Network for testing GI services

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Abstract. The use of standards is essential when building a SDI. Today we have a number of standards and specifications from organizations like W3C, OGC, ISO etc. In addition, the European Commission is specifying implementing rules related to the INSPIRE directive.

In order to comply with all these standards and specifications, testing procedures has to be developed and utilized. Some organizations like OGC, develop their own suite of testing applications. In other cases, for instance for the INSPIRE service specifications, no guidelines for testing are provided by the EC. As a result, we have a variety of development initiatives across Europe, aiming to develop testing procedures related to SDI development in general and INSPIRE specifically.

The Persistent Testbed is an initiative by AGILE, EuroSDR and OGC. Its aim is to act as research test-bed for collaborative European research in geospatial interoperability. The Persistent Testbed has now taken the initiative of creating a testing network. The aim is to coordinate the current widespread development of INSPIRE related testing procedures and software development, in an effort of making more efficient use of limited resources.

In addition to just testing if a certain service complies to a certain set of standards and specifications, the network also develop other procedures. One such procedure is to integrate INSPIRE tests with the monitoring and reporting scheme as specified by the EC. Another development is related to usability tests, which is focusing on the user's perception of the services. These tests can also be used to test to what degree the INSPIRE implementing rules fulfill the user requirements.

Keywords: Web services, testing, standards.

1 Introduction

Many organizations, private as well as public, are facing requests on cutting expenses. This also includes operations of strategic importance, such as IT management. Conforming to standards and streamlining operations are some tools used in obtaining more efficient IT operations.

Current mainstream technological IT trends are based on web technologies. By moving desktop applications to web solutions, operational costs may be cut by 35% - 50% [13]. Different blogs also report that going from in-house or outsourced web solutions to cloud computing may cut additional 50% of the remaining costs ([7], [12]). Although some of these reports may be somewhat biased, there is still a large number of indications showing a large cost reduction potential of IT operations. However, the GIS sector seems not yet to be able to deal with the new commercial offers of cloud services, such as Infrastructure as a Service (IaaS) and Software as a Service (SaaS). So we still have a large unexplored set of cost reduction possibilities ahead of us.

INSPIRE is a European directive, aiming to provide access to and better use of geographical information within Europe [2]. The implementing rules associated with this directive are based on the use of web service technologies which are direct aligned to the current IT trends and developments. The use of standardized services like WMS, WFS, WCS and CSW as well as standardized and harmonized data sets are technological cornerstones in the implementation of the INSPIRE directive.

What we see today in Europe is a large number of governmental agencies setting up their web service in order to provide their data according to the INSPIRE directive. In addition, a large number of cities and associations of cities are establishing portals and other web services for the provision of their spatial data. Many of the governmental agencies are forced to do this, due to the legal implications of

the INSPIRE directive. The incitements for the local governments vary, but often cost reduction potentials and improved services to the citizens are quoted as reasons.

Although the cloud service business models and services like Infrastructure Services (IaaS) have not yet entered the GIS and SDI markets, it is clear that the web service technologies are here to stay, at least for quite a while. One of the main advantages of web-based and cloud-based solutions is related to its scaling capabilities. If you want to increase the number of users in a desktop solution, you need to acquire more software licenses. A similar expansion in a web-based solution requires increased number of servers. In a cloud-based solution, you only need to increase the number of virtual servers.

Although there is a clear potential in cost reductions for IT management in the future, such reductions must be balanced with respect to performance and usability. In case of investing in web-based solutions or cloud based solutions, the performance of the services must be evaluated. In addition to this, the INSPIRE directive also specifies performance requirement of the services covered by the directive. Compliance with standards and specifications are crucial for SDI's as well as cloud services. We have observed a number of initiatives across Europe, where testing tools and procedures are being developed. In order to coordinate the current widespread development of testing procedures and software development, a coordinating network has been established. The network is organized under the Persistent Testbed (PTB) umbrella. The objective of this paper is to describe this networking initiative and its current state of development.

2 Testing concepts

2.1 Basic testing concepts

The INSPIRE directive, as well as the cloud computing concept, is based on the use of web services. The INSPIRE directive also relies on the use of standardized data specifications. As a consequence, the PTB testing network focuses on testing the performance and usability of web services and their compliance to standards.

