

DATABASE MANAGEMENT SYSTEM (DBMS)

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Main Characteristics of the Database Approach

- Self-describing nature of a database system: A DBMS **catalog** stores the *description* of the database. The description is called **meta-data**). This allows the DBMS software to work with different databases.
- Insulation between programs and data: Called **program-data independence**. Allows changing data storage structures and operations without having to change the DBMS access programs.
- Data Abstraction: A **data model** is used to hide storage details and present the users with a *conceptual view* of the database.

Main Characteristics of the Database Approach

- Support of multiple views of the data: Each user may see a different view of the database, which describes *only* the data of interest to that user.
- Sharing of data and multiuser transaction processing : allowing a set of concurrent users to retrieve and to update the database. Concurrency control within the DBMS guarantees that each **transaction** is correctly executed or completely aborted. OLTP (Online Transaction Processing) is a major part of database applications.

Data Model

- A **database model** referred as data model that determines the logical structure of a database and fundamentally determines in which manner data can be stored, organized and manipulated.
- The most popular example of a database model is the relational model, which uses a table-based format.
- THE IMPORTANCE OF DATA MODELS--
- Data model
 - Relatively simple representation, usually graphical, of complex real-world data structures
 - Communications tool to facilitate interaction among the designer, the applications programmer, and the end user
- Good database design uses an appropriate data model as its foundation
- Data model organizes data for various users.

Data Models

- **Data Model:** A **set of concepts** to describe the *structure* of a **database**, and certain *constraints* that the database should obey.
- **Data Model Operations:** Operations for specifying database retrievals and updates by **referring to the concepts of the data model**. Operations on the data model may include *basic operations* and *user-defined operations*.
- A collection of tools for describing
 - Data
 - Data relationships
 - Data semantics
 - Data constraints

