Outline

- Introduction
- Background
- Distributed DBMS Architecture
- Distributed Database Design (Briefly)
- Distributed Query Processing (Briefly)
- Distributed Transaction Management (Extensive)
- Building Distributed Database Systems (RAID)
- Mobile Database Systems
- Privacy, Trust, and Authentication
- Peer to Peer Systems

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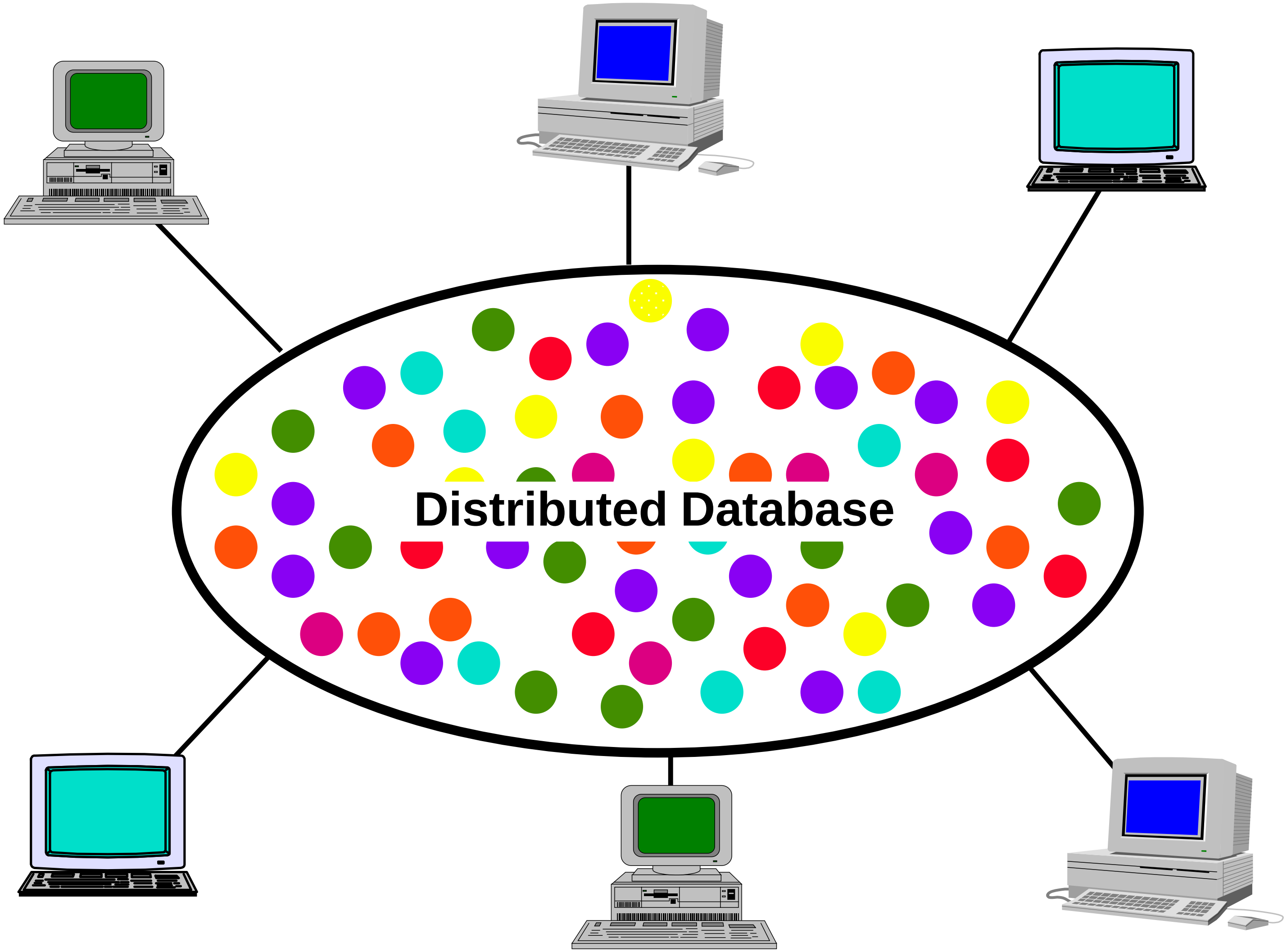
Useful References

