Lecture 1

File Systems and Databases

In this lecture, you will learn:

- What a database is, what it does, and why database design is important
- How modern databases evolved from files and file systems
- About flaws in file system data management
- What a DBMS is, what it does, and how it fits into the database system
- About types of database systems and database models

Introducing the Database

- **Data versus Information**
  - **Data constitute building blocks of information**
  - **Information produced by processing data**
  - **Information reveals meaning of data**
  - **Good, timely, relevant information key to decision making**
  - **Good decision making key to organizational survival**

Database Management

- Database is shared, integrated computer structure housing:
  - End user data
  - Metadata
- Database Management System (DBMS)
  - Manages Database structure
  - Controls access to data
  - Contains query language

Importance of DBMS

- Makes data management more efficient and effective
- Query language allows quick answers to *ad hoc* queries
- Provides better access to more and better-managed data
- Promotes integrated view of organization's operations
- Reduces the probability of inconsistent data

DBMS Manages Interaction

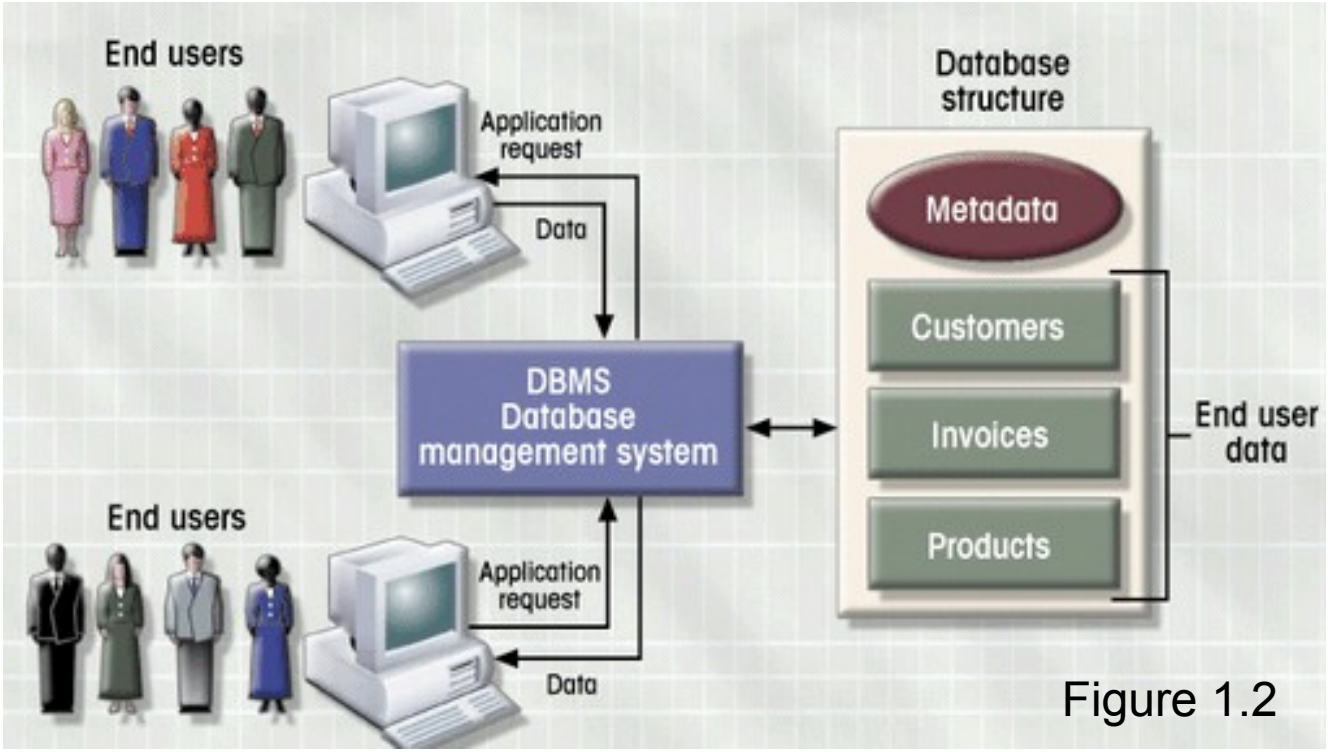


Figure 1.2

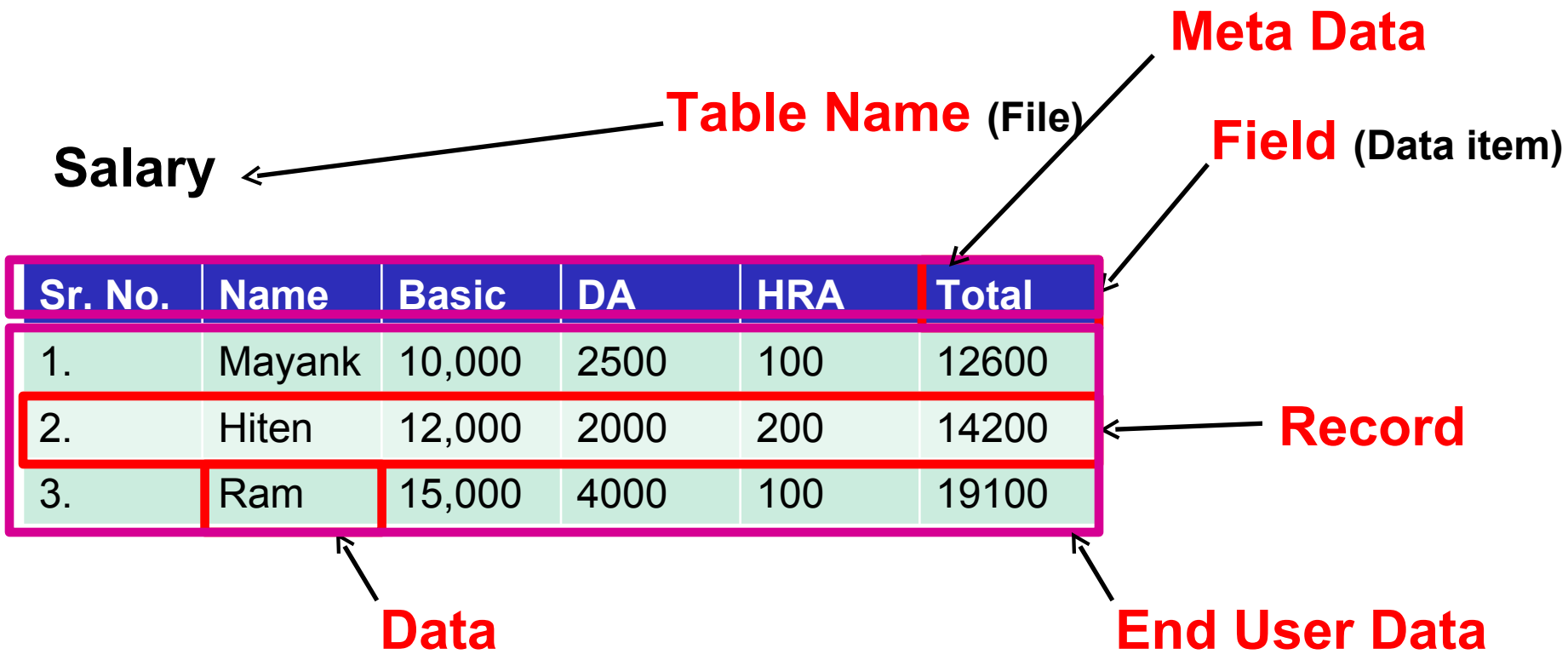
Database Design

- Importance of Good Design
  - Poor design results in unwanted data redundancy
  - Poor design generates errors leading to bad decisions
- Practical Approach
  - Focus on principles and concepts of database design
  - Importance of logical design

