Towards an XML-Based Query and Contextual Information Model in Context-Aware Mobile Information Systems

Essam Mansour

May 19, 2009

Outline

Background

Context aware mobile information systems (CAMISs):

- understand the context within which their users operate,
- process queries of the users based on the user context,
- use caching techniques to optimize query processing time and the energy consumption

Background

In order to support CAMISs, there is a need to

- model the contextual information related to mobile clients,
- model queries issued by these mobile clients, and
- notify these mobile clients by any relevant update to cached data

Research Problem

Although, database systems (DBSs) are state-of-the art for managing complex data in information systems,:

- DBSs are not aware of the context of their usage,
- Query results are retrieved without considering the context of the user/device issuing the query
- DBSs does not have an update notification mechanism

Research Problem

Problem Statement

Move the complexity of managing context-aware query processing and cache management from middlewares to a built-in function within DBMSs.

Research Objective

Objective Statement

- modeling the contextual information related to mobile clients and their queries executed at the DB server, and
- Realizing such model within DBSs to support context-aware query processing and cache management.

Context-Aware Mobile Services

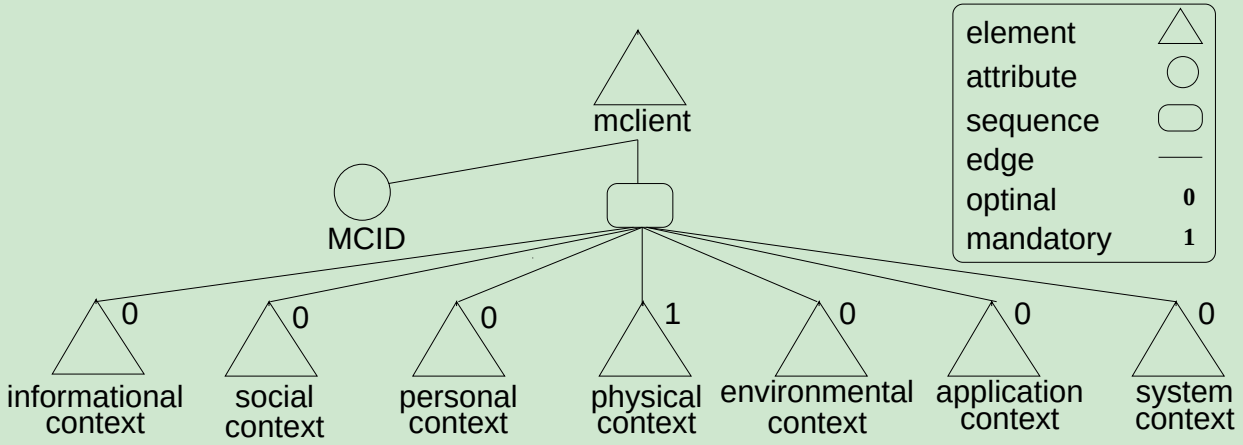
- we assume a mobile service provider (MSP) is to prepare for their customers contextual information document.
- The mobile users are supposed to issue ad-hoc or preregister queries.
- These queries might be continuous or non-continuous queries.

XReAl: An XML-Based Model for Queries and Contextual Information

- XReAl stands for **X**ML-Based **Re**lational **Al**gebra
- XReAl formalizes:
  - the contextual information of mobile clients
  - queries issued by theses clients
  - manipulation operations
- The XReAl specifications are XML documents that could be managed using any DBMS supporting XML management

