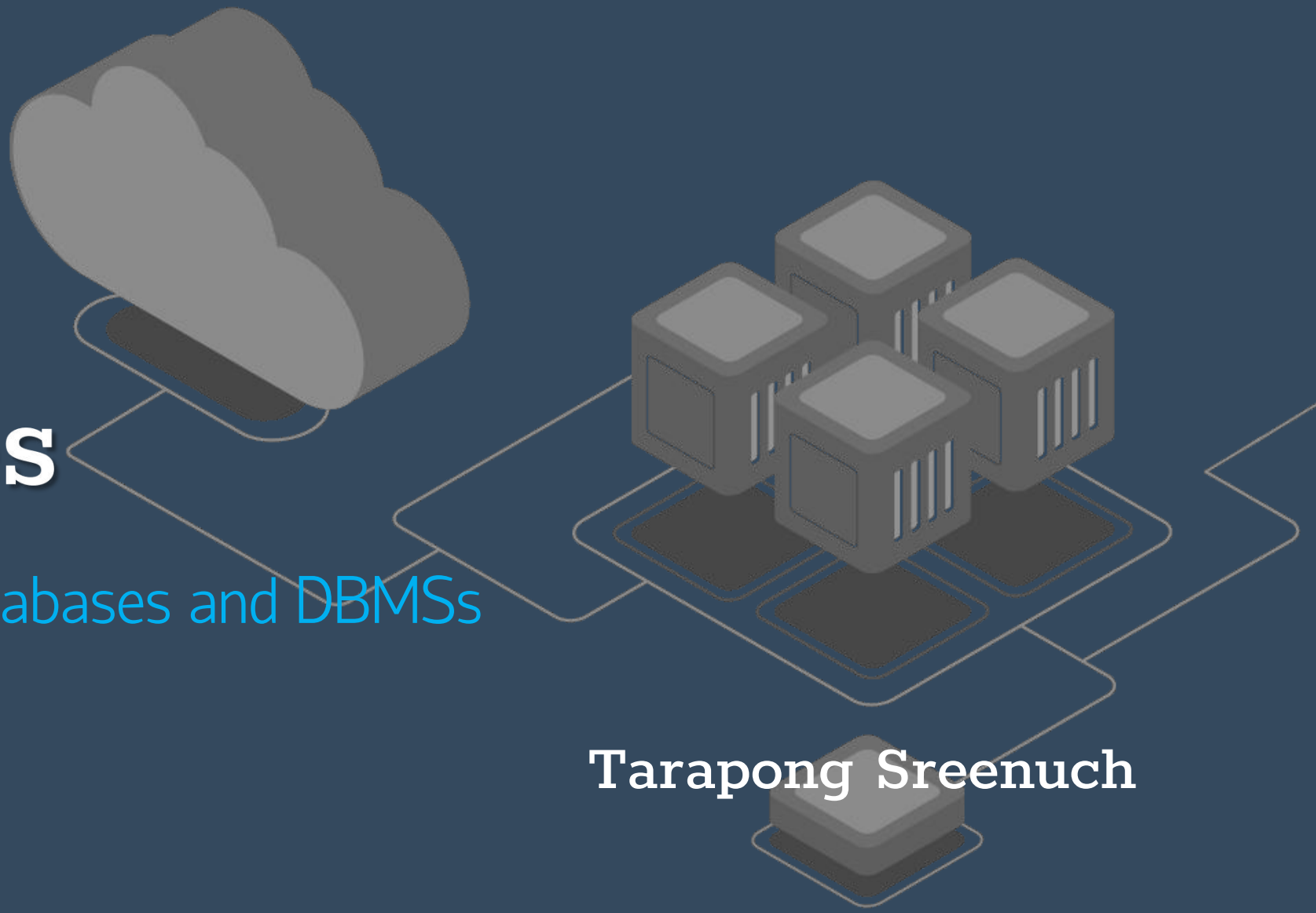
Databases

1 Introduction to Databases and DBMSs



Tarapong Sreenuch

Lecture Outline

Database Characteristics

Organisational Roles

DBMS Overview

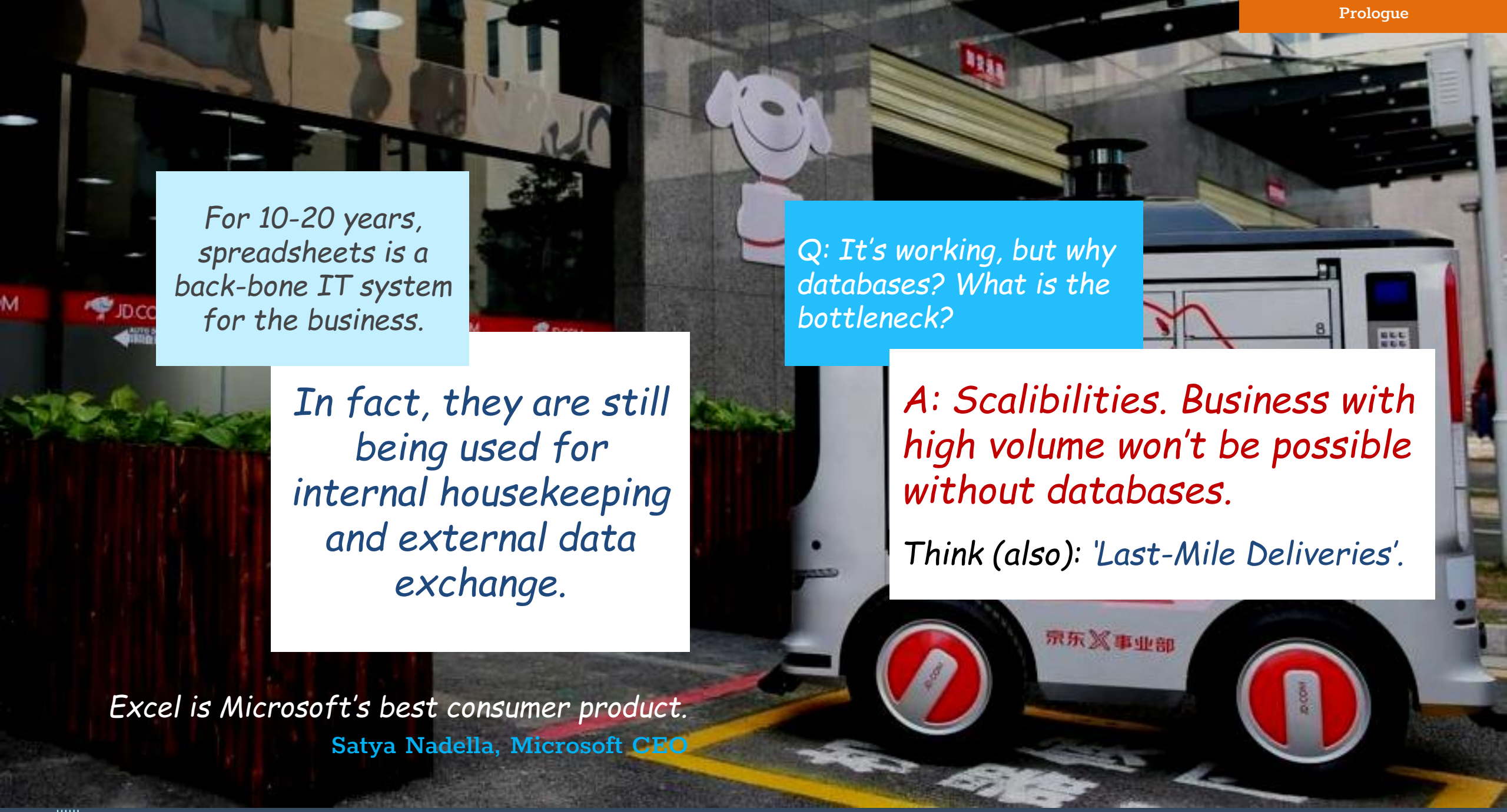
Non-Procedural Access

Transaction Processing

Data Warehouse Overview

DBMS Technology Evolution

Wrapping Up



For 10-20 years, spreadsheets is a back-bone IT system for the business.

In fact, they are still being used for internal housekeeping and external data exchange.

Q: It's working, but why databases? What is the bottleneck?

A: Scalibilities. Business with high volume won't be possible without databases.

Think (also): 'Last-Mile Deliveries'.

Excel is Microsoft's best consumer product.

Satya Nadella, Microsoft CEO

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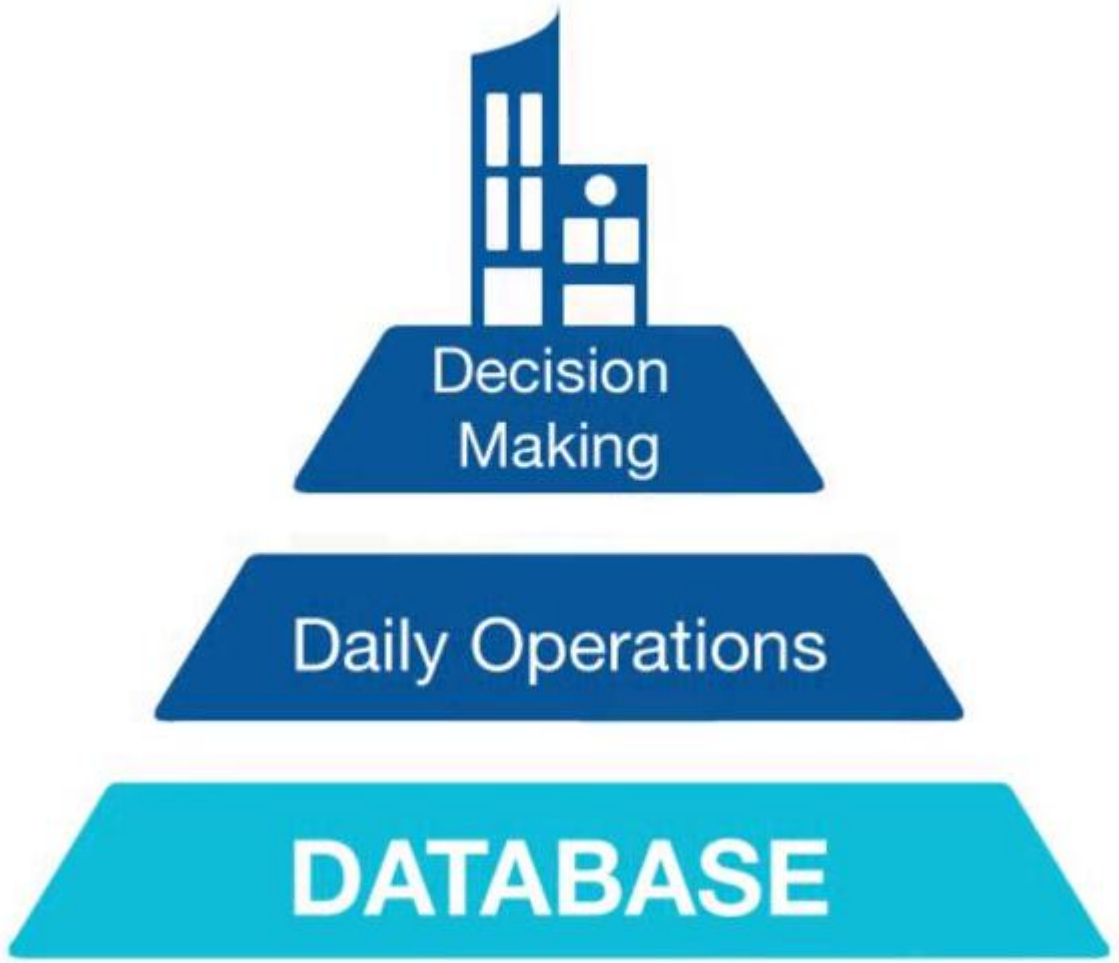
Learning Objectives