Historical Roots of Database

- First applications focused on clerical tasks
- Requests for information quickly followed
- File systems developed to address needs
  - Data organized according to expected use
  - Data Processing (DP) specialists computerized manual file systems

Different Terminology in Database



Sr. No.	Name	Basic	DA	HRA	Total
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2.	Hiten	12,000	2000	200	14200
3.	Ram	15,000	4000	100	19100

File Terminology

- **Data**
  - **Raw Facts**
- **Field**
  - **Group of characters with specific meaning**
- **Record**
  - **Logically connected fields that describe a person, place, or thing**
- **File**
  - **Collection of related records**

Simple File System

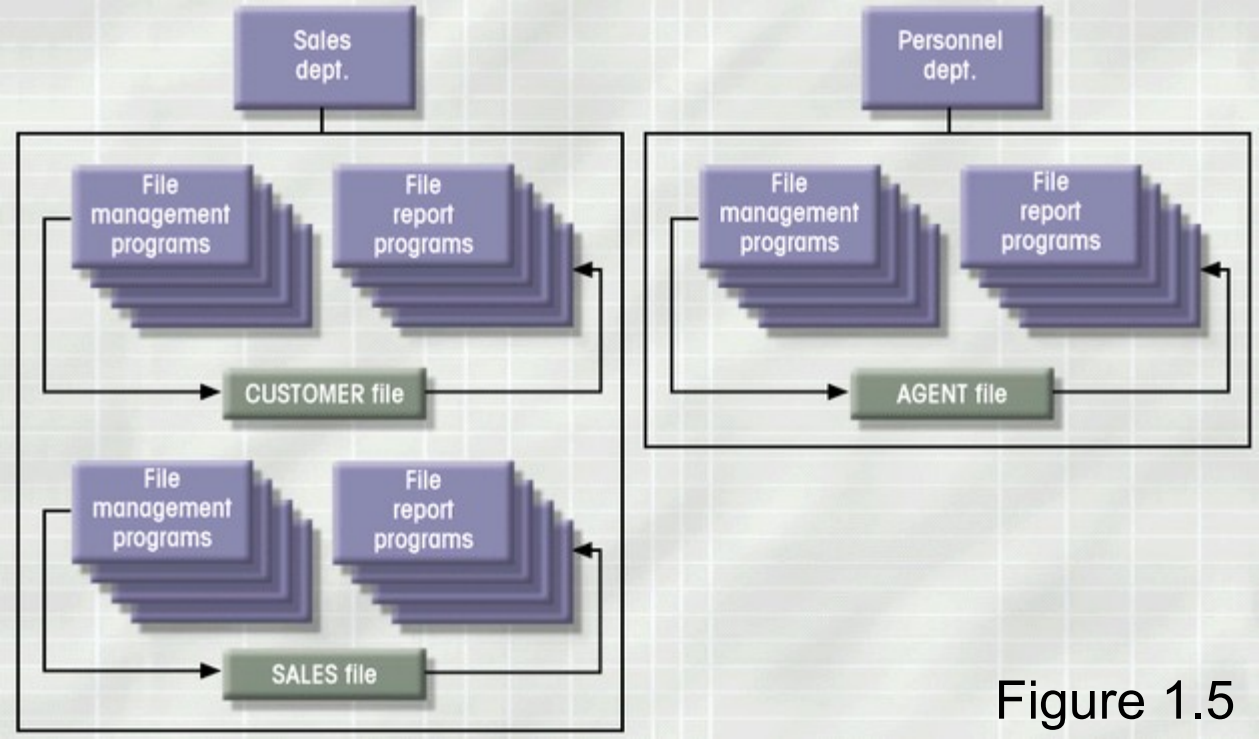


Figure 1.5

File System Critique

- **File System Data Management**
  - **Requires extensive programming in third-generation language (3GL)**
  - **Time consuming**
  - **Makes ad hoc queries impossible**
  - **Leads to islands of information**

File System Critique (con't.)

