

INFORMATION SYSTEM DEPARTMENT
INFORMATION TECHNOLOGY FACULTY– HCM UNIVERSITY SCIENCE

INTRODUCTION TO DATABASE

Chapter 01

Overview of Database System

Lecturer- PhD. NGUYEN TRAN MINH THU



KHOA CÔNG NGHỆ THÔNG TIN
TRƯỜNG ĐẠI HỌC KHOA HỌC TỰ NHIÊN



4.0 Outline

- Why Database
- Data & Information
- Database
- Type of Databases
- Evolution of File System Data Processing
- Database Management System
- Information System
- Database Design
- Systems Development Life Cycle (SDLC)
- Database Life Cycle (DBLC)
- Database Career Opportunities



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Why Databases?

A Day In Susan's Life

See how many databases she interacts with each day

*Before leaving for work,
Susan checks her
Facebook and
Twitter accounts*



Where is the data about the friends and groups stored?
Where are the "likes" stored and what would they be used for?

*On her lunch break,
she picks up her
prescription at the
pharmacy*



Where is the pharmacy inventory data stored?
What data about each product will be in the inventory data?
What data is kept about each customer and where is it stored?

*After work, Susan
goes to the grocery
store*



Where is the product data stored?
Is the product quantity in stock updated at checkout?
Does she pay with a credit card?

*At night, she plans for a trip
and buys airline tickets and
hotel reservations online*



Where does the online travel website get the airline and hotel data from?
What customer data would be kept by the website?
Where would the customer data be stored?

*Then she makes a few
online purchases*



Where are the product and stock data stored?
Where does the system get the data to generate product "recommendations" to the customer?
Where would credit card information be stored?



Why Databases?

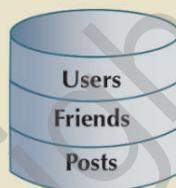
A Day In Susan's Life

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pharmacy*



Where is the pharmacy
inventory data stored?
What data about each
product will be in the
inventory data?
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is it stored?



*After work, Susan
goes to the grocery
store*



Where is the product
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Where are the product
and stock data stored?
Where does the system get
the data to generate product
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Where would credit card
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Why Databases?

- Characteristics of data in today's world
 - Ubiquitous (i.e., abundant, global, and everywhere)
 - Pervasive (i.e., unescapable, prevalent, and persistent)
- Databases make data persistent and shareable in a secure way
 - Specialized structures that allow computer-based systems to store, manage, and retrieve data very quickly



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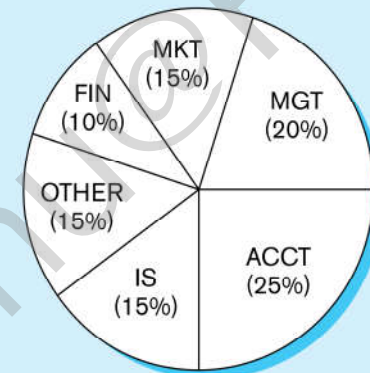
Data versus Information

| | |
|--------------------|-----------|
| Baker, Kenneth D. | 324917628 |
| Doyle, Joan E. | 476193248 |
| Finkle, Clive R. | 548429344 |
| Lewis, John C. | 551742186 |
| McFerran, Debra R. | 409723145 |

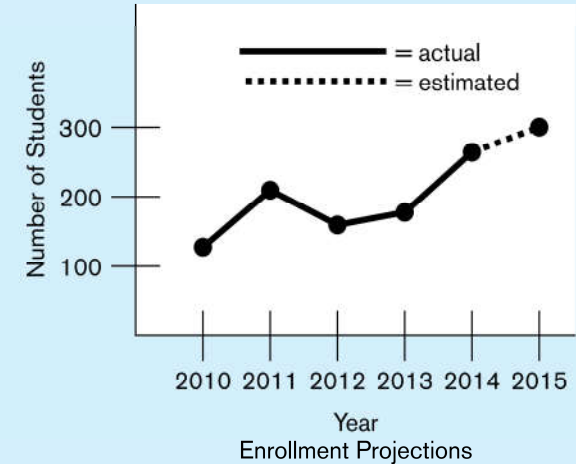
(a)

| Class Roster | | | |
|--------------------|----------------------------|-----------|-------------|
| Course: | MGT 500 Business Policy | Semester: | Spring 2015 |
| 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 |

(b)



Percent Enrollment by Major (2015)



(c)



Data versus Information

Data

- **Raw facts**
 - Have not yet been processed to reveal their meaning to the end user
- Building blocks of information
- **Data management**
 - Generation, storage, and retrieval of data

Information

- Produced by processing raw data to reveal its meaning
- Requires context
- Bedrock of **knowledge**
- Should be accurate, relevant, and timely to enable good decision making

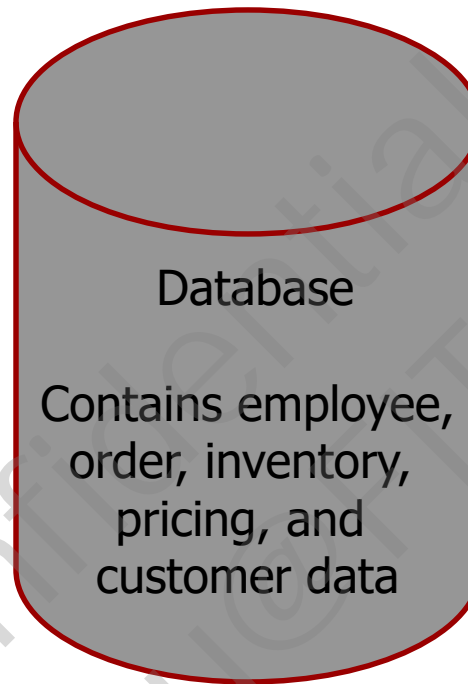


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Database

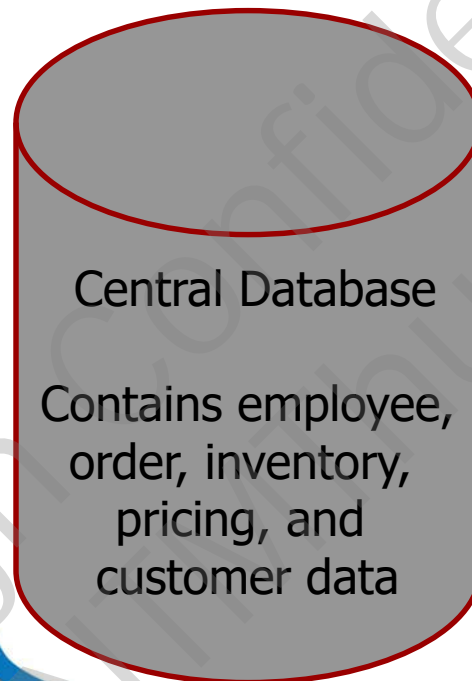


Database: organized collection of logically related data



Database

- Central repository of shared data
- Data is managed by a controlling agent
- Stored in a standardized, convenient form



**Requires a Database
Management System
(DBMS)**



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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 Databases

Classification by location

- **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 Databases

Classification by data type

- **General-purpose databases:** Contains a wide variety of data used in multiple disciplines
- **Discipline-specific databases:** Contains data focused on specific subject areas
- **Operational database:** Designed to support a company's day-to-day operations



Types of Databases

- **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
- **Online analytical processing (OLAP)**
 - Tools for 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 Databases

- **Databases can be classified to reflect the degree to which the data is structured:**
 - **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



Types of Databases

TYPES OF DATABASES

| PRODUCT | NUMBER OF USERS | | | DATA LOCATION | | DATA USAGE | | XML |
|---------------|-----------------|-----------|------------|---------------|-------------|-------------|------------|-----|
| | SINGLE USER | MULTIUSER | | CENTRALIZED | DISTRIBUTED | OPERATIONAL | ANALYTICAL | |
| | | WORKGROUP | ENTERPRISE | | | | | |
| MS Access | X | X | | X | | X | | |
| MS SQL Server | X ³ | X | X | X | X | X | X | X |
| IBM DB2 | X ³ | X | X | X | X | X | X | X |
| MySQL | X | X | X | X | X | X | X | X |
| Oracle RDBMS | X ³ | X | X | X | X | X | X | X |



