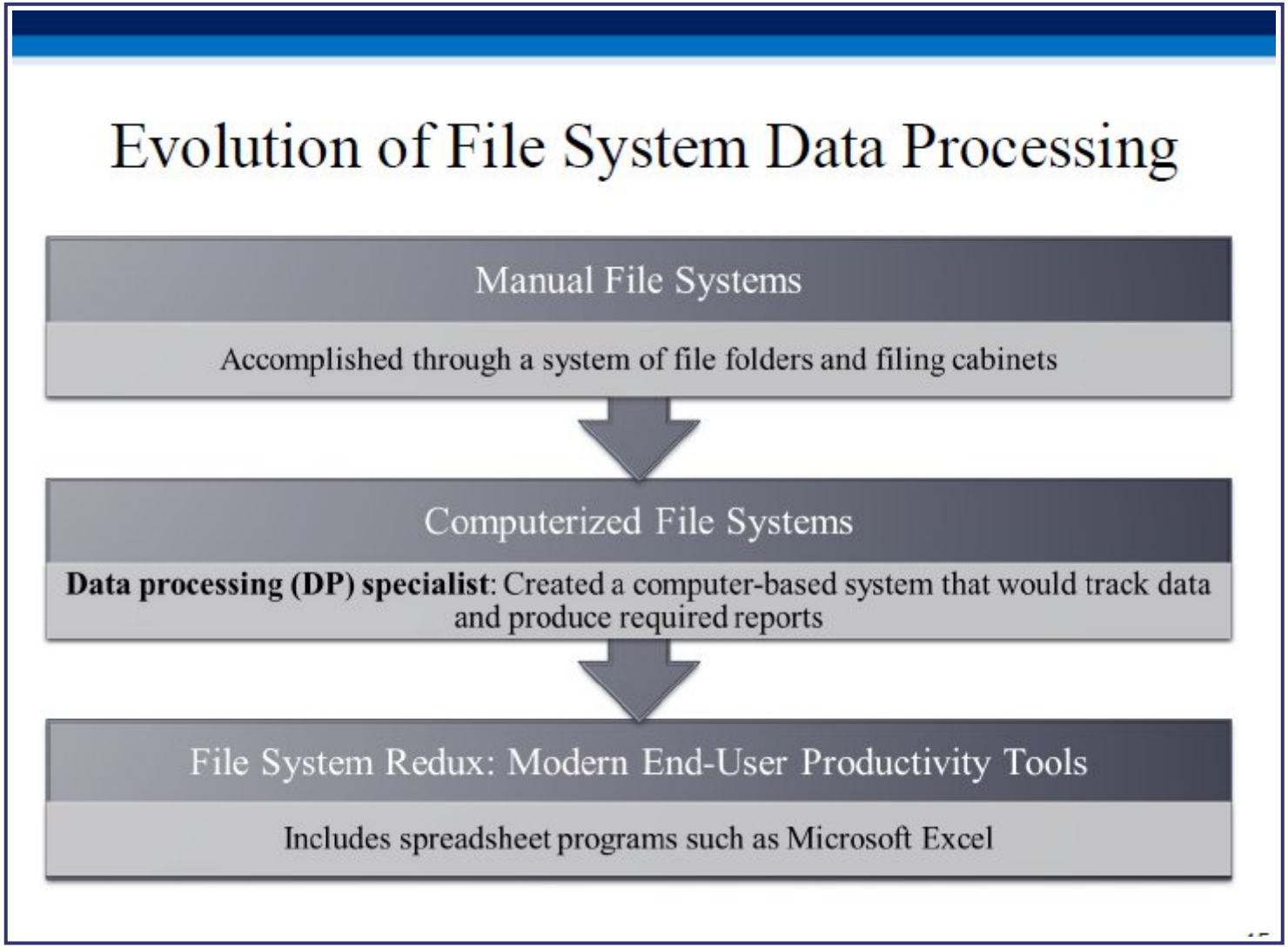
- **Online analytical processing (OLAP)**
  - Enable retrieving, processing, and modeling data from the data warehouse
- **Business intelligence**: Captures and processes business data to generate information that support decision making