Define basic terminology and database characteristics

Provide an example of a databases

Database in Organisation



Daily Operation Tasks

Decision Making Tasks

Database Management Systems

major part of software industry

revolutionary evolvement over 40 years

foundation for management of long-term memory of organisations

Data

Data Sources

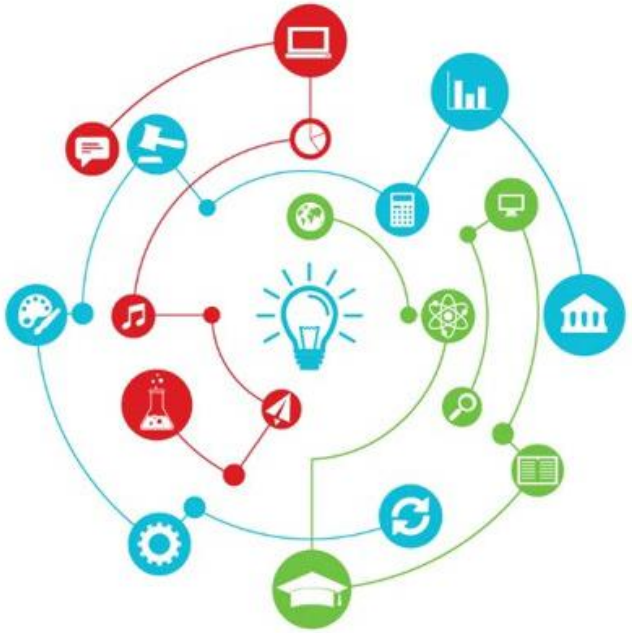
Conventional Facts

Unconventional Facts

Transformed Facts

Database Characteristics

Persistency

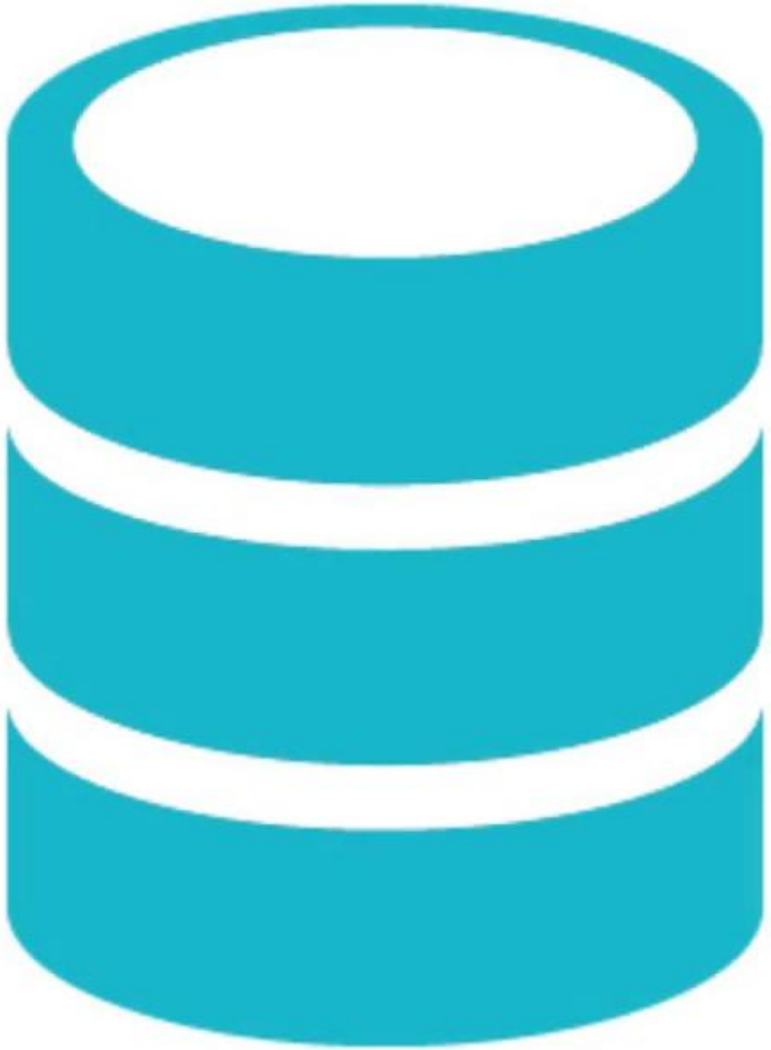


Inter-Related

Shared

Database Applications

University Database



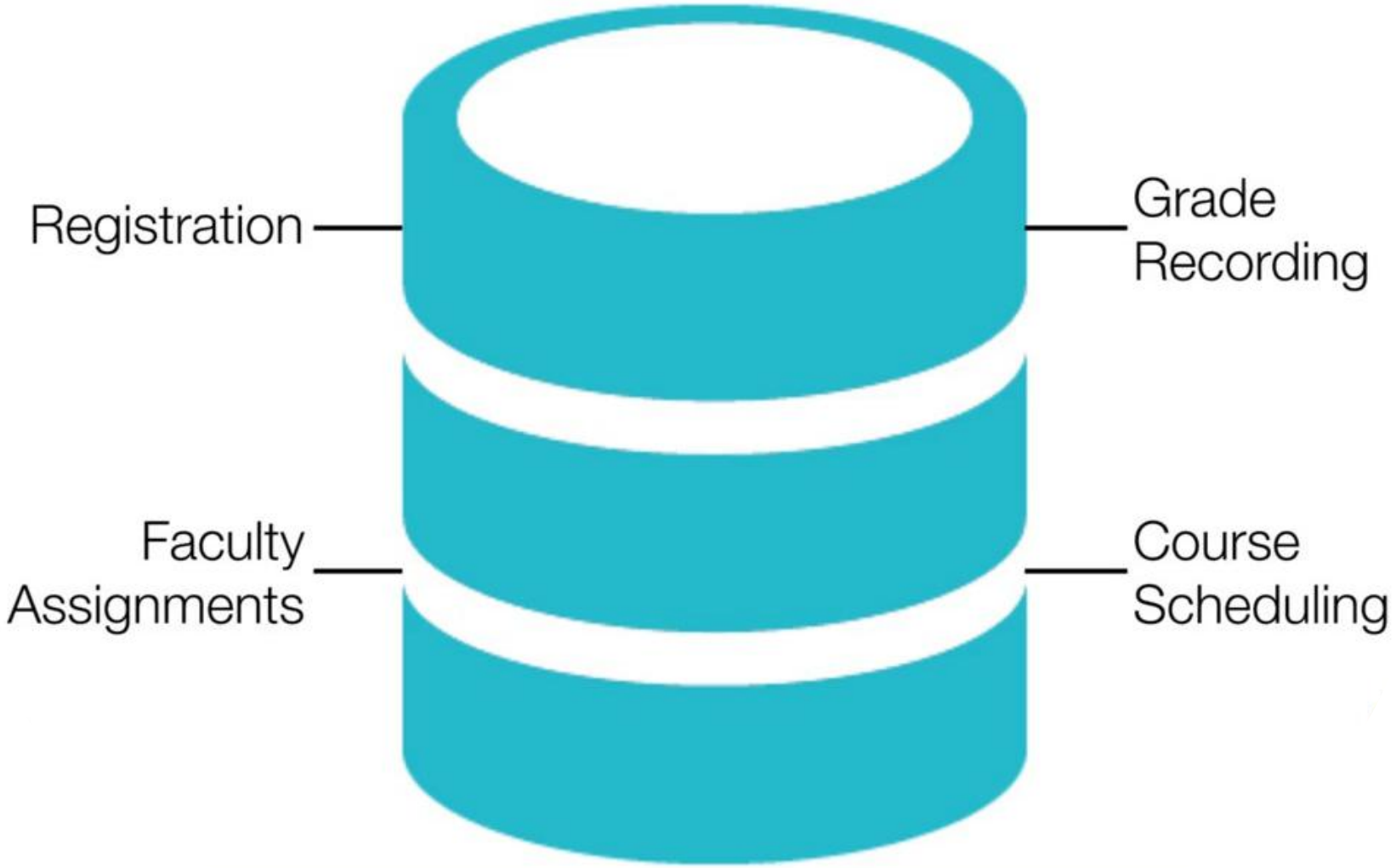
Entities:

- Students
- Faculty
- Courses
- Course offerings
- Enrollments

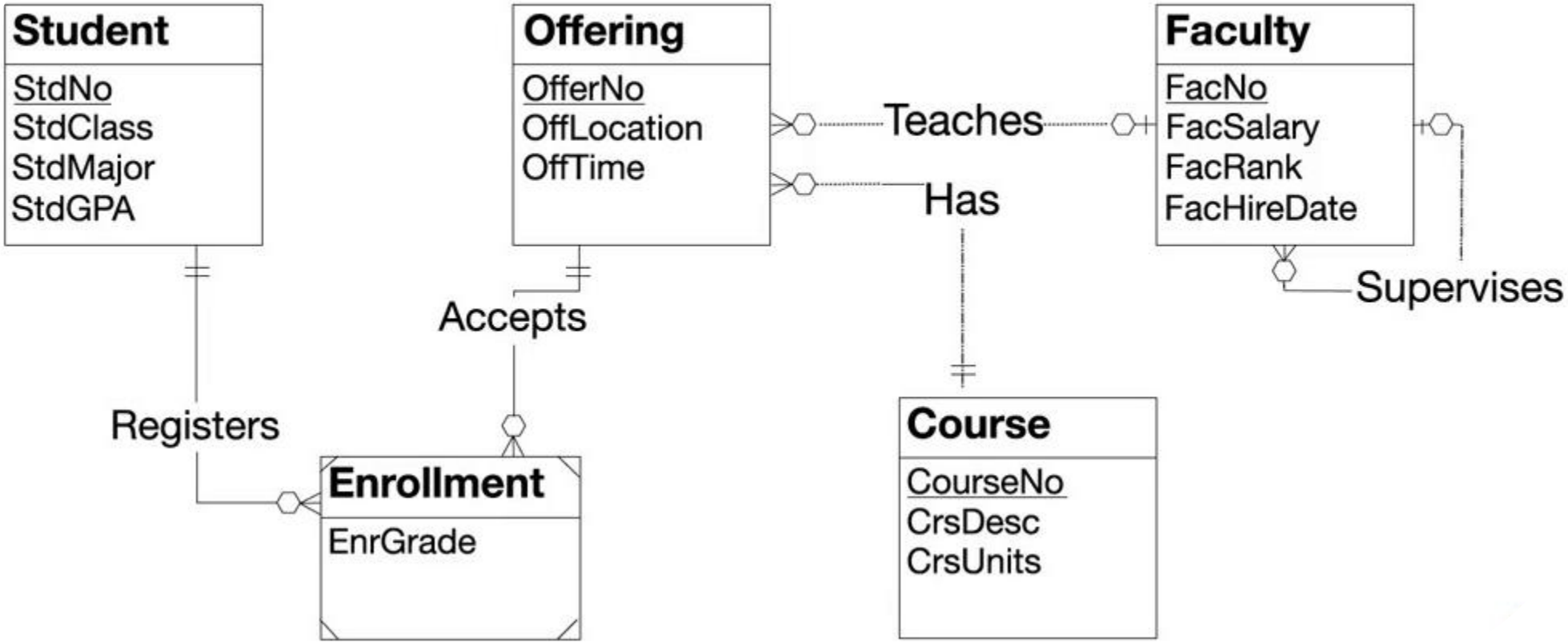
Relationships:

- Faculty Course Assignments
- Students Enrollment
- Course Scheduling

Operational Support



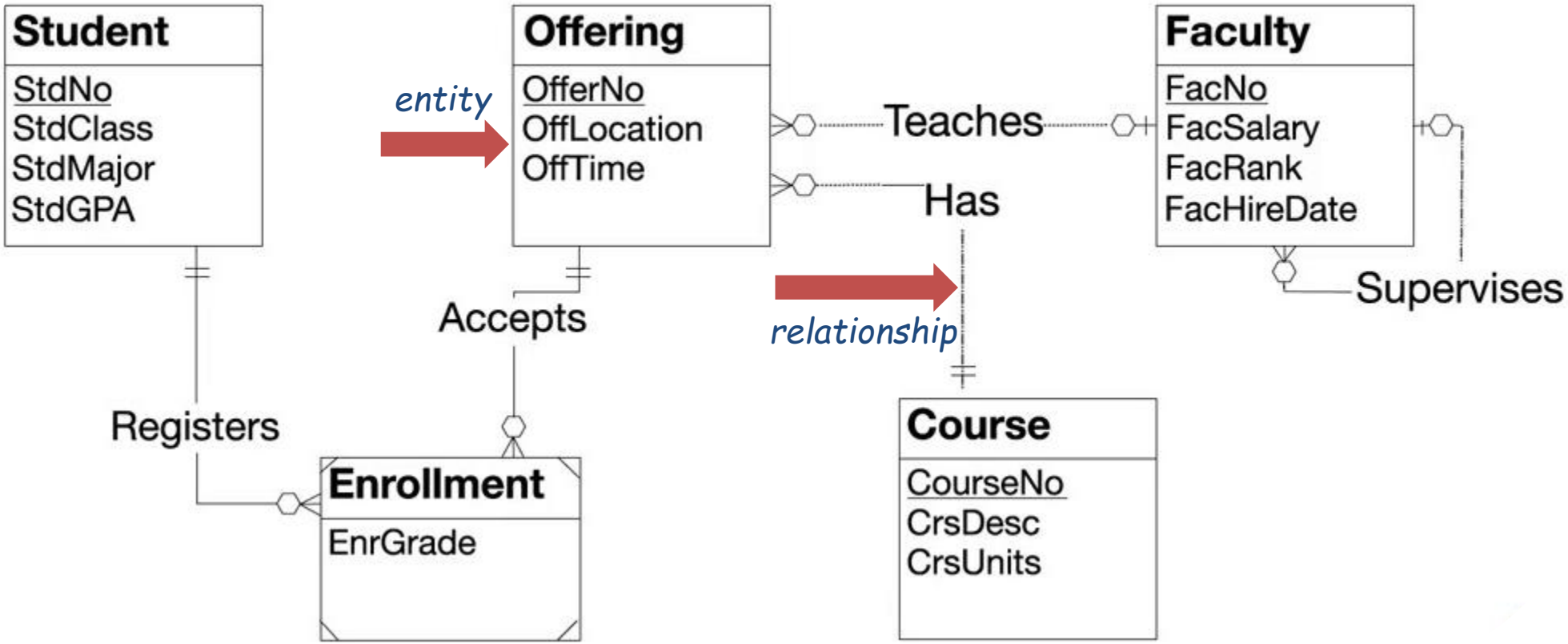
Entities and Relationships



Entity-Relationship Diagram

An entity-relationship diagram (ERD) is a type of data modeling that shows a graphical representation of objects or concepts within an information system or organization and their relationship to one another.

