Overview of distributed query processing

Data Management for Big Data
2018-2019 (spring semester)

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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

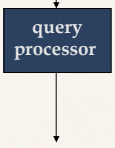
Outline (distributed DB)

- 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

high level user query



Low-level data manipulation commands for D-DBMS

Selecting Alternatives

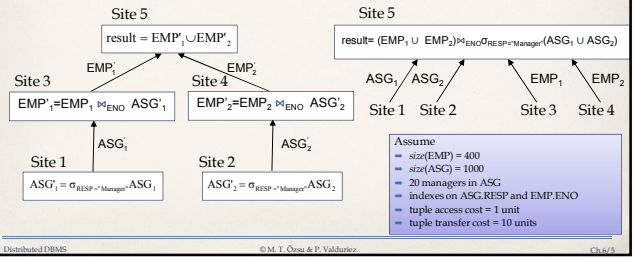
```
SELECT   *
FROM     EMP,ASG
WHERE    EMP.ENO = ASG.ENO
AND      RESP = "Manager"
```

$EMP \bowtie_{ENO} (\sigma_{RESP="Manager"} (ASG))$

What are the Additional Problems?

Site 1	Site 2	Site 3	Site 4	Site 5
$ASG_1=\sigma_{ENO\le "E3"}(ASG)$	$ASG_2=\sigma_{ENO>"E3"}(ASG)$	$EMP_1=\sigma_{ENO\le "E3"}(EMP)$	$EMP_2=\sigma_{ENO>"E3"}(EMP)$	Result

Relational algebra must be extended to model exchanging data between sites



Cost of Alternatives

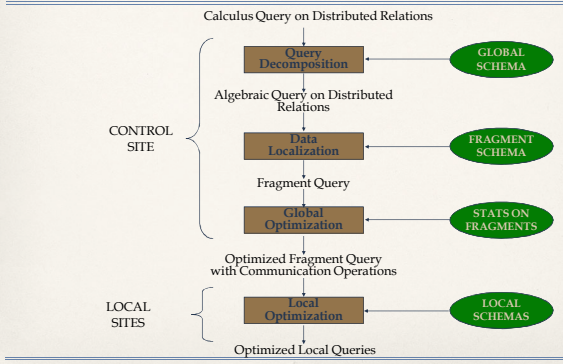
- Assume
  - ➡ *size*(EMP) = 400, *size*(ASG) = 1000, 20 managers in ASG
  - ➡ cluster indexes on ASG.RESP and EMP.ENO
  - ➡ tuple access cost = 1 unit; tuple transfer cost = 10 units
- Strategy A

➡ 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) * tuple access cost * 2	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

Query Optimization Objectives in DDBS

- To transform a query in a high-level language (SQL) on a distributed DB (seen as a single DB by the user) into an efficient execution strategy, expressed in a lower-level language (extension of relational algebra with communication and data transfer operators), on several local DB's
- Cost factors 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)

Distributed Query Processing Methodology