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



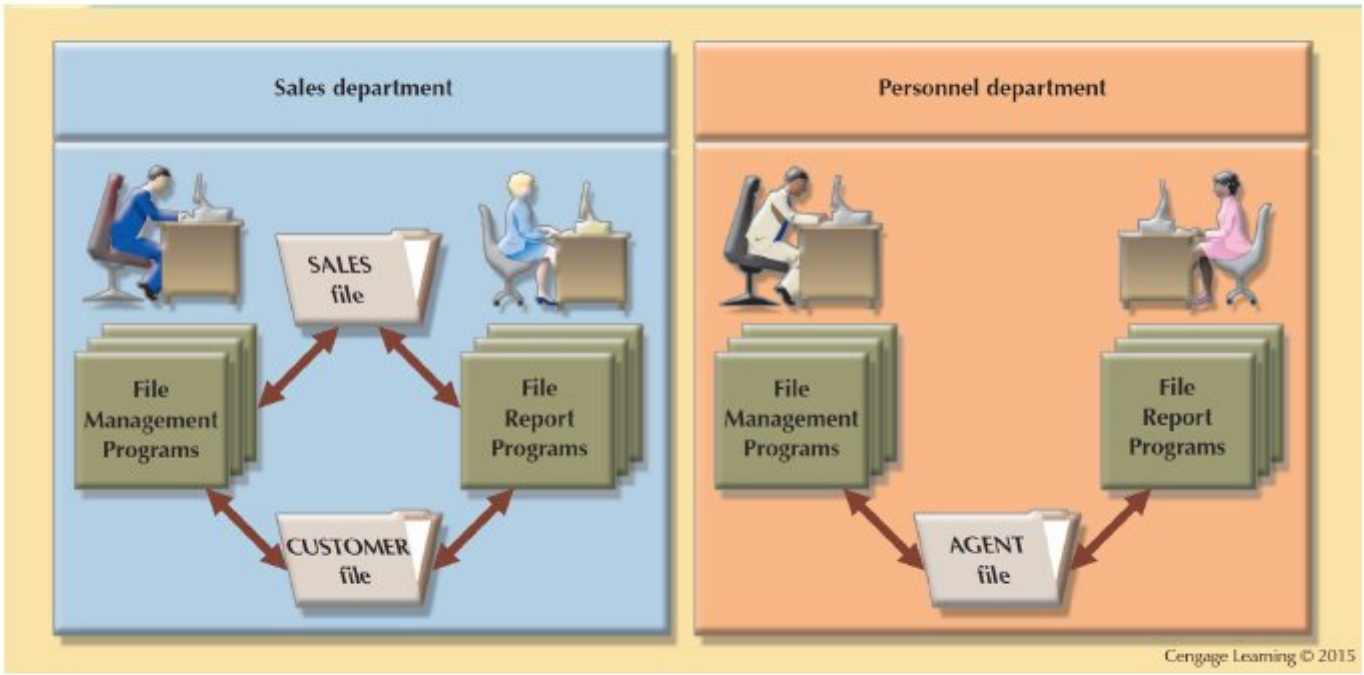
File systems

Table 1.2 - Basic File Terminology

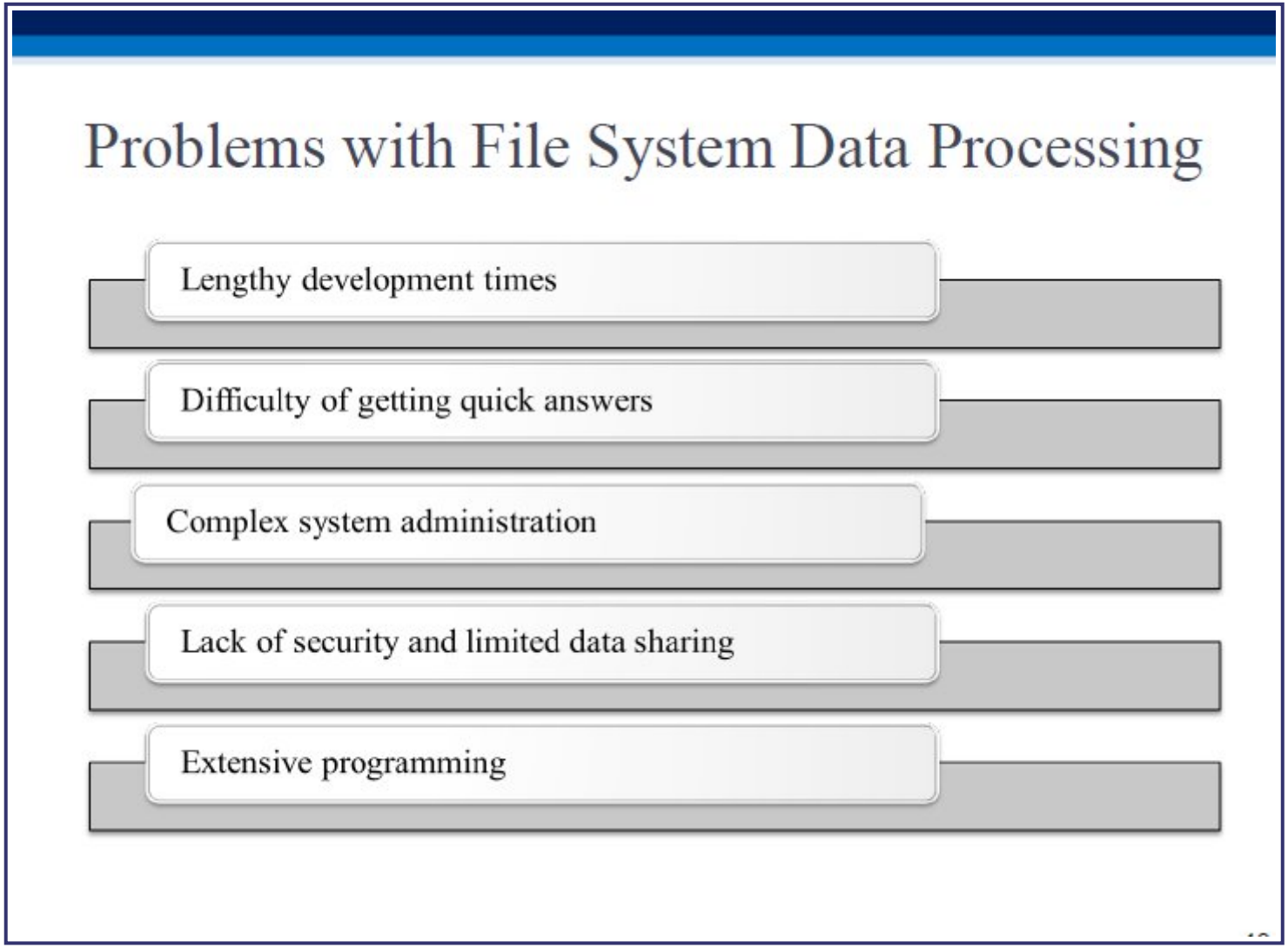
TERM	DEFINITION
Data	Raw facts, such as a telephone number, a birth date, a customer name, and a year-to-date (YTD) sales value. Data have little meaning unless they have been organized in some logical manner.
Field	A character or group of characters (alphabetic or numeric) that has a specific meaning. 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.

File system

Figure1.6 - A Simple File System



File systems: problems



'Structural' dependence (not a good thing!)