Entity-Relationship Diagram



Summary

Databases and database technology vital to modern organisations.

Database technology support daily operations and decision making.

Understanding existing databases is crutial to query formulation.

Emphasis structured data

Essential characteristics of shared, inter-related, and persistent

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Learning Objectives

Discuss organisational roles in functional areas and information technology departments

Specialise or Divert

People or Technical

Context Setting: Electricity Supplier

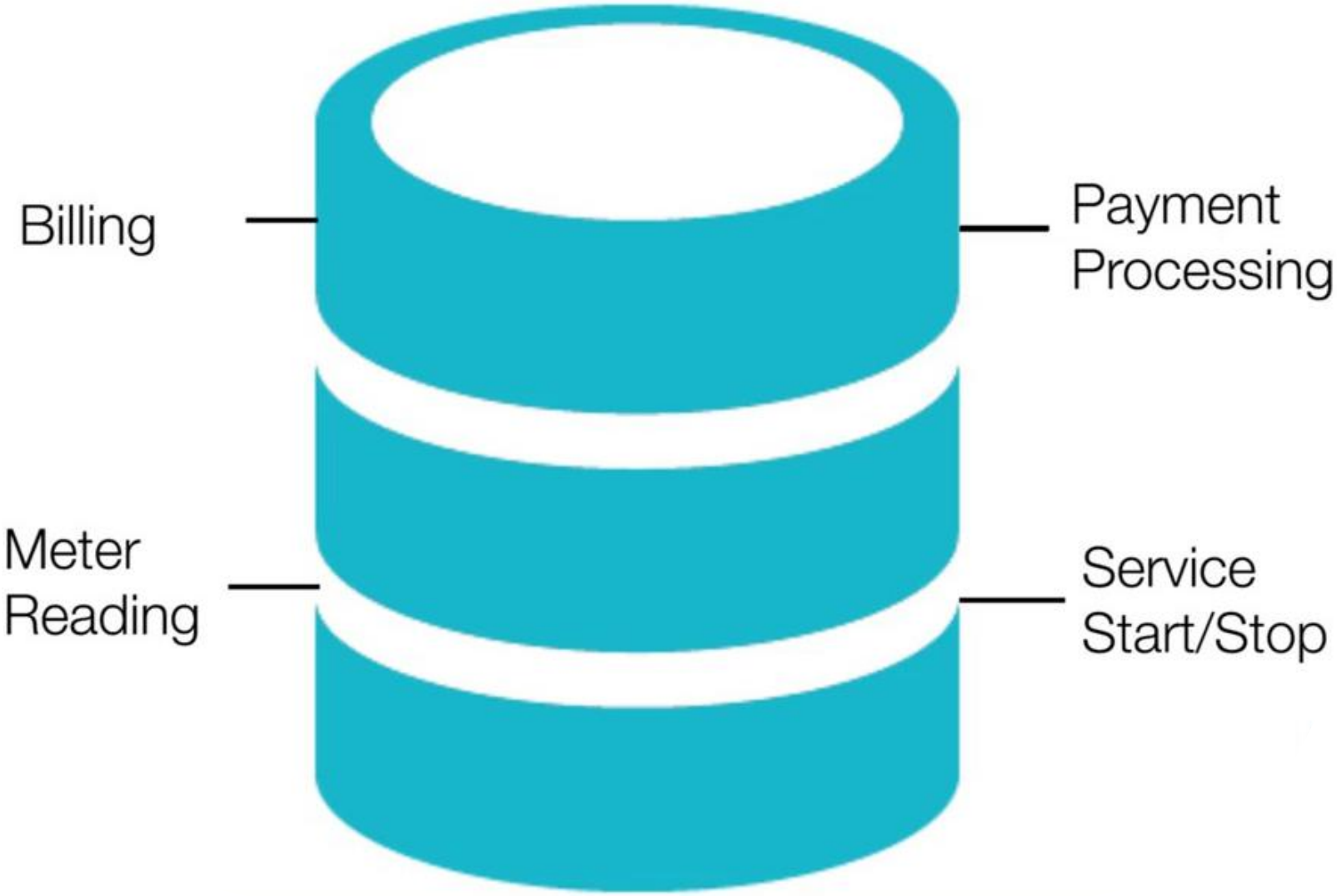
Entities:

- Customers
- Meters
- Bills
- Payments
- Meter Readings

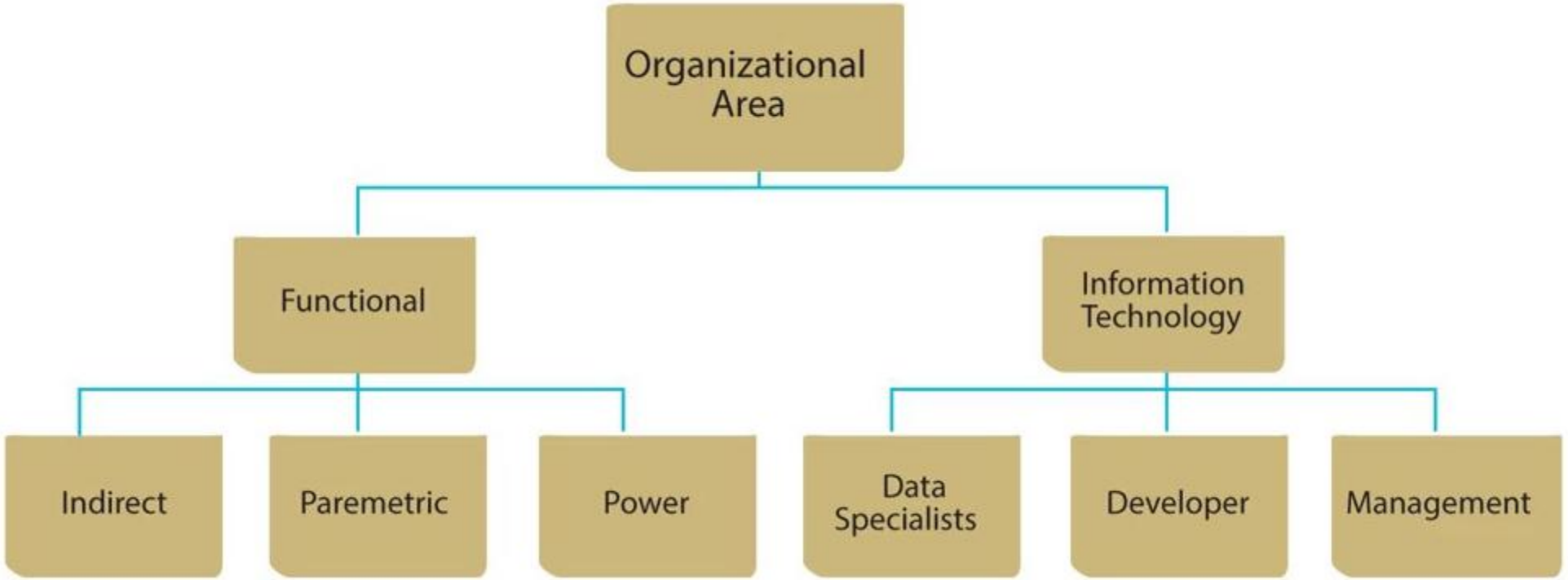
Relationships:

- Customers Make Payments
- Employees Read Meters
- Bills Sent to Customers

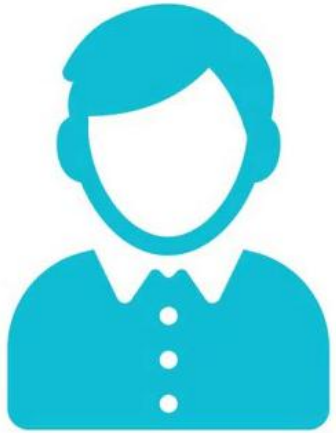
Business Functions



Database Users

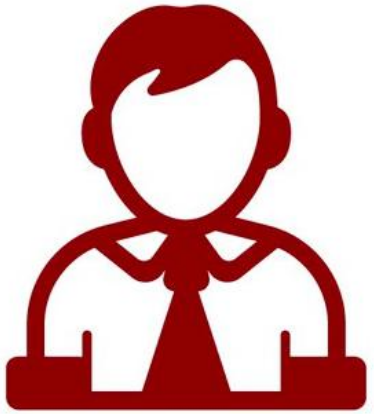


Functional Roles



Indirect User

Parametric User



Power User

IT Roles

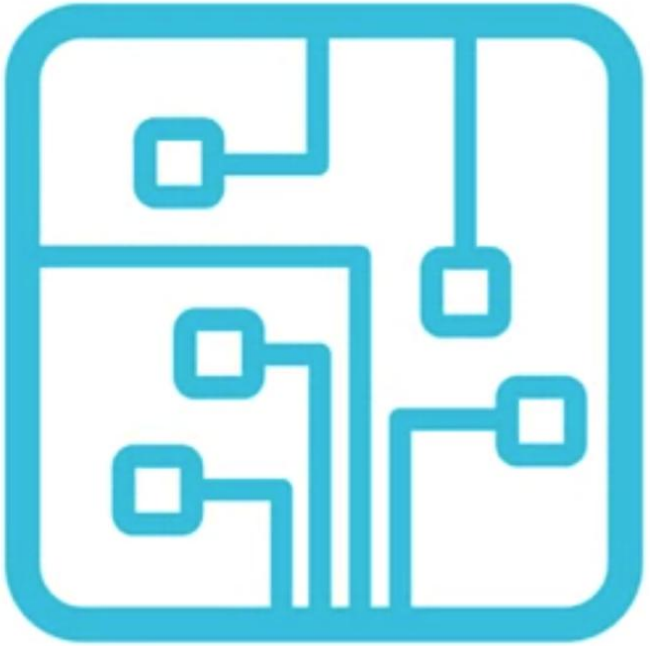
Developer

Database Administrator

Data Administrator

Interacting with Database

Accounting



Information Technology

Summary

Do you want to work in a large organisation whith more role specialisation or a samller organisation with more role diversity?

Do you want to be focused on people skills and interaction, technical skills and tasks, or mix of people and technical skills and taks?

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Learning Objectives

Define DBMS

Explain DBMS product variations

Discuss the essential difference between DBMS and desktop software

DBMS

A collection of components that supports the creation, use and maintenance of databases.