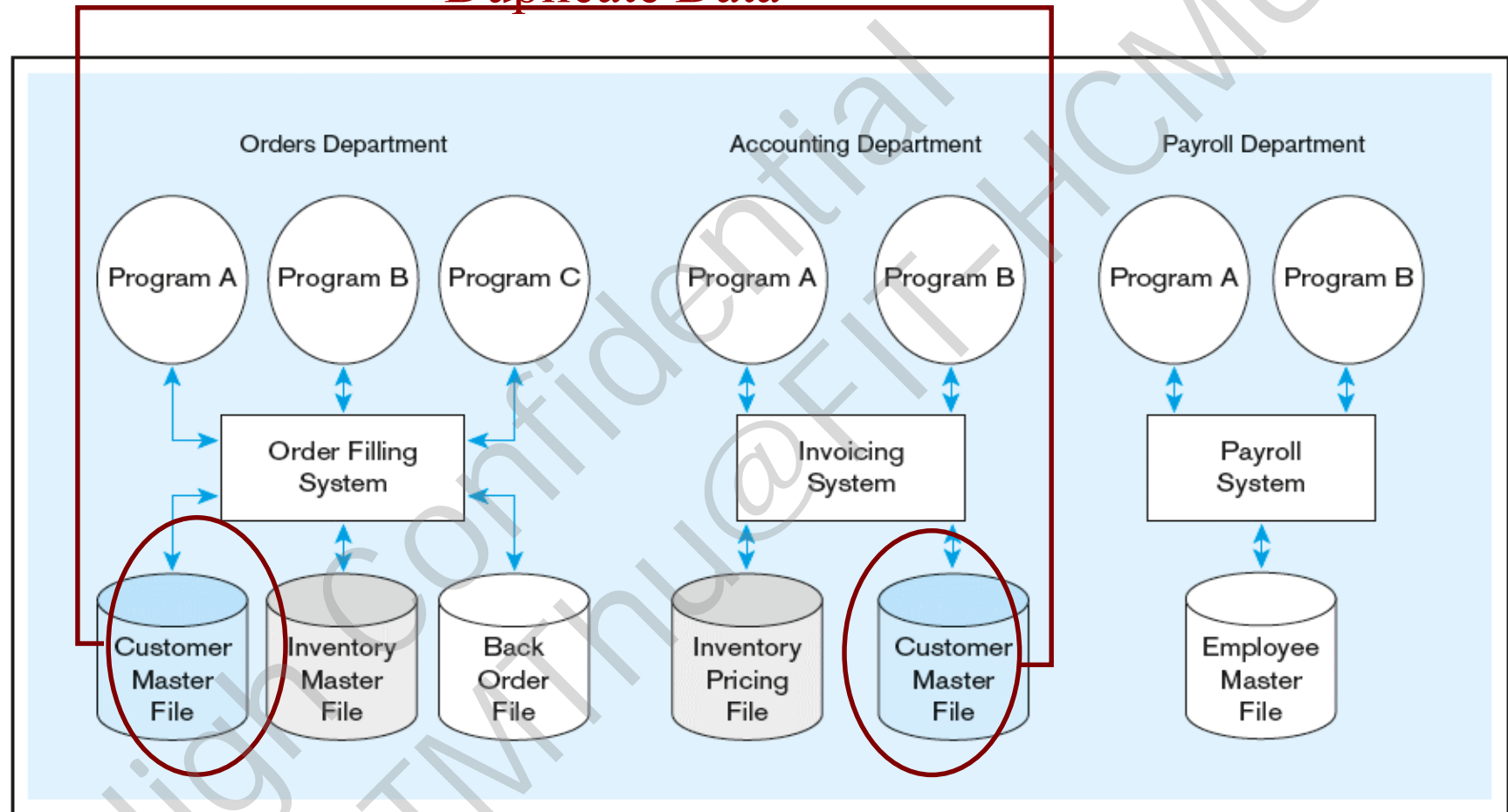
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Evolution of File System Data Processing

Duplicate Data



File Systems Processing



Evolution of File System Data Processing

Lengthy development times

Difficulty of getting quick answers

Complex system administration

Lack of security and limited data sharing

Extensive programming

Problems with File System Data Processing



Evolution of File System Data Processing

| 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 has little meaning unless it has 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. |

FIGURE 1.8 CONTENTS OF THE AGENT FILE

Database name: Ch01_Text

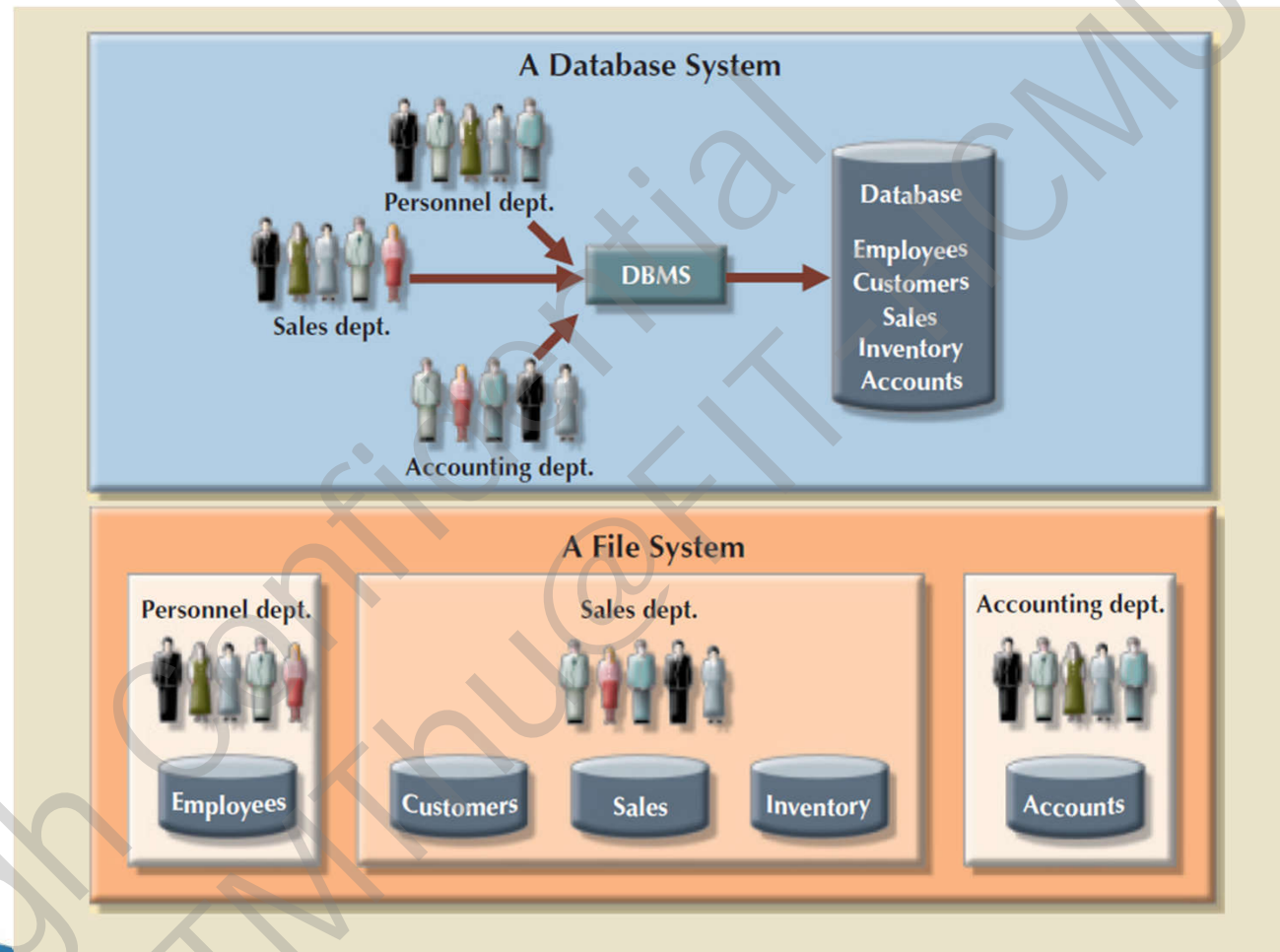
| A_NAME | A_PHONE | A_ADDRESS | ZIP | HIRED | YTD_PAY | YTD_FIT | YTD_FICA | YTD_SLS | DEP |
|--------------|--------------|--------------------|-------|-------------|----------|---------|----------|-----------|-----|
| Alex B. Alby | 713-228-1249 | 123 Toll, Nash, TN | 37119 | 01-Nov-2000 | 26566.24 | 6641.56 | 2125.30 | 132737.75 | 3 |
| Leah F. Hahn | 615-882-1244 | 334 Main, Fox, KY | 25246 | 23-May-1986 | 32213.78 | 8053.44 | 2577.10 | 138967.35 | 0 |
| John T. Okon | 615-123-5589 | 452 Elm, New, TN | 36155 | 15-Jun-2005 | 23198.29 | 5799.57 | 1855.86 | 127093.45 | 2 |

