Standardised Real-time Information Systems for Environmental Monitoring – An Elaborate Challenge

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Abstract. Environmental monitoring requires the combination of various distributed and heterogeneous data sources. The situational awareness approach aims at replacing monolithic and often incompatible measurement systems by a service-based sensor infrastructure. The proposed open-standards-based method allows for the integration of different live and archived data sources, which are the basis of a direct assessment of environmental conditions.The aim is to provide a framework for the combination of local and distributed data to achieve situational awareness in near real-time by using GIS analysis methods on the server side. The methodology can be applied to different scenarios in the fields of environmental monitoring, natural hazard prediction, early warning systems or security-specific applications.

1 INTRODUCTION

Vast amounts of measurement data with high temporal and spatial resolution will be available in the next years due to a dramatic decrease of sensor costs according to Paulsen and Riegger (2006). A main challenge in the near future will be to combine different data sources providing different formats and interfaces (Resch and Mittlboeck 2007).

Using these data for environmental monitoring applications requires a comprehensive standardisation initiative aiming at a wide interoperability of information systems. To achieve this ambitious goal, the European Commission has set up a number of directives such as the Public Sector Information Directive (PSI), which was launched in 2003 and the INSPIRE (INfrastructure for SPatial InfoRmation) directive, enacted in November 2006.

These directives can be the basis for the long-term development of a Europe-wide network of Internet-accessible sensor devices monitoring environmental conditions, climate changes or predicting natural hazards. This will result in a replacement of monolithic and incompatible sensing systems by an open measurement infrastructure creating a ‘virtual electronic sense organ’ for the whole globe. Therefore, legacy measurement systems are complemented by intelligent and autonomous sensing devices, which can

Florian Probst and Carsten Keßler (Eds.): GI-Days 2007 - Young Researchers Forum.
IfGIprints 30. ISBN: 978-3-936616-48-4

be subsumed with the term ‘Sensor Web’ (Resch and Mittlboeck 2007). In consequence, efficient mechanisms have to be developed to process the raw data in order to create geographic information layers, which can be presented to the user in a very intuitive and tailored manner.

2 SITUATIONAL AWARENESS MODEL

From the conceptual viewpoint, the framework developed with the doctoral thesis aims at integrating different standardised services such as the Open Geospatial Consortium (OGC) Web Map Services (WMS), Web Feature Services (WFS) and Web Coverage Services (WCS) and combining these data sources on the server-side with current sensor measurements as illustrated in Figure 1.

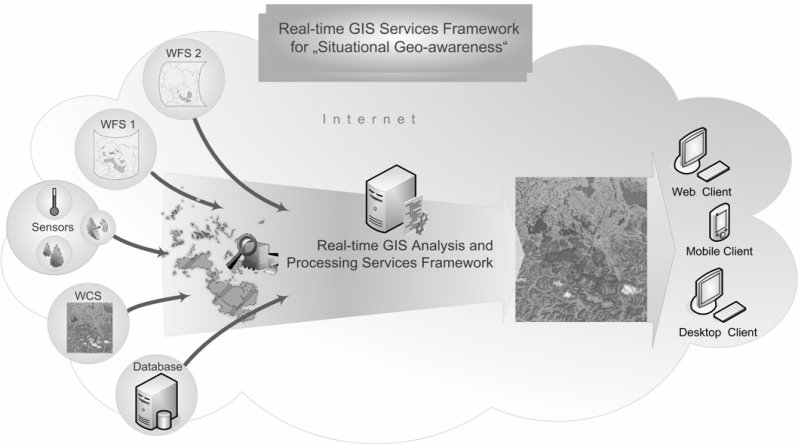

Figure 1: Geographic Real-time Service Environment.

Through the use of a geo-services infrastructure, a wide range of heterogeneous data sources can be combined to achieve instant situational awareness. Therefore, current sensor measurements are merged with other live or archived data sources. This requires a harmonisation mechanism to supply all gathered data in a common format. By the use of several OGC geo-service standards such as WCS - currently - for raster data, WFS for vector data and WMS for the combination of raster and vector data and their graphic representation, results and the source data can be provided in a distributed manner.

3 IMPLEMENTATION CONCEPT

As part of the doctorate project, a prototypical system set-up of the real-time geo-awareness concept (Resch and Mittlboeck 2007) is realised, which is illustrated in the following figure.

