Chapter 23

SWING – A Semantic Framework for Geospatial Services

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Abstract. The ability to represent geospatial semantics is of great importance when building geospatial applications for the Web. The Semantic Web Service (SWS) technology provides solutions for intelligent service annotation, discovery, composition and invocation in distributed environments. Deploying this technology into geospatial Web applications has the potential to enhance discovery, retrieval and integration of geographic information, as well as its reuse in various contexts. This chapter gives an overview of the SWING research framework, which is aimed at investigating the applicability of semantic technologies in the area of geospatial services. The goal is to provide a semantic framework that facilitates the employment of geospatial services to solve a specific task in geospatial decision making. In this chapter, we emphasize the motivation and the challenges for such a framework, point out the main components and highlight its potential impact.

23.1 Introduction and Motivation

Geographic information is an integrated part of everyday life, and geospatial services are therefore an attractive field both for research and for practical purposes. Sustainable planning of infrastructure development, spatial occupation and resource consumption requires a long-term perspective and an integrated approach to land use management across Europe. Today, many data sets are made available through geospatial Web services.

Interoperability is supported by the Open Geospatial Consortium (OGC) with a series of syntactic interface specifications, establishing protocols for the components exchanging geospatial information. However, challenges remain in supporting the crucial tasks of discovery and retrieval of information sources that meet the user’s needs. Metadata standards for the description of geodata exist as well as catalog services to search them. But these do not consider that the conceptualizations governing the different implementations have been constrained in different ways (Burrough and Frank 1995), causing semantic heterogeneity during discovery of information sources and retrieval of information (Lutz and Klen 2006).

In such open and heterogeneous environments, semantic interoperability is crucial for searching data sources and evaluating their content. What is lacking is semantic annotation of the information sources, i.e., a formal and explicit representation of their semantics (Kuhn 2005), as well as a supportive environment for realizing semantic discovery and retrieval.

While the standardization efforts of the OGC concentrate on syntactic interoperability, the Semantic Web initiative has brought the semantic issues of information processing into perspective (Berners-Lee et al. 2001). It seems promising to adopt the developments around the Semantic Web in order to approach semantic
interoperability in Geospatial Web applications. Visions, architectures and applications of this cross fertilization of Geospatial and Semantic Web technology are cumulating in the notion of a Geospatial Semantic Web (Arpınar et al. 2006; Egenhofer 2002; Fonseca and Sheth 2002; Kolas et al. 2005).

Semantic Web Services (SWS) represent the combination of two technologies: Semantic Web and Web Services. They can be defined as “self-contained, self-describing, semantically marked-up software resources that can be published, discovered, composed and executed across the Web in a task driven automatic way” (Arroyo et al. 2004). By using developments like the Web Service Modeling Ontology (WSMO) (Roman et al. 2005) and the Web Service Modeling Language (WSML) (de Bruijn 2005) for the semantic annotation of geospatial services, one could utilize SWS technology such as the Web Service Modeling Execution Environment (WSMX) to increase the efficiency and accuracy of discovering and integrating Geospatial Web services.

To describe a Web service semantically, a comprehensive knowledge of logic, ontologies, metadata and various specification languages is required. Thus, two major impediments for realizing the SWS vision in the area of geospatial services are (i) the lack of Web services that are semantically described, and (ii) the lack of development tools that can hide the complexity of and automate the creation of the necessary semantic markup.

In this context, we present a work-in-progress semantic framework for geospatial services, developed in the context of the Semantic Web Services Interoperability for Geospatial Decision Making (SWING) project, which aims at deploying SWS technology in geospatial applications. In particular, the SWING framework addresses two major obstacles that must be overcome for SWS technology to be generally adopted, i.e., to reduce the complexity of creating semantic descriptions and to increase the number of semantically described services. SWING wants to provide an open, easy-to-use SWS framework of suitable ontologies and inference tools for annotation, discovery, composition and invocation of Geospatial Web Services.

The rest of this chapter is organized as follows. In Section 23.2 we present the core challenges for the combination of SWS technology and Geospatial Web applications. Section 23.3 highlights the core components of the framework, and Section 23.4 summarizes its expected impact. Section 23.5 summarizes the chapter with an outlook on future steps in the development.

23.2 Challenges for Combining SWS Technology and Geospatial Services

SWS technologies promise an automated information processing based on the ability to assess semantic interoperability within the information flow of service-based infrastructures. We first describe a scenario for service composition to introduce the components of Geospatial Web applications. We then list the core challenges for combining SWS technology with geospatial service and illustrate the benefits with examples from the scenario.

In the scenario, a decision maker wants to produce a map that shows the ratio between production and consumption of aggregates within a certain region. Aggregates are needed as building material for a variety of construction applications, and the visualization of the production-consumption rate gives valuable information, e.g., for the planning of new quarry sites. To fulfill this request, several services are needed: