A Self-organizing XML P2P Database System

Giovanni Conforti  Giorgio Ghelli  Paolo Manghi
Carlo Sartiani
Dipartimento di Informatica - Università di Pisa
Topics

- XPeer: a data management system
- XML data
- p2p architecture
- self-organizing
- zero-administration
Presentation Outline

- System architecture
- Query processing & query algebra
- Conclusions
System Architecture
Introduction

- an open-ended and dynamic network
- a p2p hybrid architecture
  - peer nodes
  - super-peer nodes
- self-organizing and tree-shaped overlay network
  - peers: leaves
  - super-peers: internal nodes
- adaptation to changes in the network topology or in the workload
Main Issues

- keeping track of network topology changes
- keeping track of changes in local data
- routing queries over the network
Peer Nodes

peers are autonomous and may carry heterogeneous data

free local updates

peer content is described by a tree-shaped schema

tree-guide

peer nodes also execute query plans returned by the super-peer layer

peer nodes may replicate the content of other nodes and cache the result of previous queries
<market>
  <buildings>
    <building>
      <desc>Marvelous luxury house in the Hamptons</desc>
      <location>Hamptons</location>
      <price>1600000</price>
    </building>
    <building>
      <desc>Very nice flat in the Upper East Side</desc>
      <location>Upper East Side, Manhattan</location>
      <price>1350000</price>
      <type>condo</type>
    </building>
    <building>
      <desc>Elegant luxury house in the countryside</desc>
      <location>Greensboro</location>
      <price>1700000</price>
    </building>
  </buildings>
</market>
Peer Clusters

- Peer nodes are organized into clusters.
- Peer clusters are formed on a schema-similarity basis.
  - Tree similarity
- Each cluster is managed by a super-peer node.
Super-Peer Nodes

- Super-peer nodes are still peer nodes
- Super-peer tasks:
  - Query compilation
  - Replica management
  - Cache management
super-peers maintain schema information
- the list of the schemas of their peers
- the union of these schemas

this information is used for compiling queries
twig matching
Super-Peer Groups

- Super-peer nodes are organized into groups.
- Super-peers having the same father in the hierarchy form a group.
- Groups are intended to:
  - Increase the robustness of the system with respect to node or network failures.
  - Guide the query compilation process.
Overlay Network Example
Network Evolution

- cluster splitting
- group splitting
- cluster/group merge
- vertical extension/contraction
- network re-joining
Query Processing & Query Algebra
Query Processing

- three phases
  - algebraic translation: performed locally by the submitting peer
  - location assignment compilation: performed by the super-peer network
  - query execution: coordinated by the submitting peer
Query Algebra

- extension of an existing algebra for queries over XML data
- new features
  - locations, modeling peer contents and replicas
  - freshness parameters
  - absolute time $\tau$
  - replication constraints
The XQuery binding:

```xquery
for $b in input()//building
let $d in $b/desc
```

Becomes:

```xquery
return{entry[$d,$p]}( path{(//,$b,in)building[(/,$d,in)desc[0], (/,$p,in)price[0]]}(loc1 • loc3 |db1 loc2)(db1)))
```
Conclusions

- The system is being implemented
- Future issues
  - Correctness and completeness of queries
  - Formal representation of the distributed state in p2p systems