Structural and Data Dependence

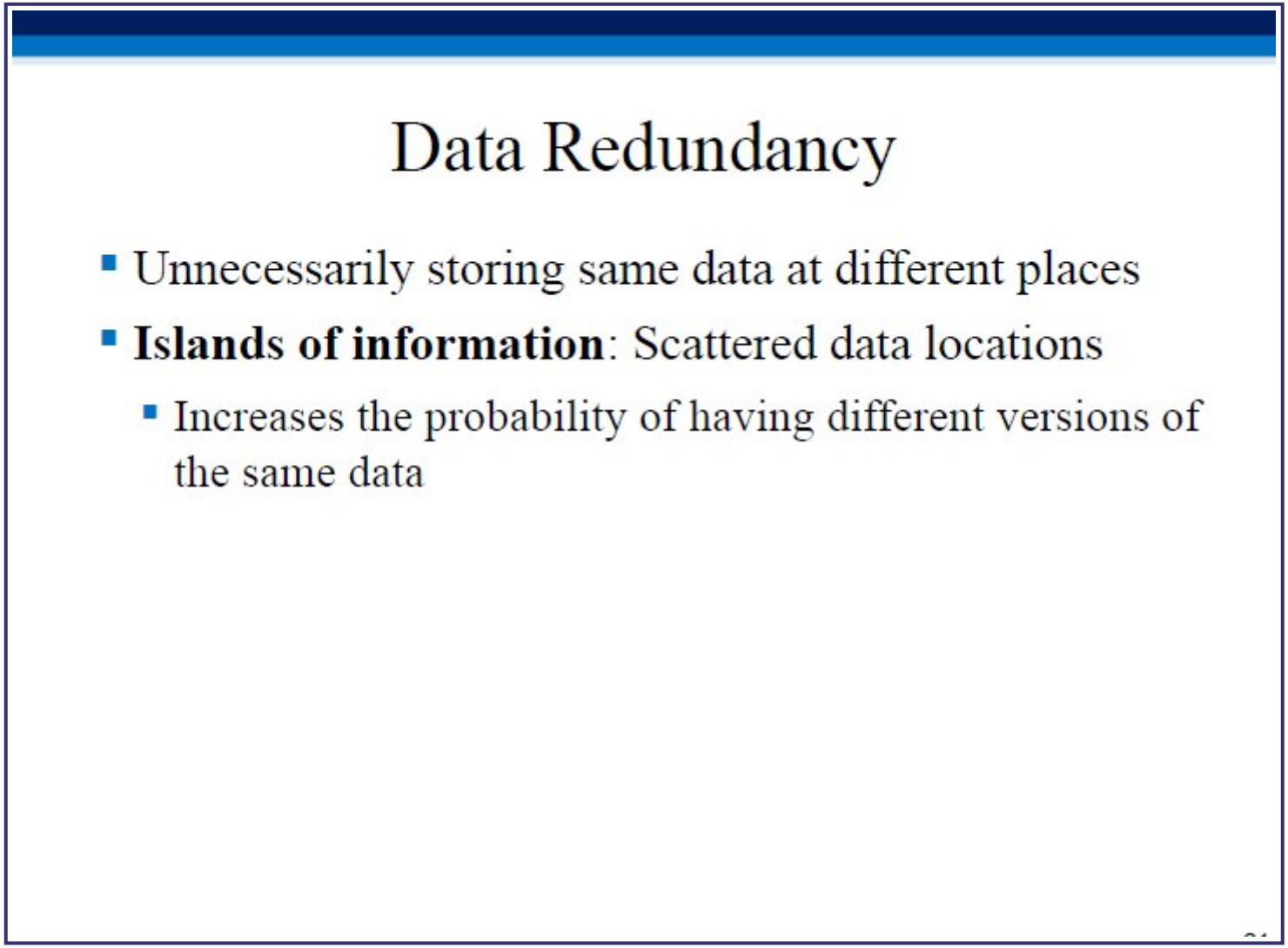
- **Structural dependence**: Access to a file is dependent on its own structure
  - All file system programs are modified to conform to a new file structure
- **Structural independence**: File structure is changed without affecting the application's ability to access the data