Software testing is here defined as the process of executing software and comparing the observed behavior to the desired behavior [14]. Software testing methodologies are basically of two different types, namely black-box testing where no knowledge about the design of the software modules is known to the tester and white-box testing, where internal data structures and algorithms are known. The white-box testing methodologies are often applied in the context of software development. This means that the testing tools are integrated with the software development process and support a more efficient development. However, in our case when testing web services is in focus, only knowledge of the service interfaces is known. This means that mainly black-box testing procedures are of interest for us, for the time being at least.

There is a variety of black-box testing methods ([9], [10]), such as domain testing, combinational tests, scenario testing, function testing etc. The choice of testing method depends on the purpose of the tests, what to measure and constraints such as legal constraints, accessibility etc.

Function testing is probably the easiest testing procedure. For a web service, each operation is identified and tested one at a time. The test is not aiming to identify the limitations of the service, just to verify that the web service respond as expected.

A request to a web service consists in principle of a call and a specification of input variables. Domain testing means that the entire domain of a single variable is tested. However, since a domain may be quite large, some kind of sampling is often required. In many cases, stratified sampling is used. For a WMS, the background color (BGCOLOR) is one of the variables. In domain testing, the domain of the background color (0x000000-0xFFFFFF) is first specified. Then possible colors within that domain are randomized and tested.

In most cases, more than one variable has to be tested. The WMS GetMap request includes for instance 15 variables. Domain testing of several variables at the same time is often called combination testing. As a consequence, multi-dimensional sampling has to be done. One example of combination

testing is when WMS requests are sent having random bounding box, random size (width and height), and random background color etc.

The domain and combination testing has its limitation. Due to the sampling procedure, there is a risk that important and common combinations are neglected. In theory, if we had a-priori knowledge about the probability and importance of each combination, this knowledge could be considered in the design of the sampling procedure. Another approach is instead to apply scenario testing. This method is based on testing meaningful combinations of functions and variables, in contrast to domain tests and combinatorial tests where more artificial combinations are used. A meaningful scenario shall involve a storyline and it should be motivating, credible, complex (close to real life) and easy to evaluate. Scenario testing has the advantage that it focuses on (hopefully) important and frequent operations. Another advantage is that it is also possibly to measure goal fulfillment for each scenario. One disadvantage is that the design of the scenarios often takes more efforts as compared to automatic sampling procedures. Example of scenario testing is the application testing of the INSPIRE data specifications as requested by the Commission.

2.2 Some SDI testing requirements

As mentioned, the objective of the PTP testing network is to coordinate the development of testing tools and procedures, related to INSPIRE and SDI. The perhaps most well-known tests are the OGC Compliance Testing Program [11]. Here the functions of the web services are tested in the sense that their responses to the requests are validated. This corresponds to function testing as described above.

When version 2.0 of the INSPIRE Data Specifications for Annex I was released [3], the stakeholders was asked to perform transformation tests and applications tests. The goal of the transformation tests was to develop and test transformation methodologies. The main outcomes were however a set of desk studies, where gap analysis was performed. These gap analysis identified gaps between the national schemas and the INSPIRE schemas in terms of content, assuming a schema translation could later be done. Some testers also carried out the actual transformations [15], while most did not. In case such tests were done, they may be considered as function tests or domain tests.

The application tests specified for the INSPIRE Data Specifications, aims to show whether a chosen use case can be implemented by using data that is harmonized according to the data specifications. This corresponds to some kind of scenario testing. However, due to the short response time for the Annex I data specification review, no real application testing was ever carried out at that time. One reason for this was the lack of harmonized data sets.

The European Commission has also released draft implementing rules for network services, such as the viewing service, download service etc. Here also some performance requirements are specified, like maximum response time, number of simultaneous users and service up time. In order to test compliance to these specification, some kind of combination testing and load and stress tests are required. One such example is the Czech tests of web services [8].

The INSPIRE principles mainly concern authorities at a national or state level. Local governments (municipalities) are in general not formally effected by the INSPIRE directive. However, as the number of local geoportals grows, there is a need to harmonize their development, for instance by applying the INSPIRE principles. But due to the variation of prices and business models among solution providers, performance and usability tests of different solutions are required. These tests, which often have a character of benchmarking, often correspond to combination testing and scenario testing.