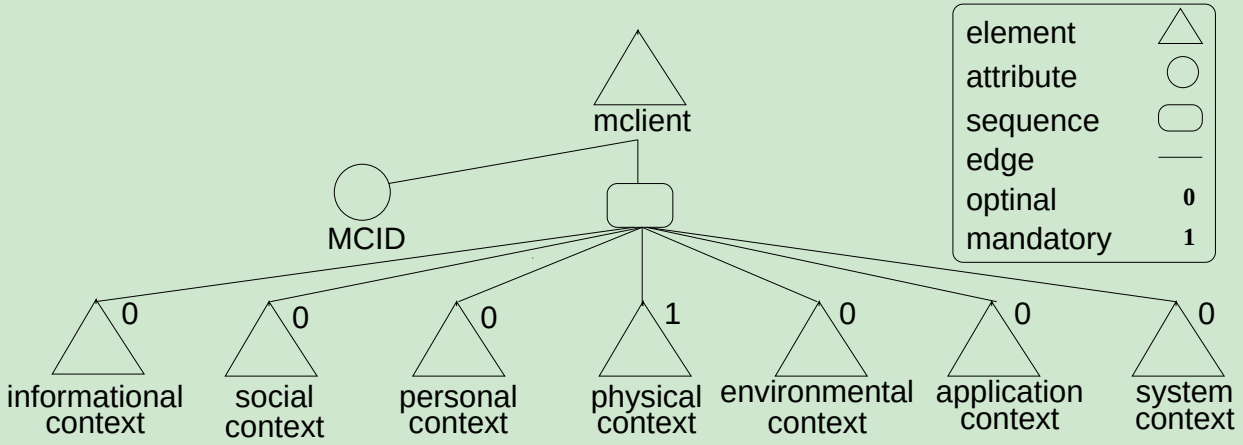
XREAL: An XML-Based Model for Queries and Contextual Information

The XREAL model for the *mobile client*



XREAL: An XML-Based Model for Queries and Contextual Information

The XREAL model for the *mobile client*



XREAL: An XML-Based Model for Queries and Contextual Information

A) Part of the physical context
B) Part of the informational context

A	B
<relative_position> <country>Germany</country> <city>Bruchsal</city> <area>south</city> <street>Durlacher<street> <postal_code>76646</postal_code> </relative_position>	<quote> +<value> +<newspaper> +<section> +<date> +<description> </quote>

XREAL: An XML-Based Model for Queries and Contextual Information

Example

The *QCL* query

retrieve the name, street, and hotline of cinemas in my current location,where the rate of the cinema is greater than four

An equivalent relational algebra for the *QCL* query

$$\overbrace{\pi_{ctab.cname,ltab.street,ctab.hotline}}^{\textbf{Projection Predicate}}(\overbrace{\sigma_{ctab.RATE>4\wedge\textbf{current location}}}^{\textbf{Selection Predicate}}(\underbrace{\rho_{ctab}(cinema\_tab) \bowtie_{ctab.LID=ltab.LID} \rho_{ltab}(location\_tab)}_{\textbf{Join Predicate}}))$$

XREAL: An XML-Based Model for Queries and Contextual Information

An equivalent relational algebra for the *QCL* query

$$\overbrace{\pi_{ctab.cname,ltab.street,ctab.hotline}}^{\textbf{Projection Predicate}}(\overbrace{\sigma_{ctab.RATE>4\wedge\textbf{current location}}}^{\textbf{Selection Predicate}}$$
$$\underbrace{(\rho_{ctab}(cinema\_tab) \bowtie_{ctab.LID=ltab.LID} \rho_{ltab}(location\_tab))}_{\textbf{Join Predicate}})$$

An equivalent relational algebra for the *QCL* query

$$(\pi_{ctab.cname,ctab.hotline,ctab.LID}(\sigma_{ctab.RATE>4}(\rho_{ctab}(cinema\_tab))))$$
$$\bowtie_{ctab.LID=ltab.LID}$$
$$(\pi_{ltab.street,ltab.LID}(\sigma_{\textbf{current location}}(\rho_{ltab}(location\_tab))))$$

An Example

The XREAL specification of the **QCL** query

```
<query QID="QID1" MCID="MC101">
  <relations>
    +<relation RID="RID01">
    +<relation RID="RID02">
  </relations>
  <join>
    <jpredicate>
      <simplePredicate>
        <attribute ofRelation="RID01">
          <name>LID</name>
        </attribute>
<operator>eq</operator>
<operand>
  <attribute
   ofRelation="RID02">
     <name>LID</name>
  </attribute>
</operand>
</simplePredicate>
</jpredicate>
</join>
</query>
```

