Spatial Services in the eGovernment: Delivering WFS and WMS Queries through the Data Exchange Layer of the Finnish National Architecture for Digital Services

Pekka Latvala, Lassi Lehto
Finnish Geospatial Research Institute
National Land Survey of Finland
Geodeetinrinne 2
Masala, Finland
pekka.latvala@nls.fi
lassi.lehto@nls.fi

Teijo Kalliomäki
Finnish Geospatial Research Institute
National Land Survey of Finland
Opastinsilta 12
Helsinki, Finland
teijo.kalliomaki@nls.fi

Abstract

The standards that are used in the eGovernment development set demands for the integrated services. In Finland, the National Architecture for Digital Services uses SOAP-based communication in the data transfer. This is in conflict with the widely-used geospatial standards. This paper deals with the challenges of integrating existing WMS and WFS services with the Finnish National Data Exchange Layer. In the pilot project, we created adapter services that transform the requests and responses between the message forms, used in the geospatial services and the SOAP forms, used in the National Data Exchange Layer. The results show that the use of adapter services requires additional implementation work and reduces service performance. At the same time, adapters also provide a way to create new easy-to-use service interfaces that can hide complex functionalities.

Keywords: eGovernment, Web Services, SOAP, Data Exchange Layer

1 Introduction

One of the ongoing global trends is that governments all over the world are moving from traditional service delivery models to an eGovernment model where public services are provided over the Internet. This shift aims for creating cost savings and better service delivery for the citizens [1].

Some of the common service types in the eGovernment are related to applying social benefits, handling of electronic recipes for pharmacies, taxation, electronic health records and voting. Spatial services can also be seen as one of the key service types in the eGovernment. They provide important data that other services across the governmental sector can use. They are also crucial in the information visualization. In addition, many of the spatial services are developed by different governmental institutions [2].

When eGovernment services are being built, the relation between the existing spatial service standards and the eGovernment implementation technologies should be taken into consideration. The standardization of spatial services is already on a mature level. Organizations such as The Open Geospatial Consortium (OGC) and Internal Standardization Organization (ISO) Technical Committee 211 have defined various standards for spatial services that are widely used. The creation of services has also been hastened by initiatives such as INSPIRE Directive [3] where services are implemented according to existing standards. Important question is how the existing spatial services can be used with the eGovernment implementation. Is it possible to use the services as such or do they have to be integrated with the eGovernment technologies?

In Finland, these questions are relevant in the context of the project 'National Architecture for Digital Services' [4] that has been launched by the Ministry of Finance in 2014.The goal of the project is to establish an infrastructure of digital services that makes the data transfer between different organizations and services easy. The project consists of four parts: 1) the implementation of National Data Exchange Layer (NDEL), 2) common service views, 3) national e-identification model and 4) role administration and user authorization.

The work, described in this paper is related to delivering OGC's WFS and WMS services through the NDEL. The second chapter introduces the NDEL and its architecture. The third chapter describes the pilot case where existing WFS and WMS services were integrated with the NDEL. The paper ends with conclusions.

2 National Data Exchange Layer

The Finnish NDEL is a platform for transferring data between services and organizations securely. It is based on the Estonian X-Road platform [5] that has been introduced in 2001. In Estonia, the X-road platform is widely used for the provision of public services. The current amount of services that are connected through it exceeds 2000 and it is used by more than 900 organizations [6].

2.1 Architecture

The X-Road platform has a decentralized architecture that is based on the publish-find-bind model [7] of the Service Oriented Architecture. The communication in the platform is made between different security servers that are run on well-defined server environments. The security servers provide connection points to the X-Road platform. The messages that are sent between them must be in the Simple Object Access Protocol (SOAP) form [8]. The architecture of the X-Road platform is described in Figure 1.

When an organization wants to use services that are provided through the platform or to connect their own services into it, they must 1) set up a security server and 2) implement an adapter service. The adapter services are used for transforming the service requests and responses between the SOAP forms and connected services' native message forms. All adapter services that are connected to the X-Road platform must also be described in a Web Services Description Language (WSDL) [9].

The central components in the X-Road platform provide services that are essential for its functioning. The central server contains information of all security servers and their services that are connected to the platform and the organizations who are managing them. This information is also saved regularly as local copies to each security server. Therefore, security servers can communicate directly with each other. The central security server is used for providing technical services to other security servers, such as adding and removing organizations. The Configuration Proxy is a component that delivers the configuration information to security servers.

The Time Stamping Authority (TSA) adds timestamps to messages that are delivered through the platform. The timestamps are stored into log files on security servers and they can be used for ensuring that the messages have not been changed during the data transfer and that they have been delivered to the specific recipient. The Certificate Authority (CA) is used for providing certificates for security services and organizations that are managing them. The certificates are used for creating secure connections between the security servers. The Online Certificate Status Protocol (OCSP) is used for checking the validity of these certificates.