- **Data Dependence**
  - **Change in file's data characteristics requires modification of data access programs**
  - **Must tell program what to do and how**
  - **Makes file systems cumbersome from programming and data management views**
- **Structural Dependence**
  - **Change in file structure requires modification of related programs**

File System Critique (con't.)

- **Field Definitions and Naming Conventions**
  - **Flexible record definition anticipates reporting requirements**
  - **Selection of proper field names important**
  - **Attention to length of field names**
  - **Use of unique record identifiers**

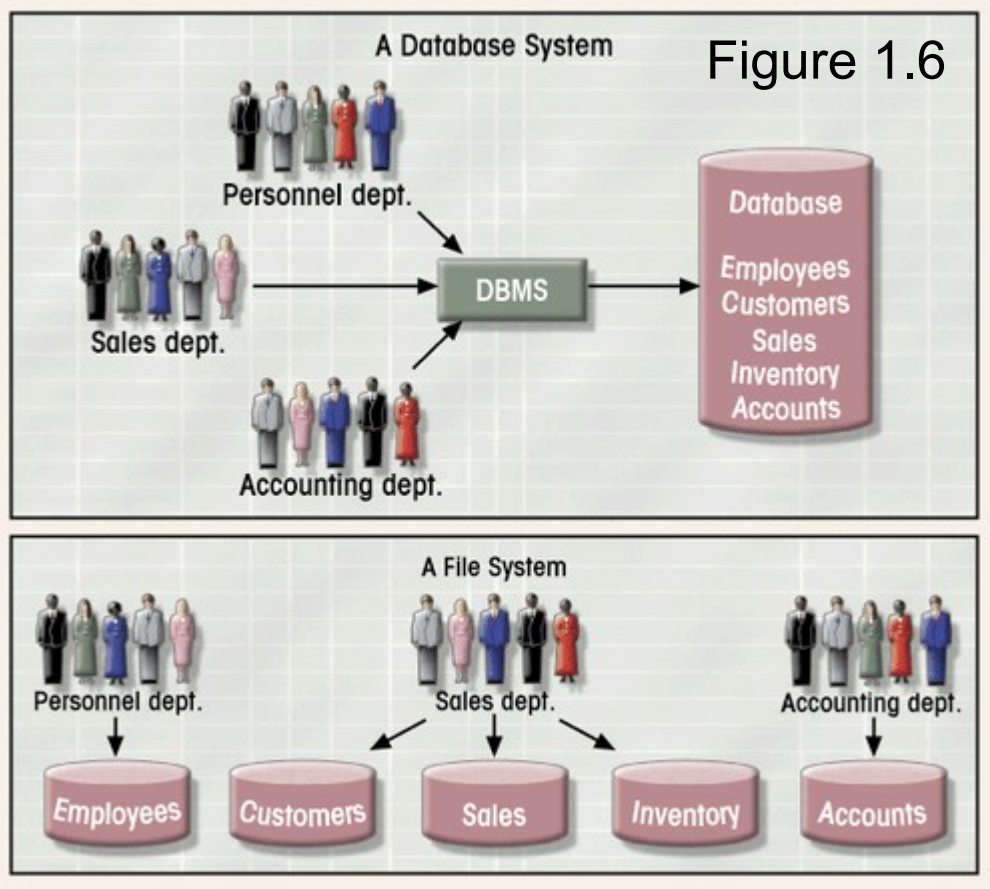
File System Critique (con't.)

