Introduction to DBMS

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Database Design

- The process of designing the general structure of the database:
- Logical Design: Deciding on the database schema
  - Database design requires that we find a “good” collection of relation schemas
  - Business decision: What attributes should we record in the database?
  - Computer Science decision: What relation schemas should we have and how should the attributes be distributed among the various relation schemas?
- Physical Design: Deciding on the physical layout of the database

Database Engine

- A database system is partitioned into modules that deal with each of the responsibilities of the overall system
- The functional components of a database system can be divided into
  - The storage manager
  - The query processor component
  - The transaction management component

Storage Manager

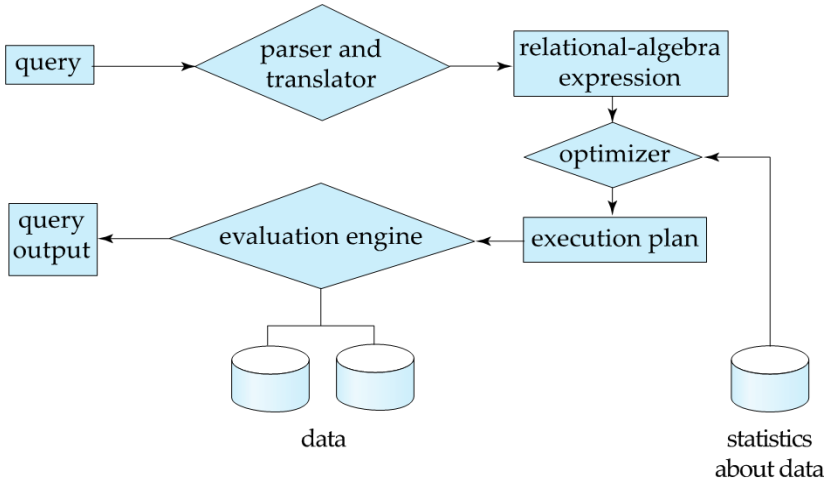
- A program module that provides the interface between the low-level data stored in the database and the application programs and queries submitted to the system
- The storage manager is responsible to the following tasks:
  - Interaction with the OS file manager
  - Efficient storing, retrieving and updating of data
- The storage manager components include:
  - Authorization and integrity manager
  - Transaction manager
  - File manager
  - Buffer manager
- The storage manager implements several data structures as part of the physical system implementation:
  - Data files: Store the database itself
  - Data dictionary: Stores metadata about the structure of the database, in particular the schema of the database
  - Indices: It can provide fast access to data items; a database index provides pointers to those data items that hold a particular value

Query Processor

- The query processor components include:
  - DDL interpreter: Interprets DDL statements and records the definitions in the data dictionary
  - DML compiler: Translates DML statements in a query language into an evaluation plan consisting of low-level instructions that the query evaluation engine understands
    - The DML compiler performs query optimization; It picks the lowest cost evaluation plan from among the various alternatives
  - Query evaluation engine executes low-level instructions generated by the DML compiler