- Textbook *Principles of Distributed Database Systems*,

  Chapter 1.4-1.7.1

Distributed Database - User View



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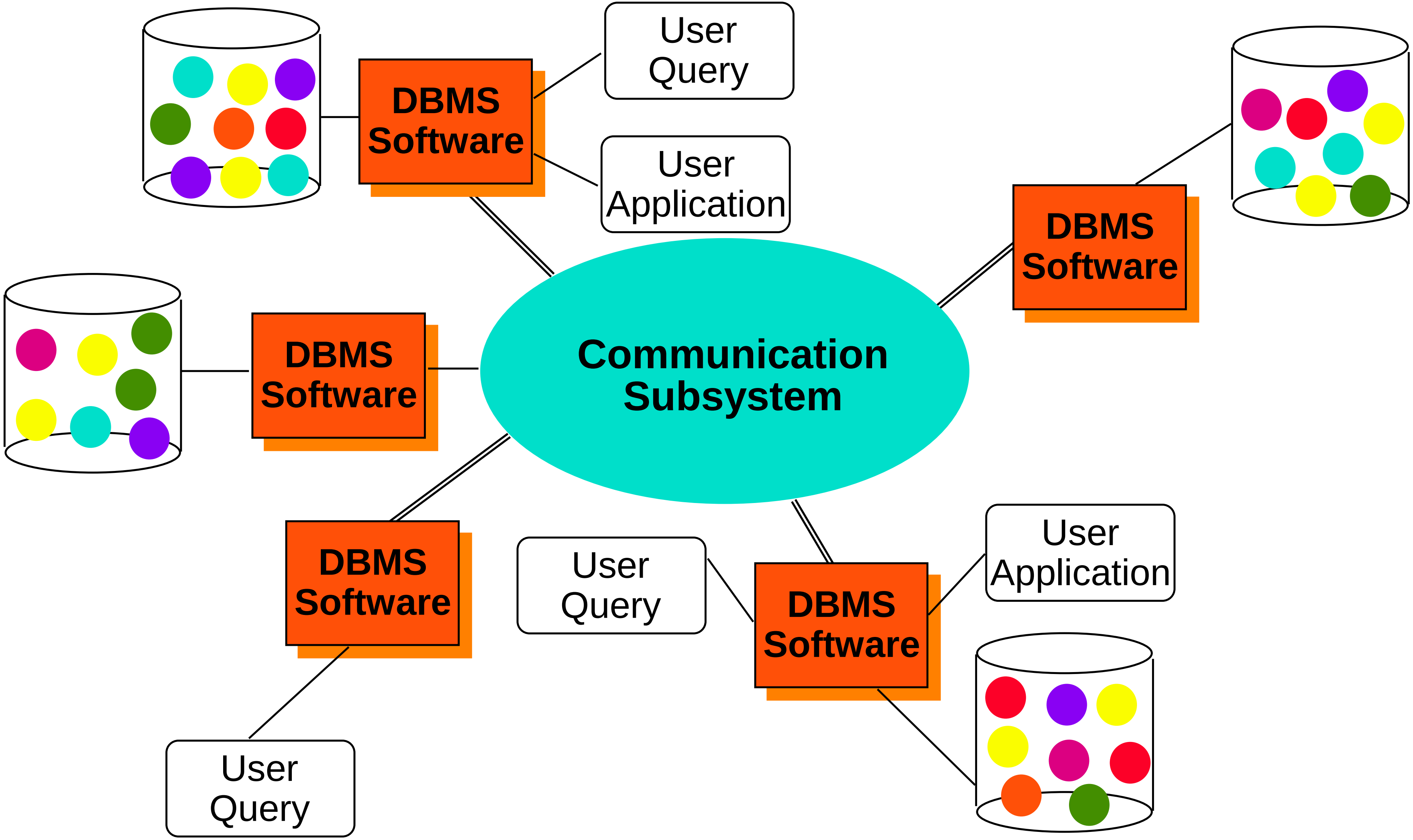
Distributed DBMS - Reality



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Potentially Improved Performance

- Proximity of data to its points of use
  - Requires some support for fragmentation and replication
- Parallelism in execution
  - Inter-query parallelism
  - Intra-query parallelism

