

# Database System Concepts and Architecture

Wojciech Połowczuk



Neisse University

# Data Models, Schemas and Instances

- Data Model: collection of concepts that can be used to describe the structure of a database
- Structure of a Database: the data types, relationships, and constraints that should hold on the data
- Categories of Data Models
  - physical (low-level) data model
  - representational (implementation) data model
  - conceptual (high-level) data model

# Categories of Data Models

- Physical Data Model: describes how data is stored in the computer
  - record formats
  - record orderings
  - access paths
- Representational Data Model
  - relational data model
  - network data model (old)
  - hierarchical model (old)
  - object data model
- Conceptual Data Model
  - entity
  - attribute
  - relationship

# Schemas, Instances and Database State

- Database Schema: description of database
- Schema Diagram
  - displays the structure of each record type but not the actual instances of records
  - displays only some aspects of a schema, such as the names of record types and data items, and some types of constraints

## Example

### SUPPLIER

SuppNumber	SuppName	Status	City
------------	----------	--------	------

### PART

PartNumber	PartName	Color	Weight	City
------------	----------	-------	--------	------

### DELIVERY

SuppNumber	PartNumber	Quantity
------------	------------	----------

# Schemas, Instances and Database State

- Database State (Snapshot)
  - the data in the database in a particular moment in time
  - current set of occurrences or **instances** in the database
- Named States
  - empty state: with no data; state after defining a new database
  - initial state: when the database is first time loaded with initial data
  - current state: at any point in time
  - valid state: state that satisfies the structure and constraints specified in the schema (DBMS)
- Database Schema  $\neq$  Database State

# Schemas, Instances and Database State

## Example

### SUPPLIER

SuppNumber	SuppName	Status	City
S1	Jones	20	New York
S2	Black	30	Paris
S3	Smith	10	London

### PART

PartNumber	PartName	Color	Weight	City
P1	Desk	Blue	20	London
P2	Monitor	Red	10	Paris

### DELIVERY

SuppNumber	PartNumber	Quantity
S1	P1	200

# The Three-Schema Architecture

## The Internal Level

has internal schema, which describes the physical storage structure of the database

## The Conceptual Level

has conceptual schema, which describes the structure of the whole database for a community of users

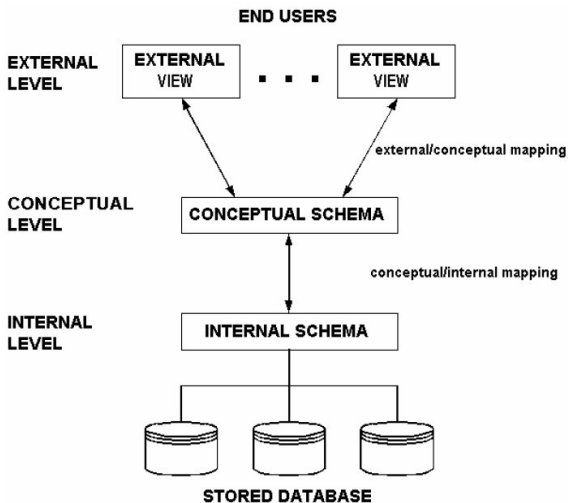
## The External Level

has many external schemas, each schema describes the part of the database that a particular user group is interested in and hides the rest of the database from that user group

## Mapping

process of transforming requests and results between levels

# The Three-Schema Architecture



# Data Independence

- Data Independence
  - capacity to change the schema at one level of database system without having to change the schema at the next higher level
  - the mapping between the two levels is changed
- Logical Data Independence
  - capacity to change the conceptual schema without having to change external schemas or application programs
- Physical Data Independence
  - capacity to change the internal schema without having to change the conceptual (or external) schemas

# DBMS Languages

- Data Definition Language (DDL)
  - internal schema
  - conceptual schema
  - mappings
- Storage Definition Language (SDL)
  - internal schema
- View Definition Language (VDL)
  - user views
  - mapping external-conceptual schema
- Data Manipulation Language (DML)
  - manipulation of the database
  - high-level (nonprocedural) DML
    - data sublanguage
    - query language
  - low-level (procedural) DML
    - data sublanguage

# DBMS Interfaces

- Menu-Based Interfaces for Browsing
  - picking options from menu
  - step-by-step menu
- Forms-Based Interfaces
  - fill out of the form entries
- Graphical User Interfaces
  - manipulating the diagram
  - utilize both menus and forms
- Natural Language Interfaces
  - English
- Interfaces for Parametric Users
  - small set of commands
- Interfaces for the DBA
  - privileged commands

# DBMS Component Modules

Typical component modules of a DBMS

## DDL compiler

process schema definitions

## Run-time Database Processor

database access at run time

## Query compiler

high-level queries

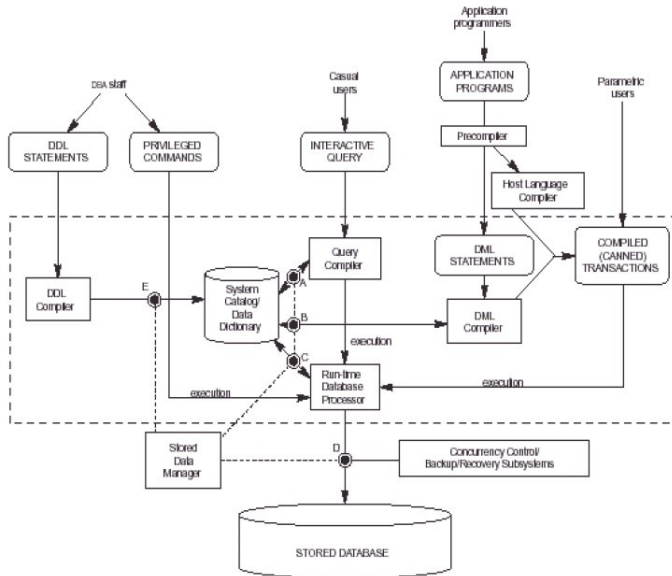
## Pre-compiler

extract DML commands from host programming language

## DML compiler

compile DML commands into object code for database access

# DBMS Component Modules



# Database System Utilities

- Loading
  - load existing data files
  - reformat the data (conversion tools)
- Backup
  - create backup copy of the database
  - restore the database
- File reorganization
  - improve performance
- Performance monitoring
  - monitor database usage
  - provide statistics

# Classification of Database Management Systems

- Data Model
  - relational data model
  - object data model etc.
  - hierarchical and network data models (old)
- Number of Users
  - single-user systems
  - multi-user systems
- Number of Sites
  - centralized DBMS
  - distributed DBMS (DDBMS)
    - homogeneous DDBMS
    - heterogeneous DDBMS
- Cost
- General-purpose or special-purpose
- On-line transaction processing systems