- **Data Redundancy**
  - **Different and conflicting versions of same data**
  - **Results of uncontrolled data redundancy**
    - **Data anomalies**
      - **Modification**
      - **Insertion**
      - **Deletion**
    - **Data inconsistency**
      - **Lack of data integrity**

Database Systems

- Database consists of logically related data stored in a single repository
- Provides advantages over file system management approach
  - Eliminates inconsistency, data anomalies, data dependency, and structural dependency problems
  - Stores data structures, relationships, and access paths

Database vs. File Systems



Database System Environment

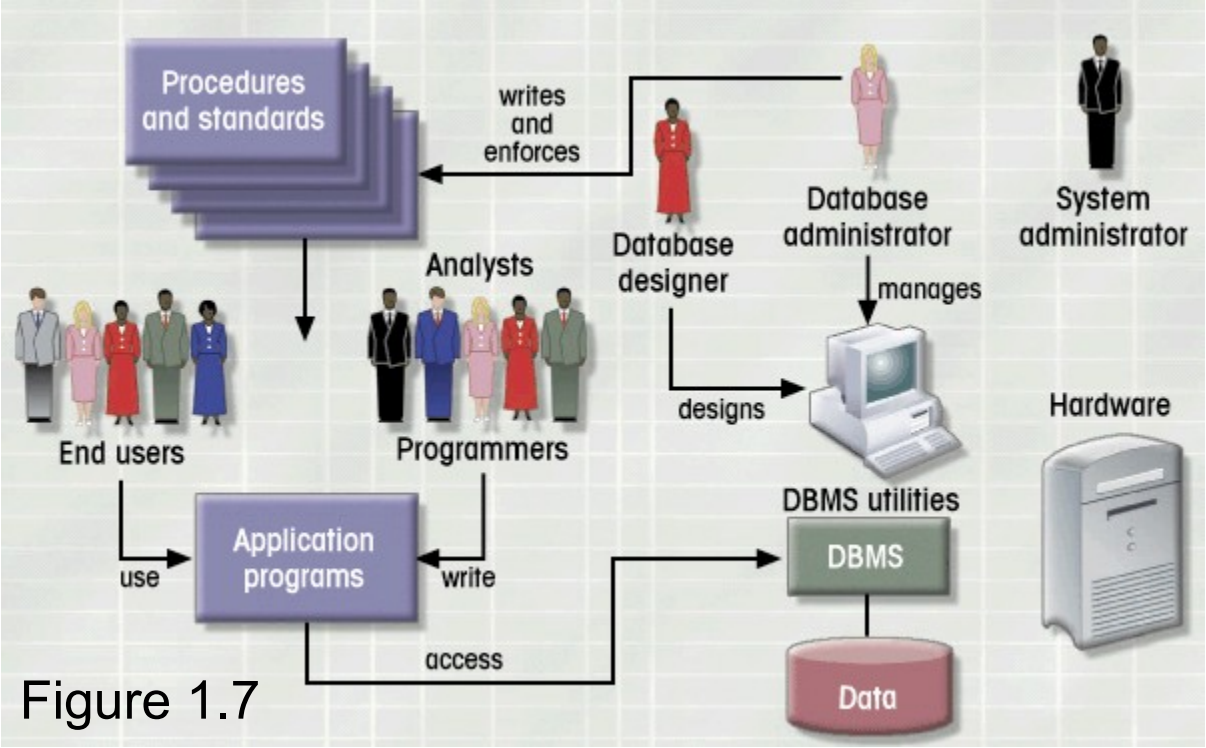


Figure 1.7

Database System Types

- Single-user vs. Multiuser Database
  - Desktop
  - Workgroup
  - Enterprise
- Centralized vs. Distributed
- Use
  - Production or transactional
  - Decision support or data warehouse

DBMS Functions

- Data dictionary management
- Data storage management
- Data transformation and presentation
- Security management
- Multiuser access control
- Backup and recovery management
- Data integrity management
- Database language and application programming interfaces
- Database communication interfaces

Database Models

- **Collection of logical constructs used to represent data structure and relationships within the database**
  - **Conceptual models: logical nature of data representation**
  - **Implementation models: emphasis on how the data are represented in the database**

Database Models (con't.)

