Federated Data Model to Improve Accessibility of Distributed Cadastral Databases in Land Administration

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Experimenting data models at Egyptian Survey Authority, Cairo, Egypt (photography by Tuladhar)

Introduction

- GIS manages a large volume of cadastral data and other related data such as data about market value, tax and use of land
- Many agencies involved in a distributed and heterogeneous processing environment
- Accessing data and integrating them in a single synchronous, consistent dataset using GIS software
  - Tremendous challenges
  - High resource, time and money
- Federated data model - a solution?
  - Integrating layers on the top of existing database systems
  - Reduce complex tasks at the users' desks

Cadastral data management

- Many developing countries organize their land data in separate agencies
  - Cadastral Parcel data
  - Topographic data
  - Ownership data
  - Tax data
- Managed at different location at central, provincial and local levels
- Egypt
  - Egyptian Survey authority (Ministry of public work and Irrigation)
    - Cadastral data
    - Topographic data
  - Real Estate department (Ministry of Justice)
    - Ownership data and registration data
  - State owned Land Agency
    - State owned land data
  - Tax department (Ministry of Finance
    - Revenue Tax Collection

Federated Database system (FDBS)

- FDBS - a collection of cooperating but autonomous component databases
  - A component db can participate in more than one federation
  - Integrated to various degree
    - Depends on the needs of federation users and desires of the administrators of the component dbs to participate in the federation and share their databases

Three key dimensions of FDBS

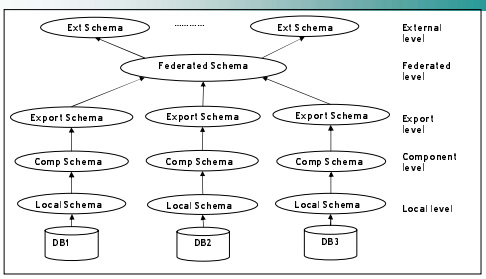
- Distribution
- Heterogeneity
- Autonomy

- Distribution
  - Multiple databases on a single/multiple computer systems - increased availability and reliability as well as improved access time
  - Existence of multiple Databases before FDBS

Three key dimensions of FDBS

- Heterogeneity
  - Database management systems
    - Difference in data models
    - Direct impacts in data structure, constraints and query languages
  - Semantic heterogeneity (Bishr, 1997)
    - Difference in hierarchies
    - Differences in classes
    - Differences in geometry
    - Differences in attributes lists and domains
- Autonomy
  - Organisations that manage databases are often autonomous - DBs are under separate and independent control
  - Three types
    - Design autonomy - ability to choose its own design. This contributes to the problem of heterogeneity
    - Execution autonomy - ability to execute local operations without interference from external operations
    - Association autonomy - ability to decide whether or how much to share its functionality and resources with others.

Federated Database Architecture

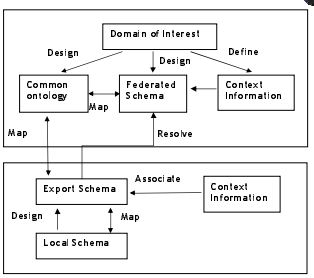


Federated database architecture (Benchikha, Boufaida and Seinturier, 2001)

- Critical issue is to map export schema to federated schema
- resolving semantic heterogeneity

Mapping Export Schema to Federated Schema

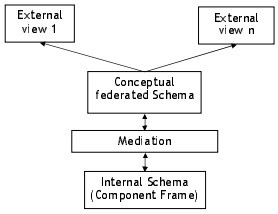
- Definition of common ontology for context to share
- Mapping its elements on federated schema
- Resolve semantic heterogeneity



Mapping between Export schema and Federated schema (Bishr, 1997)

Alternative approach for Land Administration (1)

- The above approach requires common ontology and precise design of domain within context
- Alternatively we can use simple approach for land administration based on mediation using three-tier architecture

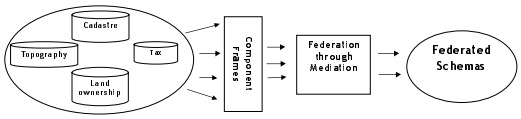


Three-level Federation Architecture based onMediation

Alternative approach for Land Administration (2)

- UML/OCL - the notion of derived class facilitates as a means to integrate certain classes and constraints which need to be shared in a federated context
- A mediator class is used for deriving federated schema
- Conflicts can be resolved within a mediator class (Balsters, 2003a and 2003b)
- Resolving conflicts
  - Renaming (homonyms and synonyms)
  - Data conversion (different data types for related attributes)
  - Default values (adding default values for new attributes)
  - Missing attributes (adding new attributes in order to discriminate between certain class objects)
  - Sub classing (creating a common super class and subclasses

Federating distributed databases



Provincial databases

- Component frame is specified in UML
- Semantic heterogeneity is analyzed to detect conflicts
- Introduce an Class mediator
- Construct an integrated schema
- Resolve conflicts via mediator class using suitable conversion functions

Preliminary findings

- Integration process does not affect individual databases
- Local people can work independently to satisfy local users
- Component frame means that local administration maintains the control over their systems and yet provides access to their data by global users
- Three level concept is possible in client/server environment

Conclusions

- We discuss various approaches for data access using federated schema (i.e. federated data model)
- Three-level federation architecture is promising, but detail investigation is recommended.
- Resolving conflicts through a mediation class require more research using real case data in land administration.
- Emerging concept in spatial data infrastructure

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Thank you for your attention