3 Pilot Case

The integration of existing WMS and WFS services with the NDEL was tested in the pilot scenario, in which a family is looking to buy or rent a summer cottage in the Northern Karelia in Eastern Finland. We developed a mobile application for the iOS platform where the locations of the available cottages can be explored on a map interface. The interface contains also supporting information that is fetched from the WMS and WFS services, developed by the different organizations participating in the project. The services that were used in the application were:

WMS Services

- Lake Water Quality service from the Finnish Environmental Institute
- Visible Infrared Imaging Radiometer Suite (VIIRS) satellite image service from the Finnish Meteorological Institute
- Topographic Basemap service from the National Land Survey of Finland
- Forest Berry Crop service from the National Resources Institute Finland

WFS Services

- Average temperature from observation stations from the Finnish Meteorological Institute
- Land property information service from the National Land Survey of Finland

In addition, a differential GNSS service providing sub-meter positioning accuracy was also included in the pilot application.

Figure 1: Architecture of the X-Road platform

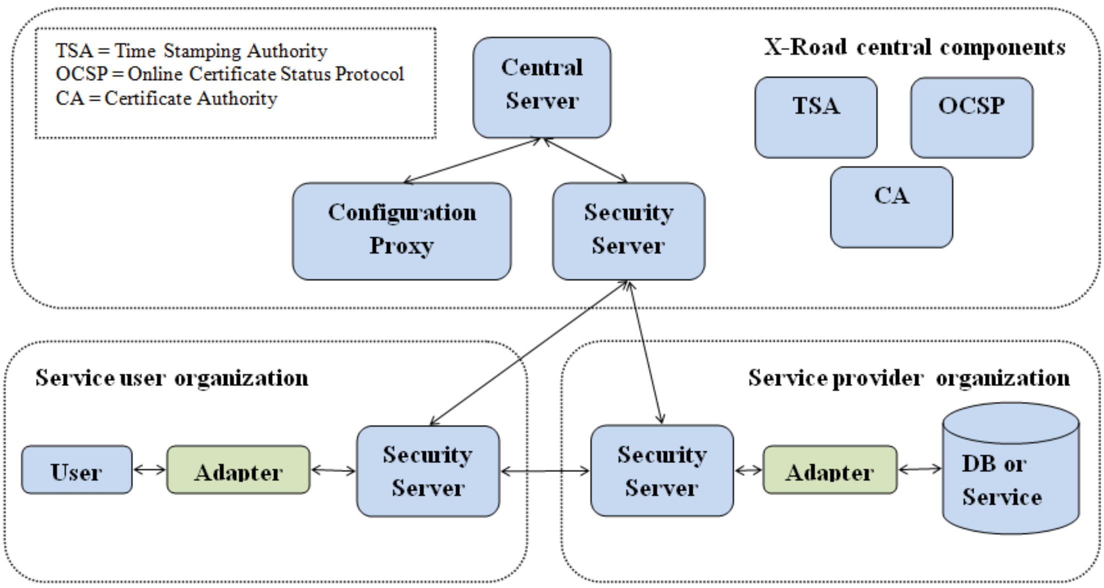
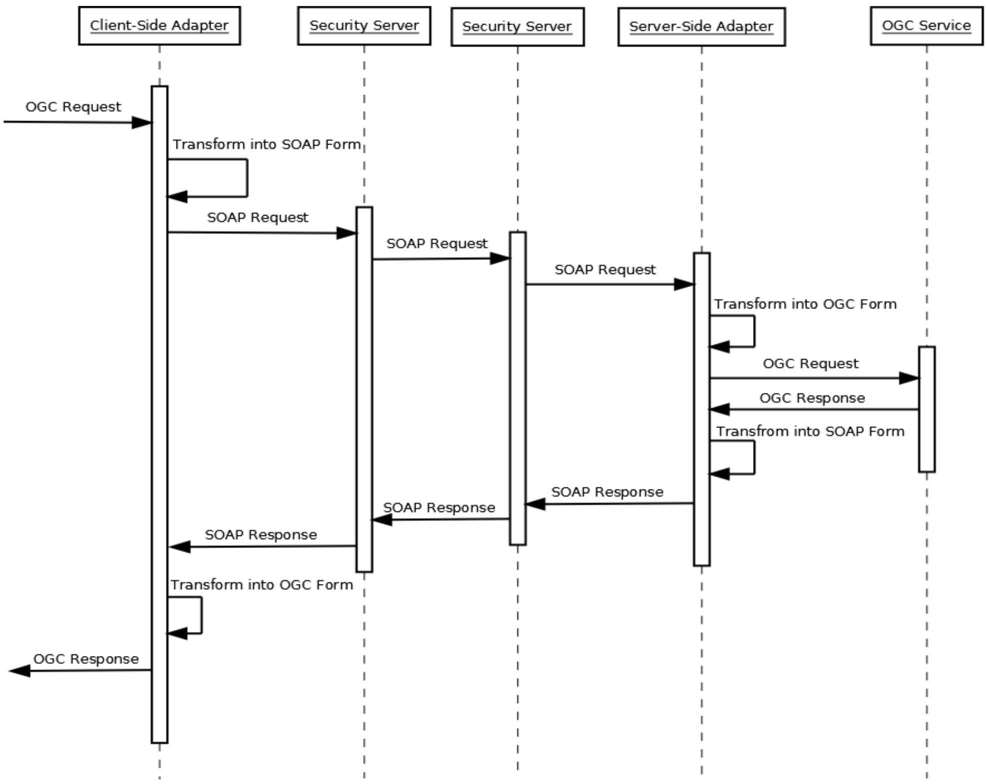