A_NAME = Agent name
A_PHONE = Agent phone
A_ADDRESS = Agent address
ZIP = Agent zip code
HIRED = Agent date of hire

YTD_PAY = Year-to-date pay
YTD_FIT = Year-to-date federal income tax paid
YTD_FICA = Year-to-date Social Security taxes paid
YTD_SLS = Year-to-date sales
DEP = Number of dependents



Evolution of File System Data Processing





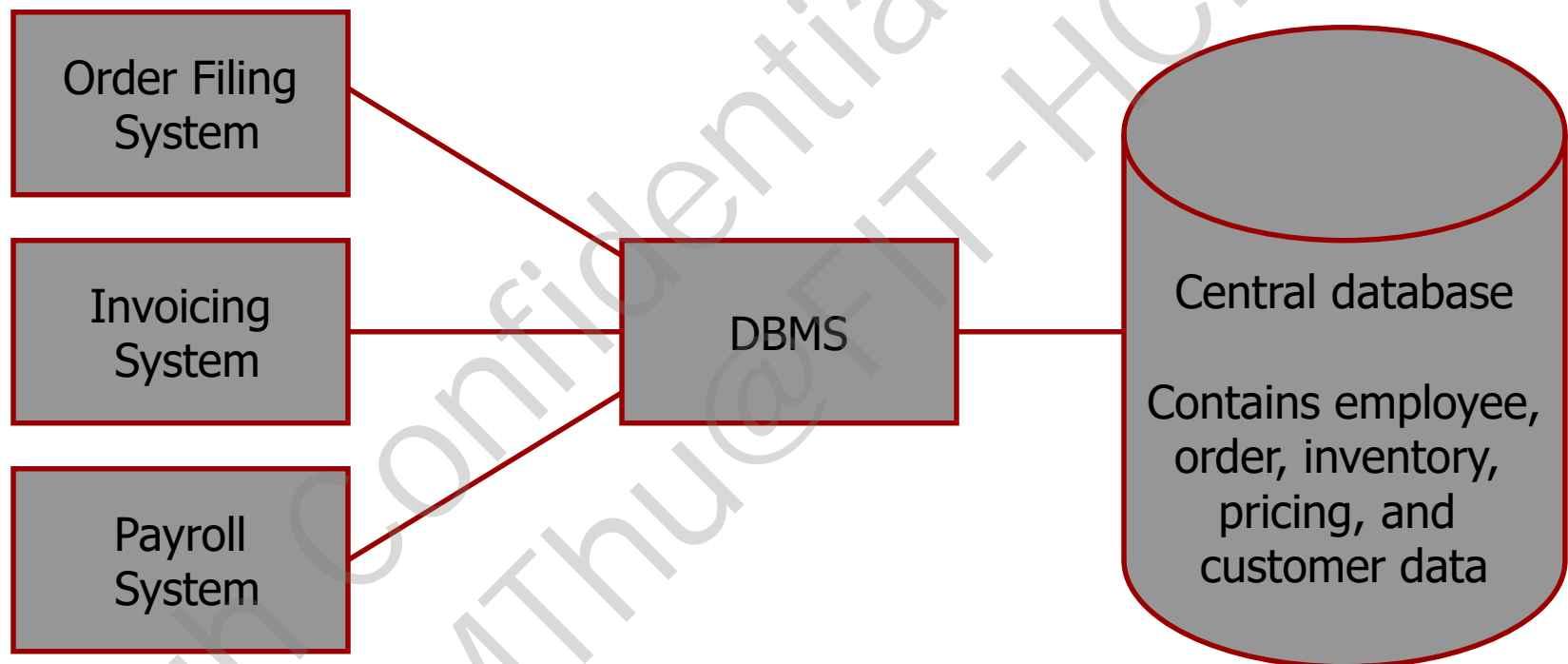
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Database Management System

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



DBMS manages data resources like an operating system manages hardware resources

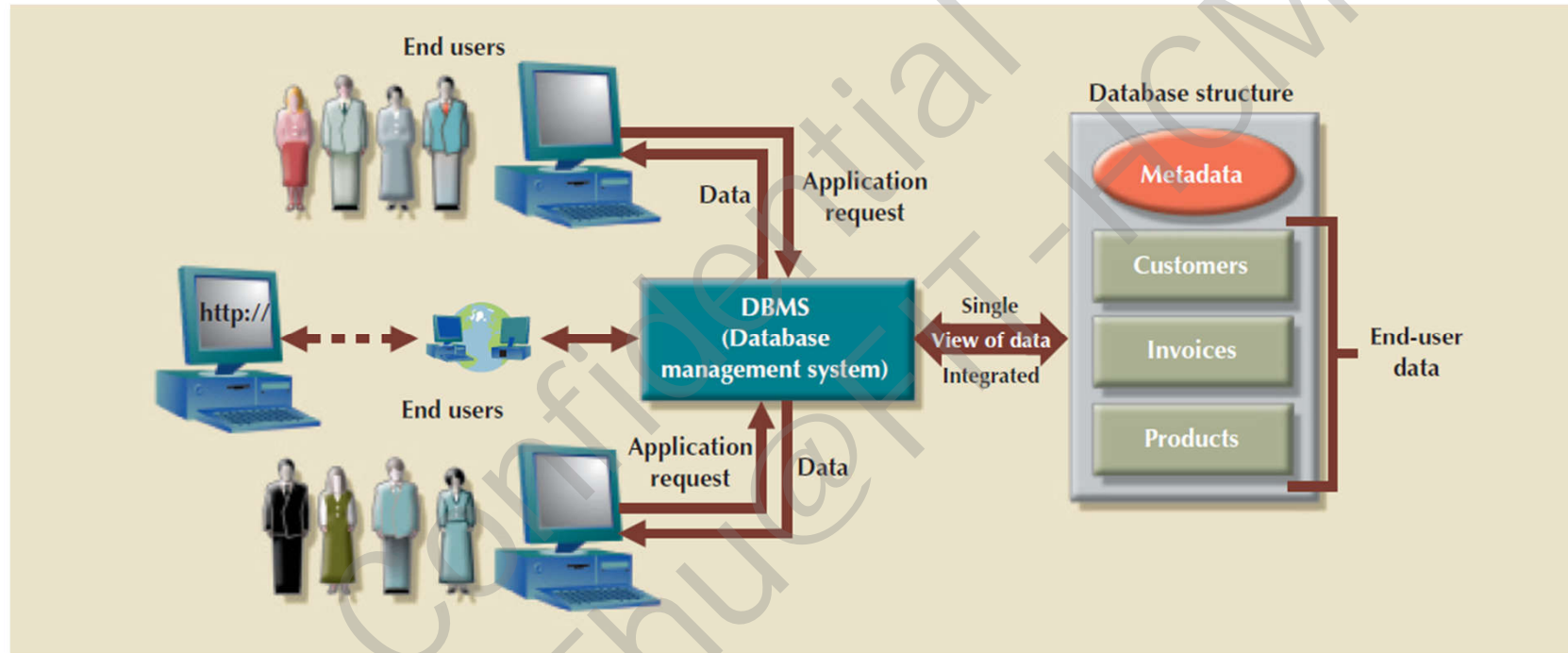


Role of the DBMS

- 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



Role of the DBMS



The DBMS Manages the Interaction between the End User and the Database



Metadata

Metadata are data that describe the properties or characteristics of end user data and the context of that data

TABLE 1-1 Example Metadata for Class Roster

| Data Item | | Metadata | | | | |
|-----------|--------------|----------|-----|-----|-----------------------------|---------------|
| 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 |

