Chapter 14
An Ontology-Based GeoDatabase Interoperability Platform

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EXECUTIVE SUMMARY

This chapter presents an ontology-based platform enabling automatic translation between a large number of geographical formats and data models. It explains the organizational motivations for developing this system, the technologies used, how its architecture and processing components were developed, what it achieves and where it still needs improvement. Since current off-the-shelf description logic reasoners are unable to process the large ontologies involved in this system, this platform uses a custom mapping algorithm that scales gracefully and still computes the required information to effect translation between supported data formats. The authors believe that the lessons learned during this project and discussed in this chapter will prove especially useful to interoperability practitioners contemplating the use of semantic technologies for enabling large-scale integration across organizational boundaries.

INTRODUCTION

Achieving efficient data conversion and integration between information sources has always been crucial for extracting maximum value from database assets, and is one of the most important areas of research for us at the CoDE department of ULB. This case presents one of the results of this research, a platform for interoperating geographical information sources, developed upon request from one of our industrial partners.

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BACKGROUND

The client for this interoperability platform is responsible for the evaluation and development of the weapons systems used by one of Europe’s national armies. Historically, the geographical databases used in the various weapon systems deployed by the defense forces were the responsibility of each arm. For example, the Army was solely responsible for procuring the cartographical data used to feed moving map devices installed in tanks and other land attack vehicles. Warships, on the other hand, are equipped not with moving maps but with chartplotters, and the data they used was the responsibility of the Navy. While from a technological perspective both these devices are very similar to each other, (as well as to GPS receivers now present in many cars) for historical reasons they tend to use completely different data formats. The Army and the Navy were thus simultaneously tasked with the development of data sets to accommodate subtly different use cases and physical formats. Predictably, they came up with schemas that had large intersecting areas of expressivity but yet presented many subtle differences that made them completely incompatible. Over the years, this problem was repeated again and again, and today the terabytes of cartographical information critical to the army’s operations are stored in dozens of different formats, with each pair of them exhibiting design differences, some fundamental and some gratuitous, which makes data conversion between them extremely difficult.

The previous paragraph might give the impression that the army managers and executives who allowed such a situation to occur have been incredibly shortsighted. This, however, couldn’t be farther from the truth. As is so often the case in the computer science industry, a long series of sensible decisions has led to a collection of legacy systems that are ill adapted to current and future needs. A little background knowledge on the history of weapon systems helps explain why.

Military Cartography

Cartographical systems are used by the military at all stages of operations, sometimes directly by humans and sometimes as an input to a largely unsupervised computer process. These various cartographical systems have to accommodate a large disparity of user interface and timing constraints, from relatively slow systems limited by the speed of human reasoning, to the most stringent real-time constraints current technology can offer. At one end of this scale lie the maps and charts used by higher command for planning strategic operations. These have relatively lax timing constraints, and are thus supported mostly by paper charts on which physical markers are laid, due to the very convenient user interface these offer. A bit further down the scale, we find the systems that power situation rooms, where tactical operations are directed. Response times here are measured in minutes, and computerized systems are expected to show a representative, real-time updated view of the tactical situation in a field hundreds of kilometers wide. Here the main bottleneck remains human reaction time. Space constraints being relatively lax, powerful computers and large screens can be used to their full potential. Still further down the scale, tank pilots use the aforementioned moving maps to get a better understanding of the tactical situation in their close vicinity. Reaction times here are measured in seconds, and space is extremely limited. Towards the end of our scale we find terrain-following autopilots, used in many warplanes and cruise missiles. Those are quintessential real-time systems: any delay in retrieving needed information or computing the appropriate trajectory leads to either overshooting the altitude bound and risking detection by enemy forces, or failing to pull up in time and crashing into the ground.

Computerized cartographical information systems started being designed for the military in the nineteen-seventies and eighties, when available computing power was extremely scarce by today’s
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