Figure 2: The request-response sequence in the X-Road platform.



3.1 Adapter Services

The WMS and WFS services were connected to the NDEL by creating adapter services that transform the requests and responses between the OGC message forms and the SOAP forms. The adapter services were connected on two different security servers, one on the server-side, representing a service provider organization’s connection point to the X-Road platform and the other on the client-side, representing a service user organization’s connection point. The use of adapter services makes the X-Road platform invisible to end-users who think they are communicating directly with the OGC services. This enables the services that are provided through the platform also to be used in applications that utilize multiple services at the same time. The basis for the service adapter implementations was a Java-based open-source XRd4J library [10] that implements the X-Road SOAP profile and the service metadata protocol.

The request-response sequence of the queries is presented in Figure 2. The client-side adapter service transforms the OGC requests into SOAP form and sends them to the client-side security server. The messages are then routed to the other security server where the requested OGC service is connected.

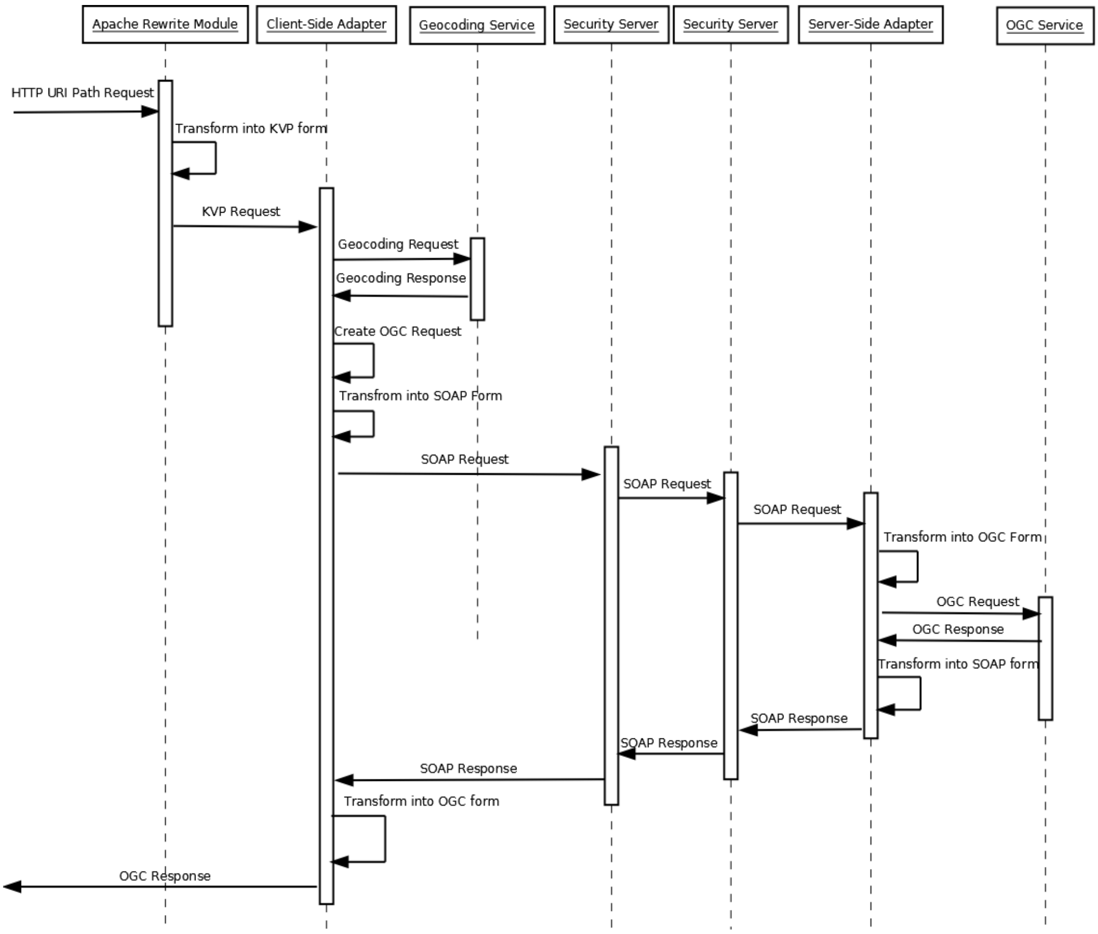
The routing is based on the SOAP message's header information. The SOAP headers contain the organization's member code who manages the service and the subsystem code and service code of the specific service to which the query is focused. The information about the different organizations and their services is maintained at the central server. This information is also stored locally to each security server with a defined expiration time. The platform can function without a connection to the central server until the information in these local copies expires.

