A Peer-to-Peer Based Semantic Agreement Approach for Spatial Information Interoperability

Doctoral Student : I Wayan Simri Wicaksana (iwayan@u-bourgogne.fr)
Supervisor: Kokou Yétongnon, Sebti Foufou ({kokou,sfoufou}@u-bourgogne.fr)

LE2I (UMR - CNRS)
Aile de l'Ingénieur - Université de Bourgogne
BP 47870 - 21078 Dijon CEDEX
Téléphone : +33 3 80 32 58 92, Fax: +33 3 80 39 68 89

Motivation Background

Decision support systems for e-government need textual and spatial information (GIS, image and traditional databases, etc) characterized by:

- large number of information sources
- heterogeneous information sources
- large volume and complex data

P2P based systems allows

- data sharing within community of users with common interest
- information retrieval based on semantic description and data source discovery

Research Objective

Provide P2P environment for data sharing by:

- representing semantic of peers
- allowing "No global view" semantic interoperability based on appropriate method of agreement between peers
- developing P2P based semantic interoperability

Propose a semantic mediation approach based on the following four pillars

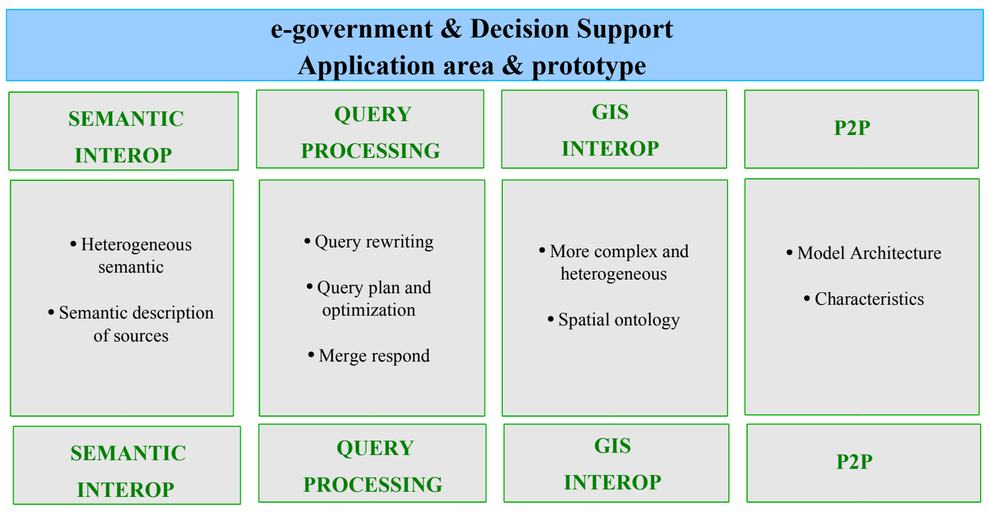

Figure 1. The Four Pillars

Basic Concept

- Semantic based representation languages (XMLS, RDFS, OWL)
- Semantic Overlay Network P2P
- Semantic Web and Query processing (RDQL, SeRQL, RQL)

Semantic Agreement Architecture

As shown in figure 2, the semantic agreement architecture consists of three contexts and three types of peers. The community context a super peer which manages the common ontology. The local contexts represent shared data available provider peers. The agreement context of a provider peer consist of a subset common ontology, an export schema, an agreement component and a query response management component. The super peer (SP) contains a reference ontology which provides a taxonomy description of the common domain. The provider peer (PP) contains export schema which represent local data. The request peer (RP) submits queries to PPs.

The agreement process is carried out between part of the SP common ontology (CO) and the PP export schema (ES). The results of the agreement are saved at the PP.

Query processing is based on agreement the export schema of the RP and PP peers. The query will directly route to appropriate PPs without the help of the SP. This help reduce the load on the SP and the impact of SP failures.

Peer Agreement Unit

The key components of the agreement process are the agreement units. They represent part of agreements between the SP common ontology and export schema at PP. Peer agreement consists of two steps. The goal of the first step is create node match elements (NME) between the SP and PP. The matching process is based on linguistic analysis and the tool (WordNet). An NME is tuple $<m_{ID}, N_{PP}, N_{SP}, R_{nc}>$, value of R_{nc}=[0,1]. In the second step, matching is carried of provider peers are matched. In the second step, different matching are established on different types of elements: class, properties, instance. The agreement unit is represented by a tuple:

$$<SMC_{ID}, ES_{PPi}, type_{PPi}, CO_{SPj}, type_{SPj}, trans_{cp}>,$$

where SMC_{ID} is unique ID, ES_{PPi} is element ES of PP, $type_{PPi}$ is type of element at PP, CO_{SPj} is element CO of SP, $type_{SPj}$ is type of element at SP, $trans_{cp}$ is a transformation function between ES & CO. The $trans_{cp}$ can be derivation mapping (class & property), and operation & constraint mapping (instances).