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



Metadata

The screenshot displays the Microsoft SQL Server Management Studio interface for the 'CISORA1\GRADSQL.CORMOR - dbo.lgcustomer' database. The 'Object Explorer' on the left shows the database structure, including tables, views, and security. The 'Table Designer' in the center shows the table columns and their properties. The 'Properties' pane on the right shows the table's identity and other properties. A blue box labeled 'Metadata' points to the 'Properties' pane.

| Column name | Data type | Allow Nulls |
|--------------|----------------|-------------------------------------|
| cust_code | numeric(38, 0) | <input type="checkbox"/> |
| cust_fname | varchar(20) | <input type="checkbox"/> |
| cust_lname | varchar(20) | <input type="checkbox"/> |
| cust_street | varchar(70) | <input checked="" type="checkbox"/> |
| cust_city | varchar(50) | <input checked="" type="checkbox"/> |
| cust_state | char(2) | <input checked="" type="checkbox"/> |
| cust_zip | char(5) | <input checked="" type="checkbox"/> |
| cust_balance | numeric(8, 2) | <input checked="" type="checkbox"/> |

Column Properties

| Property | Value |
|-------------------------------|--------------------|
| (Name) | cust_code |
| Allow Nulls | No |
| Data Type | numeric |
| Default Value or Binding | |
| Precision | 38 |
| Scale | 0 |
| Table Designer | |
| Collation | <database default> |
| Computed Column Specification | |
| Condensed Data Type | numeric(38, 0) |
| Description | |
| Deterministic | Yes |
| DTS-published | No |
| Full-text Specification | No |
| Has Non-SQL Server Subscriber | No |
| Identity Specification | No |
| Indexable | Yes |

Properties

[Tbl] dbo.lgcustomer

(Identity)

(Name) lgcustomer

Database Name CORMOR

Description

Schema dbo

Server Name cisorsa1\gradsql

Table Designer

Identity Column

Indexable Yes

Lock Escalation Table

Regular Data Sp PRIMARY

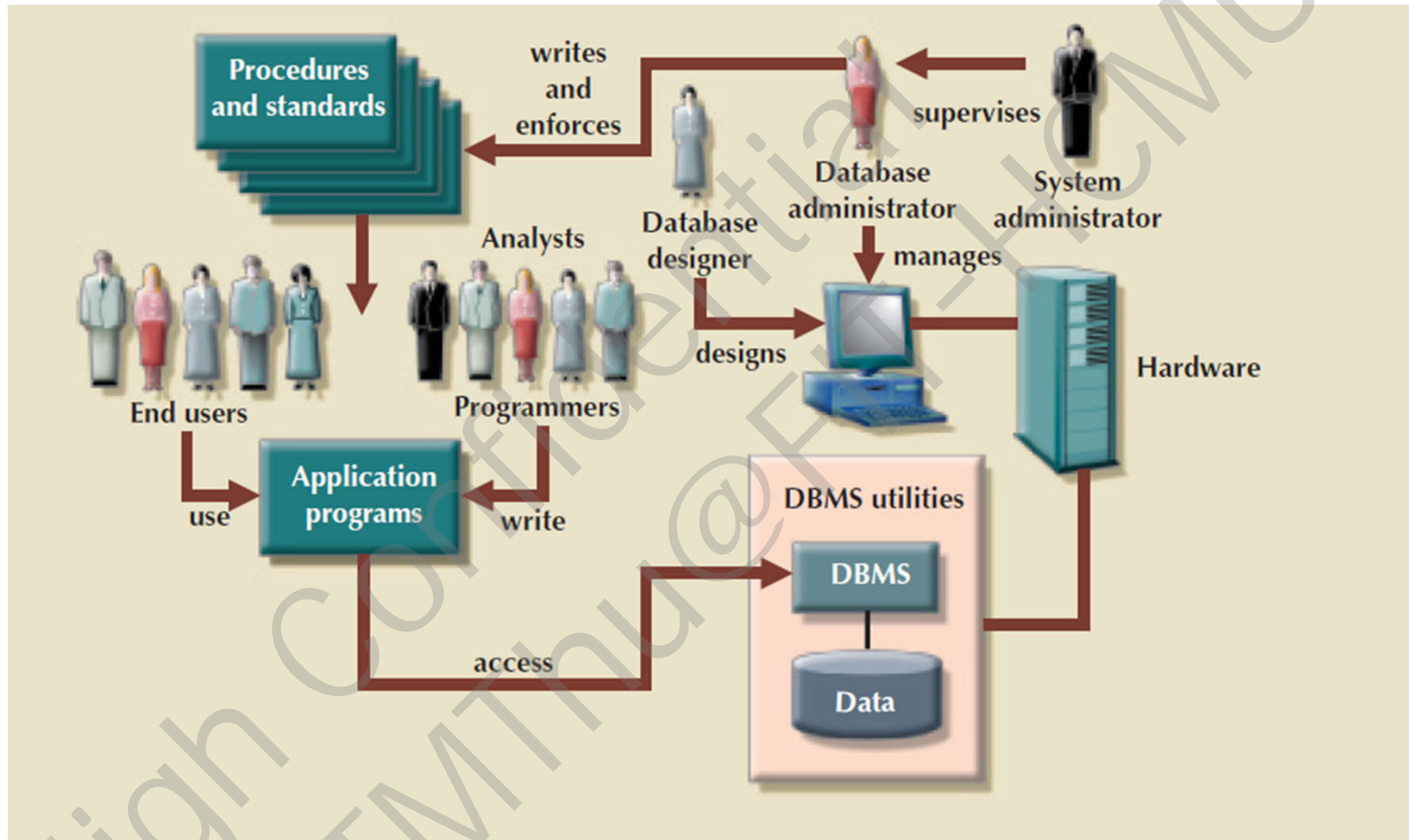
Replicated No

Row GUID Colu

Text/Image File PRIMARY



The Database System Environment





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 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 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



Disadvantages of DBMS

Increased costs

Management complexity

Maintaining currency

Vendor dependence

Frequent upgrade/replacement cycles

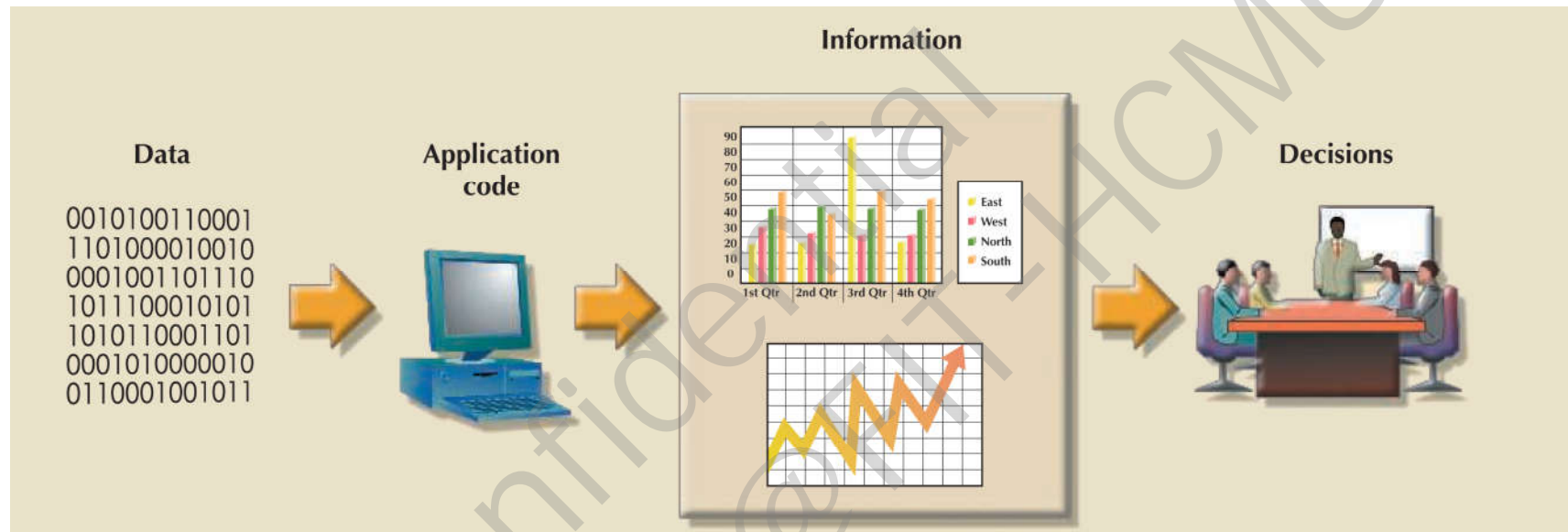


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Information System



- Provides for data collection, storage, and retrieval
- Composed of:
 - People, hardware, software
 - Database(s), application programs, procedures



Information System

- **Systems analysis:** Process that establishes need for and extent of information system
- **Systems development:** Process of creating information system
- The performance of an information system depends on three factors:
 - Database Design & Implementation
 - Application Design & Implementation
 - Administrative procedures
- **Database development:** Process of database design and its implementation



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Database Design

- Focuses on the design of the database structure that will be used to store and manage end-user data
- Well-designed database
 - Facilitates data management
 - Generates accurate and valuable information
- Poorly designed database causes difficult-to-trace errors



Why Database Design is Important?