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System Expansion

- Issue is database scaling
- Peer to Peer systems
- Communication overhead

Distributed DBMS Issues

- **Distributed Database Design**
  - how to distribute the database
  - replicated & non-replicated database distribution
  - a related problem in directory management
- **□Query Processing**
  - convert user transactions to data manipulation instructions
  - optimization problem
  - min{cost = data transmission + local processing}
  - general formulation is NP-hard

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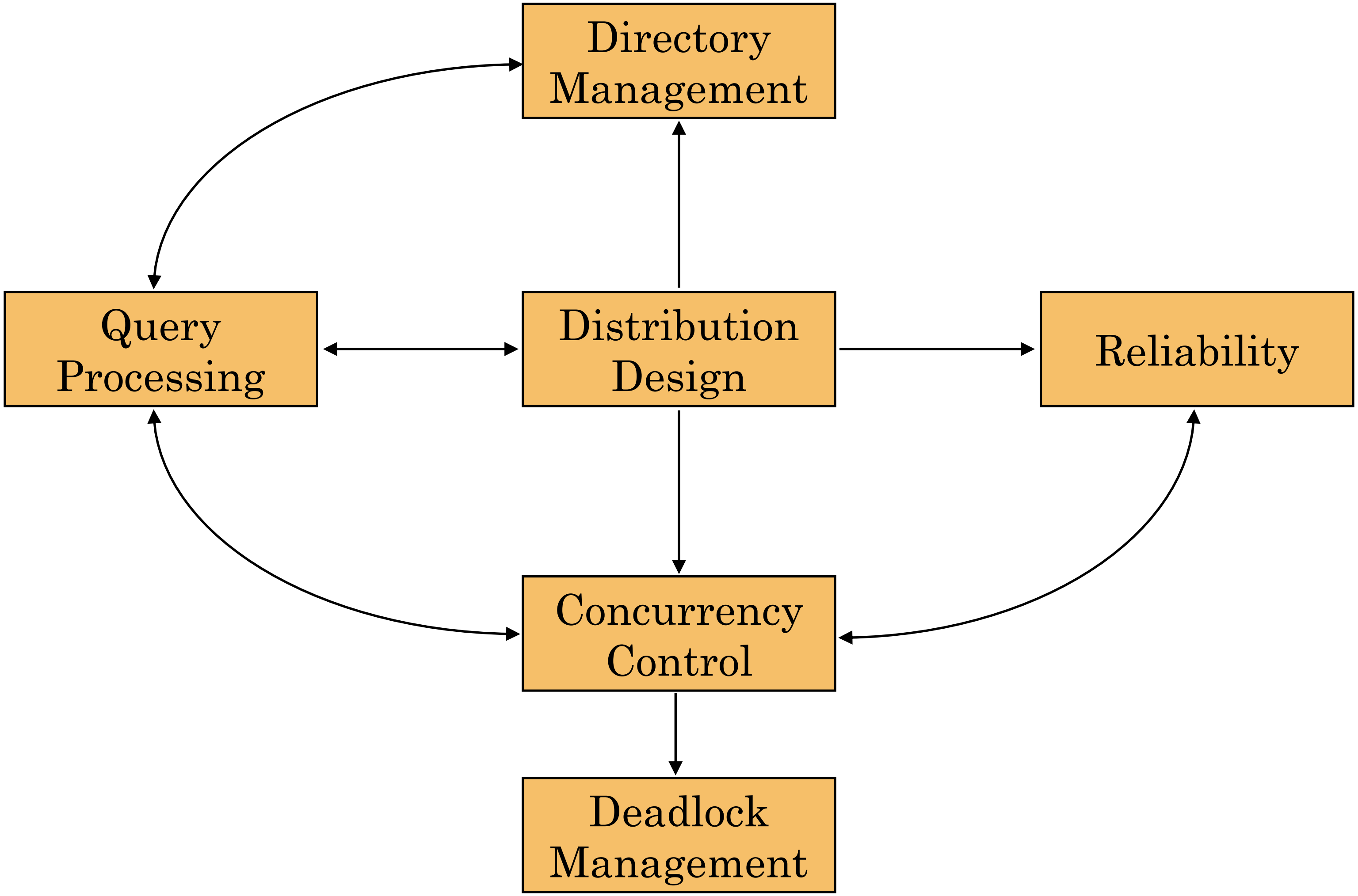
Distributed DBMS Issues

