EnviroInfo 2007 (Warschau)
Environmental Informatics and Systems Research
Copyright © Shaker Verlag, Aachen 2007. ISBN: 978-3-8322-6397-3

# Transmission of Spatial Data Through Web Services (Web Map Service and Web Feature Service) Based on Geographical Information Systems

Aleš Veršič[1]

## Abstract

This article describes two Web services using geographical information systems which enable exchange of spatial information between the distributor or government institution and clients who require environmental spatial data. The introduction explains the reasons for introducing Web services and standards governing this area, followed by a presentation of differences between the Web Map and Web Feature services and a description of their technical characteristics. The article concludes by presenting two solutions put forward by the Environmental Agency of the Republic of Slovenia.

## 1. Introduction

In 2002 three European commissionaires, namely for the environment (DG ENV), statistics (DG EUROSTAT) and research (JRC), signed an agreement to cooperate in the development of the INSPIRE initiative. This initiative resulted in a proposal for a directive of the European Commission (EC), and in February 2007 the directive was adopted. Pursuant to the directive, European Union Member States will have to set up an infrastructure for spatial information to support the EU's environmental policies, as well as policies and actions which may have a direct or indirect impact on the environment. The infrastructure will have to include metadata, spatial data sets and spatial data services ranging from the local to global level in a manner enabling multi-purpose utilisation.

Figure 1 gives the architectural model of the European infrastructure, which will be based on the infrastructure to be set up and managed by the Member States.

Side by side with the aforementioned directive goes a trend towards enabling access to data at the global level through Web services for spatial data. In most European countries, a number of distributors of spatial data facilitate the accessibility of such data through the Web Map Service (WMS) and Web Feature Service (WFS). In 2002, the Survey and Mapping Authority of the Republic of Slovenia (SMARS) "commenced with systematic set-up of a distribution environment for the survey and mapping service, as well as its integration into the Slovenian e-government system, which enables/will enable direct computer access to survey and mapping data to different user groups, such as state and local authorities, particular users (survey and mapping firms authorised to carry out survey and mapping services, notaries, lawyers, real estate agencies, building managers, etc.), other companies and natural persons" (Internet 2).

Side by side with the aforementioned directive goes a trend towards enabling access to data at the global level through Web services for spatial data. In most European countries, a number of distributors of spatial data facilitate the accessibility of such data through the Web Map Service (WMS) and Web Feature Service (WFS). In 2002, the Survey and Mapping Authority of the Republic of Slovenia (SMARS) "commenced with systematic set-up of a distribution environment for the survey and mapping service, as well as its integration into the Slovenian e-government system, which enables/will enable

[1] Agencija Republike Slovenije za okolje, Vojkova 1b, 1000 Ljubljana, e-mail: aversic@gov.si

direct computer access to survey and mapping data to different user groups, such as state and local authorities, particular users (survey and mapping firms authorised to carry out survey and mapping services, notaries, lawyers, real estate agencies, building managers, etc.), other companies and natural persons" (Internet 2).

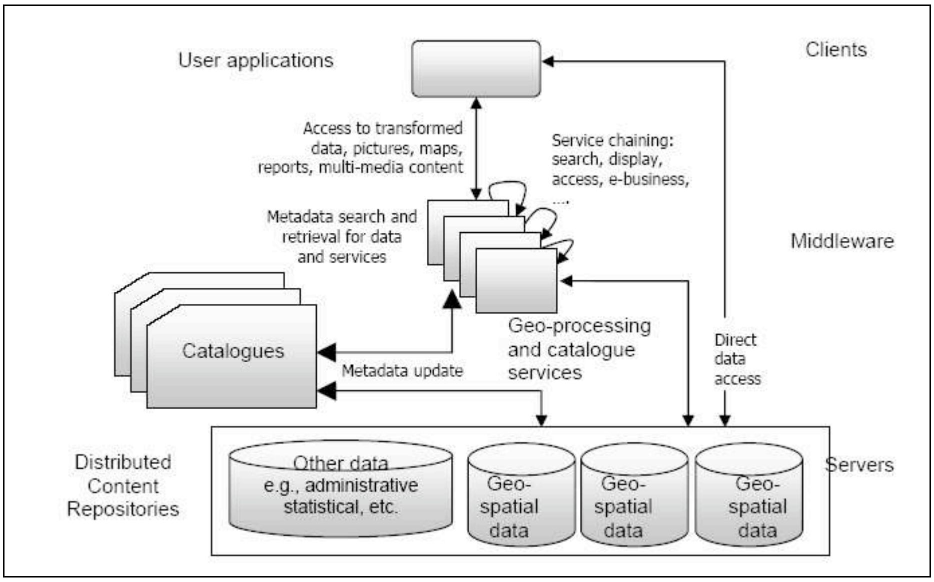


Figure 1: INSPIRE architectural model (source: Inetrnet 1)

Side by side with the aforementioned directive goes a trend towards enabling access to data at the global level through Web services for spatial data. In most European countries, a number of distributors of spatial data facilitate the accessibility of such data through the Web Map Service (WMS) and Web Feature Service (WFS). In 2002, the Survey and Mapping Authority of the Republic of Slovenia (SMARS) "commenced with systematic set-up of a distribution environment for the survey and mapping service, as well as its integration into the Slovenian e-government system, which enables/will enable direct computer access to survey and mapping data to different user groups, such as state and local authorities, particular users (survey and mapping firms authorised to carry out survey and mapping services, notaries, lawyers, real estate agencies, building managers, etc.), other companies and natural persons" (Internet 2).

"The system of distribution of survey and mapping data was set up in 2003 and the first user Web services were activated in 2004. They enable different types of examination of survey and mapping data, and transmission of selected data to the user's system" (Ažman, 2005, 56).

This is only the first step towards Web services enabling broader use. The SMARS distribution in place is intended for state administration; currently, other users may only examine data. The aim of WMS and WFS services is to provide individual users with an updated source of information that can be combined with data from other sources, thus enabling the creation of information needed by the user. The user does not need any advanced technology; a PC with appropriate software to display such data will suffice.

The governing coalition stated in the coalition agreement: "The coalition will develop public administration as a service to citizens and enterprises, and provide a business-friendly administrative environment" (Internet 3, 54).

"As regards the introduction of e-government, the coalition will focus on database computerisation, integration, and accessibility to users inside and outside public administration. By the end of the term of office, all major public sector databases (e.g. the central register) will be computerised" (Internet 3, 55).

The mission of the Environmental Agency of the Republic of Slovenia (EARS) contains the following: "Observation, analysis and prediction of natural phenomena and environmental processes; performance of tasks of national hydrology, meteorology, seismology and geophysics, environmental protection and water management services; reducing natural threats to humans and property; environmental monitoring and reporting to the national and international public and institutions; fulfilment of environmental protection requirements arising from applicable regulations; raising awareness on the environment and environmental issues among the public and institutions; *provision of quality public information on the environment*; conservation of natural resources and biodiversity, and ensuring the sustainable development of Slovenia (Internet 4).
Among its strategic objectives, the following are highlighted:

- providing quality environmental information, analysis and a professional basis for decision making
- ensuring greater public safety, and efficient methods to inform the public about environmental issues and environmentally hazardous situations
- introducing simple, citizen-friendly administrative procedures
- performing regular work with efficient operations and the lowest possible costs
- caring for the enhanced positive visibility of the agency and its tasks among the public (Internet 5)

ARSO will provide access to updated and quality environmental data through WMS and WFS services and will thus follow its mission and strategic objectives. Quality updated information, as well as the simplest possible access to needed data, are of importance to every user; therefore the utilisation of such Web-based services provides one way of transmitting spatial data.

## 1.1 Standards and standardisation

Through understanding and agreement between national institutions, standardisation aims to achieve common specifications, criteria concerning the classification of materials, products, testing and analysis, and terminology and services. Along these lines, we facilitate processes and ensure greater reliability to users – they will know what to expect if an individual product meets a defined standard.

Standards governing Web Map and Web Feature Services are: OpenGIS® Web Map Service (WMS) Implementation Specification 1.3; OpenGIS® Web Feature Service (WFS) Implementation Specification 1.1 in ISO 19119:2005; and Geographic information – Services.

In addition to those mentioned, ISO 19113:2003 is also important, as are the quality principles ISO 19114:2003, quality control assessment procedures and ISO 19115:2003, Metadata. The Slovenian Institute for Standardisation (SIST) is responsible for developing and maintaining Slovenian standards (Šumrada, 2005b). SIST operates through technical committees; the technical committee for spatial information and geomatics (SIST TC GIG) is responsible for the field of geographic information.

## 2. What is a web map and web feature service?

Following the request of an individual user, the Web Map Service (WMS) produces geo-referenced dynamic maps. Unlike the WFS service, where data on an individual area are transmitted, the WMS service produces a map in raster format (PNG, GIF or JPEG) or as a vector element in SVG or WebCGM format. The map also contains attribute data. Data drawn up in WMS mode may be accessed by PC software that enables inclusion of spatial data through WMS service, or by using an application prepared especially for such types of services.

Web Feature Service (WFS) is an interface that allows transfer of geographical data based on the Web request. Data exchange is accomplished through the XML-based GML (Geography Markup Language) format for data exchange. A more detailed description of GML is given in the next chapter.

## 3. Description of technical characteristics of web map and web feature service standards

Following is a description of the three most frequently used technological features. All three refer to procedures for data recording or performing operations, but do not indicate how the described data are mapped into databases (data file or reference data). The mapping mode is set by the server.

### 3.1 Geography Markup Language (GML) (Šumrada, 2005a)

GML is a language used for modelling, transferring and storing geographical data. It contains different features to describe geographic characteristics, namely geometry, system of coordinates, topology, time, measurement units and general values. Following is an example of a point location description.

```
<gml:location>
        <gml:Point gml:id=«point96« srsName=«epsg:4326«>
                <gml:coordinates>31:56:00S 115:50:00E</gml:coordinates>
        </gml:Point>
</gml:location>
```

Figure 2: Example of point recorded in GML format

### 3.2 WMS – Web Map Service

WMS produces maps using spatially referenced data from geographical information systems. Output data formats are different picture formats (GIF, PNG or JPEG) or vector formats (SVG or WebCGM). There are three types of operations:

- retrieval of metadata on a service
- retrieval of a map – example of a simple call:

```
http://a-map-co.com/mapserver.cgi?VERSION=1.3.0&REQUEST=GetMap&
CRS=CRS:84&BBOX=-97.105,24.913,-78.794,36.358&
```

```
WIDTH=560&HEIGHT=350&LAYERS=AVHRR-09-27&STYLES=&
FORMAT=image/png&EXCEPTIONS=INIMAGE
```

Figure 3: Example of picture request on WMS server

- information on a particular data layer on the map

Most frequently, WMS is combined with WFS and Styled Layer Descriptor (SLD) – the former provides for appropriate access to vector data, while the latter is used to define the style for mapped data.
When one wants to use WMS, the URL must be entered into the application to retrieve data from the server. (**http://k3/wmsconnector/com.esri.wms. Esrimap/zavobm?request=get capabilities&service= WMS&version=1.1.1** )
When data are obtained, the application is used to examine and combine them with other layers, and to obtain attributive data. Figure 4 shows an example of WMS use through ArcCatalogue.

