A Web-Geographical Information System to Support Territorial Data Integration

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INTRODUCTION

The design of a Web-geographical information system, Web-GIS (Worboys & Duckham, 2004; Zhong Ren & Ming Hsiang, 2003), strongly requires methodological and operational tools for dealing with information distributed in multiple, autonomous and heterogeneous data sources, and a uniform data publishing methodology and policy over Internet Web sites. In this article we describe the experience of the Politecnico di Milano group in the activities of requirement analysis and conceptual design of the DEAFIN Web-GIS (Schreiber et al., 2003), whose objective is to provide a common environment for comparison of information about available vacant industrial sites coming from different regional data sources. Heterogeneity and Web availability requirements have been taken into account in the system architecture design; the system is thus conceived as a federated Web-based information system, apt to manage and provide access to all the regional relevant information in an integrated and complete fashion. Furthermore, since the data available by a given region partner can be both spatial and alphanumeric, a Web-GIS is defined for each regional component system.

BACKGROUND

The DEAFIN (development agencies and their impact on foreign direct investments) project has been launched with the purpose of allowing companies and investors to get a comprehensive information framework about areas located in European regions suited for potential investments. The aim is to make the regional data about possible investment areas homogenous and comparable, and internationally accessible. Potential investors need both a survey and a detailed view of vacant sites in different locations in order to compare different opportunities and decide their convenience. Quite naturally, such requirements call for a federated information system (FIS), which grants local sites a great deal of autonomy while enabling interoperation by means of a global integrated conceptual schema, that is, the federated data schema. Furthermore, owing to the capillarity of the end-user locations and to the need of a simple and widely known interface, Web-based access is mandatory. To define the functional specification of the system, the following activities have been carried out:

- *analysis of the requirements* of a distributed Web-based information system relying on a common conceptual database schema of the regional information that was initially (almost completely) available on paper support;
- *conceptual design* of the DEAFIN FIS, centered on the conceptual design of the federated conceptual database schema. The regional databases must be built according to the federated schema and then made accessible via the Web. The availability of data on the Web allows potential investors to navigate in the DEAFIN site according to various and customizable

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criteria, based on a benchmarking model developed within the project.

INFORMATION REQUIREMENTS

Three regional administrations from Germany, Italy, and Sweden were involved. The project started with a data-gathering phase, aimed at collecting requirements about data and processes managed at the partner Public Administrations. A questionnaire-based tool was circulated to collect common information to be stored in the FIS.

The basis of the questionnaire is a set of the data categories managed in Public Administration information systems. The relevant data categories concern land use plans (master and regional or specific), territorial services, industrial vacant sites, mobility data, statistical and social-economic data, base cartography data, and information on cadastral units data. Information on vacant industrial sites is the main focus of the investigation. For each category, the questionnaire collected the data characteristics reported in Table 1.

In general, the data collected at the sites show uniformity with respect to the attention paid to cartographic availability, regulations and laws about reuse of vacant areas, and centralization of resources. In particular, the need exists at each regional site to introduce tools able to treat heterogeneous data, since these data more and more intensively are to come from various data sources, to be mapped into the federated schema. Also, the degree of automation is similar, since cartographic systems and basic data management tools are available at the three partners' sites.

Several ongoing local projects concern the digital acquisition of land use plans, the automation of document management, and the development of various thematic databases and Web sites. What is required is a unified common schema for the regional databases. Moreover, the need of a uniform data publishing methodology and policy over Internet Web sites emerges clearly from the participants and involves almost all data categories.

Table 1. Summary of data characteristics collected in the data-gathering phase

Data Characteristics
Availability of the data category
Location of the data source
Support technology and name of products/tools
Data format
Data owner
User roles involved in data access
Restrictions applying to data access
Performances
Maintenance policies
Availability on the Web

USAGE MODES

The data-gathering phase has also detailed a set of user profiles, which specify how different access demands can be supported by the system towards a variety of user groups. The design and implementation of profiles have obviously a deep impact on the usability of the system. Hence, a careful analysis of user typologies and profiles has been performed during the specification phase, while an enrichment of profiles and access modes has been planned in a post-implementation follow-up. The purpose is to have the system start with a set of pre-configured access typologies, and then tune the access modes and user profiles against the most typical uses observed for a fixed period on the DEAFIN pilot implementation. The first broad difference is between the profile of public administrations and that of private users, due to different data needs. Moreover, two basic interaction modes must be provided: browsing (using thematic areas and other refined search parameters) and querying (using simple and user-friendly interfaces). The system can be regarded as: a passive tool, when responding to user questions; an active tool, when used as a decision support system or when used as a standard application, allowing new European partners to join the DEAFIN consortium.

As a passive tool, the contents of the federated database can show the advantages and disadvantages of an area: the information provided can be related to the specific search needs of a specific user. These searches are different according to user types, but apart from the function of locating (or re-locating) business activities, the motivation probably exists to retrieve general information about a region.

SYSTEM ARCHITECTURE

In the literature, several approaches and tools for handling heterogeneous data sources have been developed, and standards for distributed information systems have been defined (Mylopoulos & Papazoglou, 1997; Wiederhold, 1992). For these systems, the use of multiple layer, mediator-based architectures, and of a common data model have been

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