Query Processing

- Parsing and translation
- Optimization
- Evaluation



Transaction Management

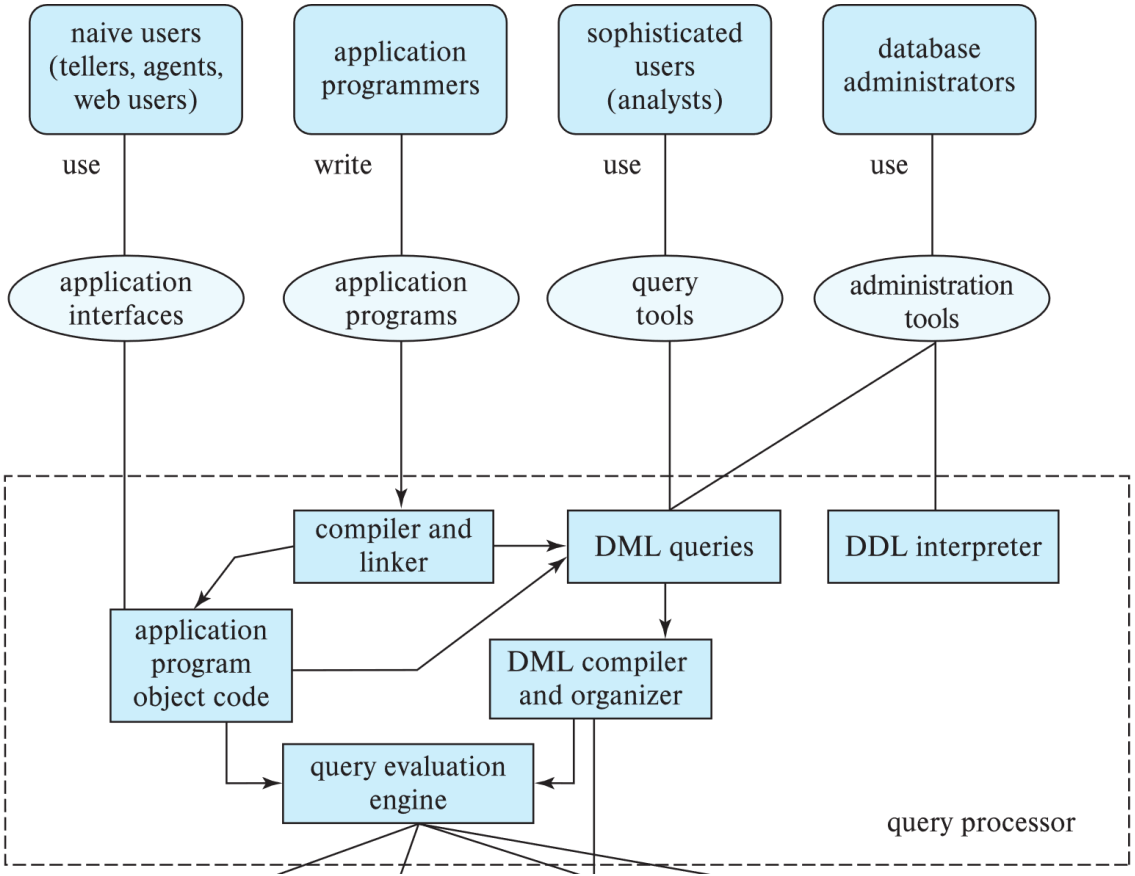
- **What if the system fails?**
- **What if more than one user is concurrently accessing/updating the same data?**

- A transaction is a collection of operations that performs a single logical function in a database application

- Transaction-management component ensures that the database remains in a consistent (correct) state despite system failures (e.g., power failures and operating system crashes) and transaction failures

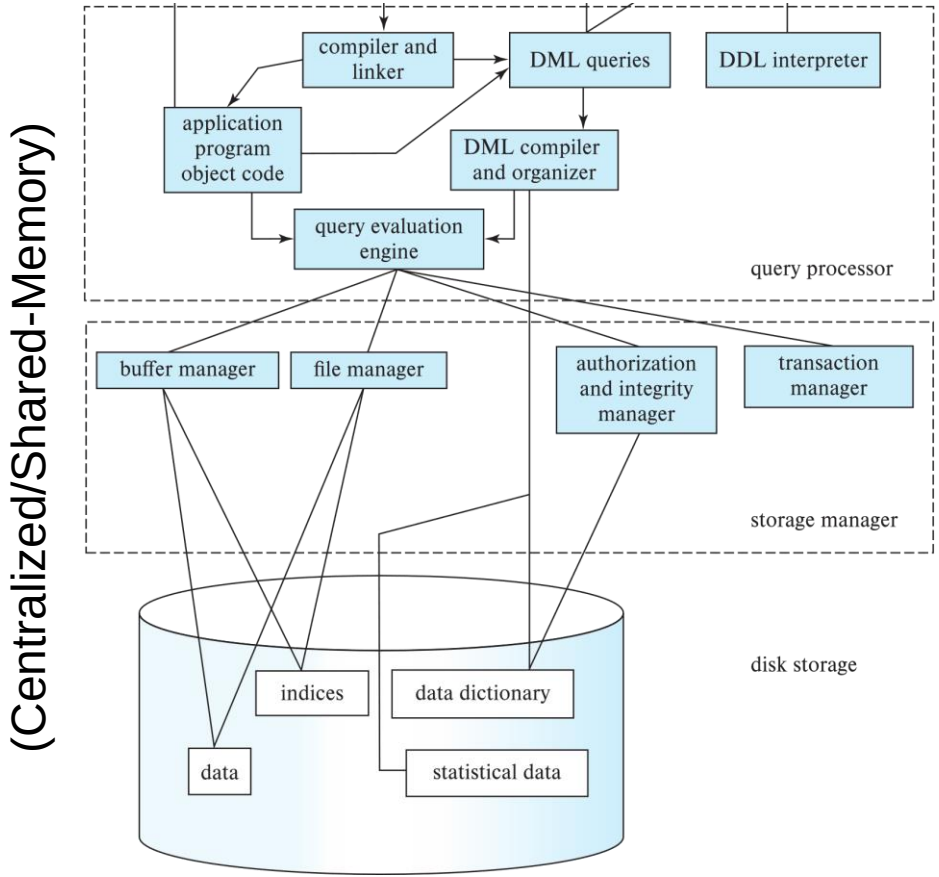
- Concurrency-control manager controls the interaction among the concurrent transactions, to ensure the consistency of the database