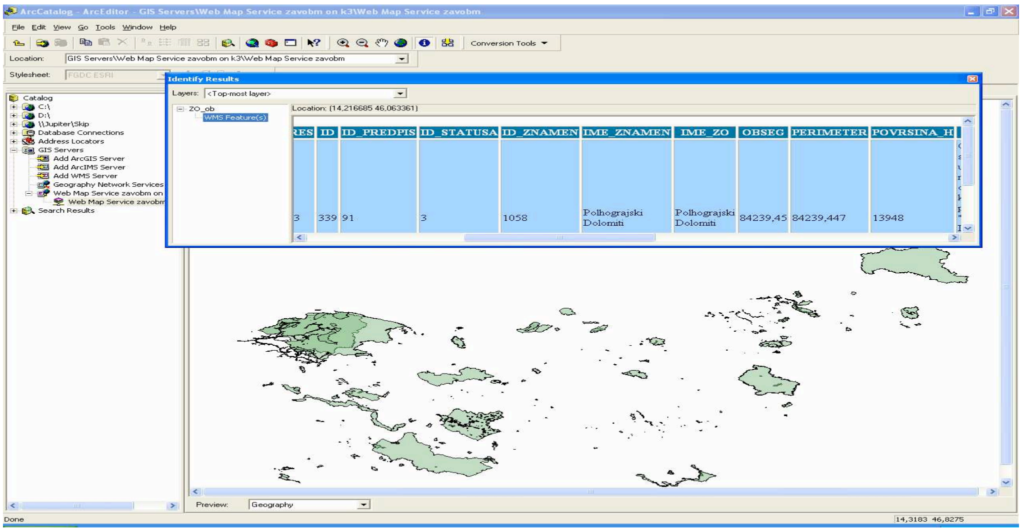


Figure 4: Example of use of WMS use through ArcCataloque (ESRI)

WMS has simplified access to graphical data (maps) from different data sources.

## 3.3 WFS – Web Feature Service

WFS enable access and modification of data using HTTP protocol.
WFS operations comprise insert, modify, delete, lock, query and search. WFS also support the following operations:

- GetCapabilities → a Web service must be able to present its capabilities: specifically, it must indicate geographical elements it supports and the operations we may perform,
- DescribeFeatureType → returns a description of the geographical feature in question,

- GetFeature → a Web service must be able to retrieve geographical features; the application must have the option of selecting the parameters it wishes to read and setting a condition according to geographical or other data,
- GetGmlObject → returns Xlink indicator to the appropriate GML object,
- Transaction → a set of operations composed of adding, modifying and deleting geographical features,
- LockFeature → a Web service must enable the option to lock a set of objects for the duration of a transaction.

# 4. Examples of implementation

## 4.1 Use of WMS supported by ArcIMS at the Environmental Agency of the RS

The ESRI enterprise is a leading provider of geographic information systems software. It supports different OGC standards in server products (ArcIMS), as well as in programs intended for final users (e.g. ArcInfo).

ArcIMS is a server for publishing maps, generated dynamically, and spatial data across the web. Source data may be stored in files on the disk, or in a database accessible through ArcSDE. Figure 6 shows the ArcIMS architecture and WMS processing set up by EARS.

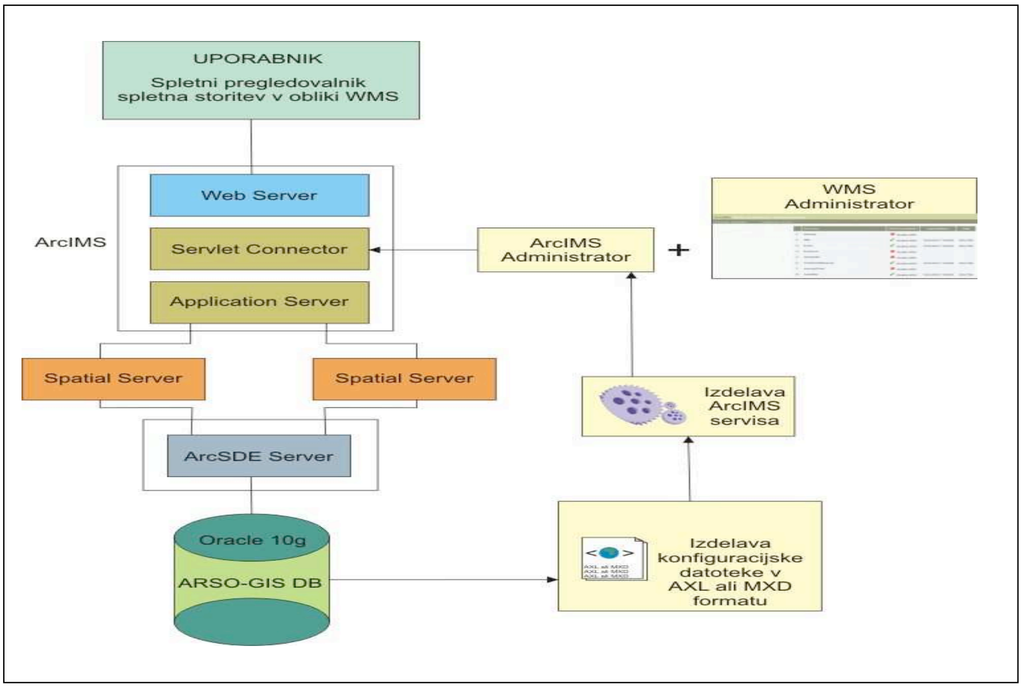


Figure 5: ArcIMS architecture and WMS processing

In order to provide spatial data, a configuration data file must be set up, storing information on the location of the data and particular settings (projection, display scale, etc.). This data file can be created in .axl or .mxd format. The data files are then published on the ArcIMS application server under the particular name of the service; the data are then available to user applications. In ArcIMS, WFS and WMS need to be set up separately. Subsequent use is very simple – existing services are published through the Web wizard as WFS or WMS. Regrettably, ArcIMS does not support the reading or modification of data via WFS protocol. ARSO spatial data may be provided in the WMS format, created by using the ArcIMS server. Data are stored in the Oracle relation base subordinate to the ArcSDE server, enabling the sorting of these data.

ArcIMS service is provided by the ArcIMS administrator, using a configuration data file. Thus we have created an ArcIMS service which may be used for Web browsing or WMS. Using ArcIMS – WMS Connector Administrator, we publish the ArcIMS service as WMS.

ARSO adopted the decision to make WMS Web services available free of charge, although in the first phase the access shall be limited to a particular group of users. They are:

- State authorities and authorities of self-governing local communities
- public agencies, public funds, public institutes and public commercial institution
- other bodies governed by public law
- private legal entities performing public services within the competence of state or local communities
- foreign institutions and/or organisations established by states or international organisations.

## 4.2 Use of WFS supported by GISRepSystem at the Environmental Agency of the RS

The GISRepSystem solution enables simple publication of data from the Oracle Spatial format, using the WFS standard. It enables installation on any J2EE-compatible application server. Within the ARSO project we used data stored in Oracle Spatial format, while the solution provides for the creation of flexible data sources.

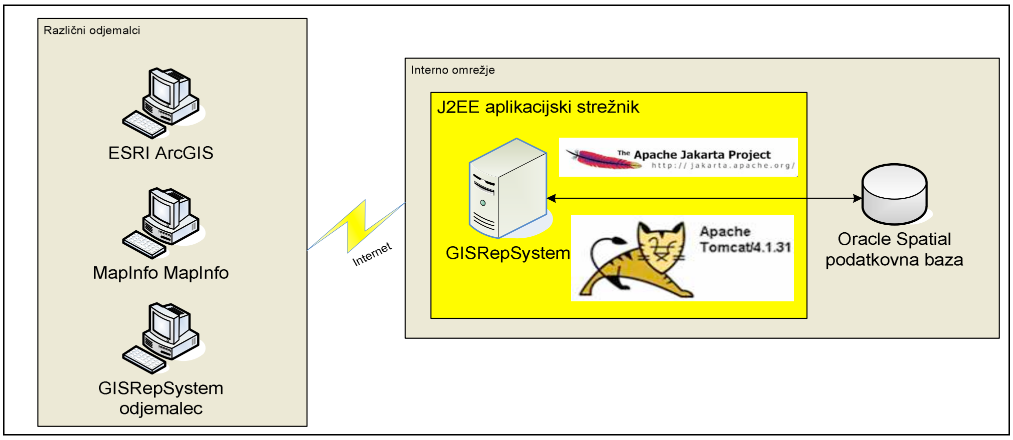


Figure 7: Installation of the GISRepSystem in the information system

The customer is also an essential part of the GISRepSystem system, copying data from the given data source (WFS server) into the selected output format (e.g. ESRI Shape or OGC GML). In addition to copying data, its advanced functionality includes:

- selection of one or more WFS data sources
- limitation of copied data according to selected columns and given criteria
- frequency of updating data and output format
- merging data sources into larger groups, called profiles
- background functioning of the program, which facilitates uninterrupted daily performance of replications.

