
Database Systems 2

Lecture 19

Distributed Databases

Objectives

- Concepts.
- Advantages and disadvantages of distributed databases.
- Functions and architecture for a DDBMS.
- Distributed database design.
- Levels of transparency.

Concepts

Distributed Database

A logically interrelated collection of shared data (and a description of this data), physically distributed over a computer network.

Distributed DBMS

Software system that permits the management of the distributed database and makes the distribution transparent to users.

Concepts

Collection of logically-related shared data.

Data split into fragments.

Fragments may be replicated.

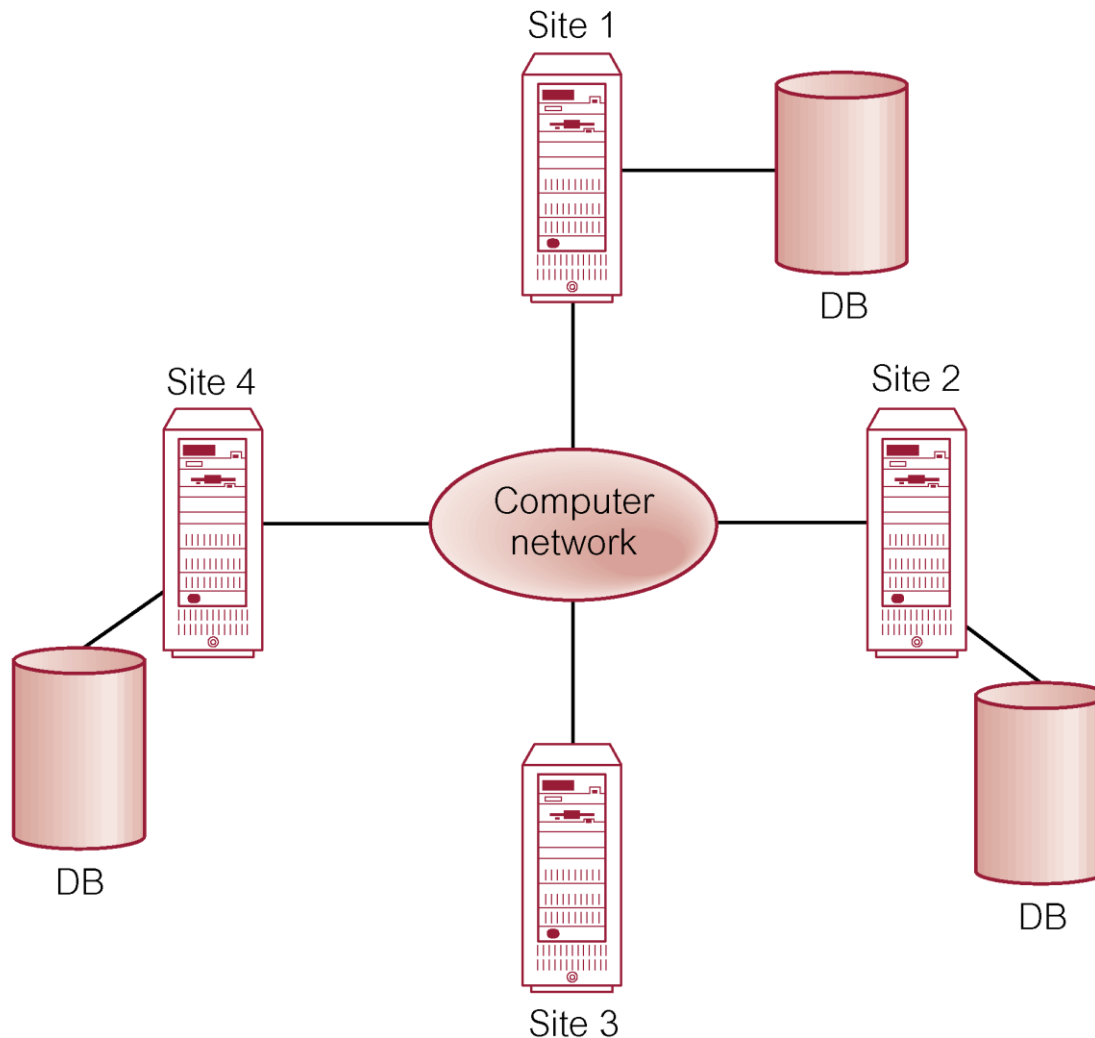
Fragments/replicas allocated to sites.