The server-side adapter transforms the requests back into original query forms and sends them to the OGC service. The OGC responses are packaged again into SOAP form and sent back to the client-side adapter that unpackages them from the SOAP envelopes and returns to the client.

The transformation of service requests are handled differently for GET and POST queries. The POST queries can be packaged easily into the SOAP form because they are defined in the XML format. The transformation of GET queries can be implemented in various ways. The simplest way is to package the query strings as such, inside a single XML element. The advantage of this approach is that it is easy to develop.

The query parameters can also be typed strictly by assigning each parameter to a specific XML element and selecting default values and value enumerations for them. The advantage of this approach is that the details of the service interface can be described in a WSDL document that can be used for automatic code generation in the client-side**.** The disadvantage is that it is a more complicated implementation.

Figure 3: An example of the request-response sequence in the new APIs.



For WFS queries, both GET and POST request methods are widely supported in the available server applications. For WMS queries, only GET requests have large application support because the XML-based encoding for the GetMap operation has been defined only in the Styled Layer Descriptor (SLD) specification [11] and not in the WMS specification itself.

The transformation of service responses is different, based on the returned content type. The responses of WFS queries and those WMS operations that produce XML-based data can be easily packaged into SOAP messages. The return types in the WMS GetMap operation are raster images. Images can be encoded into text with the Base64 encoding, and put either inside the SOAP message's internal element structure or they can be sent through the SOAP with attachments [12] mechanism, in which attachments are sent after the initial SOAP message.

The drawback of the adapter implementations in general is that the OGC service responses contain URLs that are pointing to the original services. Responses would need to be analyzed and those URLs replaced with ones that point to the adapter service.

The results of the performance tests show that the use of X-Road degrades the query performance. The WFS queries' performance is 1.3 times slower when compared to the direct OGC queries and for the WMS services this is 1.5 times slower. Most of the difference comes from the data transformation process that is carried out between the OGC forms and the SOAP form.

3.2 New APIs

The X-Road platform's requirement for the creation of adapter services opens up possibilities for the easy implementation of new interfaces to the OGC services. These new APIs might be useful especially in the eGovernment context where many users potentially come outside of the geospatial field. The OGC interfaces can become quite complicated for example in situations that require the use of complex filtering expressions. The adapter services can hide this complexity under simple requests. They may also be used for combining complex service request sequences, utilizing several services, under a single service call.

We created in the pilot project new APIs for WMS and WFS services that contain also built-in geocoding functionalities. The new APIs are formulated as simple HTTP URI paths. An example of the new WFS query interface is:

http://[domain]/spatialobject/parcel/Helsinki/Opastinsilta/12

For WMS queries similar type of query can be formulated as:

http://[domain]/map/basemap/Helsinki/Opastinsilta/12

The request-response sequence that is used in the new APIs is presented in Figure 3. The query is performed by first sending the HTTP URI path to Apache web server's rewrite module that reformats the query string as a key-value pair query and sends it to the client-side adapter service. The adapter service extracts the address information from the request and formulates a query to a geocoding service that returns the coordinates for the given address. In the original query, the path part after the *domain* section indicates whether the request is a *map* request that will be sent to a WMS service or a *spatialobject* request that will be sent to a WFS service. The following path section specifies the individual background service. Additional path parameters can be specified as necessary. For example, in the WFS example the requested coordinate system is specified directly in the adapter service but this choice could be also given to the user.

4 Conclusions

The NDEL platform is a part of the Finnish National Architecture for Digital Services and it is based on the Estonian X-Road solution. The use of OGC services with the X-Road requires the development of adapter services that mediate the communication between the OGC message forms and SOAP messages.

The creation of these adapter services can be seen as an additional work in comparison to using directly the OGC interfaces. According to performance tests, the use of adapters degrades the service performance, which is between 1.3 and 1.5 times slower than direct service requests.

The positive aspect in the use of adapter services is that they have to contain WSDL-based service descriptions, which opens the option for automatic code generation in the client-side. The service adapter development makes it also possible to introduce new service interfaces to the OGC services with a small effort. They can be designed to be easy to use, while they can contain very complex service request sequences.

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