- Relationships in Conceptual Models
  - One-to-one (1:1)
  - One-to-many (1:M)
  - Many-to-many (M:N)
- Implementation Database Models
  - Hierarchical
  - Network
  - Relational

Hierarchical Database Model

- **Logically represented by an upside down tree**
  - **Each parent can have many children**
  - **Each child has only one parent**

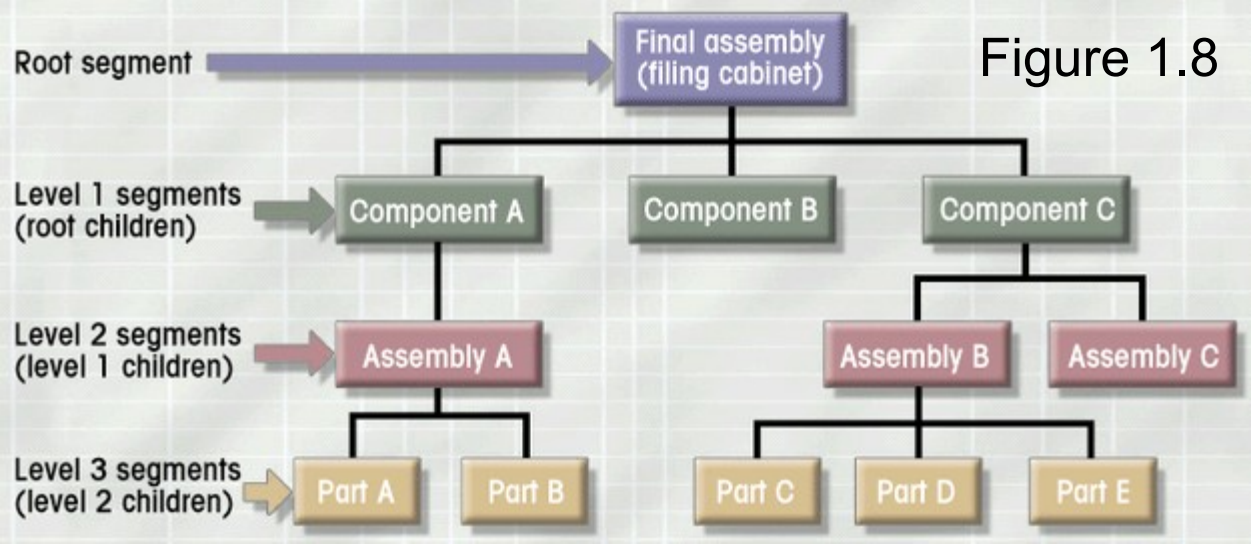


Figure 1.8

Hierarchical Database Model

- Advantages
  - Conceptual simplicity
  - Database security and integrity
  - Data independence
  - Efficiency
- Disadvantages
  - Complex implementation
  - Difficult to manage and lack of standards
  - Lacks structural independence
  - Applications programming and use complexity
  - Implementation limitations

Network Database Model

- Each record can have multiple parents
  - Composed of sets
  - Each set has owner record and member record
  - Member may have several owners