Why are there blanks in rows 9 and 10?

How to produce an alphabetical listing of employees?

How to count how many employees are certified in Basic Database Manipulation?

Is Basic Database Manipulation the same as Basic DB Manipulation?

What if an employee acquires a fourth certification?
Do we add another column?

| ID | ENum | Name | Title | HireDate | Skill1 | Skill1Date | Skill2 | Skill2Date | Skill3 | Skill3Date |
|----|-------|-----------------------|---------------------|-----------|------------------------------|------------|--------------------------------|------------|--------------------------|------------|
| 1 | 02345 | Brian Oates | DBA | 2/14/1995 | Basic Database Management | 2/14/2002 | Advanced Database Management | 2/14/2005 | Basic Web Design | 8/9/2003 |
| 2 | 08273 | Marco Bienz | Analyst | 7/28/2006 | Basic Web Design | 3/8/2009 | Advance Process Modeling | 8/19/2012 | | |
| 3 | 06234 | Jasmine Patel | Programmer | 8/10/2005 | Basic Web Design | 8/10/2007 | Advanced C# programming | 8/10/2007 | Basic DB manipulation | 1/29/2012 |
| 4 | 03373 | Franklin Johnson, Jr. | Purchasing Agent | 3/15/2002 | Advanced Spreadsheets | 6/20/2011 | | | | |
| 5 | 13567 | Almond, Robert | Analyst | 9/30/2012 | Basic Process Modeling | 9/30/2014 | Basic Database Design | 5/23/2015 | | |
| 6 | 10282 | Richardson, Amanda | Clerk | 4/11/2011 | | | | | | |
| 7 | 09382 | Susan Mathis | Database Programmer | 8/2/2010 | Basic DB Design | 8/2/2012 | Basic Database Manipulation | 8/2/2012 | Advanced DB Manipulation | 5/1/2013 |
| 8 | 14311 | Duong, Lee | Programmer | 9/1/2014 | Basic Web Design | 9/1/2016 | | | | |
| 9 | | | | | Master Database Programming | | | | | |
| 10 | | | | | Basic Spreadsheets | | | | | |
| 11 | 09002 | Wade Gaither | Clerk | 5/20/2010 | Advanced Spreadsheets | 5/16/2013 | Basic Web Design | 5/16/2013 | | |
| 12 | 13383 | Raymond F. Matthews | Programmer | 3/12/2012 | Basic C# Programming | 3/12/2014 | | | | |
| 13 | 09283 | Chavez, Juan | Clerk | 7/4/2010 | | | | | | |
| 14 | 04893 | Patricia Richards | DBA | 6/11/2004 | Advanced Database Management | 6/11/2006 | Advanced Database Manipulation | 9/20/2012 | | |
| 15 | 13932 | Lee, Megan | Programmer | 9/29/2013 | | | | | | |

EMPLOYEE SKILLS CERTIFICATION IN A POOR DESIGN



Why Database Design is Important?

Table name: EMPLOYEE

| Employee_ID | Employee_FName | Employee_LName | Employee_HireDate | Employee_Title |
|-------------|----------------|----------------|-------------------|---------------------|
| 02345 | Johnny | Jones | 2/14/1995 | DBA |
| 03373 | Franklin | Johnson | 3/15/2002 | Purchasing Agent |
| 04893 | Patricia | Richards | 6/11/2004 | DBA |
| 06234 | Jasmine | Patel | 8/10/2005 | Programmer |
| 08273 | Marco | Bienz | 7/28/2006 | Analyst |
| 09002 | Ben | Joiner | 5/20/2010 | Clerk |
| 09283 | Juan | Chavez | 7/4/2010 | Clerk |
| 09382 | Jessica | Johnson | 8/2/2010 | Database Programmer |
| 10282 | Amanda | Richardson | 4/11/2011 | Clerk |
| 13383 | Raymond | Matthews | 3/12/2012 | Programmer |
| 13567 | Robert | Almond | 9/30/2012 | Analyst |
| 13932 | Megan | Lee | 9/29/2013 | Programmer |
| 14311 | Lee | Duong | 9/1/2014 | Programmer |

Table name: CERTIFIED

| Employee_ID | Skill_ID | Certified_Date |
|-------------|----------|----------------|
| 02345 | 100 | 2/14/2002 |
| 02345 | 110 | 8/9/2003 |
| 02345 | 180 | 2/14/2005 |
| 03373 | 120 | 6/20/2011 |
| 04893 | 180 | 6/11/2006 |
| 04893 | 220 | 9/20/2012 |
| 06234 | 110 | 8/10/2007 |
| 06234 | 200 | 8/10/2007 |
| 06234 | 210 | 1/29/2012 |
| 08273 | 110 | 3/8/2009 |
| 08273 | 190 | 8/19/2012 |
| 09002 | 110 | 5/16/2013 |
| 09002 | 120 | 5/16/2013 |
| 09382 | 140 | 8/2/2012 |
| 09382 | 210 | 8/2/2012 |
| 09382 | 220 | 5/1/2013 |
| 13383 | 170 | 3/12/2014 |
| 13567 | 130 | 9/30/2014 |
| 13567 | 140 | 5/23/2015 |
| 14311 | 110 | 9/1/2016 |

Table name: SKILL

| Skill_ID | Skill_Name | Skill_Description |
|----------|--------------------------------|---|
| 100 | Basic Database Management | Create and manage database user accounts. |
| 110 | Basic Web Design | Create and maintain HTML and CSS documents. |
| 120 | Advanced Spreadsheets | Use of advanced functions, user-defined functions, and macroing. |
| 130 | Basic Process Modeling | Create core business process models using standard libraries. |
| 140 | Basic Database Design | Create simple data models. |
| 150 | Master Database Programming | Create integrated trigger and procedure packages for a distributed environment. |
| 160 | Basic Spreadsheets | Create single tab worksheets with basic formulas |
| 170 | Basic C# Programming | Create single-tier data aware modules. |
| 180 | Advanced Database Management | Manage Database Server Clusters. |
| 190 | Advance Process Modeling | Evaluate and Redesign cross-functional internal and external business processes. |
| 200 | Advanced C# Programming | Create multi-tier applications using multi-threading |
| 210 | Basic Database Manipulation | Create simple data retrieval and manipulation statements in SQL. |
| 220 | Advanced Database Manipulation | Use of advanced data manipulation methods for multi-table inserts, set operations, and correlated subqueries. |

EMPLOYEE SKILLS CERTIFICATION IN A GOOD DESIGN



Type of Database Design

- **Existing Database**

- Old data: worksheet, files.
- Extracting data from another databases
- Design using Normal Form

- **Design a new database**

- Database analysis based on user requirements.
- Database design for data extracting.