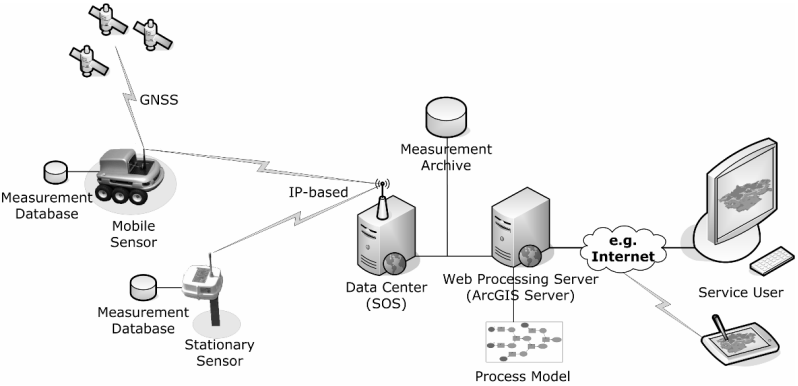

Figure 2: Real-time Situational Awareness Topology.

The implementation includes a simple Sensor Web system, which is compliant with the OGC Sensor Web Enablement (SWE) initiative. With SWE, a standardised framework of the OGC is developed, providing for a broad and easy discovery, accessibility and controllability of different sensor types in a standardised way. The programme comprises eight standards ranging from a sensor description language and an XML-based measurement data encapsulation structure to different services such as alerting mechanisms or sensor registries (cf. Botts, 2006).

As it is important that different data sources can be combined regardless of political and domain-specific particularities, pre-processing systems are required, which provide generalised data in a structured format. Therefore, an OGC Sensor Observation Service (SOS) compliant application is developed for the standardised availability of current sensor data. Furthermore, a server-side processing mechanism is realised to combine live sensor measurements with other data in complex process models. The analysis results are provided in a user-centred web client.

Thus, the main idea of the concept is to shift processing capabilities from the client to the server. The client only needs to send a request for the appropriate sensor data and to instruct the processing server in order to combine the measurement data with external information and other heterogeneous data sources in a pre-defined manner. This results in the creation of in-

tuitively understandable information layers, also for users without profound GIS knowledge.

However, this combination of new and partly fragmentarily developed technologies requires a generalised framework comprising a series of geo-standards, semantic and format conventions. This guarantees an uncomplicated adaptability of the base concept for different application scenarios.

4 CONCLUSION

The paper presents ongoing research on the topic of situational awareness, which stands for a direct assessment of environmental conditions by the use of live sensor measurements. The final system implementation, which constitutes a prototypical realisation of the generalised framework, will comprise a sensor network, which is realised compliant with the OGC SWE initiative, a server-side processing algorithm e.g. for different interpolation, pattern matching or trend analysis operations and a user-centred web interface for the visual presentation of the results.

The main advantage of the complete system is that previous approaches, which offered GIS functionality only in resource-consuming desktop applications, can be replaced by web-based analysis tools. This means that complex GIS analysis processes are performed on a central processing server and the results are provided to the user via the web.

From the long-term conceptual viewpoint, the system aims at replacing hitherto post-processing mechanisms by near real-time analysis methods allowing for instant environmental situational awareness, which is crucial for a wide range of application scenarios such as environmental monitoring, natural hazard prediction or different security applications resulting in increased efficiency in emergency management and prevention (Resch et al., 2007).

REFERENCES

Botts, M., G. Percivall et al. (2006). OGC Sensor Web Enablement: Overview And High Level Architecture. http://www.opengeospatial.org, Open GIS Consortium White Paper, 7 July 2006.

Paulsen, H. and U. Riegger (2006). „SensorGIS - Geodaten in Echtzeit“. In: GIS-Business 8/2006: pp. 17-19, Cologne.

Resch, B. and M. Mittlboeck (2007). Einbindung von Echtzeitmessinformation in Geographische Informationssysteme. in Strobl, J., T. Blaschke and G. Griesebner (Eds.) (2007): Angewandte Geoinformatik 2007. Bei-

träge zum 19. AGIT-Symposium Salzburg. Wichmann, Heidelberg. ISBN 978-3-87907-451-8: pp. 615-620.

Resch, B., D. Schmidt and T. Blaschke (2007). Enabling Geographic Situational Awareness in Emergency Management. Geospatial Integration for Public Safety Conference, New Orleans, USA, May 15-17, 2007.