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Sensor Web Application to Transport Infrastructures Monitoring

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We introduce the reference architecture of a distributed, Web-based information system for generating, publishing, cataloguing, and processing spatial remote-sensing data for sensor-based transport infrastructure monitoring applications.

This system is being defined in the framework of the FP7 ISTIMES project (Integrated System for Transport Infrastructures Surveillance and Monitoring by Electromagnetic Sensing), and will be further developed and implemented in two test bed sites. The lessons learnt from these phases of development and implementation will be incorporated in a final release of the architecture.

The overall aim of the ISTIMES project is to exploit heterogeneous in-situ sensors, supported by specific satellite measurements, for non-destructive electromagnetic monitoring, providing real-time, detailed information and imagery of the infrastructure status, to improve decision support for security stakeholders.

From an ICT (Information and Communication Technology) point of view, ISTIMES aims at designing an open networked architecture that can accommodate a wide range of remote and in-situ sensors, and can easily scale up to allow the integration of additional sensors and to interface with other networks.

The implementation of a network of Web-enabled sensors, so-called Sensor Web, is commonly recognized as a key enabler for many applications.

The ISTIMES system architecture takes into account the state-of-the-art of the current standardization initiatives in the field, as well as other relevant EU-funded projects (e.g. FP6 Orchestra, SANY, OSIRIS).

A leadership role in the field is played by OGC, which promotes the Sensor Web Enablement (SWE) initiative, aiming at identifying architectural solutions for building the Sensor Web. SWE is the current geomatics standard baseline for Web-enabled sensor systems.

SWE collects and integrates several standards in a service-oriented approach and offers mechanisms for sensor system discovery and tasking, based on the Web and the OGC geo-processing framework.

The ISTIMES system architecture is based on the following design rationale:
• Shift from “system” to “infrastructure” or “System of Systems”;
• Shift from the traditional data-centric approach to a Service-Oriented Architecture (SOA) approach;
• Focus on multidisciplinary interoperability.

It features an extended SOA approach, where the communication between service consumers and providers may be facilitated by appropriate value-added services, according to the mediator pattern. This decoupling of servers and clients has proven beneficial in a number of use-cases, including: discovery, processing, access, and security.

Our main contributions have regarded:
• The recognition of the potential system users (including scientists and citizens) and of appropriate use-cases;
• The design of a four-layered set of services, progressively abstracting the low-level acquisition of data to the production of synthesized meaningful notifications;
• The identification of the system components and of possible technological implementations (when available).

A significant challenge for ISTIMES applications concerns the accommodation of real-time, streaming data

sensors, such as high-resolution cameras. The approach taken is to process these data locally, trough a high-bandwidth link. The final release of the ISTIMES system architecture may further investigate this aspect.

Another issue concerns asynchronous event management, which is naturally implied by monitoring applications. The approach taken resorts to the OGC best practices. We are actively contributing to the recently started OGC effort to identify a standard solution for Publish/Subscribe functionalities in OGC services, as a component of the more general Event-driven Architecture pattern, under investigation by the OGC and other standardization bodies.

Our experience constitutes a valuable test-bed for the current best practices and standards in multi-sensors, real-time monitoring systems. It will be contributed to the GEOSS Architecture Implementation Pilot - Phase 4, to be developed in early 2011, and possibly provide valuable feedback for the future evolution of the standards.

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