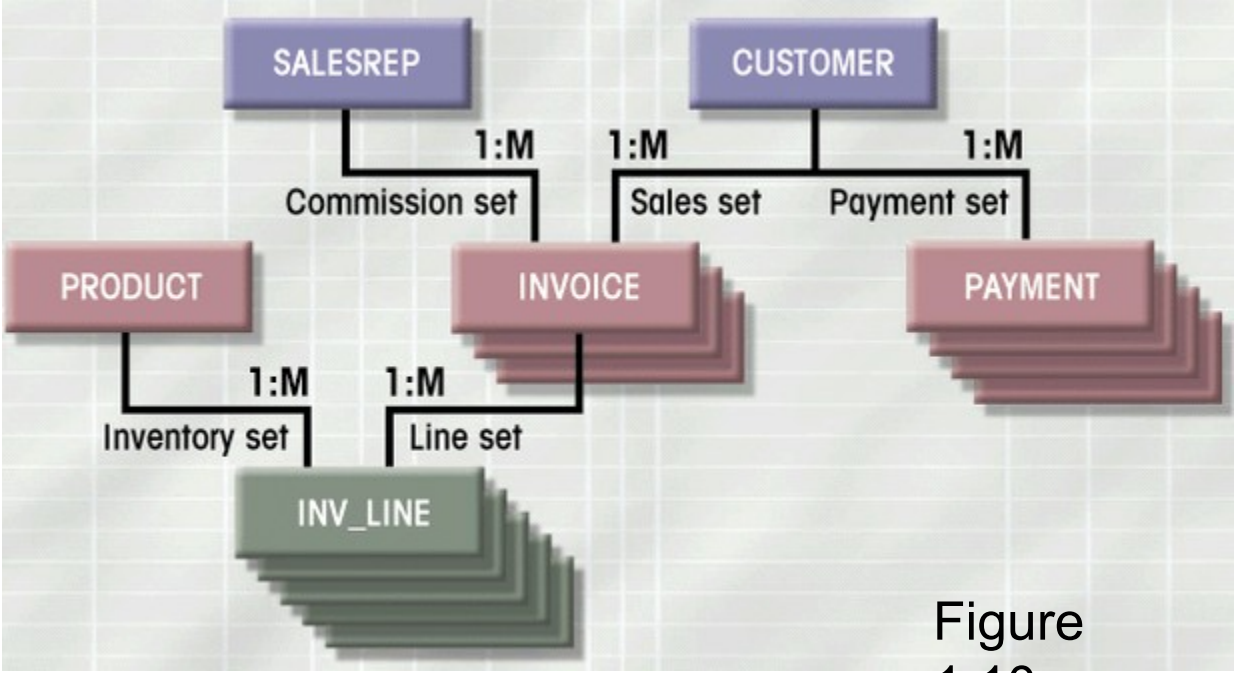


Figure 1.10

Network Database Model

- Advantages
  - Conceptual simplicity
  - Handles more relationship types
  - Data access flexibility
  - Promotes database integrity
  - Data independence
  - Conformance to standards
- Disadvantages
  - System complexity
  - Lack of structural independence

Relational Database Model

- Perceived by user as a collection of tables for data storage
- Tables are a series of row/column intersections
- Tables related by sharing common entity characteristic(s)

Relational Database Model (con't.)