At this point, a question might be raised as to why replications of geographic data on the local computer are needed if the local GIS tool enables direct access to GIS data via WFS protocol. According to our experience, this tool is useful mainly in cases where users have access to a large quantity of data and each transfer via WFS protocol would slow down their work.

Furthermore, only the latest versions of the GIS software program support the WFS standard. The majority of users have older versions or tools installed, which will not support the WFS standard in the near future. Since the replication program supports ESRI Shapefile record of data, the data can be used also in older versions. And finally, in some cases we wish only to transfer data to users and external contractors for further processing. In such cases, GIS tools are not needed since the data may be exported into ESRI Shapefile or GML format.

Through the GISRepSystem, users will be able to obtain data via the WFS service. Access to the data will be made available through the Java application WFSCLientUI, which will enable the transfer of data in .shp or .gml format. The second possibility is through WFS protocol, where a user enters the URL address into the application, which supplies him with a display of data on the basis of the WFS service. In this way, the user obtains data in real time and directly from the distribution server, not from the local computer as in the first instance.

## 5. Conclusion

Services like WMS and WFS may further simplify access to spatial data. Such distribution provides a more reasonable solution, as the data are available to users 24/7, while the distributor is left with the task to maintain this service. In comparison with the existing method, costs are higher in the initial phase; however, the users are provided with updated data and they need not be concerned whether they have the latest data version, since it is the distributor who is responsible for providing current data from the distribution base.

Another issue is verification of user access to WMS and WFS services. In the area of Web applications, access is conducted through a user name and password, application through a valid e-mail address, digital certificates, and so on. An appropriate method of authorisation may be set generally on the application server. Still, WMS/WFS specifications do not require support for these methods. In practice, this implies that the WFS/WMS server cannot be connected through the most common GIS tools (ESRI ArcGIS, MapInfo, INTERGRAPH), which undoubtedly undermines all the efforts to provide simple access to data.

In case of large quantities of data, a problem will occur as to the speed of their transfer. Due to using XML data records (mainly WFS), metadata take up the major part of the space, defining the structure of the data record and not the content itself. Therefore, various techniques for data compression are highly recommended. There are a number of algorithms optimised for compressing XML data (e.g. XMill); yet in practice, the GZIP algorithm has been identified as the most appropriate.

The use of WMS supported by ArcIMS has created problems concerning the coordinate system. ArcIMS provides data in geographic coordinates despite the D-48 projection recorded in the configuration data file; therefore, transformation into the Slovenian D-48 coordinate system is necessary. Unquestionably such transformation is required if the spatial data concerning the border areas are to be merged, since all neighbouring countries have their own coordinate systems. In the future this issue will be eliminated, as it is foreseen that all European countries shall adopt the ETRS89 coordinate system.

## Bibliography

Internet 1: http://inspire.jrc.it/reports/position_papers/inspire_ast_pp_v4_3_en.pdf (24. 6. 2006)

Internet 2: http://www.zrc-sazu.si/slogis/zbornik.htm (24. 6. 2006)

Internet 3: http://portal.opengeospatial.org/files/?artifact_id=5316 (6.3.2006)

Internet 4: http://www.arso.gov.si/o_agenciji/strate~ski_dokumenti/poslanstvo/ (6 March 2006)

Internet 5: http://www.arso.gov.si/o_agenciji/strate~ski_dokumenti/cilji/ 6.3.2006)

Šumrada, R. (2005a): Strukture podatkov in prostorske analize. Fakulteta za gradbeništvo in geodezijo, Univerze v Ljubljani, Ljubljana.

Šumrada, R. (2005b): Tehnologija GIS. Fakulteta za gradbeništvo in geodezijo, Univerze v Ljubljani, Ljubljana.

Ažman, I. (2005): Vzpostavitev slovenske prostorske podatkovne infrastrukture. Magistrska naloga. Ekonomska fakulteta, Univerze v Ljubljani, Ljubljana.