DATABASE COMPONENTS
Typical DB Components

- The stored database
- The catalog (a DB about the DB)
  - identifies tables, fields, keys, etc., in the stored DB
  - statistics: size of tables, how stored
  - mappings.
- Data Manager: performs accesses to disk at request of ...
- Runtime DB Processor
  - Carries out access plans of higher level components
More Typical DB Components

- DDL Compiler
  - Checks for Correctness & permissions
  - Translates into Catalog Entries
  - Uses RT processor

- Query Processor
  - Checks for Correctness & permissions
  - Translates into Stored DB access and manipulation plans
  - Uses RT processor
Processing Command includes Checking Correctness

- correct syntax
- correct references:
  - if a query refers to a table's column,
  - the table and column better exist!
Compile Data Definition Stmt

• DDL Statement like "Create Table' sent to DDL Compiler
• Compiler Creates Catalog Manipulation Plan for Runtime Processor.
• R/T processor gives page by page instructions to Stored Data Manager.
• But first has to Check Correctness.
DDL: 1 – Check Syntax

- DDL Compiler can check syntax of statement all by itself
- No need to consult catalog to know:
  ```sql
  creat table xyz (  
    integer idnum;  
    string name)  
  has mistakes.
  ```
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DDL: Check Syntax

- DDL Statement
- DDL compiler
- Runtime DB processor
- Data Manager
- catalog
- Stored database
DDL: Check Syntax

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DDL: Check Syntax

DDL Statement → DDL compiler

Illegal syntax!

Runtime DB processor

Data Manager

catalog

Stored database
DDL: 2 – Check References

• Syntax is correct
• But
  
  dno integer foreign key references
  dept(dnumber)
  may be a mistake (no such table)
• Can only be discovered by checking the catalog.
Database Creation Time

- DDL compiler
- Runtime DB processor
- Data Manager
- catalog
- Stored database
Database Creation Time

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- DDL compiler
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Database Creation Time

DDL Statement → DDL compiler

- Runtime DB processor
- Data Manager
- catalog
- Stored database
Database Creation Time

1. **DDL Statement**
2. **DDL compiler**
3. **Runtime DB processor**
4. **Data Manager**
5. **catalog**
6. **Stored database**
7. **A plan to Check References**
Database Creation Time

- DDL Statement
- DDL compiler
- Runtime DB processor
- Data Manager
- catalog
- A plan to Check References
- Step by step instructions
- Stored database
Database Creation Time

**DDL Statement** → **DDL compiler**

- **Runtime DB processor**
  - **Data Manager**
    - **A plan to Check References**
    - **Step by step instructions**

**catalog** → **Stored database**

- **A plan to Check References**
- **Step by step instructions**
Database Creation Time

- DDL Statement
- DDL compiler
- Runtime DB processor
- Data Manager
- catalog
- Stored database

A plan to Check References
Step by step instructions
A plan to Check References

Step by step instructions

Table referenced in foreign key does not exist!
DDL: 2 – Check References

• Other errors discovered from catalog
  – Table already exists
  – User does not have right to create table

• While in catalog gather information
  – For use in compiling DDL statement
  – About referenced tables
  – About existing indexes
DDL: 3 – Compile DDL

- Compiler now has info about referenced tables and indexes
- Makes plan to create table
- Plan means to make entries in Catalog
  - `USER_TABLES`, `USER_TAB_COLUMNS`, `ALL_CONSTRAINTS`, etc.
- Builds plan to make entries
DDL: Compile DDL

After first trip to catalog to check references

DDP compiler

Runtime DB processor

Data Manager

Catalog

Stored database
DDL: Compile DDL

- DDL Statement
- After first trip to catalog to check references
- DDL compiler
- Runtime DB processor
- Data Manager
- catalog
- Stored database
DDL: Compile DDL

DDL Statement

After first trip to catalog to check references

Runtime DB processor

DDL compiler

Plan to create table in Catalog

catalog

Data Manager

Stored database
DDL: Compile DDL

**DDL Statement**

After first trip to catalog to check references

- **Runtime DB processor**
- **Data Manager**
- **DDL compiler**
- Plan to create table in Catalog
- Step by step instructions

- catalog
- Stored database
DDL: Compile DDL

DDL Statement

After first trip to catalog to check references

Runtime DB processor

Data Manager

DDL compiler

Plan to create table in Catalog

Step by step instructions

catalog

Stored database
DDL: Compile DDL

**DDL Statement**

After first trip to catalog to check references

**Data Manager**

**Runtime DB processor**

**DDL compiler**

Plan to create table in Catalog

Step by step instructions

No DATA stored in Stored Database, only Metadata in catalog.
Interactive DML

• Query Processor processes DML similarly to DDL Compiler
  – Validates Syntax
  – Checks references in Catalog
  – Checks statistics to decide best plan for implementing the query
• R/T Processor takes the plan and parcels it out to the Data Manager.
DML: 1 - Syntax

- Query Processor checks syntax with no help from catalog.
- `select fname, lname
  where dno=5`
  is syntactically incorrect on its face.
DML: 2 – Refs and Info

• Consult Catalog to check validity of references, etc.
  – Do tables, columns exist?
  – Does user have proper privileges?
• Get info used to construct plan
  – How is data stored?
  – How many tuples?
  – What indexes exist?
DML: Refs and Info

DML Statement

Query Processor

Runtime DB processor

Data Manager

catalog

Stored database
DML: Refs and Info

DML Statement ➔ Query Processor

First Design Plan:
Checks References
Gets Stats

USER

Runtime DB processor

Data Manager

catalog

Stored database
DML: Refs and Info

DML Statement -> Query Processor

First Design Plan:
Checks References
Gets Stats

Step by step instructions

Runtime DB processor

Data Manager

catalog

Stored database
DML: Refs and Info

DML Statement

Query Processor

First Design Plan:
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Step by step instructions

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Stored database

USER

?
DML: Refs and Info

DML Statement

Query Processor

First Design Plan:
Checks References
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Step by step instructions

Runtime DB processor

Data Manager

catalog

Stored database

USER

Design Info

?
DML: Refs and Info

DML Statement

Query Processor

No column DNUM in table EMPLOYEE

First Design Plan: Checks References Gets Stats

Step by step instructions

RUNTIME DB processor

Data Manager

catalog

Stored database

USER

Design Info

User asked: No column DNUM in table EMPLOYEE

Design Info: First Design Plan: Checks References Gets Stats

Step by step instructions:...

USER: No column DNUM in table EMPLOYEE
DML: Refs and Info

DML Statement

Query Processor

First Design Plan: Checks References Gets Stats

Runtime DB processor

Data Manager

Step by step instructions

catalog

Stored database
DML: Refs and Info (2)

• But let’s assume the references are all ok
• And the user has all required privileges
DML: Refs and Info

Design Info from last access

Results returned to Processor and User
DML: Refs and Info

Results returned to Processor and User

- Query Processor
- Second: Query Implementation Plan
- Runtime DB processor
- Data Manager
- catalog
- Stored database

Design Info from last access
DML: Refs and Info

Results returned to Processor and User

Query Processor

Second: Query Implementation Plan

Runtime DB processor

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Design Info from last access
DML: Refs and Info

Results returned to Processor and User
DML: Refs and Info

Results returned to Processor and User
Results returned to Processor and User
“Prepare” statements

- When we get to PL/SQL and PHP you will learn about “preparing” SQL statements.
- Building these implementation plans is the main part of preparation.