3 The PTB testing network

As already described, we have currently a situation where there is a need for a variety of testing tools and procedures, related to INSPIRE and SDI development in general. During discussions related to the implementation of the INSPIRE directive, it was realized that several organizations develop their own testing tools and procedures in parallel. The OGC develop and publish procedures for testing of their specifications. Future Position X in Gävle, Sweden develop procedures for INSPIRE testing, performance testing and usability testing. At Bundesamt für Kartografie und Geodäsie (BKG) in

Frankfurt, attention is being paid to integrating testing procedures with the INSPIRE monitoring and reporting scheme. The Technical University of Ostrava in the Czech Republic has also developed tests related to performance testing of geoportals and SDI implementations [8]. Also within European projects such as NatureSDIplus, GIS4EU, ESDIN etc, similar tests are supposed to be developed and executed. In order to coordinate these development efforts, EuroSDR [4] and AGILE [1] has agreed on starting a network for sharing such experiences and results. This network is organized under the Persistent Testbed (PTB) umbrella.

The Persistent Testbed is an initiative by AGILE, EuroSDR and OGC [6]. Its aim is to act as research test-bed for collaborative European research in geospatial interoperability. The PTB started its operations in 2007. During the first phase of the testbed, a number of services were developed, organized in use cases such as portrayal, discovery, schematization, fog monitoring and semantic web services. In 2009, this first phase has ended and the final results are currently being prepared. At the time of writing this paper, a new call for participation is currently being prepared. The call is planned to include an invitation for participation in the PTB testing network as well as a call for new initiatives.

The objective of the PTB testing network is to coordinate the development efforts that currently takes place within different organizations, projects and initiatives. The following activities are currently planned.

- Invitation to join the initiative will be submitted to projects and organizations
- Two - three seminars will be organized, in conjunction with other main events such as the AGILE conference
- A wiki site for sharing experiences will be established
- A report on the experiences and achievements will be compiled at the end of 2010

The network is organized in two levels. The core group consists of partners that develop testing tools and procedures and are willing to share their results and experiences. The coordination here consists of specifying time plans and development tasks for each partner. In case of overlap, coordination actions are expected to be initiated. The core group currently consists of representatives from the University of Gävle, Sweden, Future Position X, Sweden, Bundesamt für Kartografie und Geodäsie (BKG), Germany, Technical University of Ostrava, Czech Republic and the University of Nottingham, United Kingdom.

The second level of the network consists of individuals and organizations that are interested in monitoring the progress of the PTB testing network. Participation at this level is open to everyone and information is provided through the forum of the network (to be established).

4 The GeoTest Project

The GeoTest project [5] is an initiative of the National Land Survey of Sweden, Future Position X and the GIS Institute at the University of Gävle. The aim of the initiative is to develop a testing and demonstration environment for geodata and GI services. The initiative also aims to support the development of an infrastructure for geodata and to the implementation of the INSPIRE directive in Sweden. The GeoTest project is officially recognized as a part of the national SDI strategy.

The project started with the transformation testings of INSPIRE Annex 1 data specifications. Five themes (addresses, hydrography, transport network, place-name and cadastral areas) were tested and reported [15].

At the GeoTest centre, services and certification procedures are developed for those that have a need for carrying out tests of their geodata and in such a way assure the quality of the entire process from producer of data to users and citizens. The expected effect is a safer use of the geodata for all parties in the chain as well as a more efficient use of the geodata that now are made available to the SDI society via different portals and web services.

Thanks to the fact that the GeoTest Centre is being built up in co-operation between several strong actors within the area, it is possible to scale up the activities, as well as securing the supply of know-

how, when needs arises. The development plans are based on the process approach of Research-Learning-Development-Innovation-Demonstration.

At the GeoTest centre, producers, users and test teams are offered a meeting place for exchange of experiences and development of methods. Lab environments for testing and different types of data and applications are provided. These environments can be adapted to the desires and needs of different clients. The current developments are based on the needs that are stated in INSPIRE's time table and requirements stated by local governments and other authorities. As a result, the current development focuses on performance tests and usability testing.

5 Conclusions and summary

The conclusions can be summarized as follows

- Due to the INSPIRE directive and due to the increasing interest in web based GI services, the needs for new tools testing procedures for GI services has increased.
- Current development of testing procedures for GI services is fragmented and spread across organizations and countries. There is a clear opportunity in improving effiency by a higher degree of cooperation.
- The AGILE-EuroSDR-OGC persistent testbed (PTB) has formed a network aiming to coordinate the development efforts and to share its results.

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