DBMS Features

Data Acquisition

Storang

Dissemination

Maintenance

Retrieval

Formatting

Enterprise DBMS

IBM MySQL Microsoft SAP TERADATA ORACLE

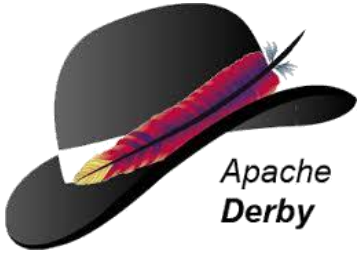
Organisations with very large databases
Thousands of simultaneous users
Strong reliability & performance

Desktop DBMS

KEXI

Small workgroups with smaller databases
Tens of simultaneous users
Modest reliability & performance

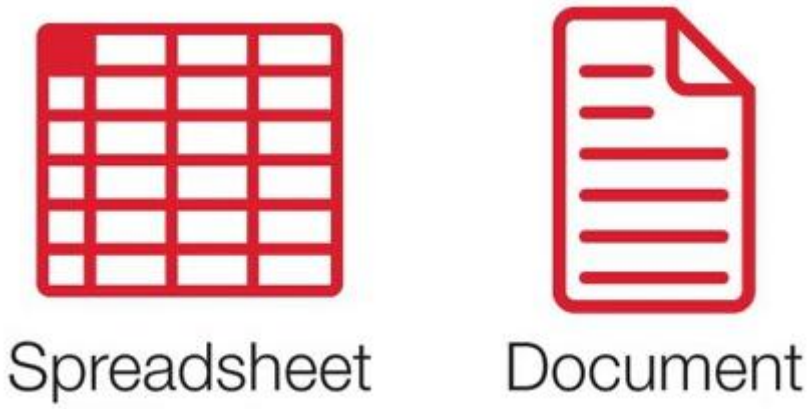
Embedded DBMS



Sold by value-added software resellers
Hidden from users
Require little to no ongoing maintenance

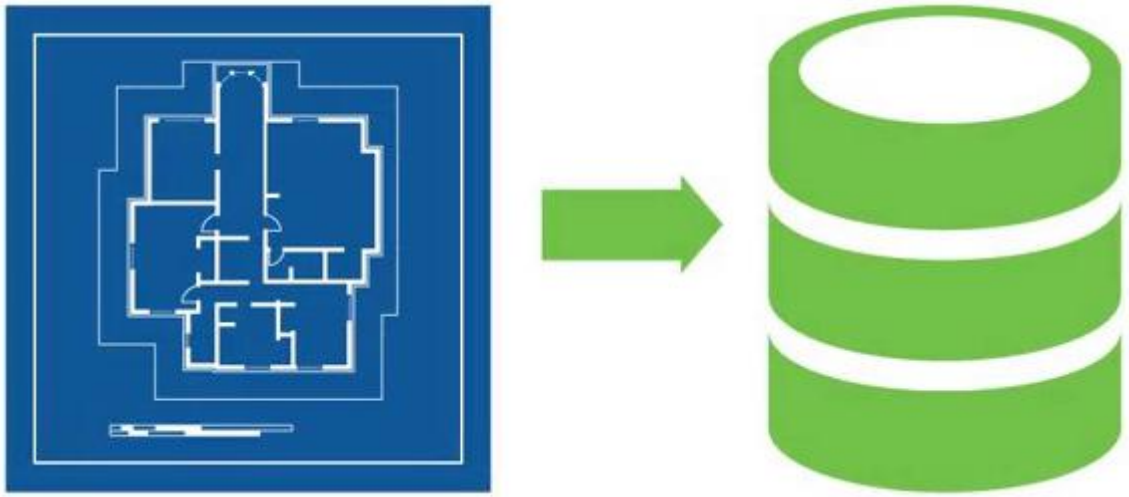
Database Definition

There is little or no planning is required for Spreadsheets and Documents.

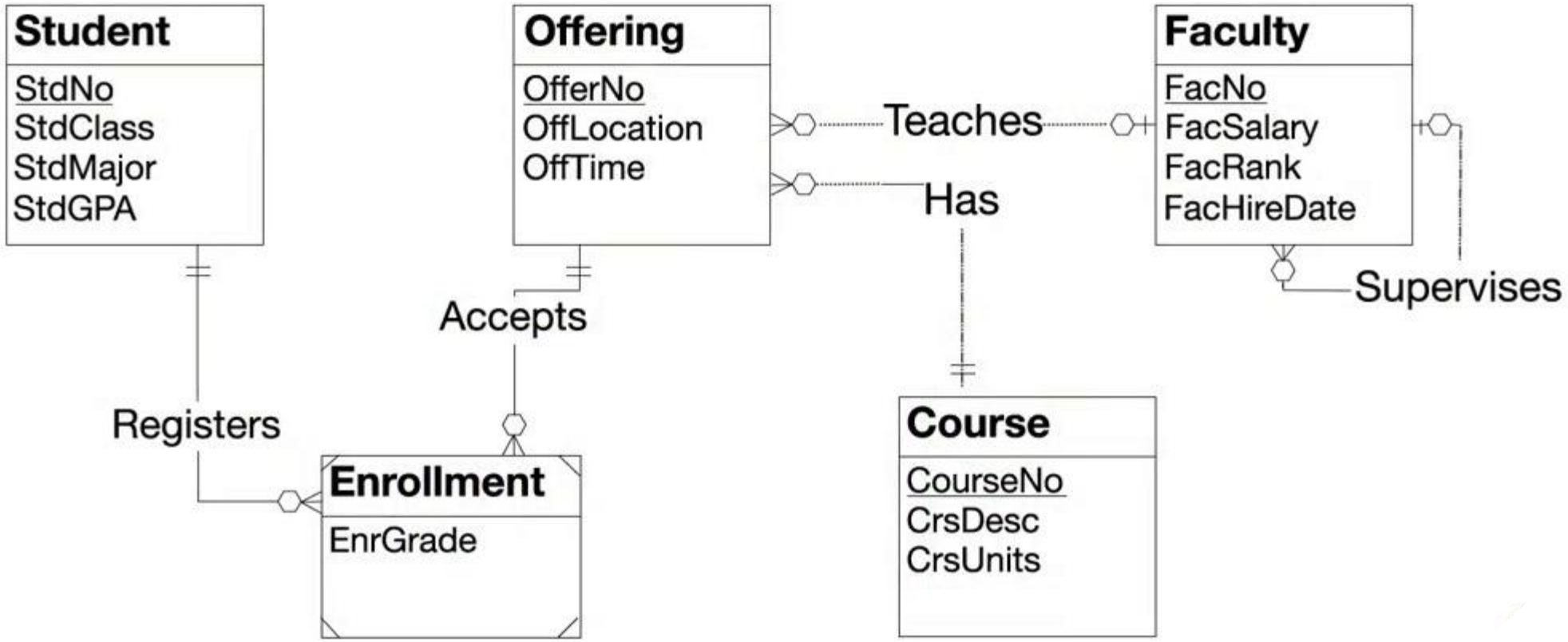


Planning for Databases

Planning is essential for databases, even for small workgroup databases.



Entities and Relationships



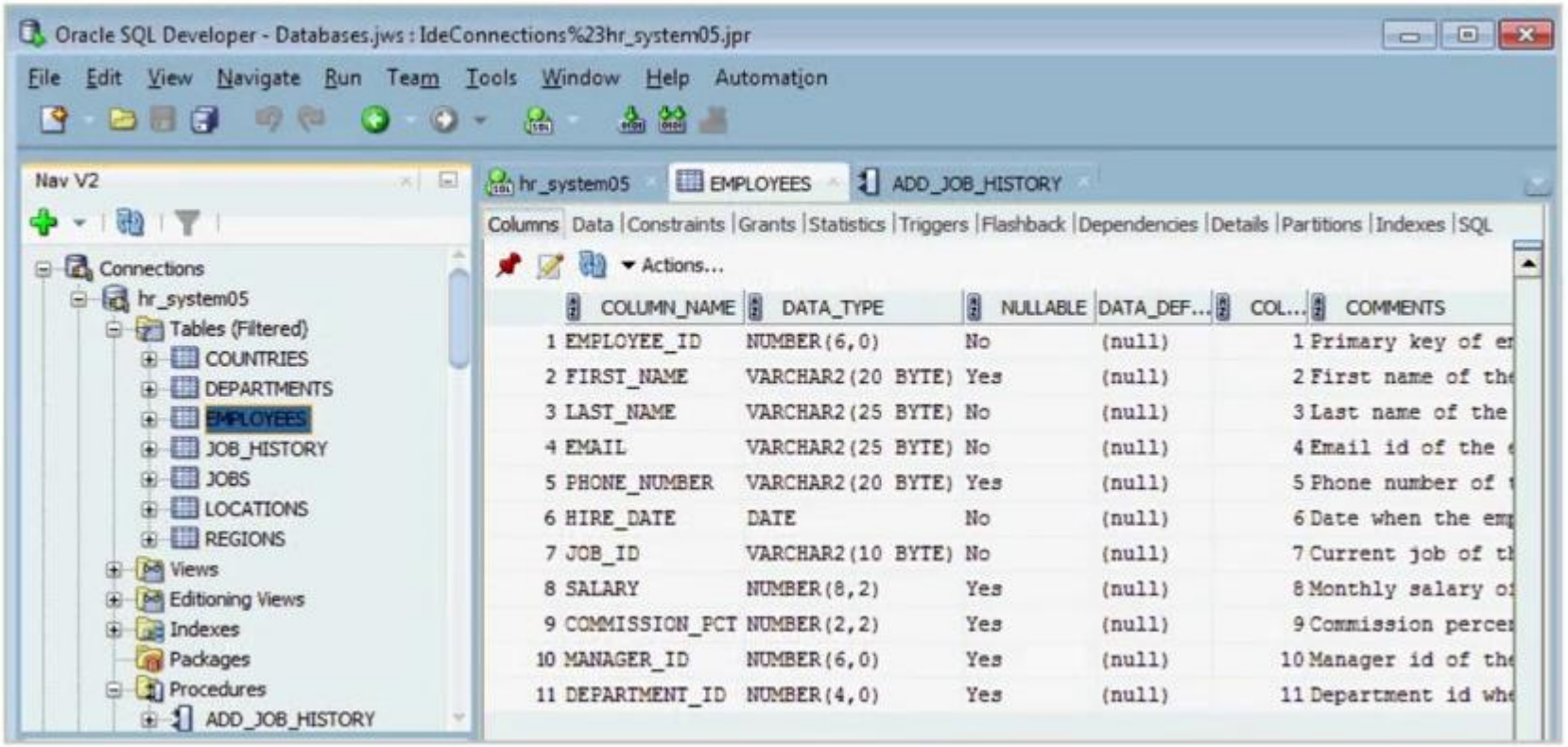
Structured Query Language

SQL is used to communicate with a database.
It is the standard language for relational database management systems.

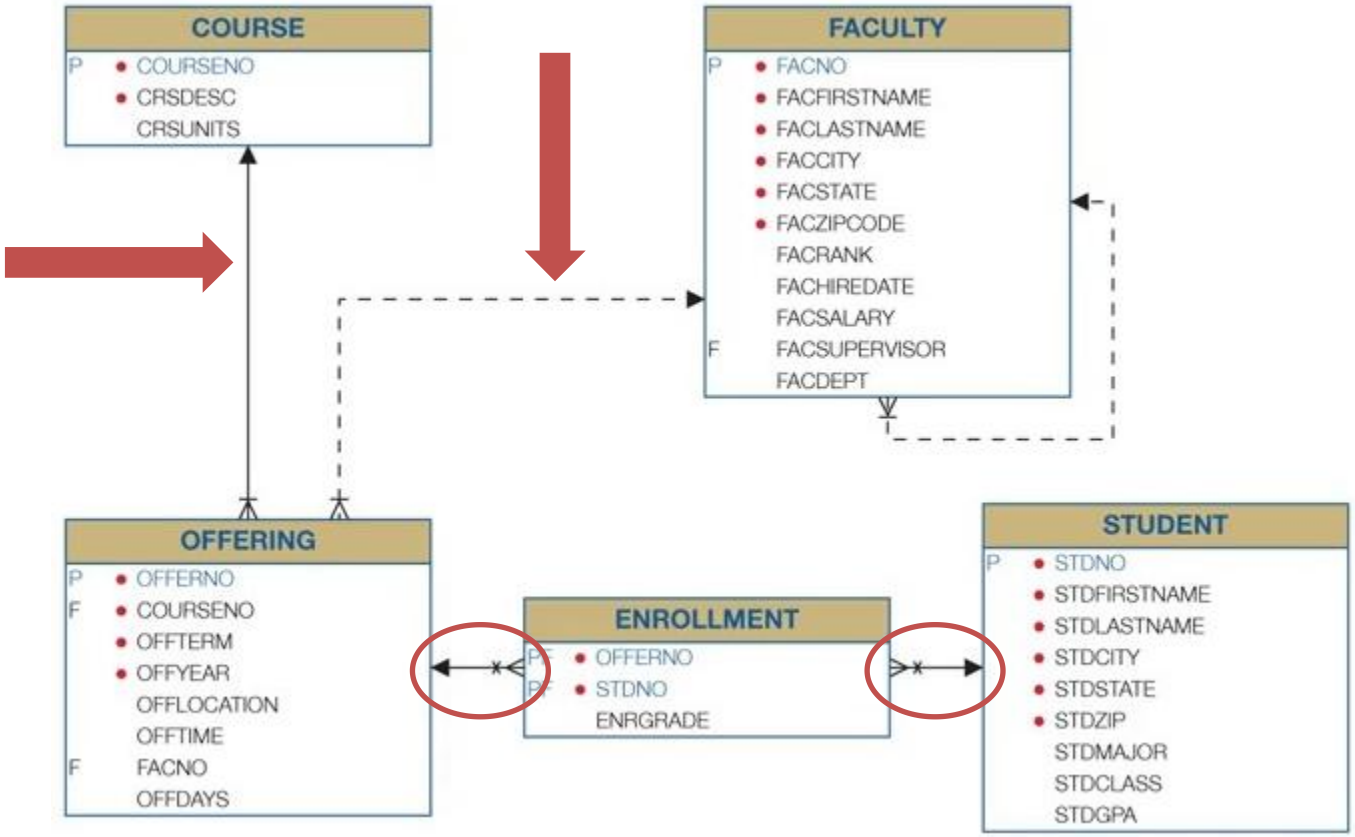
Example:

```
CREATE TABLE table_name
(
column_name1 data_type(size),
column_name2 data_type(size),
column_name3 data_type(size),
....
);
```