- **Concurrency Control**
  - Synchronization of concurrent accesses
  - Consistency and isolation of transactions' effects
  - Deadlock management
- **Reliability**
  - How to make the system resilient to failures
  - Atomicity and durability
- **Privacy/Security**
  - Keep database access private
  - Protect against malicious activities
- **Trusted Collaborations (Emerging requirements)**
  - Evaluate trust among users and database sites
  - Enforce policies for privacy
  - Enforce integrity

Relationship Between Issues



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Related Issues

- **Operating System Support**
  - operating system with proper support for database operations
  - dichotomy between general purpose processing requirements and database processing requirements
- **Open Systems and Interoperability**
  - Distributed Multidatabase Systems
  - More probable scenario
  - Parallel issues
- **Network Behavior**

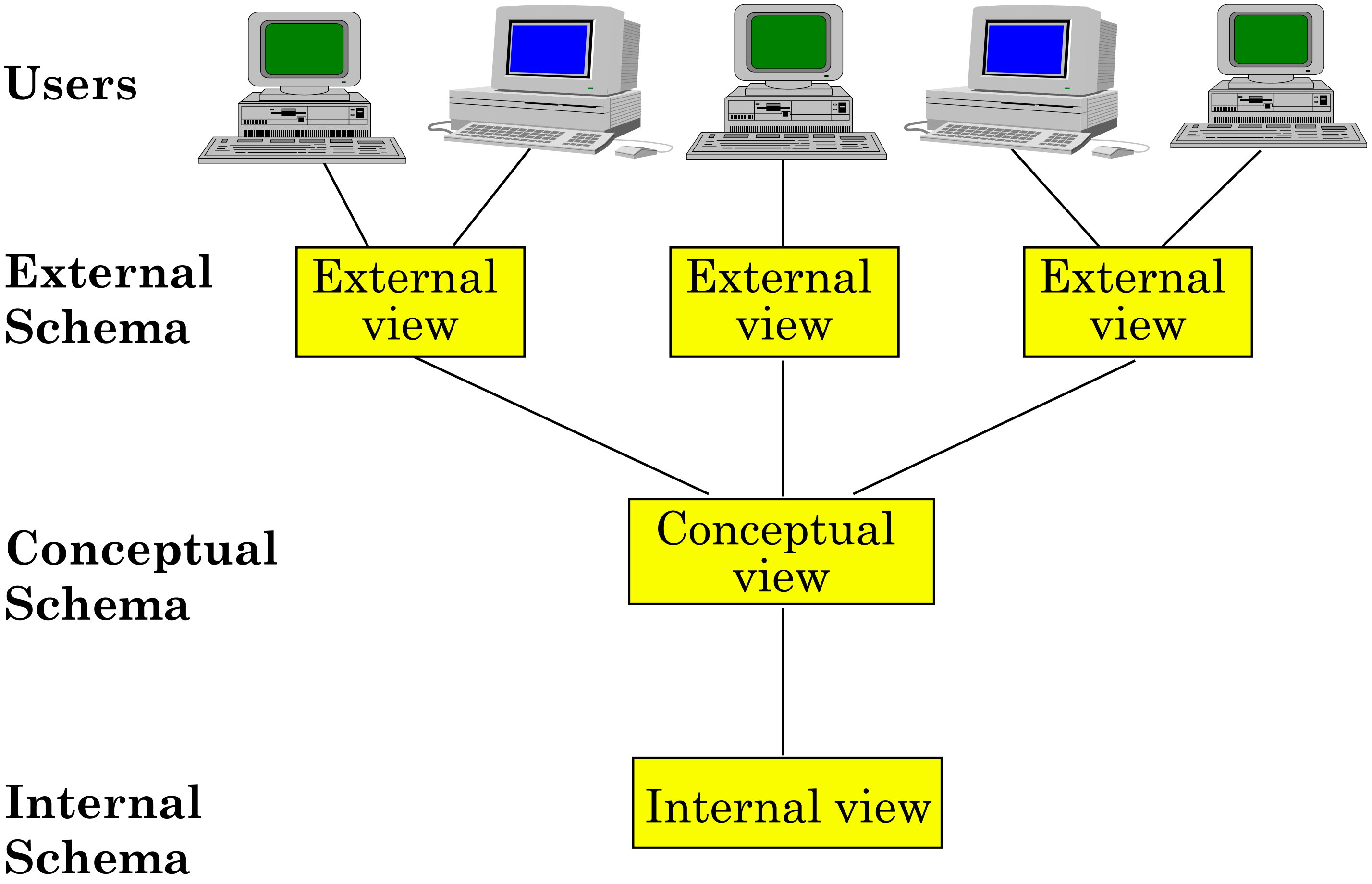
Outline

- Introduction
- Background
- Distributed DBMS Architecture
  - Introduction to Database Concepts
    - Architecture, Schema, Views
  - Alternatives in Distributed Database Systems
  - Datalogical Architecture
  - Implementation Alternatives
  - Component Architecture
- Distributed Database Design (Briefly)
- Distributed Query Processing (Briefly)
- Distributed Transaction Management (Extensive)
- Building Distributed Database Systems (RAID)
- Mobile Database Systems
- Privacy, Trust, and Authentication
- Peer to Peer Systems

Architecture of a Database System

- Background materials of database architecture
- Defines the structure of the system
  - components identified
  - functions of each component defined
  - interrelationships and interactions between components defined

ANSI/SPARC Architecture



Users

External Schema

External view

External view

External view

Conceptual Schema

Conceptual view

Internal Schema

Internal view

Standardization

Reference Model

- A conceptual framework whose purpose is to divide standardization work into manageable pieces and to show at a general level how these pieces are related to one another.

Approaches

- **Component-based**