Sites linked by a communications network.

Data at each site is under control of a DBMS.

DBMSs handle local applications autonomously.

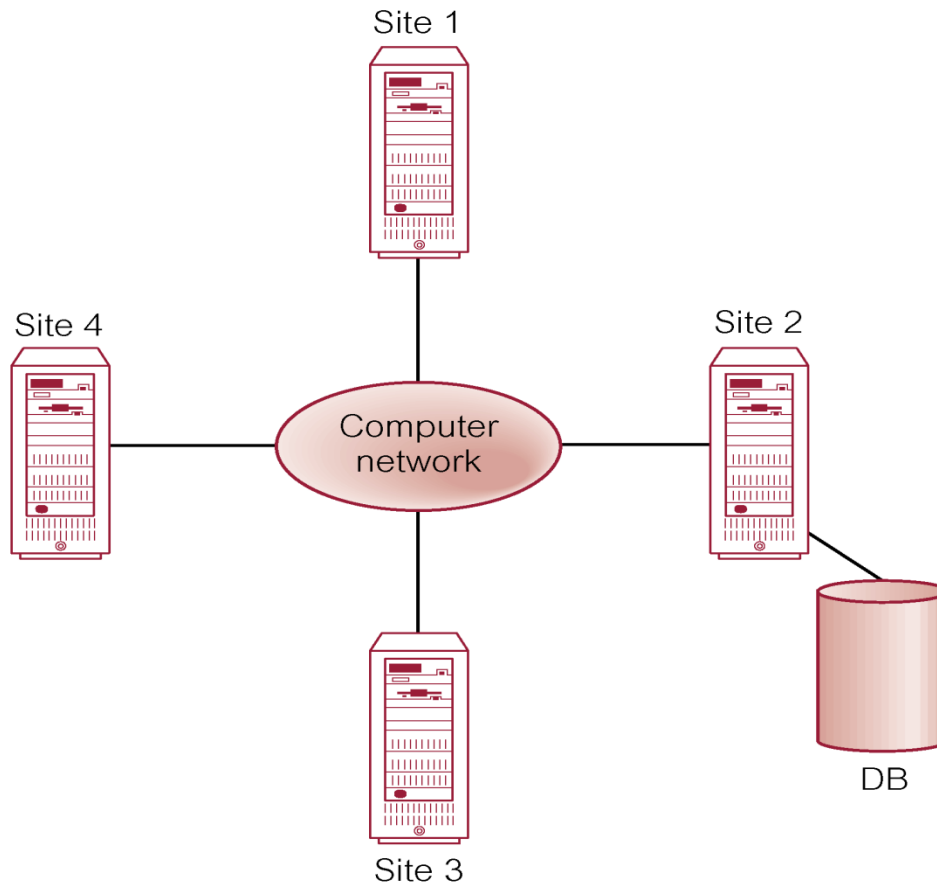
Distributed DBMS



As opposed to..

Distributed Processing

A centralized database that can be accessed over a computer network.



This is not a DDBMS

Types of DDBMS

- **Homogeneous DDBMS**
- **Heterogeneous DDBMS**

Homogeneous DDBMS

All sites use same DBMS product.

Much easier to design and manage.

Approach provides incremental growth and allows increased performance.

Heterogeneous DDBMS

Sites may run different DBMS products, with possibly different underlying data models.

Occurs when sites have implemented their own databases and integration is considered later.

Translations required to allow for:

- Different hardware.
- Different DBMS products.
- Different hardware and different DBMS products.

Typical solution is to use *gateways* – program to convert from Oracle data model to MySQL data model.