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

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

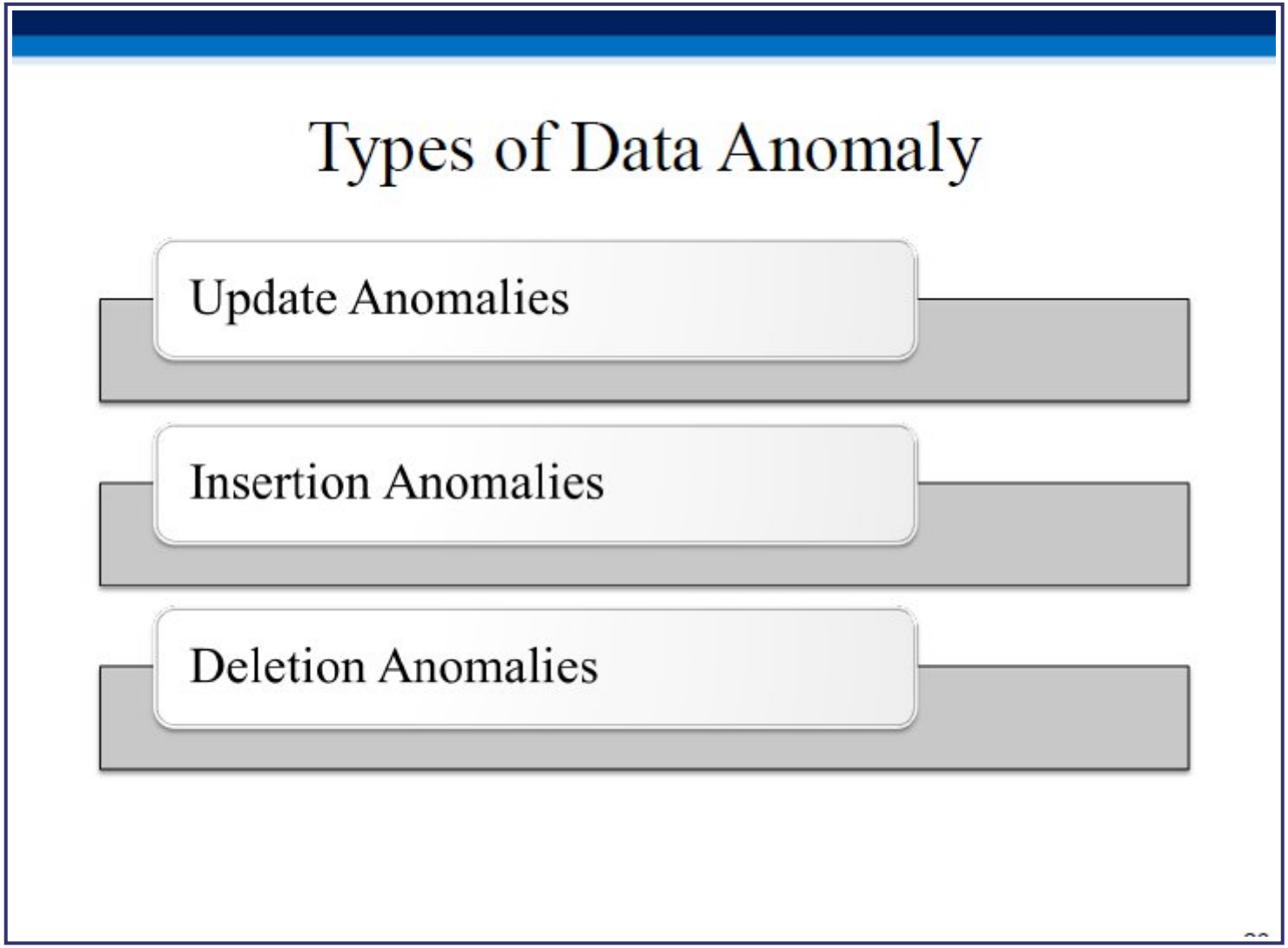


Why is redundancy not a good thing?

