Geophysical Research Abstracts
Vol. 12, EGU2010-11688, 2010
EGU General Assembly 2010

A resource-oriented architecture for a Geospatial Web

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In this presentation we discuss some architectural issues on the design of an architecture for a Geospatial Web, that is an information system for sharing geospatial resources according to the Web paradigm.
The success of the Web in building a multi-purpose information space, has raised questions about the possibility of adopting the same approach for systems dedicated to the sharing of more specific resources, such as the geospatial information, that is information characterized by spatial/temporal reference. To this aim an investigation on the nature of the Web and on the validity of its paradigm for geospatial resources is required.
The Web was born in the early 90's to provide "a shared information space through which people and machines could communicate" [Berners-Lee 1996]. It was originally built around a small set of specifications (e.g. URI, HTTP, HTML, etc.); however, in the last two decades several other technologies and specifications have been introduced in order to extend its capabilities. Most of them (e.g. the SOAP family) actually aimed to transform the Web in a generic Distributed Computing Infrastructure. While these efforts were definitely successful enabling the adoption of service-oriented approaches for machine-to-machine interactions supporting complex business processes (e.g. for e-Government and e-Business applications), they do not fit in the original concept of the Web.
In the year 2000, R. T. Fielding, one of the designers of the original Web specifications, proposes a new architectural style for distributed systems, called REST (Representational State Transfer), aiming to capture the fundamental characteristics of the Web as it was originally conceived [Fielding 2000]. In this view, the nature of the Web lies not so much in the technologies, as in the way they are used. Maintaining the Web architecture conform to the REST style would then assure the scalability, extensibility and low entry barrier of the original Web. On the contrary, systems using the same Web technologies and specifications but according to a different architectural style, despite their usefulness, should not be considered part of the Web.
If the REST style captures the significant Web characteristics, then, in order to build a Geospatial Web it is necessary that its architecture satisfies all the REST constraints. One of them is of particular importance: the adoption of a Uniform Interface. It prescribes that all the geospatial resources must be accessed through the same interface; moreover according to the REST style this interface must satisfy four further constraints: a) identification of resources; b) manipulation of resources through representations; c) self-descriptive messages; and, d) hypermedia as the engine of application state.
In the Web, the uniform interface provides basic operations which are meaningful for generic resources. They typically implement the CRUD pattern (Create-Retrieve-Update-Delete) which demonstrated to be flexible and powerful in several general-purpose contexts (e.g. filesystem management, SQL for database management systems, etc.). Restricting the scope to a subset of resources it would be possible to identify other generic actions which are meaningful for all of them. For example for geospatial resources, subsetting, resampling, interpolation and coordinate reference systems transformations functionalities are candidate functionalities for a uniform interface. However an investigation is needed to clarify the semantics of those actions for different resources, and consequently if they can really ascend the role of generic interface operation.
Concerning the point a), (identification of resources), it is required that every resource addressable in the Geospatial Web has its own identifier (e.g. a URI). This allows to implement citation and re-use of resources, simply providing the URI. OPeNDAP and KVP encodings of OGC data access services specifications might provide a basis for it.
Concerning point b) (manipulation of resources through representations), the Geospatial Web poses several issues. In fact, while the Web mainly handles semi-structured information, in the Geospatial Web the information is typically structured with several possible data models (e.g. point series, gridded coverages, trajectories, etc.) and encodings. A possibility would be to simplify the interchange formats, choosing to support a subset of data models

and format(s). This is what actually the Web designers did choosing to define a common format for hypermedia (HTML), although the underlying protocol would be generic.

Concerning point c), self-descriptive messages, the exchanged messages should describe themselves and their content. This would not be actually a major issue considering the effort put in recent years on geospatial metadata models and specifications.

The point d), hypermedia as the engine of application state, is actually where the Geospatial Web would mainly differ from existing geospatial information sharing systems. In fact the existing systems typically adopt a service-oriented architecture, where applications are built as a single service or as a workflow of services. On the other hand, in the Geospatial Web, applications should be built following the path between interconnected resources. The link between resources should be made explicit as hyperlinks. The adoption of Semantic Web solutions would allow to define not only the existence of a link between two resources, but also the nature of the link.

The implementation of a Geospatial Web would allow to build an information system with the same characteristics of the Web sharing its points-of-strength and weaknesses. The main advantages would be the following:

• The user would interact with the Geospatial Web according to the well-known Web navigation paradigm. This would lower the barrier to the access to geospatial applications for non-specialists (e.g. the success of Google Maps and other Web mapping applications);

• Successful Web and Web 2.0 applications - search engines, feeds, social network - could be integrated/replicated in the Geospatial Web;

The main drawbacks would be the following:

• The Uniform Interface simplifies the overall system architecture (e.g. no service registry, and service descriptors required), but moves the complexity to the data representation. Moreover since the interface must stay generic, it results really simple and therefore complex interactions would require several transfers.

• In the geospatial domain one of the most valuable resources are processes (e.g. environmental models). How they can be modeled as resources accessed through the common interface is an open issue.

Taking into account advantages and drawback it seems that a Geospatial Web would be useful, but its use would be limited to specific use-cases not covering all the possible applications. The Geospatial Web architecture could be partly based on existing specifications, while other aspects need investigation.

References

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