Open Database Access and Interoperability

Open Group formed a Working Group to provide specifications that will create a database infrastructure environment where there is:

- Common SQL API that allows client applications to be written that do not need to know vendor of DBMS they are accessing.
- Common database protocol that enables DBMS from one vendor to communicate directly with DBMS from another vendor without the need for a gateway.
- A common network protocol that allows communications between different DBMSs.

Group has now evolved into DBIOP Consortium and are working on version 5 of DRDA (Distributed Relational Database Architecture) standard.

- **<https://collaboration.opengroup.org/dbiop/>**

Functions of a DDBMS

Expect a Distributed DBMS to have at least the functionality of a DBMS.

Also to have following functionality:

- Extended communication services.
- Extended Data Dictionary.
- Distributed query processing.
- Extended concurrency control.
- Extended recovery services.

Distributed Database Design

Fragmentation

Tables may be divided into a number of sub-tables, which are then distributed.

Data Placement

Each fragment is stored at site with “optimal” distribution.

Replication

Copy of fragment may be maintained at several sites.

Fragmentation

Definition and allocation of fragments carried out strategically to achieve:

- Locality of Reference.
- Improved Reliability and Availability.
- Improved Performance.
- Balanced Storage Capacities and Costs.
- Minimal Communication Costs.

Involves analyzing most important applications, based on quantitative/qualitative information.

Types of Fragmentation

Four types of fragmentation:

- Horizontal,
- Vertical,
- Mixed,
- Derived.

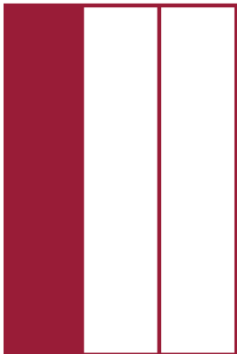
Other possibility is no fragmentation:

- If relation is small and not updated frequently, may be better not to fragment relation.

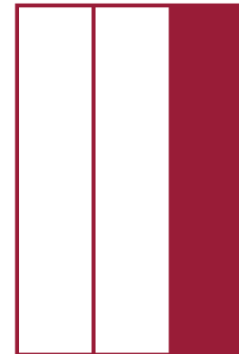
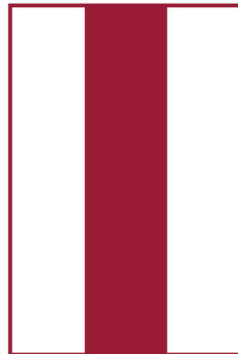
Horizontal and Vertical Fragmentation



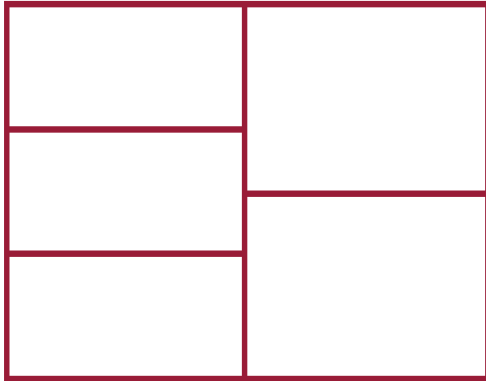
(a)



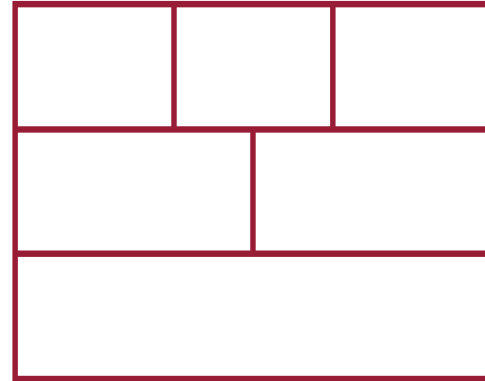
(b)



Mixed Fragmentation



(a)



(b)

If Staff table distributed according to branch location, then the properties that are managed by those staff should also be distributed in the same way.