Database Users



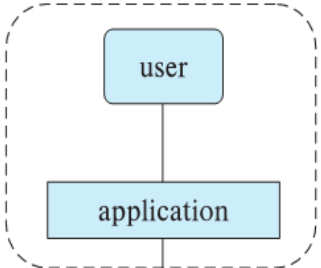
Database Architecture

- Centralized databases
  - One to a few cores, shared memory
- Client-server,
  - One server machine executes work on behalf of multiple client machines
- Parallel databases
  - Many core shared memory
  - Shared disk
  - Shared nothing
- Distributed databases
  - Geographical distribution
  - Schema/data heterogeneity

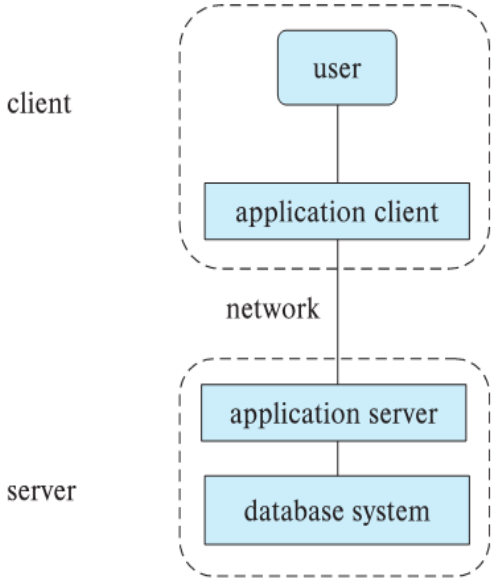


Database Applications

- Database applications are usually partitioned into two or three parts
- Two-tier architecture: The application resides at the client machine, where it invokes database system functionality at the server machine
- Three-tier architecture: The client machine acts as a front end and does not contain any direct database calls
  - The client end communicates with an application server, usually through a forms interface
  - The application server in turn communicates with a database system to access data



Two-tier architecture



Three-tier architecture

Database Administrator

- A person who has central control over the system is called a database administrator (DBA)
- Functions of a DBA include:
  - Schema definition
  - Storage structure and access-method definition
  - Schema and physical-organization modification
  - Granting of authorization for data access
  - Routine maintenance
  - Periodically backing up the database
  - Ensuring that enough free disk space is available for normal operations, and upgrading disk space as required
  - Monitoring jobs running on the database

History of Database Systems

- 1950s and early 1960s:
  - Data processing using magnetic tapes for storage
    - Tapes provided only sequential access
  - Punched cards for input
- Late 1960s and 1970s:
  - Hard disks allowed direct access to data
  - Network and hierarchical data models in widespread use
  - Ted Codd defines the relational data model
    - Would win the ACM Turing Award for this work
    - IBM Research begins System R prototype
    - UC Berkeley (Michael Stonebraker) begins Ingres prototype
    - Oracle releases first commercial relational database
  - High-performance (for the era) transaction processing
- 1980s:
  - Research relational prototypes evolve into commercial systems
    - SQL becomes industrial standard
  - Parallel and distributed database systems

History of Database Systems

    - Wisconsin, IBM, Teradata
  - Object-oriented database systems
- 1990s:
  - Large decision support and data-mining applications
  - Large multi-terabyte data warehouses
  - Emergence of Web commerce
- 2000s
  - Big data storage systems
    - Google BigTable, Yahoo PNuts, Amazon,
    - “NoSQL” systems
  - Big data analysis: beyond SQL
    - Map reduce and friends
- 2010s
  - SQL reloaded
    - SQL front end to Map Reduce systems
    - Massively parallel database systems
    - Multi-core main-memory databases

Next Lecture

Basic Terminologies and ER Model

Thank you for your attention...

Any question?

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