Overview of distributed query processing

Data Management for Big Data

2018-2019 (spring semester)

Dario Della Monica

These slides are a modified version of the slides provided with the book

Özsu and Valduriez, *Principles of Distributed Database Systems* (3rd Ed.), 2011

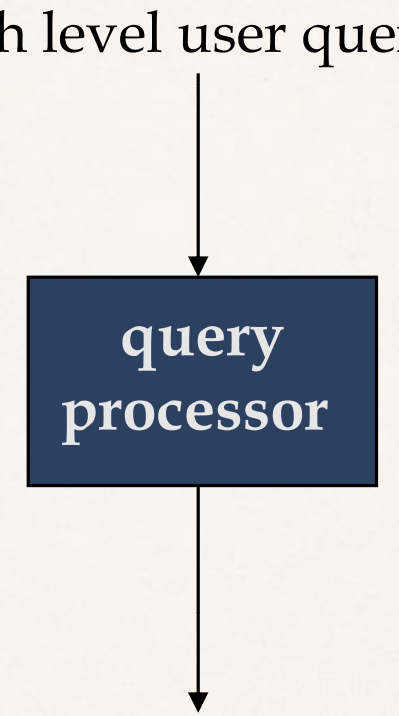
The original version of the slides is available at: extras.springer.com

Outline (distributed DB)

- Introduction (Ch. 1) *
- Distributed Database Design (Ch. 3) *
- Distributed Query Processing (Ch. 6-8) *
  - ➡ **Overview (Ch. 6)** *
  - ➡ Query decomposition and data localization (Ch. 7) *
  - ➡ Distributed query optimization (Ch. 8) *
- Distributed Transaction Management (Ch. 10-12) *

* Özsu and Valduriez, *Principles of Distributed Database Systems* (3rd Ed.), 2011

Query Processing in a D-DBMS



Selecting Alternatives

```
SELECT    *
FROM      EMP,ASG
WHERE     EMP.ENO = ASG.ENO
AND       RESP = "Manager"
```

$$EMP \bowtie_{ENO} (\sigma_{RESP=\text{“Manager”}} (ASG))$$

$$\sigma_{RESP=\text{“Manager”}} (EMP \bowtie_{ENO} (ASG))$$

What are the Additional Problems?

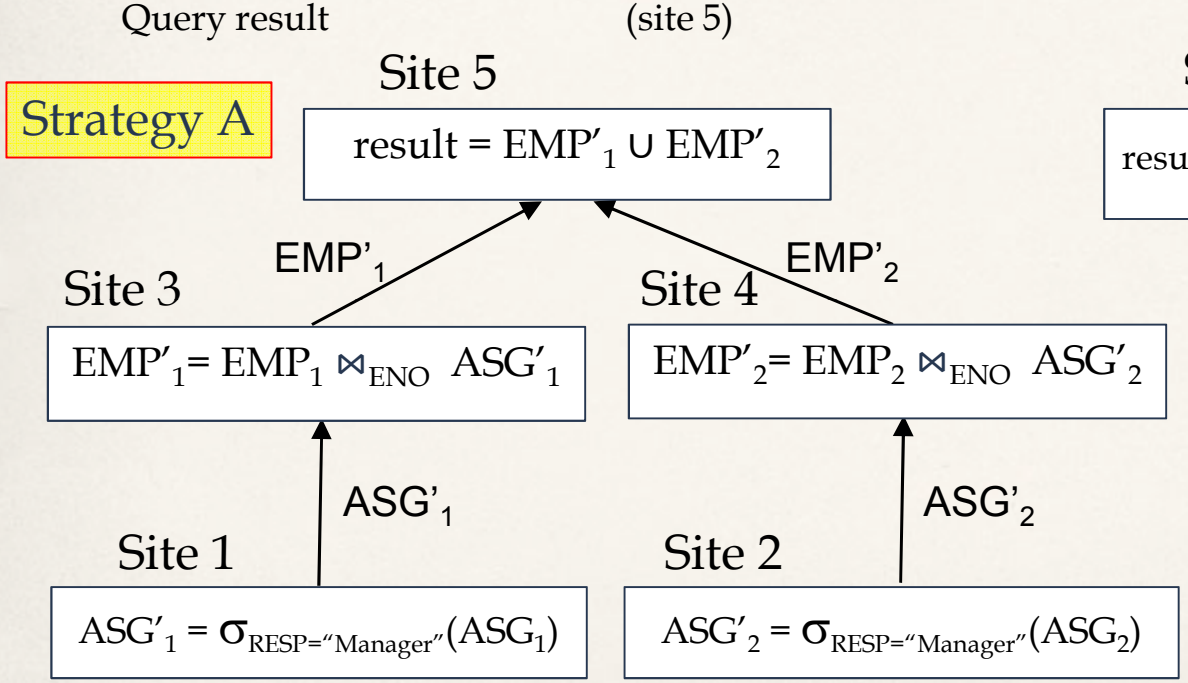
- More parameters
  - Fragmentation
  - Replication
  - Data exchange alternatives/multiple sites
- To transform a **global query on relations** of a distributed DB (seen as a single DB by the user) into **local queries on fragments** stored on several local DB's (**data localization**)
- QEP must include information on communications (data transfers among sites) and on which sites operations are performed
- Use of semijoins to reduce the amount of data transferred among sites
  - Focus of the optimizer is selecting optimal order for join and semijoin operations
- Centralized vs. distributed optimization
- Cost to minimize
  - Centralized DB: CPU and I/O cost only (actually, only I/O)
  - Distributed DB: also communication costs
  - Communication costs are the dominating ones (even though this might not be the case with increased network speed, especially within Local Area Network)