  - Components of the system are defined together with the interrelationships between components.
  - Good for design and implementation of the system.
- **Function-based**
  - Classes of users are identified together with the functionality that the system will provide for each class.
  - The objectives of the system are clearly identified. But how do you achieve these objectives?
- **Data-based**
  - Identify the different types of describing data and specify the functional units that will realize and/or use data according to these views.

Conceptual Schema Definition

```
RELATION EMP [
        KEY = {ENO}
        ATTRIBUTES = {
                ENO        : CHARACTER(9)
                ENAME      : CHARACTER(15)
                TITLE      : CHARACTER(10)
        }
]
RELATION PAY [
        KEY = {TITLE}
        ATTRIBUTES = {
                TITLE      : CHARACTER(10)
                SAL        : NUMERIC(6)
        }
]
```

Conceptual Schema Definition

```
RELATION PROJ [
    KEY = {PNO}
    ATTRIBUTES = {
        PNO     : CHARACTER(7)
        PNAME   : CHARACTER(20)
        BUDGET  : NUMERIC(7)
    }
]
RELATION ASG [
    KEY = {ENO,PNO}
    ATTRIBUTES = {
        ENO     : CHARACTER(9)
        PNO     : CHARACTER(7)
        RESP    : CHARACTER(10)
        DUR     : NUMERIC(3)
    }
]
```

Internal Schema Definition

```
RELATION EMP [
        KEY = {ENO}
        ATTRIBUTES = {
                ENO       :  CHARACTER(9)
                ENAME     :  CHARACTER(15)
                TITLE     :  CHARACTER(10)
        }
]
                              ⇓
INTERNAL_REL EMPL [
        INDEX ON E# CALL EMINX
        FIELD = {
                HEADER   : BYTE(1)
                E#       : BYTE(9)
                ENAME    : BYTE(15)
                TIT      : BYTE(10)
        }
]
```

External View Definition – Example 1

Create a BUDGET view from the PROJ relation

```
CREATE   VIEW     BUDGET(PNAME, BUD)
 AS      SELECT   PNAME, BUDGET
         FROM     PROJ
```

External View Definition – Example 2

Create a Payroll view from relations EMP and TITLE_SALARY

```
CREATE    VIEW      PAYROLL (ENO, ENAME, SAL)
AS        SELECT    EMP.ENO,EMP.ENAME,PAY.SAL
          FROM      EMP, PAY
          WHERE     EMP.TITLE = PAY.TITLE
```