Data Placement Strategies

Four alternative strategies regarding placement of fragments:

- Centralized,
- Partitioned (or Fragmented),
- Complete Replication,
- Selective Replication.

Data Placement Strategies

Centralized:

Consists of single database and DBMS stored at one site with users distributed across the network. Not really a DDBMS.

Partitioned:

Database partitioned into disjoint fragments, each fragment assigned to one site.

Complete Replication:

Consists of maintaining complete copy of database at each site.

Selective Replication:

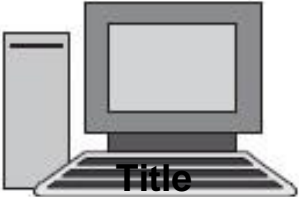
Combination of the above methods.

What does the Semantic Web have to do with this?

The idea of a distributed database was one of the starting points for the development of the Semantic Web.

Table 3.1 Tabular Data about Elizabethan Literature and Music				
ID	Title	Author	Medium	Year
1	<i>As You Like It</i>	Shakespeare	Play	1599
2	<i>Hamlet</i>	Shakespeare	Play	1604
3	<i>Othello</i>	Shakespeare	Play	1603
4	"Sonnet 78"	Shakespeare	Poem	1609
5	<i>Astrophil and Stella</i>	Sir Phillip Sidney	Poem	1590
6	<i>Edward II</i>	Christopher Marlowe	Play	1592
7	<i>Hero and Leander</i>	Christopher Marlowe	Poem	1593
8	<i>Greensleeves</i>	Henry VIII Rex	Song	1525

Horizontal Fragmentation



	Title	Author	Medium	Year
1	As You Like It	Shakespeare	Play	1599

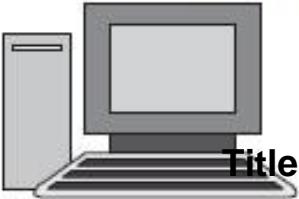
Title

Author

Medium Year

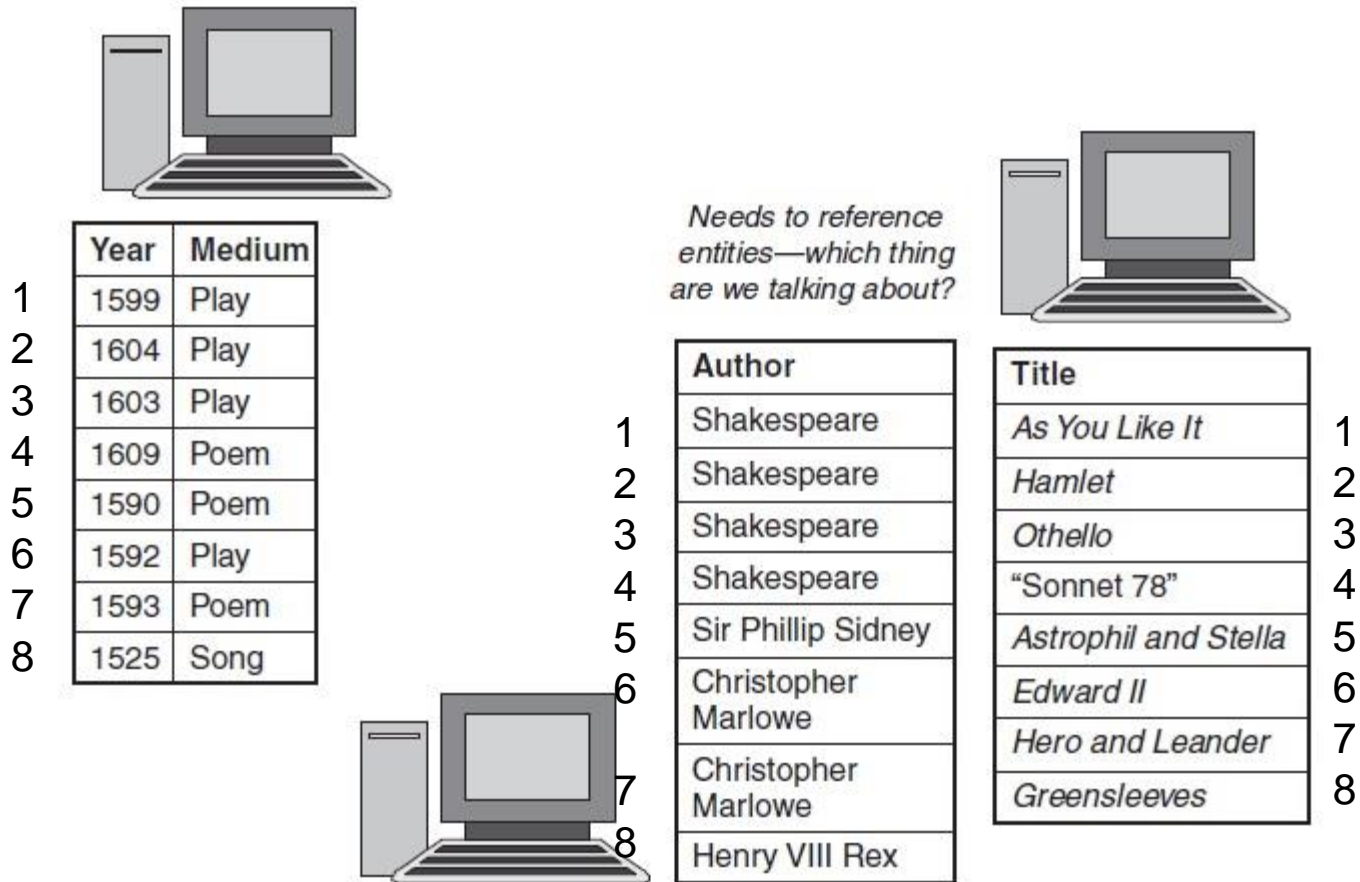
Needs common schema—which column is which?