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

The three types of data anomalies



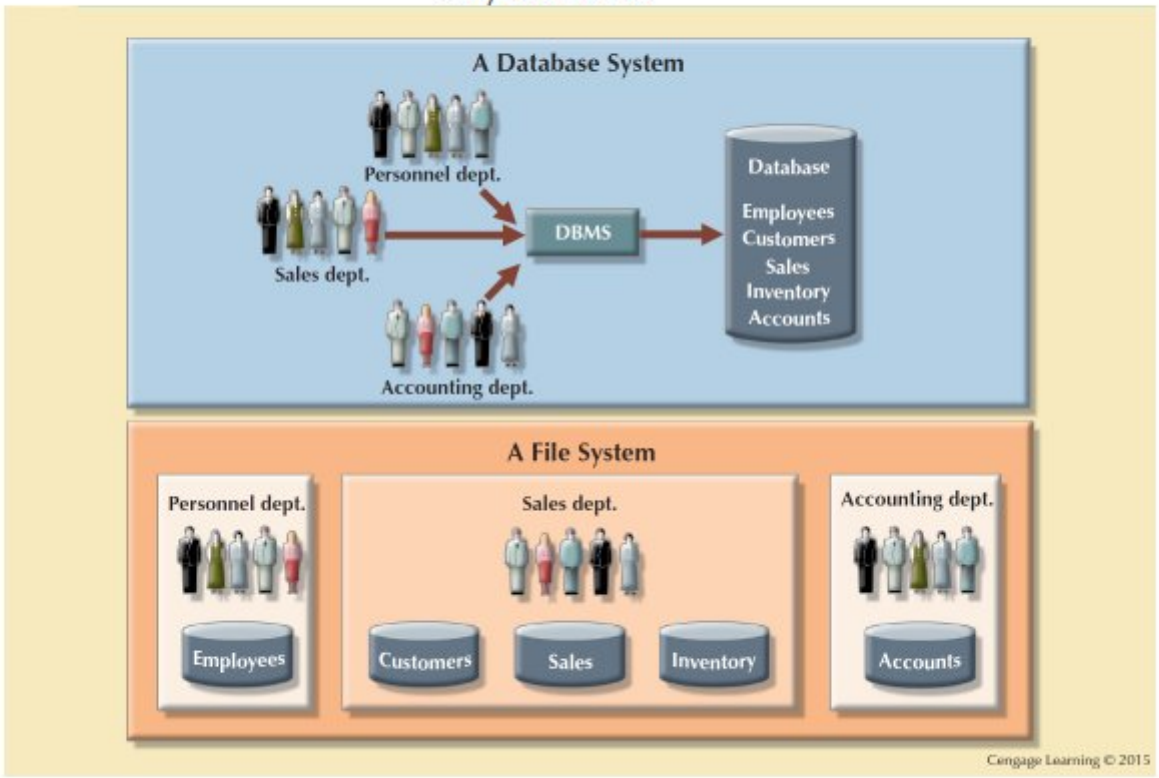
DB systems

Database Systems

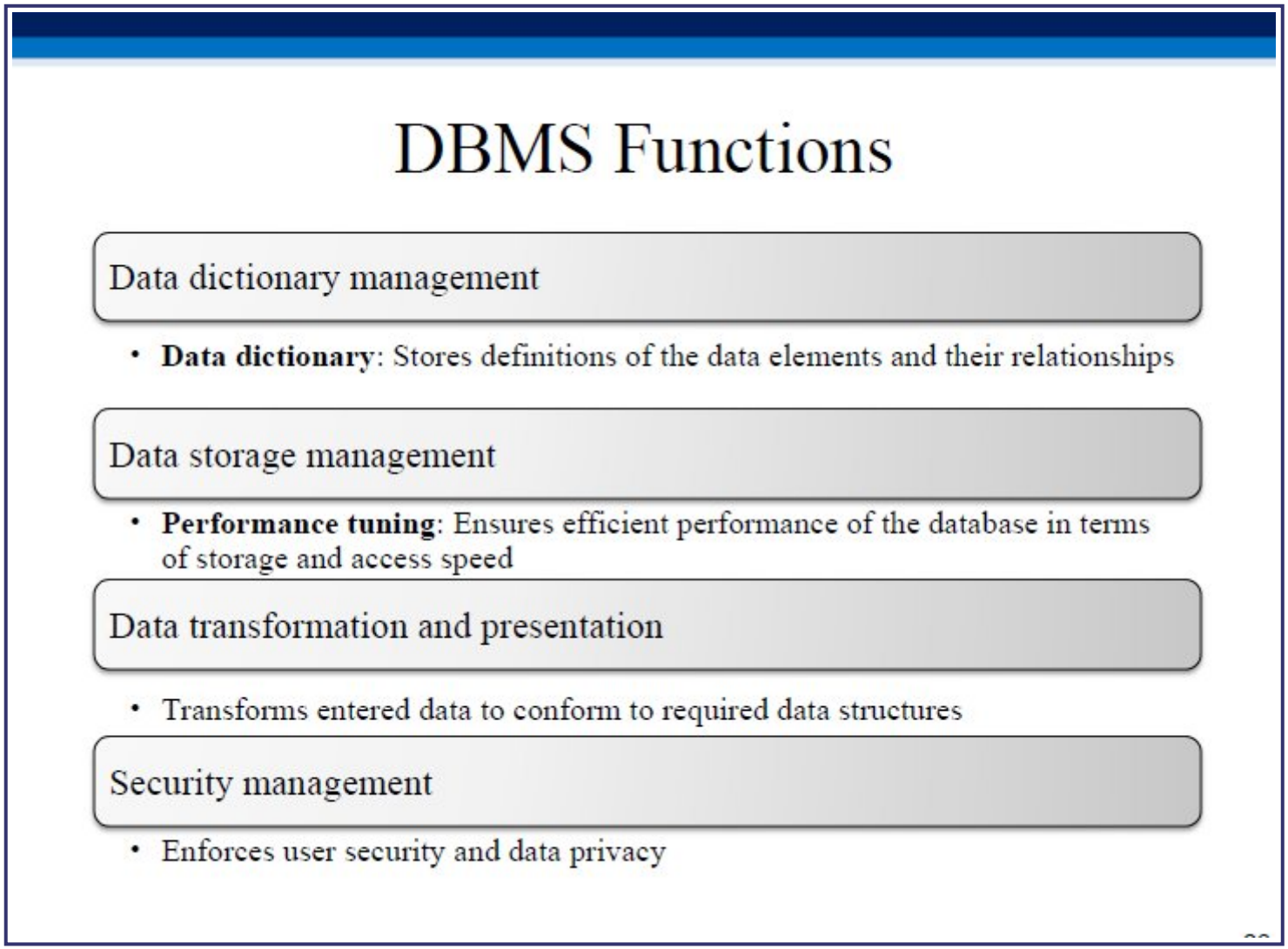
- Logically related data stored in a single logical data repository
  - Physically distributed among multiple storage facilities
  - DBMS eliminates most of file system's problems
- Current generation DBMS software:
  - Stores data structures, relationships between structures, and access paths
  - Defines,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

