Service-Oriented Geovisualization for Geodesign

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Abstract

A rapidly growing collection of digital tools, systems, and applications is shaping the way we manage challenges in scientific disciplines and, to a significant degree, defines the scope of possible options and solutions we can develop. In the past few years, a general movement toward distributed, service-based IT solutions can be observed: Service-Oriented Architectures (SOA), Service-Oriented Computing (SOC), and Software-as-a-Service (SaaS), for example, represent fundamental technologies (GOLD et al. 2004).

In particular, the market for user devices has undergone a strong change toward mobile, wireless-operating, energy-sensitive smartphones and tablets; demand is also increasing for purely web-based solutions to simplify accessing, managing, and providing applications. As HAUN (2013) points out: "Smartphones and tablets are already key to doing business. But next year? These devices will rule business."

Although web services represent one fundamental paradigm for service-based modeling, implementing, and deploying geo-information systems and allow us to build complex, robust, interoperable, distributed, and standardized IT solutions, *service-oriented geovisualization* is still in its infancy. For it, "different mechanisms for the portrayal, delivery, and exploitation of 3D geodata based on open standards-based formats and services" have to be investigated as, for example, in the OGC 3D Portrayal Interoperability Experiment (OGC 2012).

Today's geovisualization applications and systems largely rely on the user device's capabilities for processing, rendering, and interacting with 3D virtual environments, generally follow a single-threaded execution model, and handle data by streaming and local caching. For service-oriented geovisualization, these processes and functions have to be decomposed, restructured, specifically assigned to servers and clients, and (partially) standardized. Service-oriented visualization approaches, in general, benefit from recent developments in mobile 3D graphics and rendering (e.g., WebGL, multi-core mobile CPUs, and dedicated GPUs for mobile devices).

The software architecture of geovisualization applications and systems demands efficient methods for coping with the conditions and restrictions of mobile devices such as limited networking and computing resources. These challenges include the following:

- How to transmit and stream massive 3D model data to mobile or web applications?
- How to decouple the complexity of 3D models from the complexity of 3D data transmission?
- How to handle energy-intensive 3D rendering tasks on energy-sensitive devices?
- How to cope with the diversity of 3D hardware capabilities on mobile devices?
- How to adapt and optimize graphics and interaction design for mobile devices?

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- How to ensure scalability in terms of the number of users and the amount of data?
- How to ensure cross-platform compatibility and consistent implementations?

Service-oriented approaches for scalable, mobile geovisualization applications can be based on a number of key technological concepts, such as the following:

- Server-based 3D rendering and remote 3D rendering
- Image-based 3D scene reconstruction on mobile devices
- Image-based interaction with 3D scenes on mobile devices
- Combination of level-of-detail (LOD) and level-of-abstraction (LOA) techniques
- Multi-resolution modeling for massive geodata

In the talk, I will address the aforementioned issues along with many technology building blocks recently developed in the field of mobile solutions for virtual 3D city models and landscape models. In particular, I will show how to use image-based reconstruction to transmit complex 3D models efficiently (HILDEBRANDT et al. 2011; DÖLLNER et al. 2012) and how to handle large-scale, big virtual 3D city models and big 3D point clouds within a SOC environment (RICHTER & DÖLLNER 2013). Concepts and techniques for 3D model generalization and level-of-abstractions are also discussed (SEMMO et al. 2012).

Based on service-oriented geovisualization, complex virtual 3D models together with related geodata and georeferenced data can be efficiently accessed, processed, analyzed, and visualized on mobile devices or within standard browsers. Service-based geovisualization not only will help to enhance and optimize workflows, tools, and applications in the field of geodesign but also will serve as a key element for building new forms of online communication, public participation, and information dissemination.

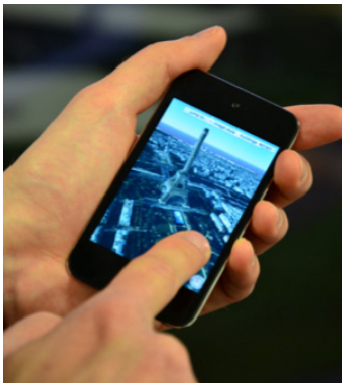

Fig. 1: Examples of mobile applications operating on service-based geovisualization

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