- **Re-design Database**

- Transform existing database to a new one.
- Integrated two or more databased together.
- Giving techniques & design methods for databases.
- Applying normal form principle and mapping rules between models

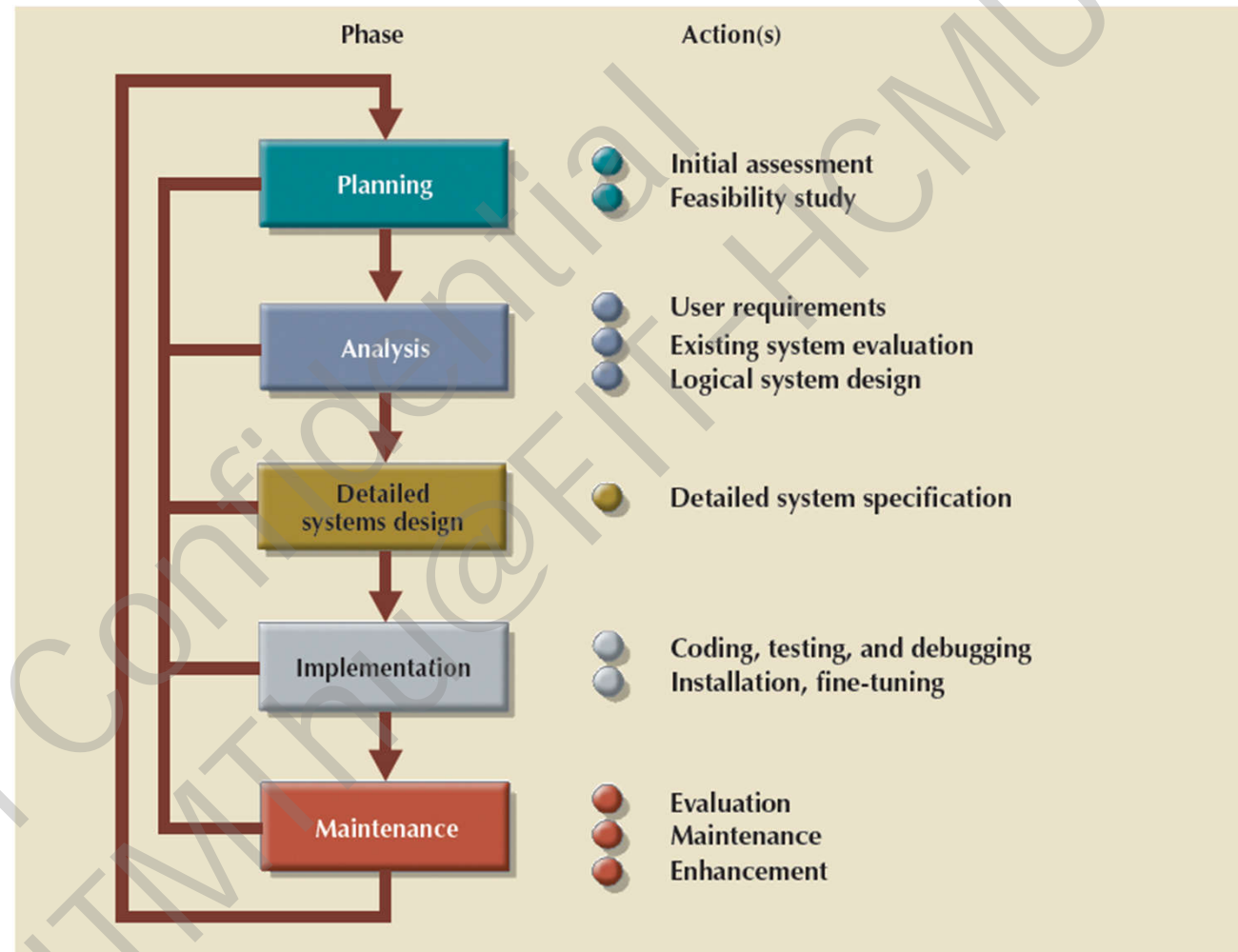


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Systems Development Life Cycle (SDLC)





Systems Development Life Cycle (SDLC)

- Traces history of an information system
- Provides a picture within which database design and application development are mapped out and evaluated
- Iterative rather than sequential process

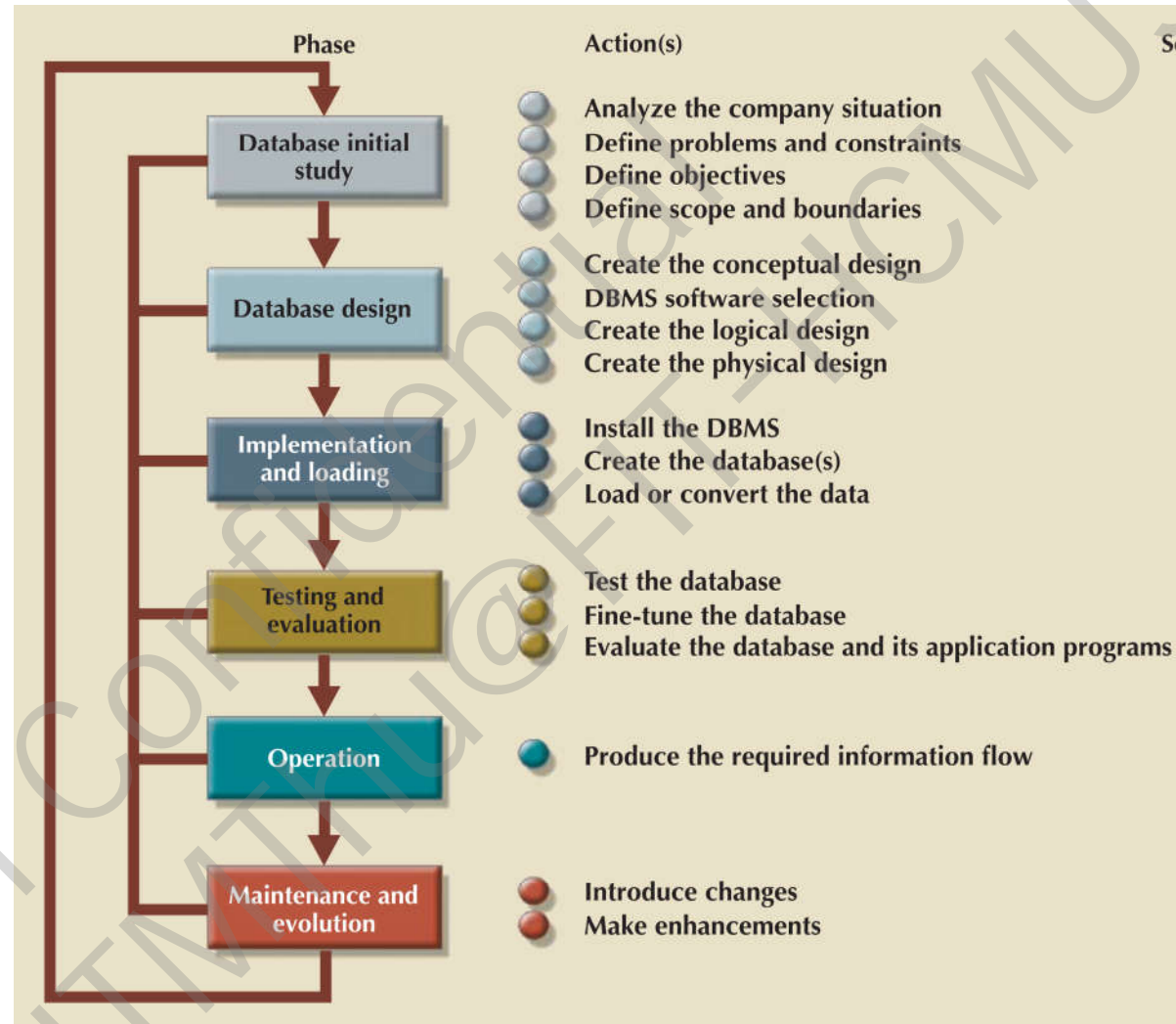


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The Database Life Cycle (DBLC)





The Database Life Cycle (DBLC)