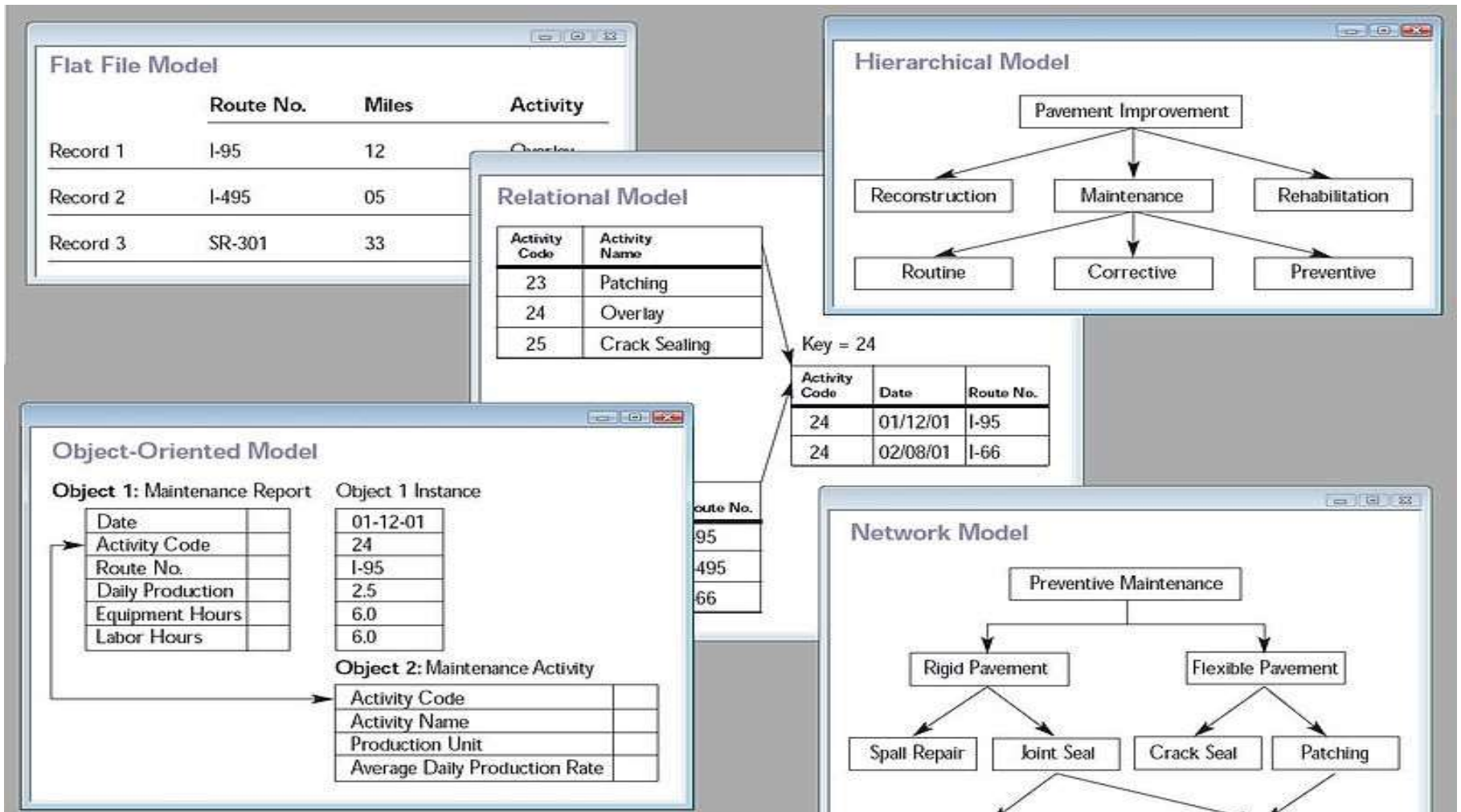
Categories of data models

- **Conceptual (high-level, semantic) data models:**
 - Provide concepts that are close to the way many users *perceive* data. (Also called **entity-based** or **object-based** data models.)
- **Physical (low-level, internal) data models:**
 - Provide concepts that describe details of how data is stored in the computer.
- **Implementation (representational) data models:**
 - Provide concepts that fall between the above two, balancing user views with some computer storage details.

Classification of Data Models-

- **Based on the data model used:**
 - **Traditional:**
 - Relational,
 - Network,
 - Hierarchical.
 - **Emerging: Object-based data models**
 - Object-oriented,
 - Object-relational.
- Entity-Relationship data model (mainly for database design)
- Semi-structured data model (XML)

Collage of Five Types of Data Models



Classification of Data Models-

- It is integrated collection of concept for manipulating data and relationship between data. It has some basic models:-
 - 1) **FILE BASED SYSTEM or PRIMITIVE MODEL-**
 - The entities or object are represented by records that are stored together in files. Relationship between objects are represented by directory.
 - 2) **TRADITIONAL DATA MODEL-**
 - They are based on records.
 - For example - Hierarchical data model, Network data model and Relational data model.
 - 3) **SEMANTIC DATA MODEL-**
 - It is come from semantic network developed by artificial intelligence. Semantic network is used for organizing and representing general knowledge.

History of Data Models

- **Hierarchical Data Model**: implemented in a joint effort by IBM and North American Rockwell around 1965.
 - Resulted in the IMS family of systems. The most popular model.
 - Other system based on this model: System 2k (SAS inc.)
- **Relational Model**: proposed in 1970 by E.F. Codd (IBM), first commercial system in 1981-82. Now in several commercial products (DB2, ORACLE, SQL Server, SYBASE, INFORMIX).
- **Network Model**: the first one to be implemented by Honeywell in 1964-65 (IDS System). Adopted heavily due to the support by CODASYL (CODASYL - DBTG report of 1971).
 - Later implemented in a large variety of systems - IDMS (Cullinet - now CA), DMS 1100 (Unisys), IMAGE (H.P.), VAX -DBMS (Digital Equipment Corp.).

History of Data Models

- **Object-oriented Data Model(s)**: O-O Programming Languages such as C++ (e.g., in OBJECTSTORE or VERSANT), and
- Smalltalk (e.g., in GEMSTONE).
- Additionally, systems like O₂, ORION (at MCC - then ITASCA), IRIS (at H.P.- used in Open OODB).
- **Object-Relational Models**:
- Most Recent Trend. Started with Informix Universal Server.
- Exemplified in the latest versions of Oracle-10i, DB2, and SQL Server etc. systems.

So, several models have been proposed for implementing in a database system.

Hierarchical Data Model

- It is the oldest form of data base model.
- It was developed by IBM for IMS (information Management System).
- It is a set of organized data in tree structure. DB record is a tree consisting of many groups called segments.
- It uses one to many relationships.
- The data access is also predictable.

APPLICATIONS:-

- 1)It is a semantic model because of real world phenomenon.
 - e.g.-social structure or biological structure etc.
- 2)Physical model-you can see it is in the form of disc storage.

ADVANTAGES:-

- 1)**Simplicity**- due to simple design of tree structure .
- 2)**Data sharing**- due to centralization.

Hierarchical Data Model

- 3) **Data security**- because of database management system.
- 4) **Efficiency**- because of support of large data which may have one to many relationships.

DISADVANTAGES:-

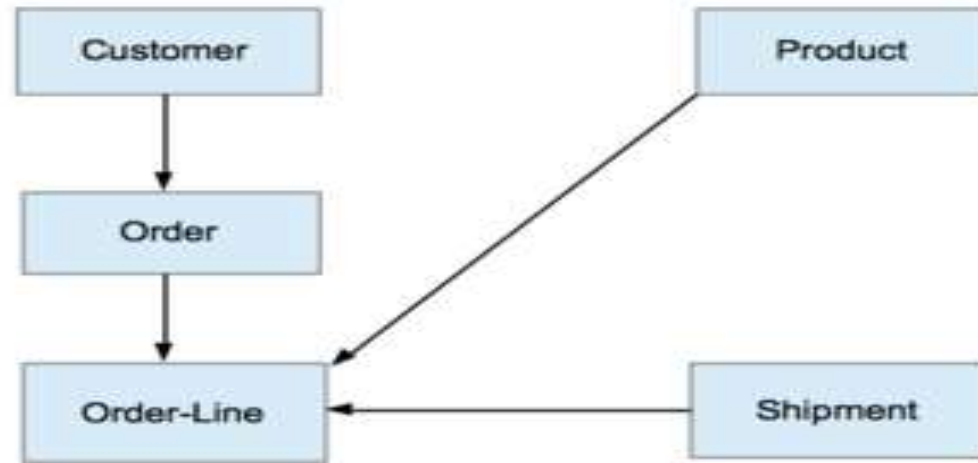
- 1) **Implementation complexity**- because of physical storage.
- 2) **Inflexibility**- because of changes in one segment can affect another segment.
- 3) Changes in DBMS causes of **changes in application program**.
- 4) It has **no standard**.
- 5) Implementation limitation due to **many to many relationship** that supports of real life problem.
- 6) Navigational and procedural nature of processing.
- 7) Database is visualized as a linear arrangement of records.
- 8) Little scope for "query optimization"