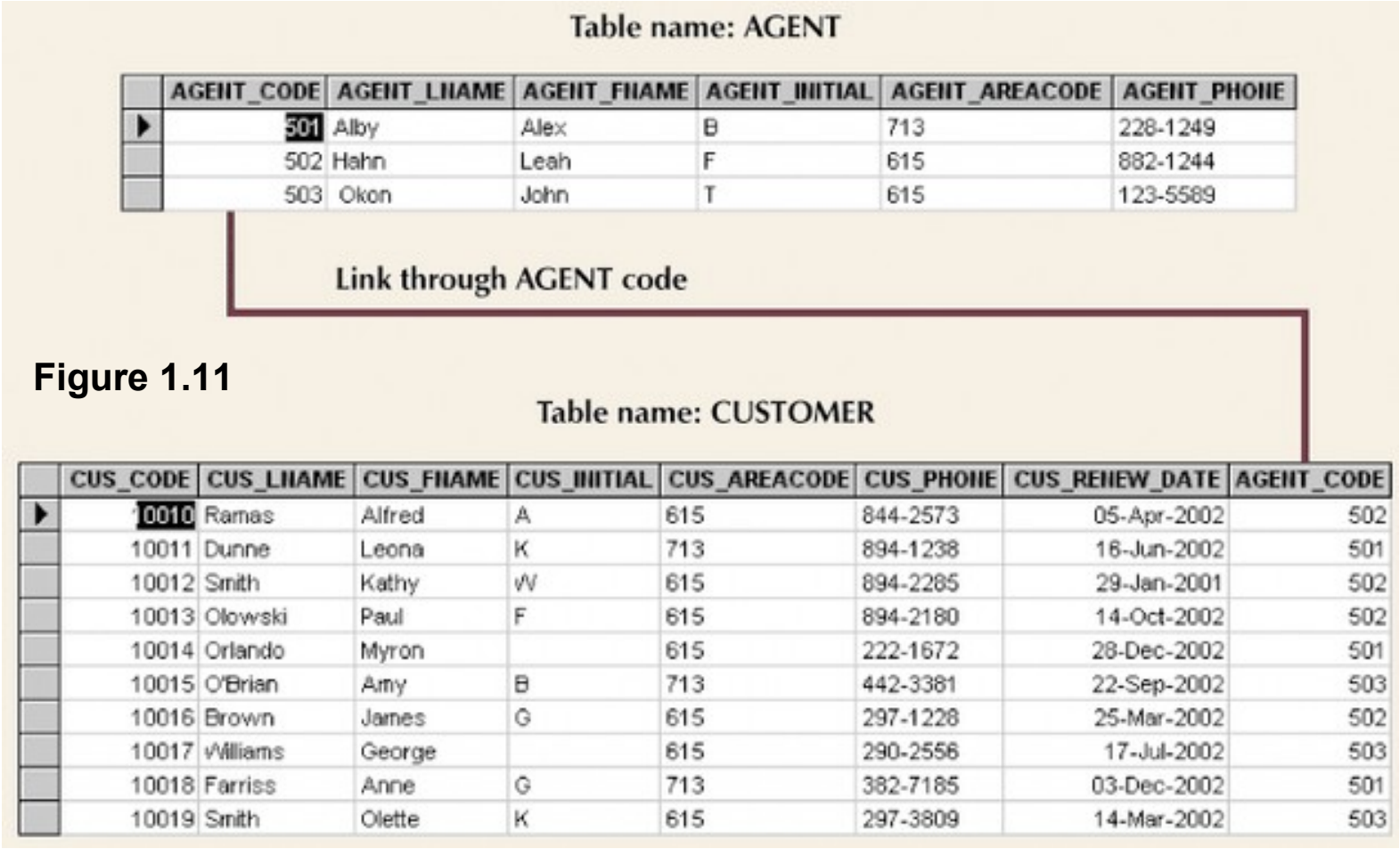


Figure 1.11

Relational Database Model

- **Advantages**
  - **Structural independence**
  - **Improved conceptual simplicity**
  - **Easier database design, implementation, management, and use**
  - **Ad hoc query capability with SQL**
  - **Powerful database management system**

Relational Database Model

- **Disadvantages**
  - **Substantial hardware and system software overhead**
  - **Poor design and implementation is made easy**
  - **May promote “islands of information” problems**

Entity Relationship Database Model

- Complements the relational data model concepts
- Represented in an entity relationship diagram (ERD)
- Based on entities, attributes, and relationships

Figure 1.13

Entity Relationship Database Model

- Advantages
  - Exceptional conceptual simplicity
  - Visual representation
  - Effective communication tool
  - Integrated with the relational database model
- Disadvantages
  - Limited constraint representation
  - Limited relationship representation
  - No data manipulation language
  - Loss of information content

Object-Oriented Database Model

- Objects or abstractions of real-world entities are stored
  - Attributes describe properties
  - Collection of similar objects is a class
    - Methods represent real world actions of classes
    - Classes are organized in a class hierarchy
  - Inheritance is ability of object to inherit attributes and methods of classes above it

OO Data Model

- Advantages
  - Adds semantic content
  - Visual presentation includes semantic content
  - Database integrity
  - Both structural and data independence
- Disadvantages
  - Lack of OODM
  - Complex navigational data access
  - Steep learning curve
  - High system overhead slows transactions

Database Models and the Internet

- Characteristics of "Internet age" databases
  - Flexible, efficient, and secure Internet access
  - Easily used, developed, and supported
  - Supports complex data types and relationships
  - Seamless interfaces with multiple data sources and structures
  - Simplicity of conceptual database model
  - Many database design, implementation, and application development tools
  - Powerful DBMS GUI make DBA job easier