Analyze company situation

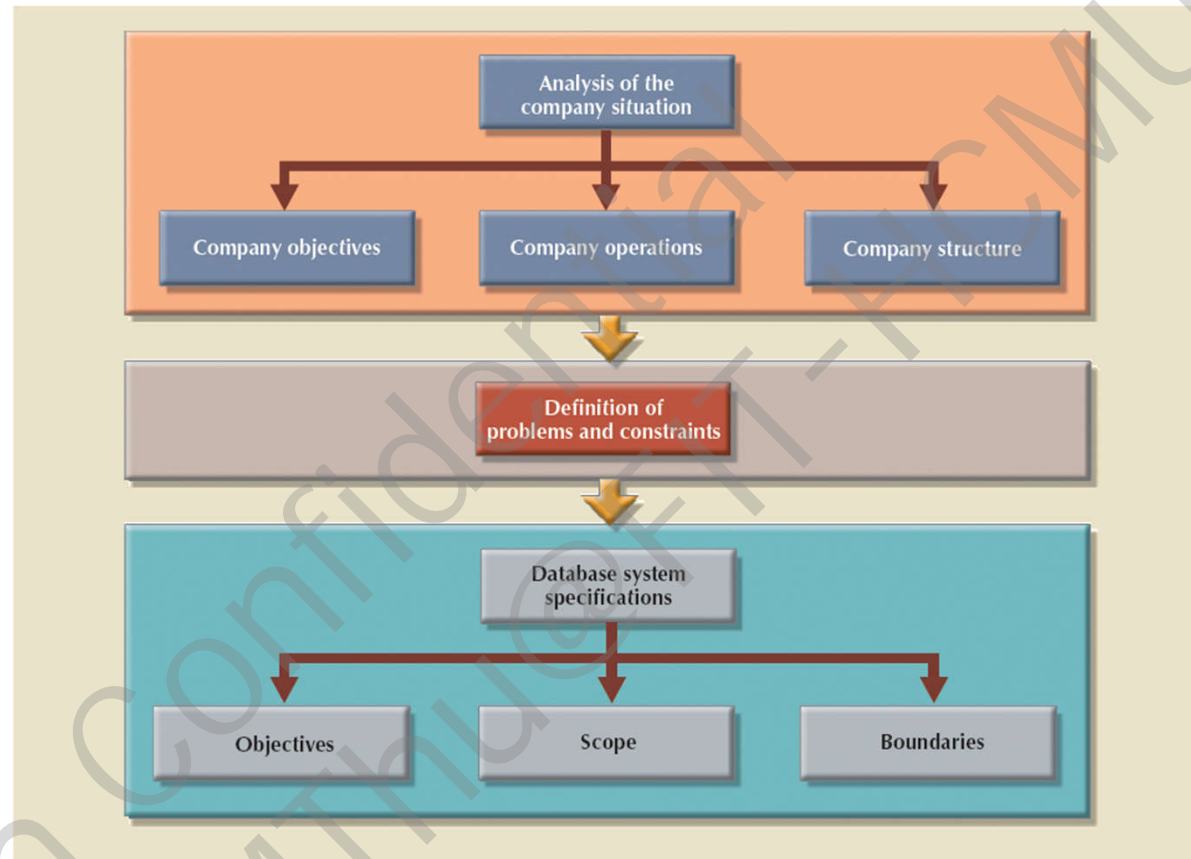
Define problems and constraints

Define objectives

Define scope and boundaries

Purpose of Database Initial Study

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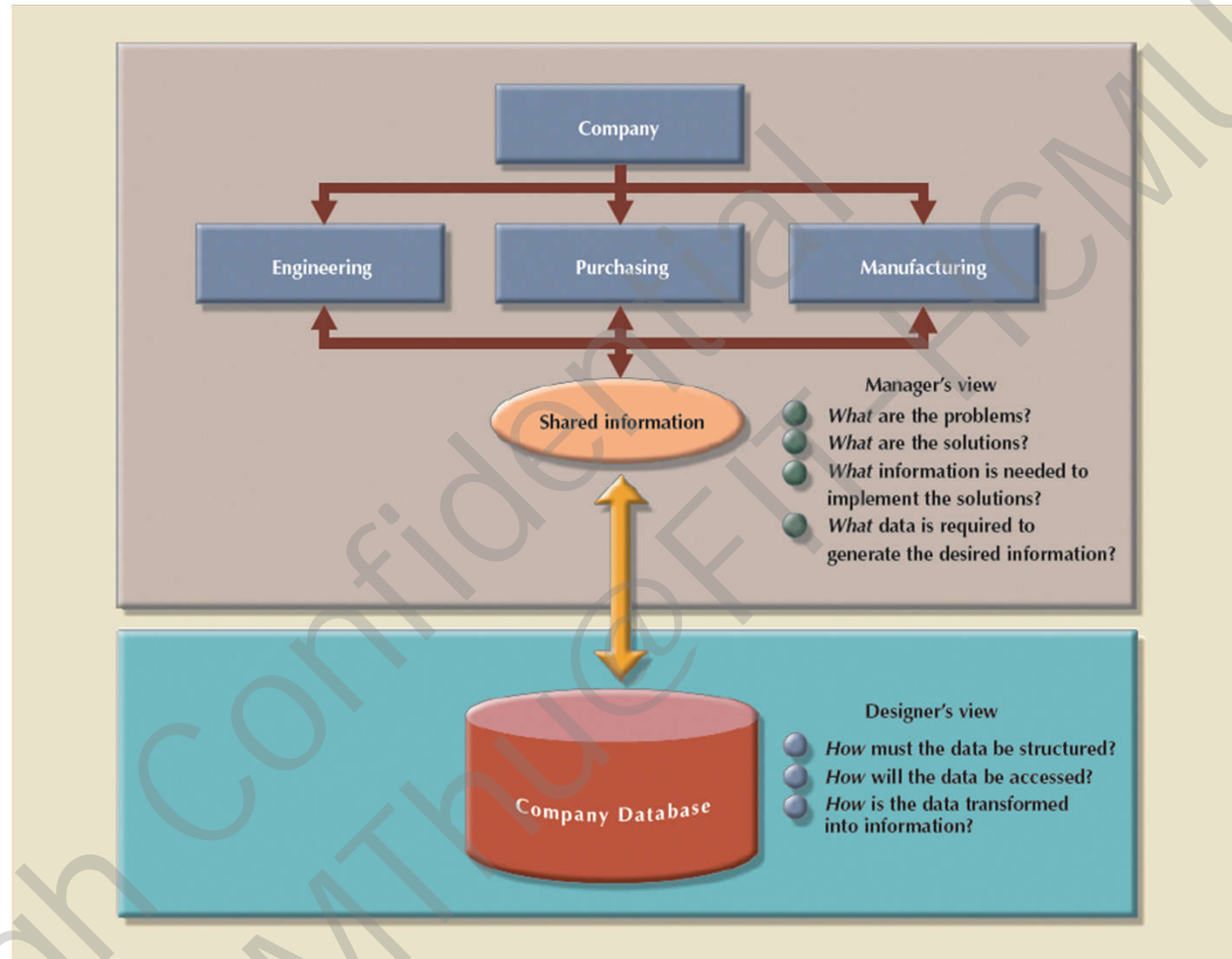


A SUMMARY OF ACTIVITIES IN THE DATABASE INITIAL STUDY



Database Design

- Supports company's operations and objectives
- Most critical phase
 - Ensures final product meets user and system requirements
- Points for examining completion procedures
 - Data component is an element of whole system
 - System analysts/programmers design procedures to convert data into information
 - Database design is an iterative process