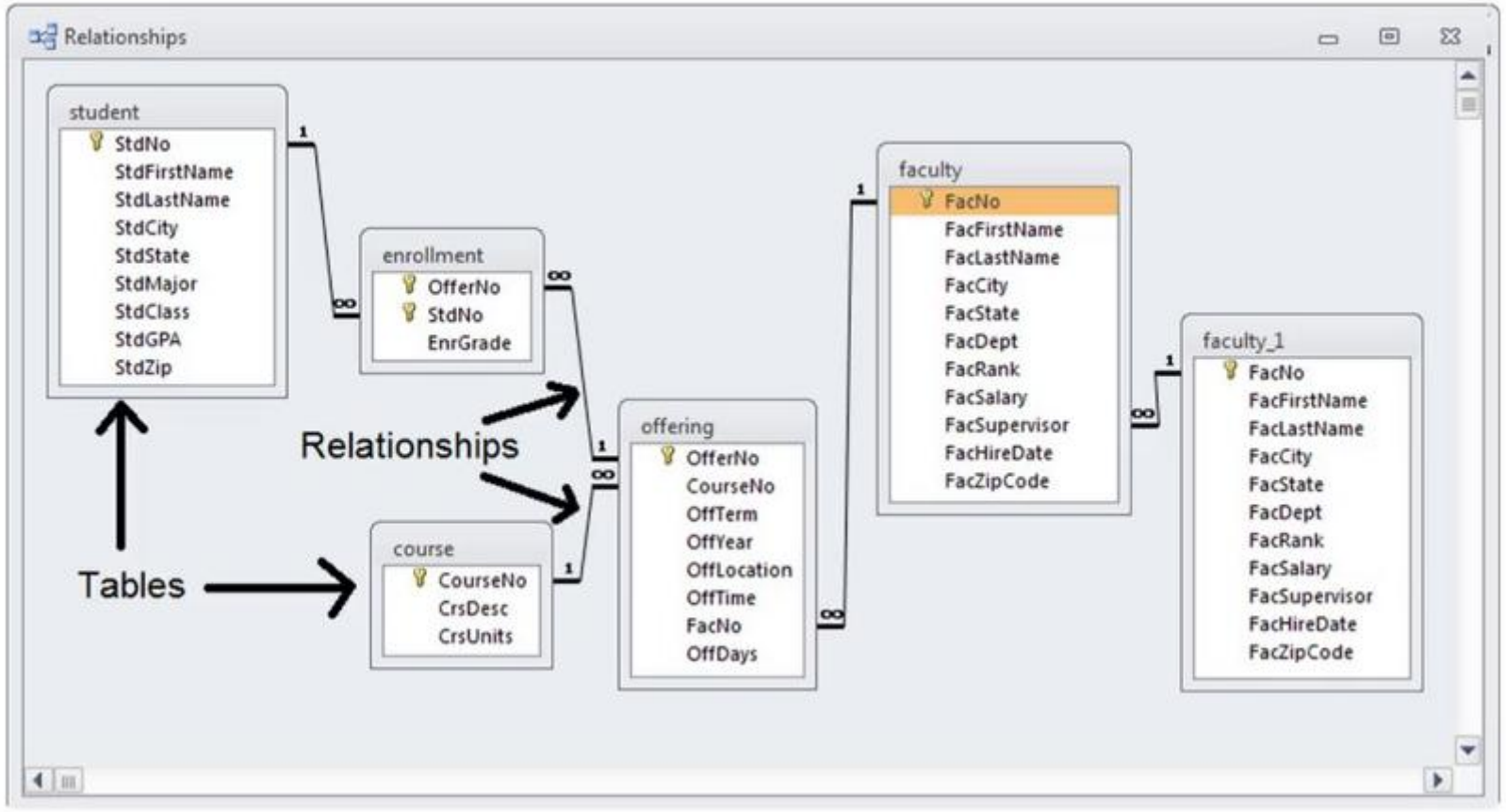
DBMS Tools


Oracle SQL Developer - Databases.jws : IdeConnections%23hr_system05.jpr
File Edit View Navigate Run Team Tools Window Help Automation
Nav V2
Connections
hr_system05
Tables (Filtered)
COUNTRIES
DEPARTMENTS
EMPLOYEES
JOB_HISTORY
JOBS
LOCATIONS
REGIONS
Views
Editioning Views
Indexes
Packages
Procedures
ADD_JOB_HISTORY
hr_system05
EMPLOYEES
ADD_JOB_HISTORY
Columns Data Constraints Grants Statistics Triggers Flashback Dependencies Details Partitions Indexes SQL
Actions...
COLUMN_NAME DATA_TYPE NULLABLE DATA_DEF... COL... COMMENTS
1 EMPLOYEE_ID NUMBER(6,0) No (null) 1 Primary key of
2 FIRST_NAME VARCHAR2(20 BYTE) Yes (null) 2 First name of
3 LAST_NAME VARCHAR2(25 BYTE) No (null) 3 Last name of the
4 EMAIL VARCHAR2(25 BYTE) No (null) 4 Email id of the
5 PHONE_NUMBER VARCHAR2(20 BYTE) Yes (null) 5 Phone number of
6 HIRE_DATE DATE No (null) 6 Date when the
7 JOB_ID VARCHAR2(10 BYTE) No (null) 7 Current job of
8 SALARY NUMBER(8,2) Yes (null) 8 Monthly salary
9 COMMISSION_PCT NUMBER(2,2) Yes (null) 9 Commission
10 MANAGER_ID NUMBER(6,0) Yes (null) 10 Manager id of
11 DEPARTMENT_ID NUMBER(4,0) Yes (null) 11 Department id

Oracle Relational Diagram



MS Access Diagram



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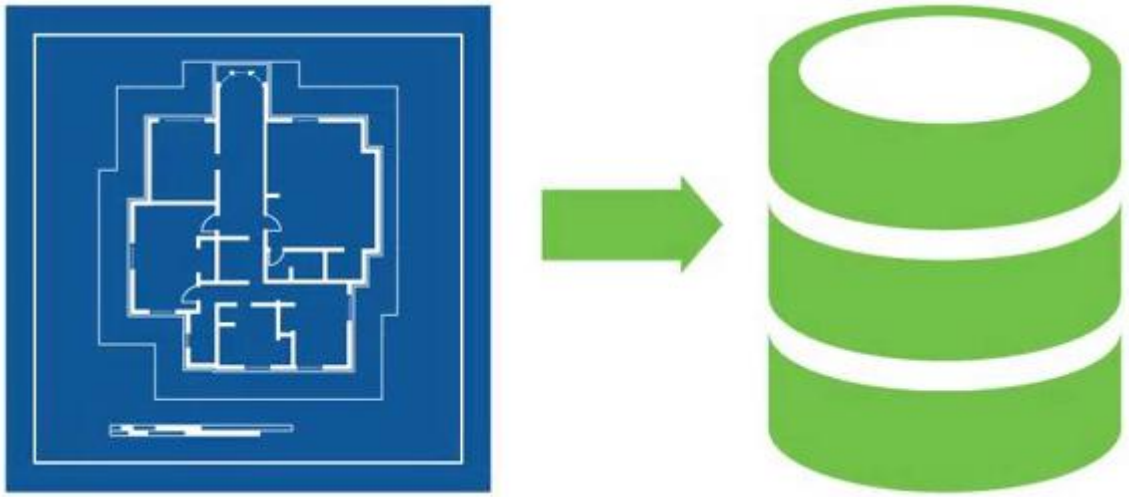

DBMS

A collection of componenets that supports the creation, use and maintenance of databases.

Non-Procedural Access

Set-Oriented

Only need to specify what data to retrieve rather than how to retrieve it.

Database Characteristics

Organisational Roles

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Non-Prodecural Access

Transaction Processing

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DBMS Technology Evolution

Wrapping Up

Learning Objectives

Discuss the important of non-procedural access

Explain the link between the five types of application development tools and non-prodecural access

Query

A database query can be either a simple data retrieval query or an action query that performs additional operations on the data, such as insertion, updating or deletion.