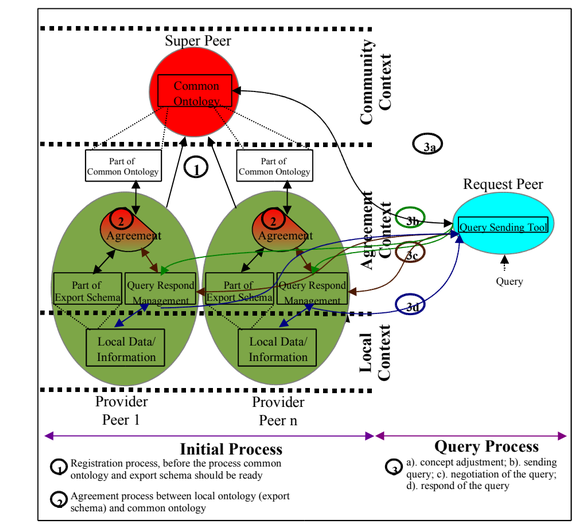

Figure 2. The P2P Based Semantic Agreement Approach

Example

Figure depicts provider peers with different modelizations of roads. In PP1, PP2 and PP3 roads are respectively described by their areas (covered surface), densities (number of car per hour), and sizes (width). Consider the following query "find secondary street" submitted by a RP peer looking for secondary street based on size. PP3 can respond to the query because it has same the view, but PP1and PP2 can not directly answer. For example there is negotiation between RP and PP2 (density). PP2 will inform RP that it has classification based on density so that RP can redefine its concept view as a tuple <SMCID, densityPP2, attributePP2, sizeSPj, attributeSP, transcp=convert 'size to density'>. The conversion tuple element can be a function, a look up table, or re-adjusted view. RP rewrites the query into "find secondary street with density=X".

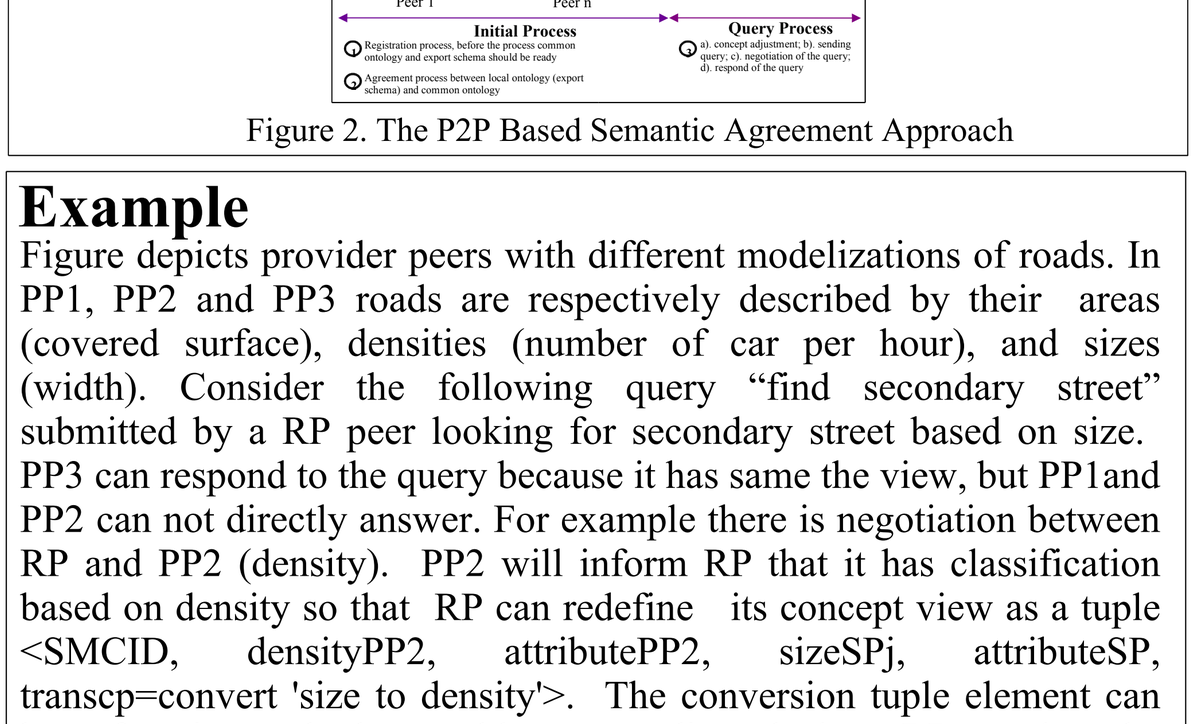

Figure 3. Example P2P Semantic Agreement

References

1. Y. Bishr, Semantic Aspects of Interoperability GIS, PhD Thesis, Wageningen Agricultural University, Netherlands 1997.
2. M. Arumug,, A. Sheth, and B. Arpinar, Towards Peer-to-Peer Semantic Web: A Distributed Environment for Sharing Semantic Knowledge on the Web.
3. T.S. Bacastoz and B. Lewis, Peer-to-Peer GIS.
4. Open GIS Consortium, http://www.opengis.org
5. Kokou Yétongnon, Seksun Suwanmanee, Djamal benslimane, Pierre-Antoine Champin, A web-centric semantic mediation approach for spatial information systems, Journal of Visual Language and Computing December 2005 (to appear).
6. F. Giunchiglia and P. Shvaiko, Semantic Matching Technical Report DIT-03-013, Apr. 2003.
7. . Klien, etc, An Architecture for Ontology-based Discovery and Retrieval of Geographic Information; In GI Jahrestagung (2), pages 574-578, 2004.