Two Views of Data: Business Manager and Database Designer

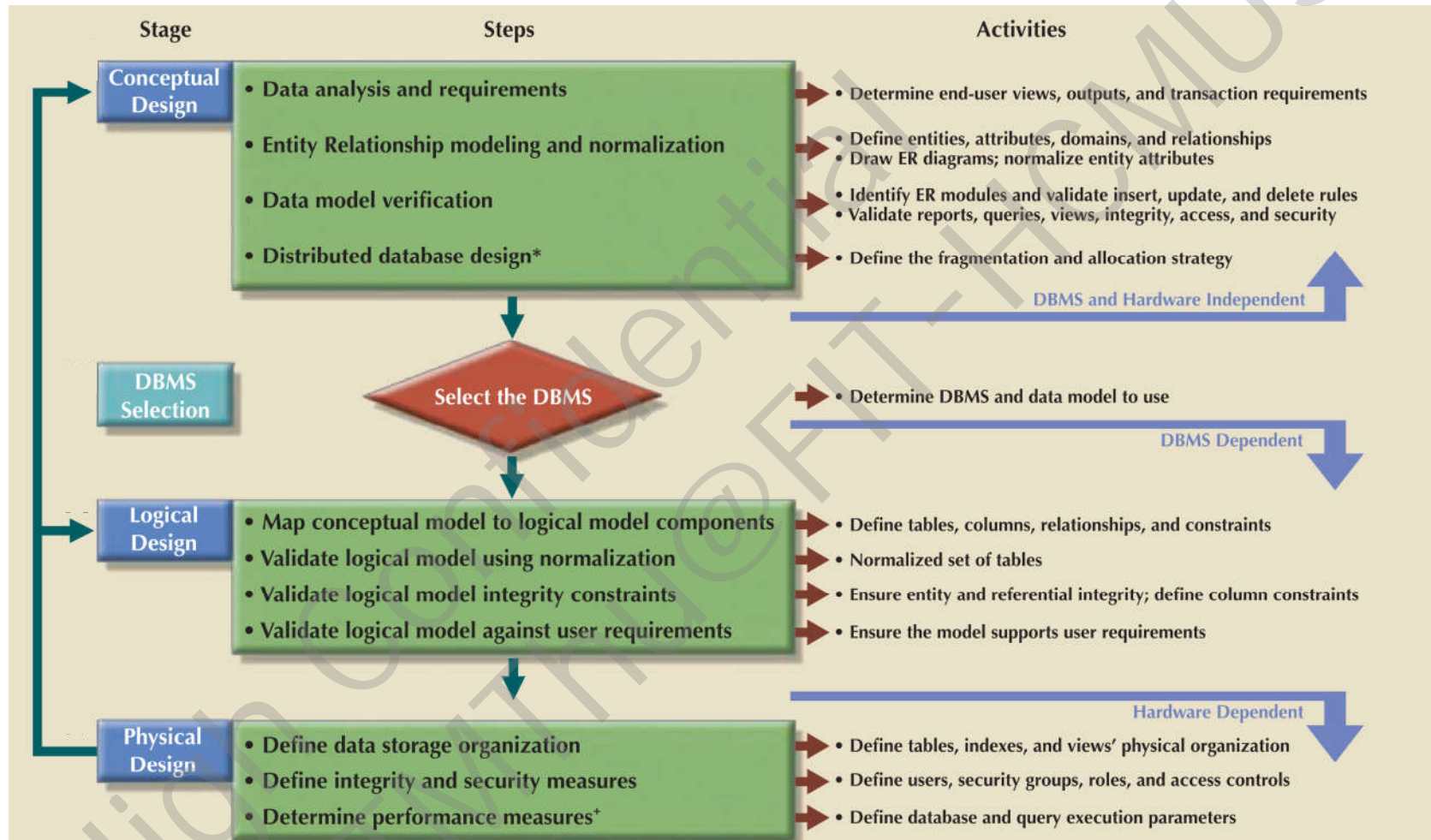


Database Design

- Install the DBMS
 - **Virtualization:** Creates logical representations of computing resources independent of underlying physical computing resources
- Create the databases
 - Requires the creation of special storage-related constructs to house the end-user tables
- Load or convert the data
 - Requires aggregating data from multiple sources

Implementation and Loading

Database Design Process





Database Design

- Physical security
- Password security
- Access rights
- Audit trails
- Data encryption
- Diskless workstations
- Optimization

Testing and Evaluation



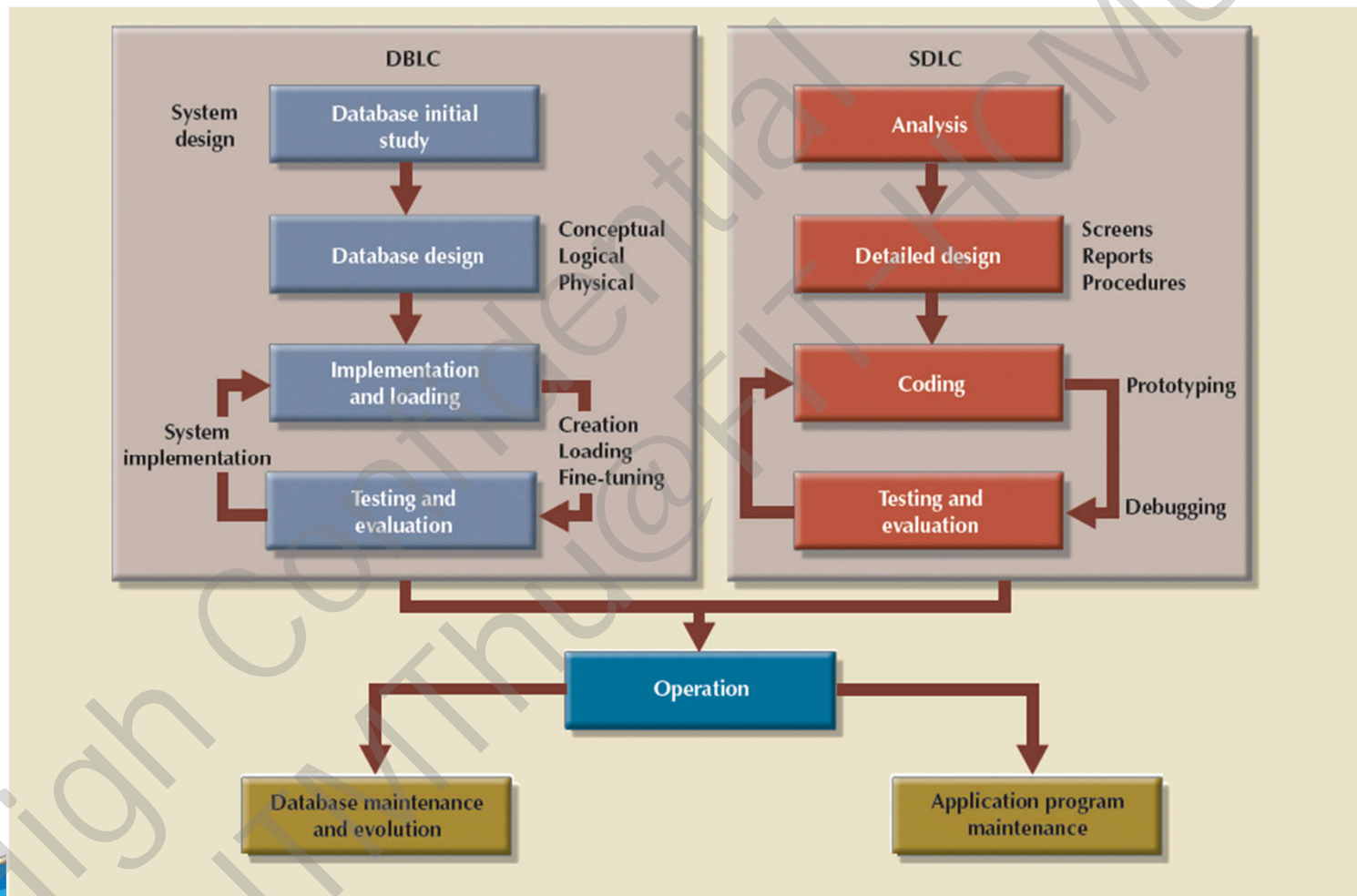
Database Design

- Preventive maintenance (backup)
- Corrective maintenance (recovery)
- Adaptive maintenance
- Assignment of access permissions and their maintenance for new and old users
- Generation of database access statistics
- Periodic security audits
- Periodic system-usage summaries

Maintenance and Evolution



Parallel Activities in the DBLC and the SDLC





4.0 Outline

- Why Database
- Data & Information
- Database
- Type of Databases
- Evolution of File System Data Processing
- Database Management System
- Information System
- Database Design
- Systems Development Life Cycle (SDLC)
- Database Life Cycle (DBLC)
- **Database Career Opportunities**



Database Career Opportunities

DATABASE CAREER OPPORTUNITIES

| JOB TITLE | DESCRIPTION | SAMPLE SKILLS REQUIRED |
|--------------------------------|--|--|
| Database Developer | Create and maintain database-based applications | Programming, database fundamentals, SQL |
| Database Designer | Design and maintain databases | Systems design, database design, SQL |
| Database Administrator | Manage and maintain DBMS and databases | Database fundamentals, SQL, vendor courses |
| Database Analyst | Develop databases for decision support reporting | SQL, query optimization, data warehouses |
| Database Architect | Design and implementation of database environments (conceptual, logical, and physical) | DBMS fundamentals, data modeling, SQL, hardware knowledge, etc. |
| Database Consultant | Help companies leverage database technologies to improve business processes and achieve specific goals | Database fundamentals, data modeling, database design, SQL, DBMS, hardware, vendor-specific technologies, etc. |
| Database Security Officer | Implement security policies for data administration | DBMS fundamentals, database administration, SQL, data security technologies, etc. |
| Cloud Computing Data Architect | Design and implement the infrastructure for next-generation cloud database systems | Internet technologies, cloud storage technologies, data security, performance tuning, large databases, etc. |