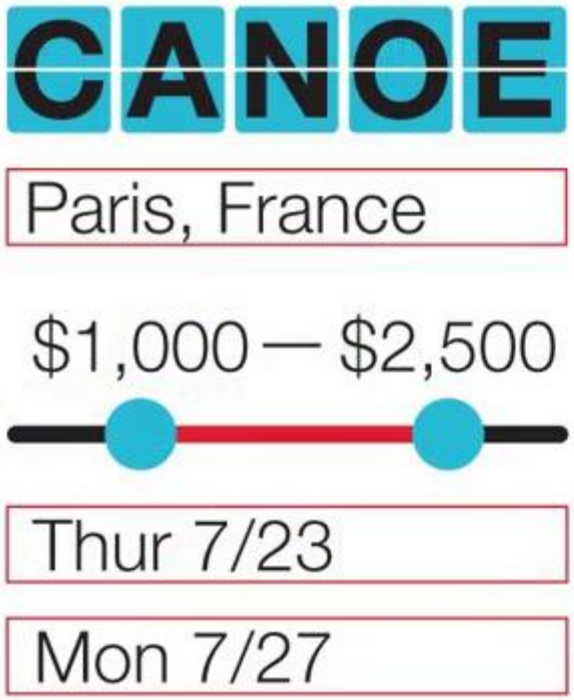
Planning a Vacation

The 'What' of the Trip

Planning a Vacation

The 'How' of the Trip

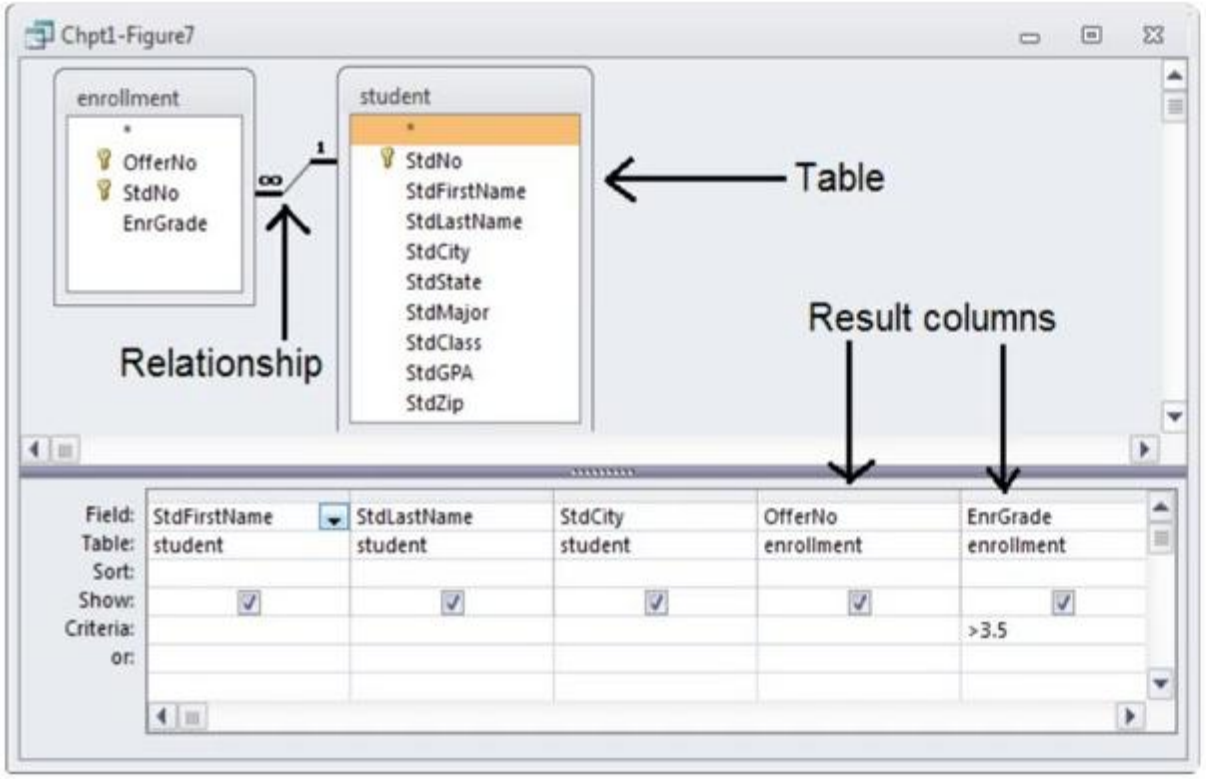
Planning a Vacation



Sample SELECT Statement

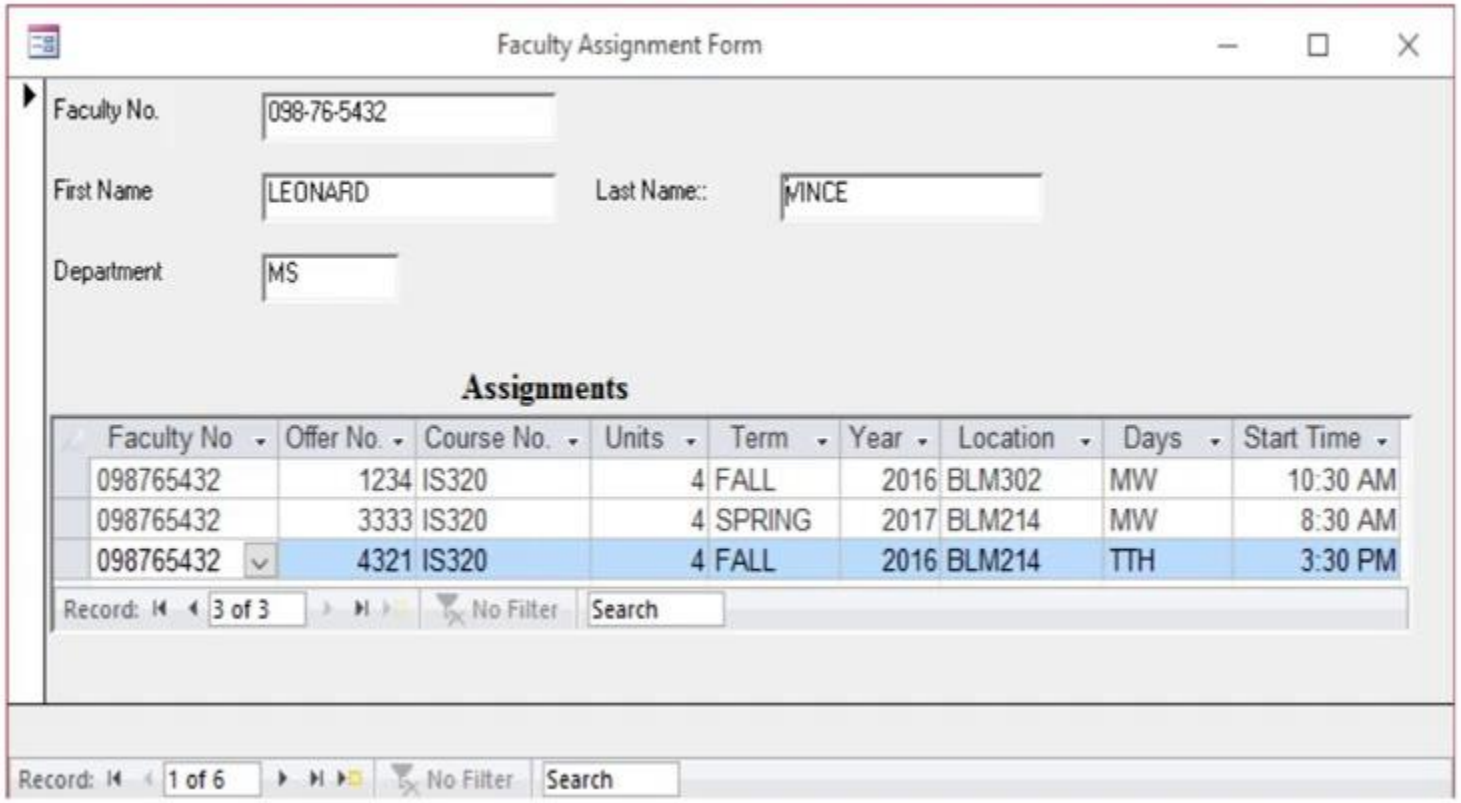
```
SELECT OfferNo, CourseNo, FacFirstName, FacLastName
 FROM Offering INNER JOIN Faculty
     ON Faculty.FacNo = Offering.FacNo
WHERE OffTerm = 'FALL' AND OffYear = 2016
    AND FacRank = 'ASST' AND CourseNo LIKE 'IS%';
```

DBMS Graphical Tools



StdFirstName	StdLastName	StdCity	OfferNo	EnrGrade
MARIAH	DODGE	SEATTLE	1234	3.3
BOB	NORBERT	BOTHELL	5679	3.7
ROBERTO	MORALES	SEATTLE	5679	3.8
MARIAH	DODGE	SEATTLE	6666	3.6
LUKE	BRAZZI	SEATTLE	7777	3.7
WILLIAM	PILGRIM	BOTHELL	9876	4

Form


Faculty Assignment Form
Faculty No. 098-76-5432
First Name LEONARD
Last Name:: VINCE
Department MS
Assignments
Faculty No | Offer No. | Course No. | Units | Term | Year | Location | Days | Start Time
098765432 | 1234 | IS320 | 4 | FALL | 2016 | BLM302 | MW | 10:30 AM
098765432 | 3333 | IS320 | 4 | SPRING | 2017 | BLM214 | MW | 8:30 AM
098765432 | 4321 | IS320 | 4 | FALL | 2016 | BLM214 | TTH | 3:30 PM
Record: 3 of 3 No Filter Search
Record: 1 of 6 No Filter Search

Report

Faculty Work Load Report for the 2016-2017 Academic Year

Department	Name	Term	Offer Number	Units	Limit	Enrollment	Percent Full	Low Enrollment
FIN								
	JULIA MILLS							
		WINTER	5678	4	20	1	5.00%	☑
		Summary for 'term' = WINTER (1 detail record)						
		Sum		4		1		
		Avg					5.00%	
	Summary for JULIA MILLS							
	Sum			4		1		
	Avg						5.00%	
Summary for 'department' = FIN (1 detail record)								
Sum				4		1		
Avg							5.00%	

Procedural Language Interface

Batch processing

Customisation and automation

Performance improvement

Summary

Database technology vital to modern organisations

Crucial DBMS feature: nonprocedural access

Query language, visual tool, form tool, report tool, and embedding

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Lesson Objectives

Provide an example of a transaction that you use

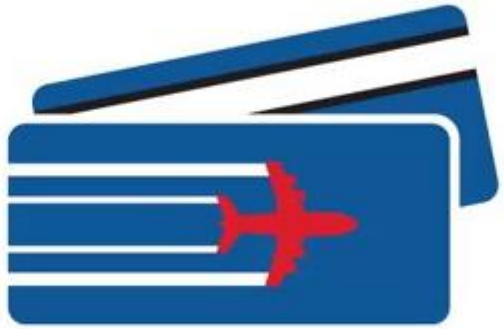
Briefly explain key characteristics of database transactions

