Potentials and Challenges of Service-Oriented 3D Geovisualization

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Abstract

Virtual 3D city models are digital, georeferenced representations of spatial objects, structures and phenomenons of urban areas, which are increasingly built and leveraged in various application areas such as urban planning, environmental management and tourism. Visual representations of geospatial information and 3D city models in particular proved to be valuable means to facilitate thinking, understanding, and knowledge construction about human and physical environments, at geographic scales of measurement. Geodata and computing functionality is increasingly available as distributed resources that can be accessed through the Internet. This increased availability has created the demand and feasibility to build distributed systems that leverage these resources for visualizing and interacting with geospatial information. For the implementation of such distributed systems, the application of the architectural concept *service-oriented architecture* (SOA) and OGC standards are commonly proposed.

In this paper, we discuss potentials and challenges that arise when building standards-based, distributed systems according to the SOA paradigm for the purpose of geovisualization.

First, we briefly introduce fundamentals of geovisualization and the SOA paradigm. Then, we identify characteristics of service-oriented geovisualization systems by contrasting the application of the SOA paradigm in the geospatial domain to its application in the domain of enterprise information systems where the paradigm originated and where it has been researched and applied to a large extent. In order to combine SOA concepts, geovisualization concepts and OGC standards in a common conceptual frame of reference, we present an architectural framework that organizes and relates the aforementioned concepts. The architectural framework and following discussion of potentials and challenges are illustrated with a practical example from the tourism application area.

The discussion of the potentials of service-oriented geovisualization includes the following aspects. The potentials can be attributed to characteristics of the SOA paradigm, the geovisualization domain and standardization respectively. The primary potential of the application of the SOA paradigm in the geospatial domain is that it supports the uniform access, exploitation, integration and reuse of distributed geodata and geospatial functionality. Furthermore, the application of the SOA paradigm supports building geovisualization systems that yield high structural quality and maintainability and that can react to changing requirements in an agile and efficient way. The utilization of standards offers the potential of building and reusing services and systems that are interoperable and are of higher general quality by profiting from the work of domain experts. The application of the SOA paradigm for designing geovisualization systems implies the functional decomposition of the geovisualization pipeline and externalization into functional services. Services resulting from this decomposition yield the potential to be reused in processes they were not explicitly designed for. Compared to traditional geovisualization applications, service-oriented systems have advantages in better accounting for user requirements, the general process and their dynamics.

Regarding the challenges of service-oriented geovisualization our discussion includes the following aspects. On the data management level, the general tendency of geodata of being heterogeneous, occurring in massive amounts and appearing in multiple representations (e.g., level of detail) imposes challenges that are not yet solved sufficiently. On the functional level, the key challenge is to functionally decompose the geovisualization pipeline into services while balancing forces such as the goal of separating concerns, performance, reusability, granularity, maturity and potential for standardization. On the process level, the issue of composing processes from services in the geospatial domain in a transparent, effective and efficient way is still not resolved. On the interaction level, there is still need for specific interaction concepts that take into account that the decomposition and distribution of functionality and data introduces limitations on the overall performance of the system and the control and availability of individual components.