DB vs file system

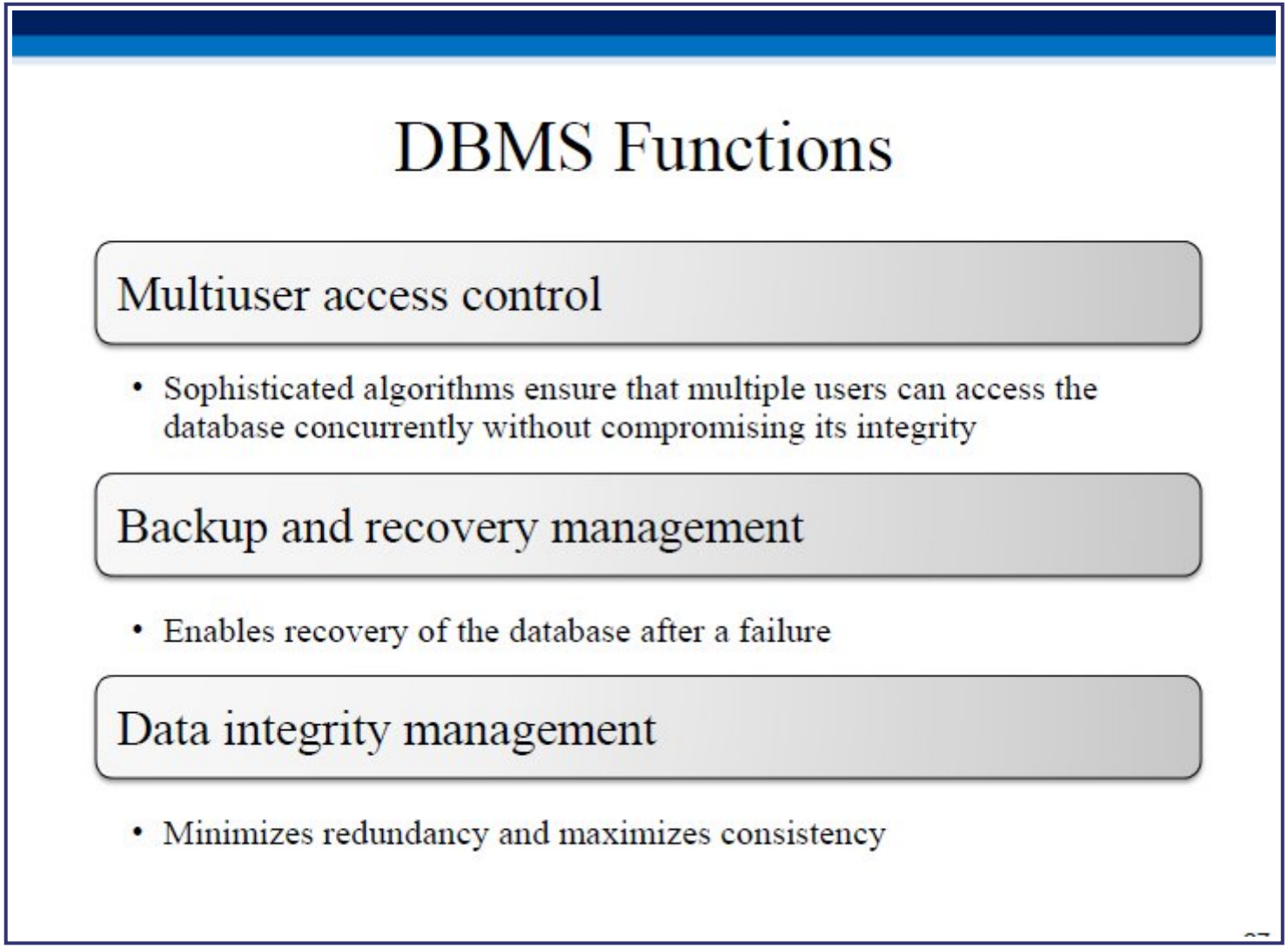
Figure 1.8 - Contrasting Database and File Systems



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

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

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

How DBs could be "bad"