4	Sonnet 78	Shakespeare	Poem	1609
6	Edward II	Christopher Marlowe	Play	1592

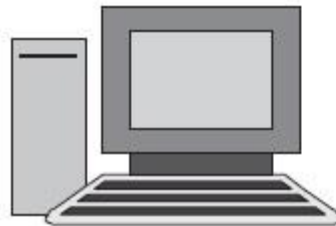


	Title	Author	Medium	Year
7	Hero and Leander	Christopher Marlowe	Poem	1593
3	Othello	Shakespeare	Play	1603

Vertical Fragmentation



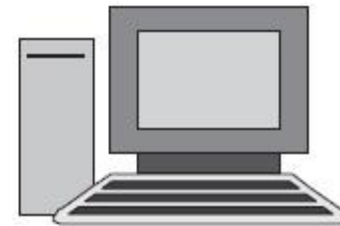
Mixed Fragmentation



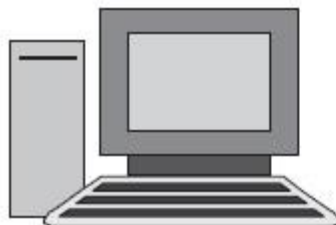
	Medium
Row 7	Poem

	Title
Row 2	Hamlet

*Needs to reference both
schema and entities*



	Author
Row 4	Shakespeare



	Year
Row 2	1604

	Medium
Row 6	Play

A triple can be thought of a single cell.

The database keeps track of where each triple is stored (probably using namespaces)

The idea of 'a table' is more to do with how you wish to view the data, and less to do with where the data is physically located.

Subject	Predicate	Object
Row 7	Medium	Poem
Row 2	Title	Hamlet
Row 4	Author	Shakespeare
Row 2	Year	1604
Row 6	Medium	Play

There are database systems specifically designed to store data in this way. They are called 'Triplestores'.

They are still being developed – the relational database will be with us for some time yet!

But the RDF language which is part of the Semantic Web concept could show the direction in which databases may develop in the near future.