Explain the word 'transparency' for transaction processing services

Product Management

Transaction Management

Transaction Management

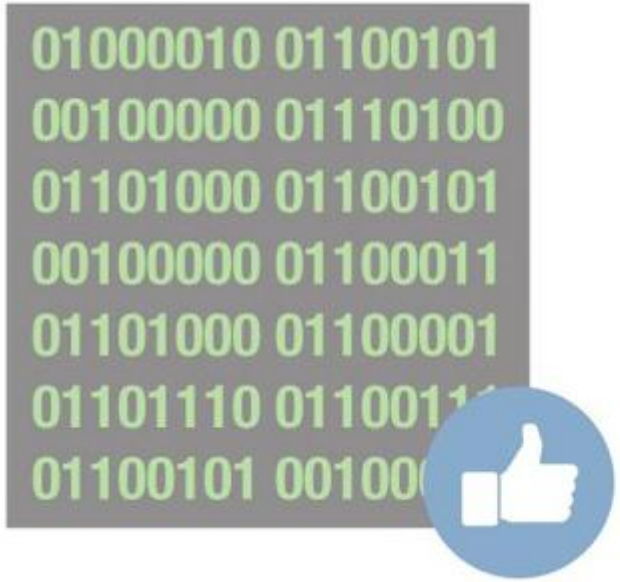


Buying a Car

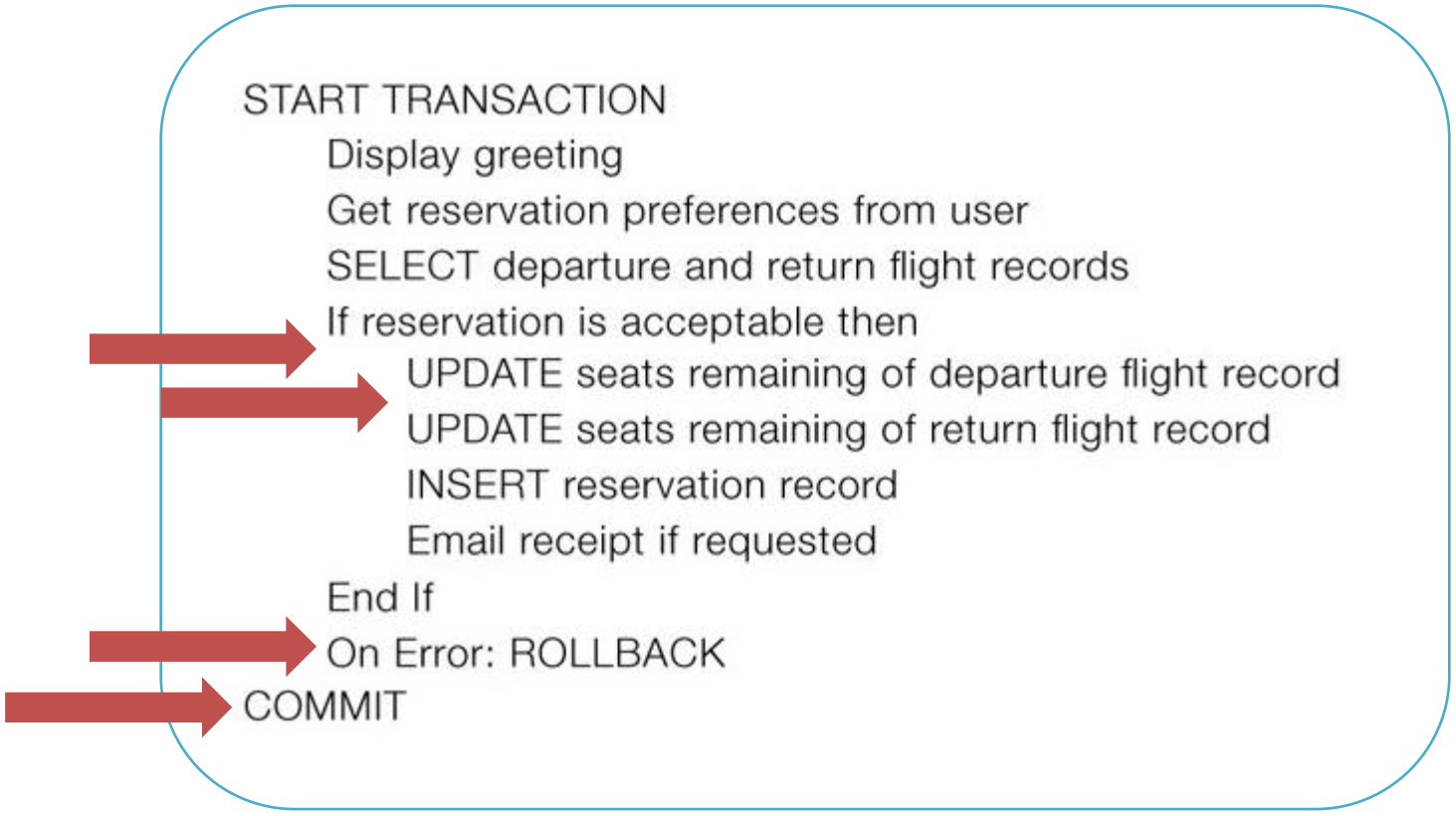
Database Transactions

Database Transactions

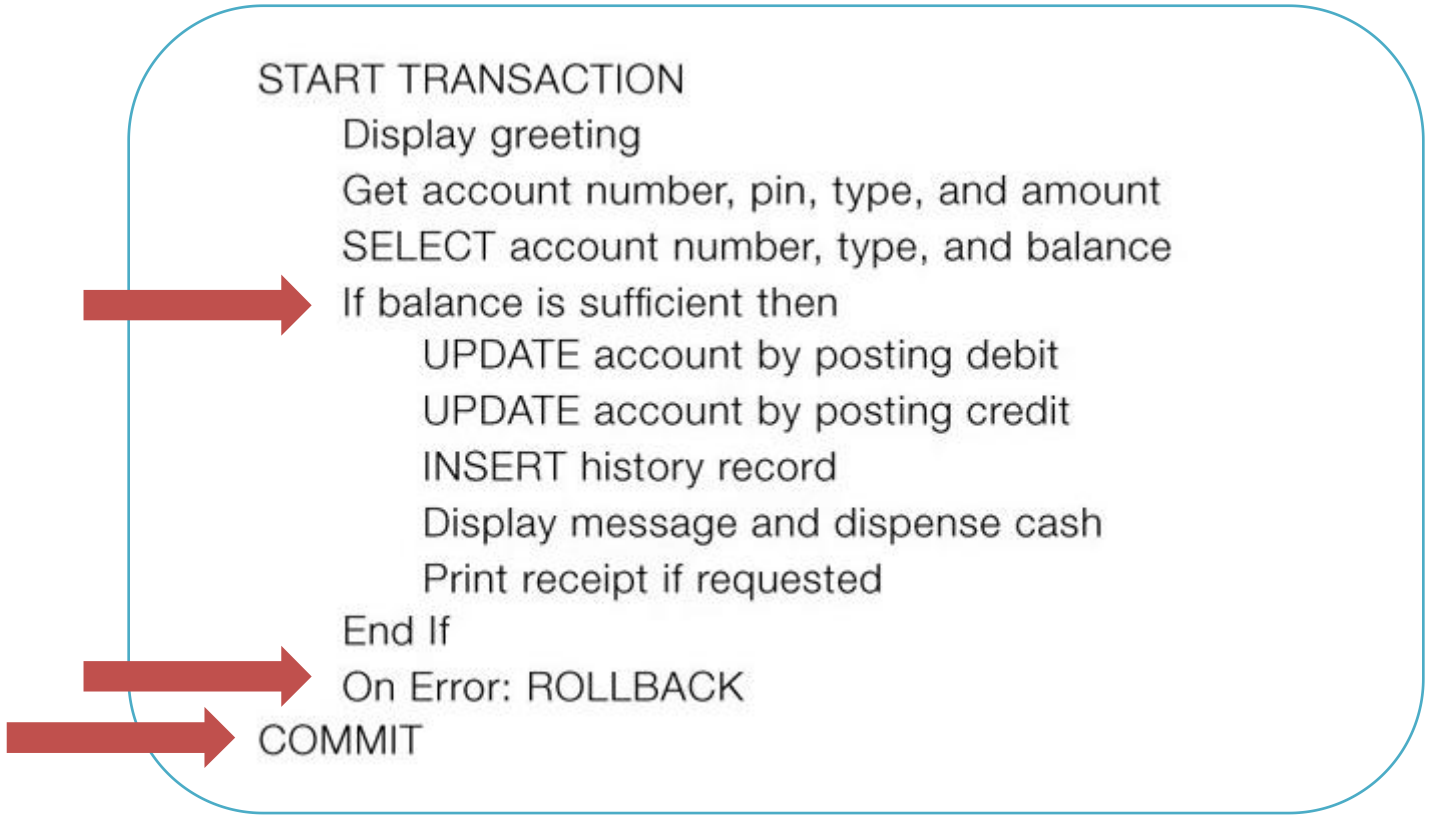
No Loss of Data Requirment



Airline Transaction Example



ATM Transaction Example



Transaction Processing

Supports daily operations of an organisation

Collection of database operations

Reliable and efficient processing of transactions as one unit of work

No lost data due to interference among multiple users

Recover from failures without loss of data for completed transactions

DBMS Internal Features

Concurrency control manager

Recovery manager

Transparent services for application developers

Internal details of transaction processing are invisable.

Summary

Transactions are units of information work that must be processed together.

DBMS's provide services that ensure reliable transaction processing with no data losses from concurrent users and failures after completeion.

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Lesson Objectives

List three levels of decision making and at least one decision on each level

Define data warehouse

Explain at least one characteristic different for transaction processing versus business intelligent prcessing

Decision Making Hierarchy

Operational Level

Tactical Level

Strategic Level

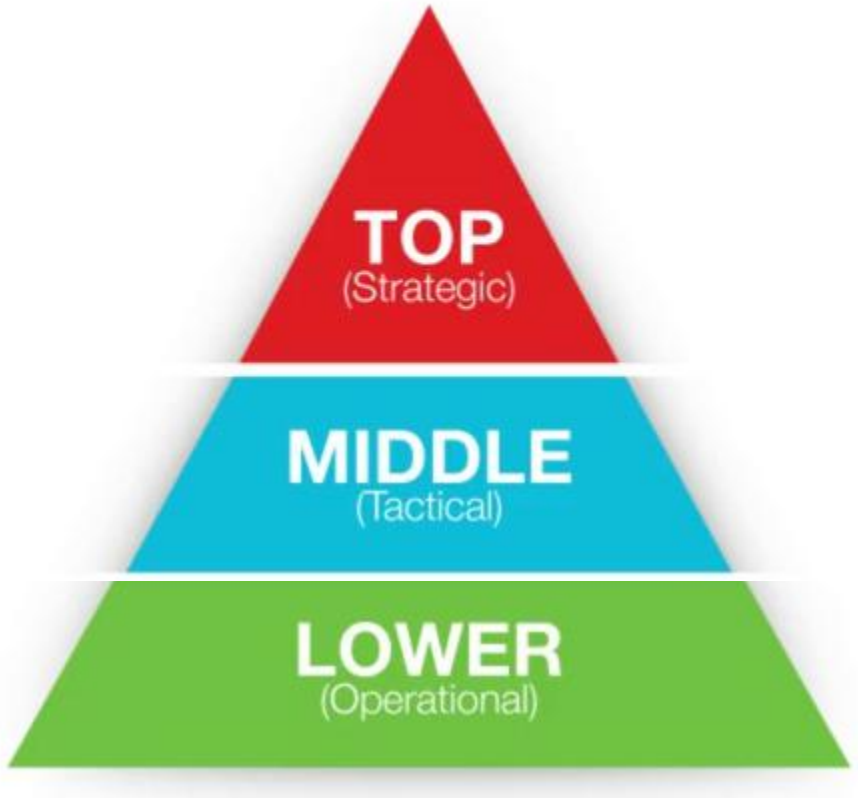
Reasons for Investing in an Operational Database

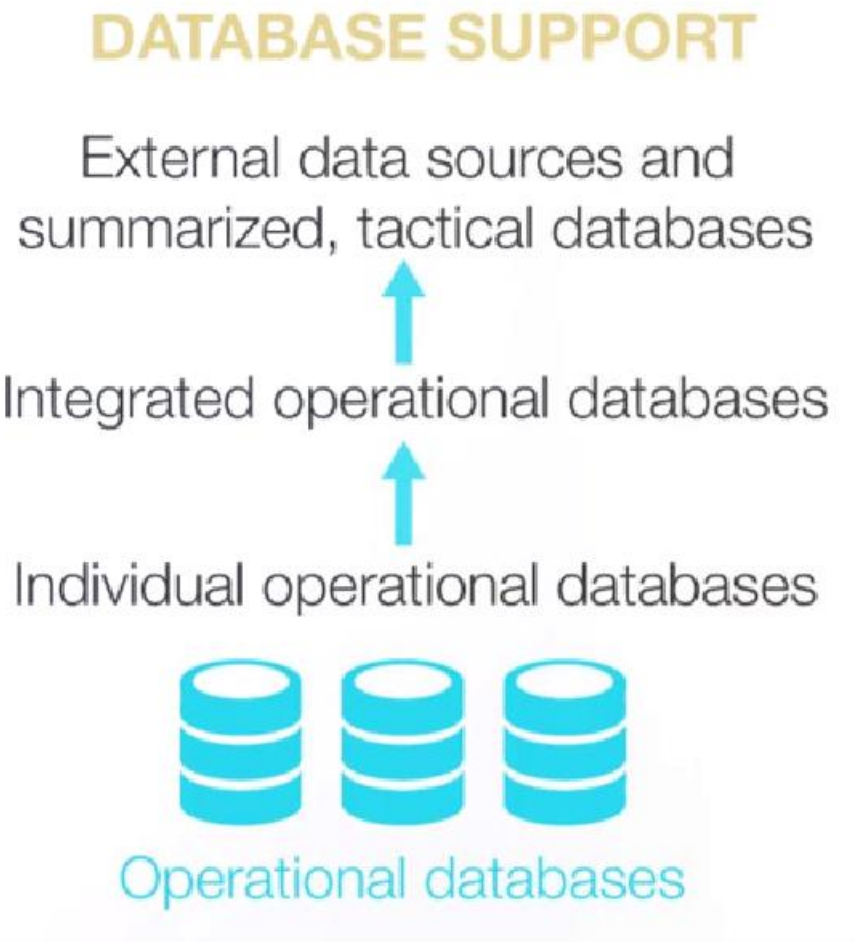
Faster Processing

Larger volumes of business

Reduced personnel costs

Operational Databases



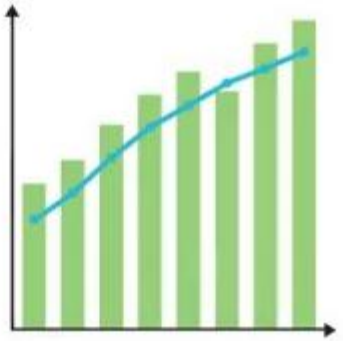


Data Warehouse

Term coined by William Inmon in 1990

Refers to a logical centralised data repository where data from operational databases and other sources are integrated, cleaned and standardised to support business intelligence.

Benefits from a Data Warehouse



Business Intelligence Processing

Secondary data from operational databases

Substancial processing for transformations and integration

Large volumes of data reporting

Individual-Level Data

Provides flexibility for responding to a wide range of business intelligence needs.

Summary

Data warehouse processing supports tactical and strategic decision making.

Business intelligence processing evolution since mid 1990s

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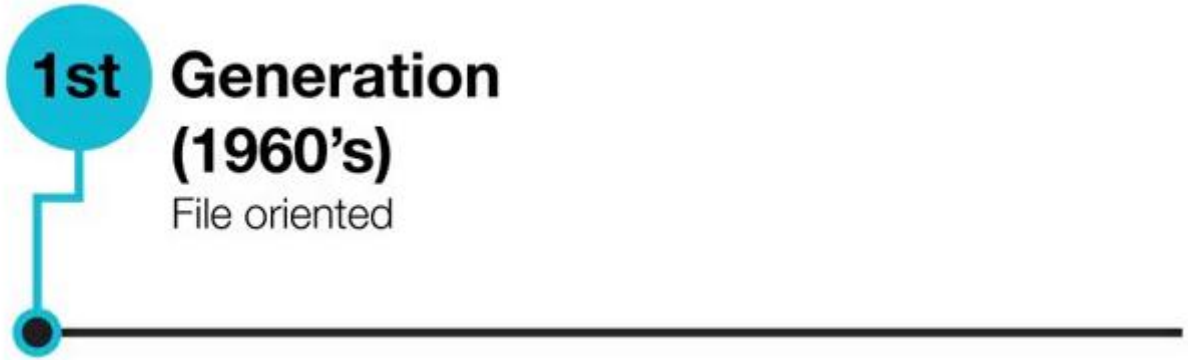
Learning Objectives

Appreciate the advances in database technology and the contribution of database technology to modern society

List the major periods of database technology evolution and one advancement in each period