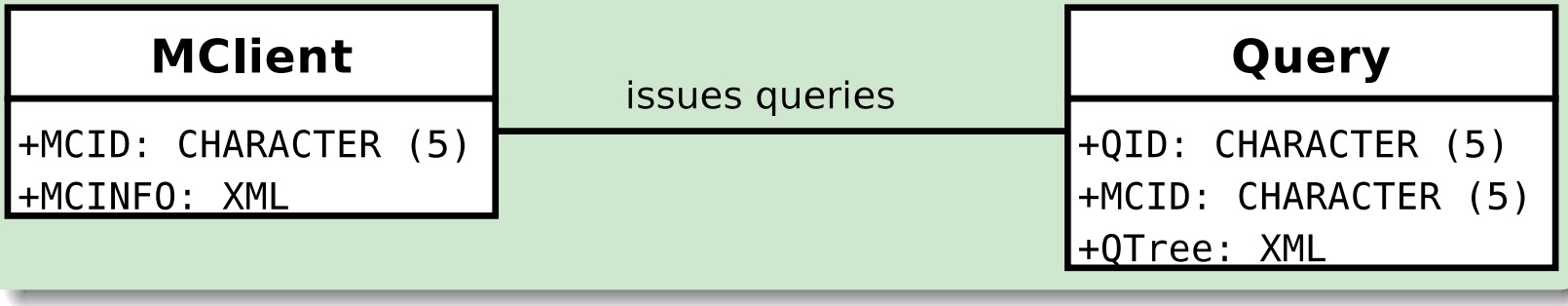
A Prototype System

Our prototype system:

- is a proof-of-concept system utilizes XREAL to realize within DBMS:
  - a context-aware query processor
  - an update notification mechanism *(Essam Mansour, Hagen Höpfner, EDBT 09)*
- is implemented using Sun Java 1.6 and DB2 Express-C 9.5

A Prototype System: Repository

The ER diagram of the XReAl Repository



A Prototype System: Context-Aware Query Processor

Context-Aware Relational Algebra is a relational algebra with context aware operators, such as:

- current location
- close to
- approaching
- ...

A Prototype System: Context-Aware Query Processor

An equivalent relational algebra for the *QCL* query

$$(\pi_{ctab.cname,ctab.hotline,ctab.LID}(\sigma_{ctab.RATE>4}(\rho_{ctab}(cinema\_tab))))$$
$$\bowtie_{ctab.LID=ltab.LID}$$
$$(\pi_{ltab.street,ltab.LID}(\sigma_{\textbf{current location}}(\rho_{ltab}(location\_tab))))$$

An equivalent relational algebra for the *QCL* query

$$(\pi_{ctab.cname,ctab.hotline,ctab.LID}(\sigma_{ctab.RATE>4}(\rho_{ctab}(cinema\_tab))))$$
$$\bowtie_{ctab.LID=ltab.LID}$$
$$(\pi_{ltab.street,ltab.LID}(\sigma_{postal\_code=76646}(\rho_{ltab}(location\_tab))))$$

Conclusion

The major advantages of the XREAL model:

- the direct integration into modern DBSs,
- XREAL provides context-aware management support within these DBSs, and
- the XREAL specification is to be shared among heterogeneous applications and systems.

Future work

- the support of all relational algebra operation in the XREAL model
- the formalization of the correlation between different contexts
- the formalization of advanced context-aware predicates in the form relational algebra operations, and
- Developing a context-aware query processor within DBMSs based on XREAL.

Contact Me

Thank You

Dr. Essam Mansour
Research Associate
School of Information Technology
International University in Germany
Email : essam.mansour@ieee.org
Web page: http://it.i-u.de/dbis