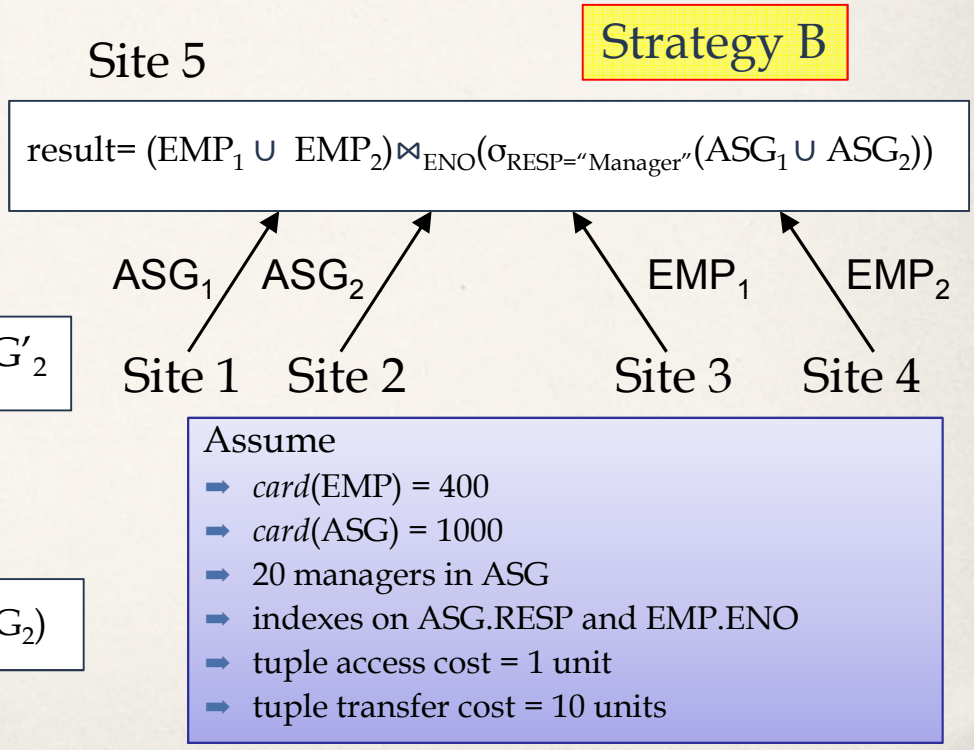
What are the Additional Problems? – Example

- Global query: $EMP \bowtie_{ENO} (\sigma_{RESP="Manager"} (ASG))$
- Fragmentation and allocation

$ASG_1 = \sigma_{ENO \leq "E3"}(ASG)$ (site 1)
$ASG_2 = \sigma_{ENO > "E3"}(ASG)$ (site 2)
$EMP_1 = \sigma_{ENO \leq "E3"}(EMP)$ (site 3)
$EMP_2 = \sigma_{ENO > "E3"}(EMP)$ (site 4)
Query result (site 5)

Relational algebra must be extended to model exchanging data between sites





Cost of Alternatives

- Assume
  - *card* (EMP) = 400, *card*(ASG) = 1000, 20 managers in ASG
  - indexes on ASG.RESP and EMP.ENO
  - tuple access cost = 1 unit; tuple transfer cost = 10 units
- Strategy A
  - produce ASG': (10+10) * tuple access cost — 20
  - transfer ASG' to the sites of EMP: (10+10) * tuple transfer cost — 200
  - produce EMP': (10+10) * 2 * tuple access cost — 40
  - transfer EMP' to result site: (10+10) * tuple transfer cost — 200

  Total Cost — 460
- Strategy B
  - transfer EMP to site 5: 400 * tuple transfer cost — 4,000
  - transfer ASG to site 5: 1000 * tuple transfer cost — 10,000
  - produce ASG': 1000 * tuple access cost — 1,000
  - join EMP and ASG': 400 * 20 * tuple access cost — 8,000

  Total Cost — 23,000

Distributed Query Processing Methodology