DBMS Technology Evolution

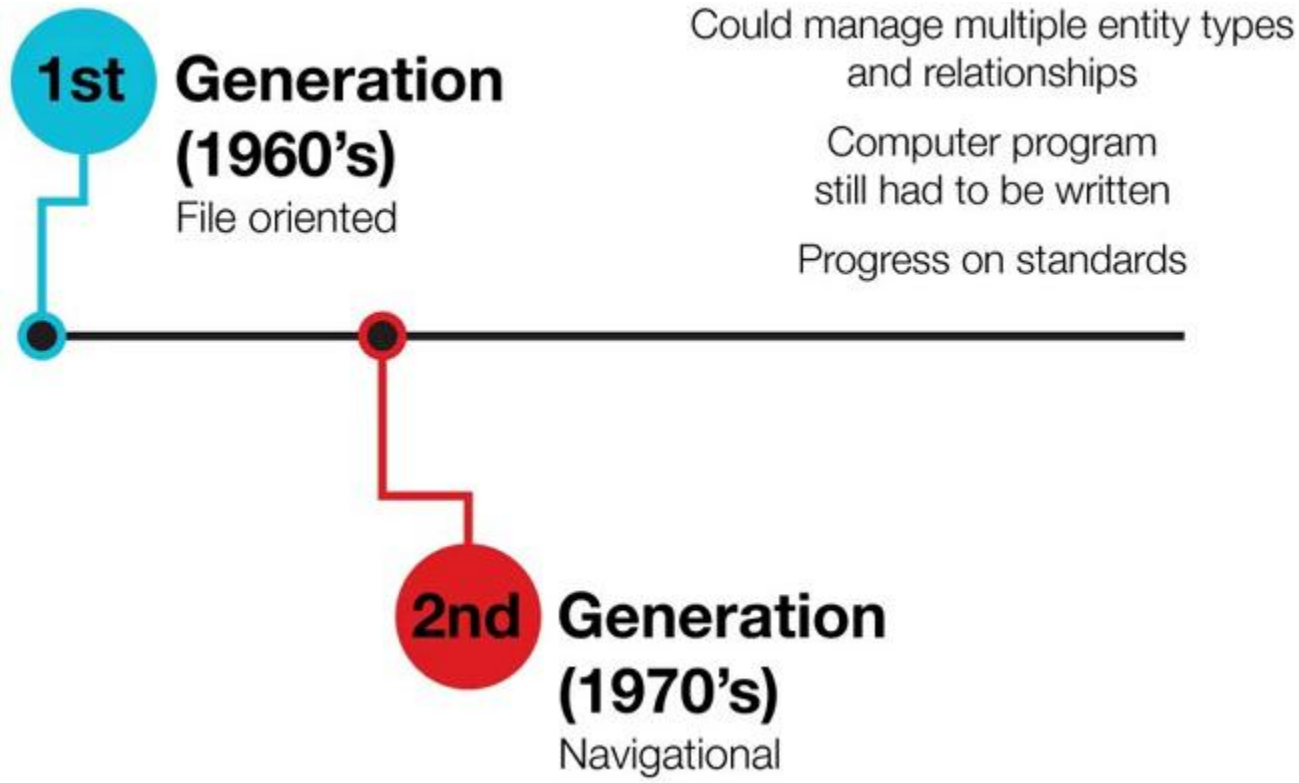


Supported sequential and random searching of files

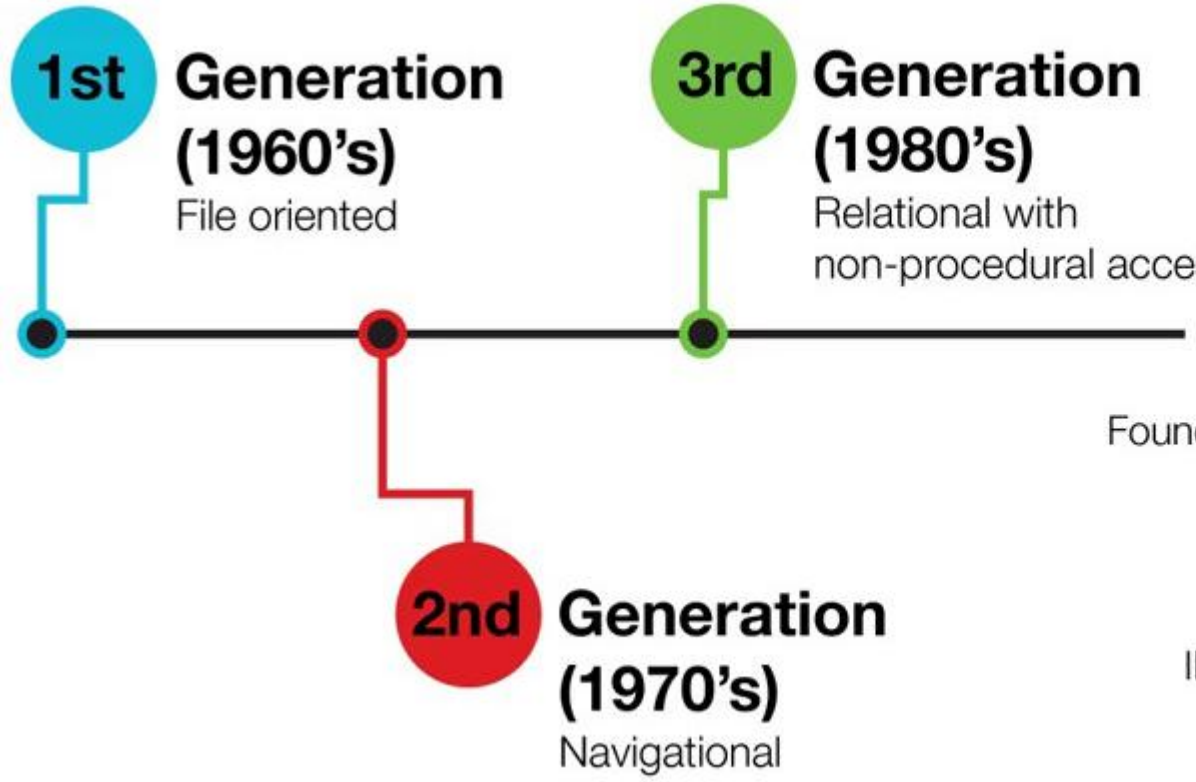
User was required to write detailed computer programs to access data

No standards

DBMS Technology Evolution



DBMS Technology Evolution

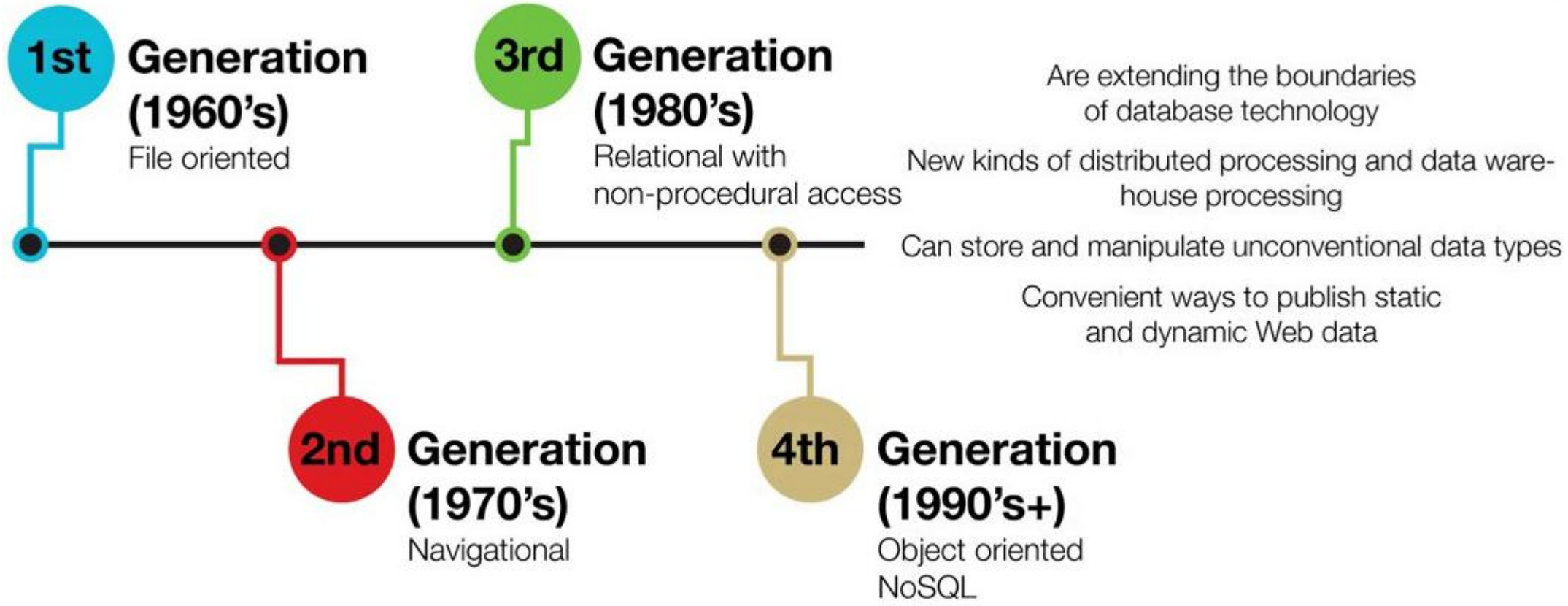


Foundation based on mathematical relations and associated operators.

Optimization technology was developed

IBM performed pioneering research to enable commercialization of relational database technology

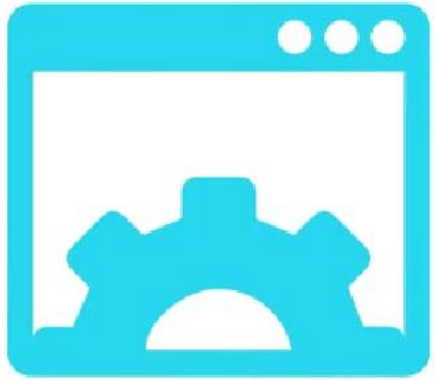
DBMS Technology Evolution



Advance in DBMS

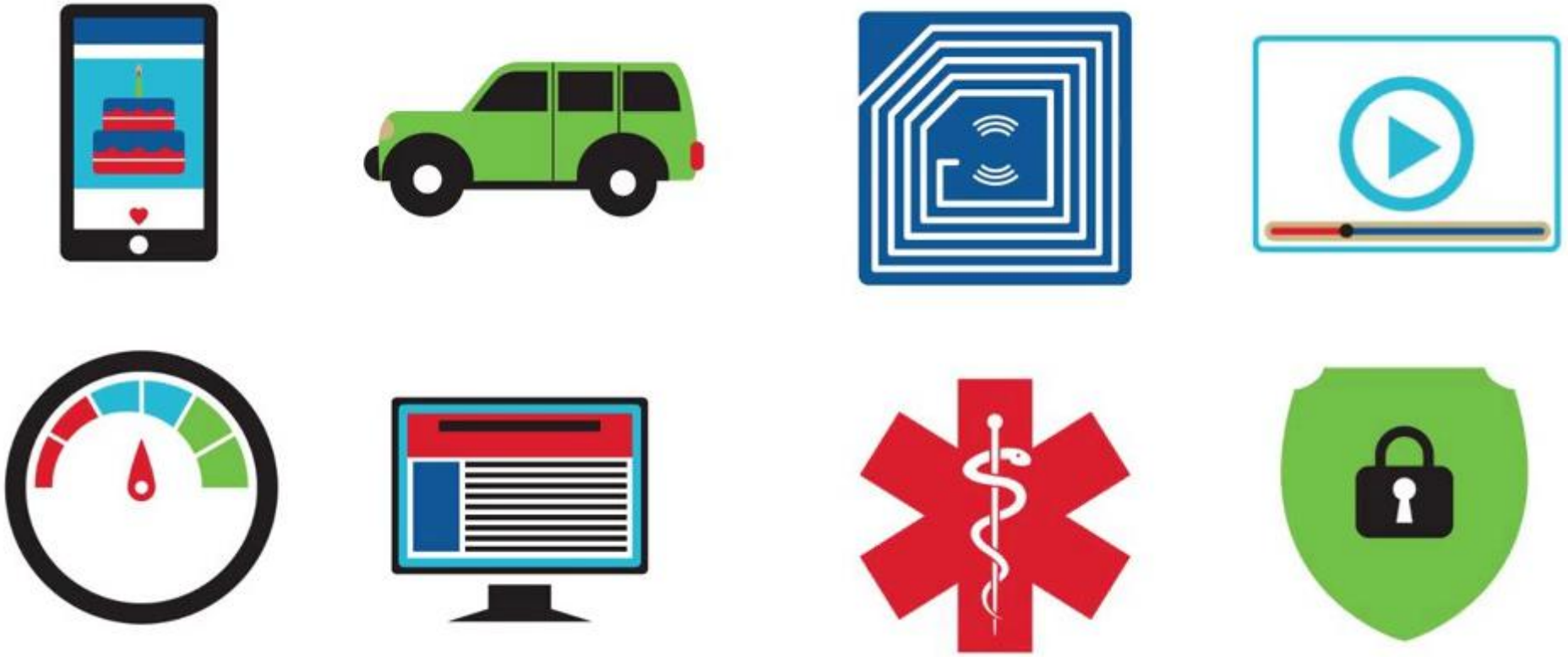
Business Intelligence Processing

Cloud Computing



Optimised for Big Data

Big Data Growth



NoSQL

A NoSQL (originally referring to 'non SQL') database provides a mechanism for storage and retrieval of data that is modeled in means other than the tabular relations used in relational databases. NoSQL systems are also called 'Not only SQL' to emphasise that they may also support SQL-like query languages.

Enterprise DBMS

IBM

MySQL

Microsoft

SAP

TERADATA

ORACLE

Desktop DBMS

Open Source DBMS Products

Source code is available for free.

Service contracts are available for a fee.

Typically have a lower cost of ownership.

DB-Engines Ranking (October 2022)

1. Oracle
2. MySQL
3. Microsoft SQL Server
4. PostgreSQL
5. MongoDB
6. Redis
7. Elasticsearch
8. IBM DB2
9. Microsoft Access
10. SQLite

Summary

Databases and database technology are vital to modern organisations supporting both the daily operations and decision making.

Database technology has undergone remarkable evolution over 50 years.

The industry remains highly competitive with a continued high level of innovation.

Database Characteristics

Organisational Roles

DBMS Overview

Non-Prodecural Access

Transaction Processing

Data Warehouse Overview

DBMS Technology Evolution

Wrapping Up

Summary

DBMS technologies provides a foundation for management of long-term memory of organisations. DBMS enables daily operational tasks and supports short- and long-term decision makings in business.

SQL is a non-procedural language basing on set operations. We specify 'What' from the data, but not 'How' to get it.

Transactions are units of information work that must be processed together. DBMS provide services that ensure reliable transaction processing with no data losses from concurrent users and failures after completion.

DBMS has continually evolved over the past 40 years from file storage, searchable, relational with SQL access, and now NoSQL to support Big Data requirements.

References

Mannino M., *Database Design, Application Development, and Administration*, 7th Edition, Chicago Business Press, 2019.

Mainnio M., J. Karimi and A. W. Lukens, *Data Wareshouse and Business Intelligence Specialization*, University of Colorado, 2022.