Network Data Model

- -It is an alternative to hierarchical data model.
- -Formalized by DBTG(Data Base Task Group).
- -It provides multiple path among segments.
- -This model allows having one to one, one to many and many to many relationship.
- -Data modeling in it has a set construct. A set consist a set name, an owner record type and member record type. A member record type can have role in more than one set. It introduces the concept of multi-parent concept.
- - A network database stores information in data sets which are similar to files and tables.
- -Multiple paths eliminates some of the drawbacks of hierarchical database model but it causes a new disadvantage. i.e. maintaining all the links or you can say that relationship between them.
- -Relationship are hierarchical in manner i.e., pre computed.

Network Data Model

- The **network model** is a database model conceived as a flexible way of representing objects and their relationships.
- Its distinguishing feature is that the schema, viewed as a graph in which object types are nodes and relationship types are arcs, is not restricted to being a hierarchy or lattice.



Network Data Model →

It's an alternative to hierarchical DB.
formalised in 1971 by Database Task Group (DBTG)
provides multiple paths among segments (grouping of fields)
This Model allows having 1 to 1, 1 to many & many to many relationships.

Data modelling in it as set construct.

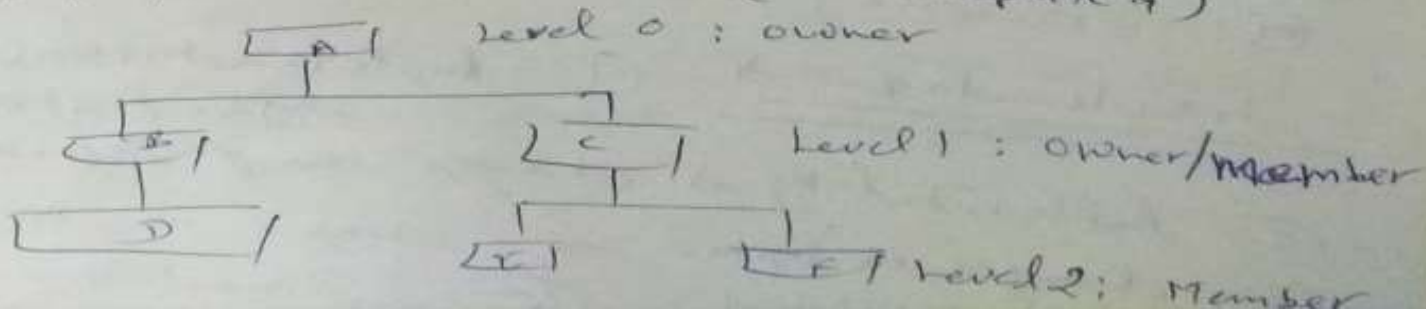
A set consist of an owner Record type, a set name & a member Record type.

A member Record type can have role in more than one set, It introduces ~~hierarchical~~ Multiparent concepts.

A Networked Database stores information in data sets, which are similar to files & tables.

Multiple paths eliminates some of the drawbacks of hierarchical model. But in it main Disadvantage is that maintaining all the links.

Relationship are hierarchical (pre-computed)



Network Data Model

■ **ADVANTAGES:-**

- 1) Simplicity due to easy design.
- 2) More relationship i.e., one to one, one to many or many to many which helps in modeling real life.
- 3) Data access is here because of owner record type can access all member record type.
- 4) Data integrity- A member does not exist without of owner. A user must define both.
- 5) Standard DBTG.
- 6) Network Model is able to model complex relationships and represents semantics of add/delete on the relationships.
- 7) Can handle most situations for modeling using record types and relationship types.
- 8) Language is navigational; uses constructs like FIND, FIND member, FIND owner, FIND NEXT within set, GET etc. Programmers can do optimal navigation through the database.

Network Data Model

DISADVANTAGES:-

- System complexity- The records maintained using pointers so whole database structure gets more complex.
- Not user friendly- It is designed by highly skilled professionals.
- The structural changes to the database is very difficult.
- Navigational and procedural nature of processing.
- Database contains a complex array of pointers that thread through a set of records.
- Little scope for automated "query optimization"