Chapter XV

Spatial Monitoring and Routing System for the Transportation of Hazardous Materials

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INTRODUCTION

The concept of Environmental Information Systems (EIS) emerged from the concerns and the efforts carried on by world wide private and official organisations in order to promote an effective use of environmental data. These data are of various natures such as statistics, thematic maps, or documents describing the identification and the quantification of the environmental resources. The Environmental Information Systems became institutional tools providing pragmatic solutions for sustainable development in various fields. The objective of an EIS is to increase the quality and the efficiency in the decision-making process.

To achieve this goal, the EIS requires the integration of various information processing technologies: Geographical Information Systems (GIS); Database Management Systems (DBMS); Space Imagery; Decision Support Systems (DSS); etc. However, the implementation of such an integration generates new requirements, namely data interoperability, data description by metadata, reverse engineering from existing applications and remote data access and data processing. This leads to the reconsideration of the analysis and design methodology.

Another difficulty of implementation of an EIS comes from the diversity of knowledge concerning the environment and the multiplicity of actors in this field.

This leads to various ways to perceive and represent data depending on the field. Actually, not only are these data complex and heterogeneous, but they are also analysed according to multiple points of view. Indeed, the analysis of any phenomenon over the environment can be made from any of the following points of view, be it economic and social, ecological, territorial, demographic or organisational. It involves problems of integration of those points of view, and organisational problems.

Finally, data availability is crucial to make an EIS operational. Indeed, an EIS is a federated information system. It interacts with many remote systems that store or produce environmental data. In spite of this distributed system architecture, there should be no failure in accessing data. Specific mechanisms are then necessary, such as replicated databases (Pacitti et al., 1999).

This chapter describes an information system reactive toward the vulnerability of the hazardous materials (HazMat) transportation. This system arises from a project involving the authors (Boulmakoul et al., 1997a; 1997b). The project aims at developing a Spatial Decision Support System (SDSS) for hazardous materials transportation routing and monitoring. Hence, this chapter constitutes an operational contribution in the area of EIS.

This chapter is organised as follows. The next section introduces basic concepts and research works related to the HazMat transport domain. Our experience and the system architecture will be described in the third section. The functioning principle is then sketched. The test zone shows a typical application context and highlights the expected benefits of such EIS.

BACKGROUND

Geographical and federated information systems

Geographical Information Systems (GIS) are information systems that can manage, maintain, and retrieve geographical data (see Figure 1). The fundamental characteristics of these data are that they are to be spatially referenced (i.e., localised in space), multisource and multimedia (Laurini and Milleret, 1990; 1993; Laurini and Thompson, 1992).

The GIS provides five basic functions: geographical data acquisition; assembling different data sources; archiving these data; retrieval and analysis; and result display. The core of a GIS is a Spatial DBMS that is an extension of a conventional relational DBMS holding spatial features. The GIS contributes, in addition, to decision-making aid and allows the communication of information between several operators.

The federated databases are heterogeneous databases that offer a common

Figure 1. GIS structure.
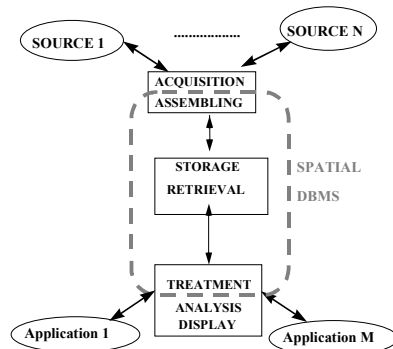
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