Implementation of the Elements of the Polish National Spatial Data Infrastructure Based on Open Source Software

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Abstract

A successful implementation of interoperable SDI requires three types of specifications: information model description, binding rules, and best practice guidelines. These are covered by the 191xx series of ISO standards, INSPIRE documents and OGC specifications. They set out the direction for the SDI implementation.

This paper focuses on implementing SDI at the local government level in Poland. The architecture of the Polish cartographic and geodetic information infrastructure is presented and examples of open source software based solutions are discussed. These examples are built by a group of professionals appointed by the Surveyor General of Poland to disseminate open standards and open source spatial solutions. These efforts, and other initiatives like them, may speed up the implementation of INSPIRE, and improve the operations of public administration at the local level.

1. Introduction

Building interoperable SDI at many scales, from the global, to national, state, regional and local, is a big challenge. Modern SDI are collections of high-end GIS applications, accessible over the Internet, offering several functionalities deployed as geographic web services. The architecture of SDI is described by several models which differ by the view point and taxonomy used.

In most cases the architecture is designed following the SOA paradigm in which services expose their functionalities on a service bus through well specified interfaces. Moreover, the architecture allows information processing chaining. The services are utilized by the clients which are usually Internet enabled applications, geoportals, and other nodes of SDI.

To overcome the problem of uniform managing, maintaining distributed geographic resources in the heterogeneous SOA environment, formal actions are necessary to assure interoperability at the semantic, technological and organizational level. These actions resulted in defining ISO 19xxx standards, OGC specification, and INSPIRE rules. Based on these documents a number of open-source solution have been designed by various entities, and these can be used to solve specific problems in establishing SDI.

ISBN 978-0-620-42117-1

The paper is about applying open source software compliant with these standards in the process of implementing elements of the Polish National Spatial Data Infrastructure. This is illustrated with two examples of Web service based spatial solutions.

2. Geospatial information infrastructure

2.1 INSPIRE

In May 2007 the European Commission has decided to implement a Spatial Data Infrastructure whose purpose would be to support the activities of the national and local governments, to provide geospatial information to the public, and to facilitate monitoring the implementation of the European Commission policies. The initiative, called INSPIRE, called on the member states of the EU to provide the spatial data infrastructures as elements of INSPIRE. These infrastructures must contain: spatial data sources, metadata, spatial data services, network services, access rights, and coordination agreements. The INSPIRE network services architecture specifies the following types of services: Discovery Services, View Services, Download Services, Transformation Services, Services for Invoking Spatial Data Service.

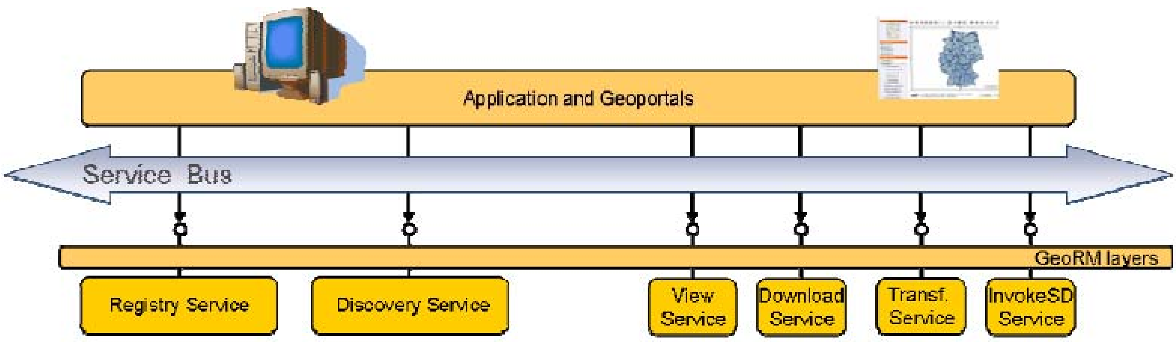

Figure 1. INSPIRE network services (excerpted from an INSPIRE document)

There are further services necessary to implement the above mentioned, some explicitly required by INPIRE, like GeoRM services, and some not explicitly mentioned, but nevertheless required to run an interoperable SDI, such as registry services, providing access to resources describing the data in order to allow for their correct processing and interpretation. These services are exposed to the INSPIRE service bus and can be accessed via the GeoRM layer by applications and geoportals.

2.2 Polish geodetic and cartographic infrastructure

Access to the governmental geospatial data in Poland is regulated by the geodetic and cartographic law. The accuracy and validity of these data is guaranteed by the governmental Surveying and Mapping Service. In the Polish geodetic and cartographic infrastructure the documentation centers play a crucial role. They are a part of Surveying and Mapping Service and are formally organized in a structure which was designed in the early seventies of the 20th century. The main objectives of these centers was similar to those which were defined in the INSPIRE directive. The centers were required to collect geospatial data (NGCA – the National Geodesic and

Cartographic Asset) for multiple use, maintain them, and provide data and metadata on users' request. But at the time of their establishment, geospatial data were in an analog format, hidden behind security access rules. There was no open access to these data, and the only users were government agencies. Today the Surveying and Mapping Service is responsible for establishing official geodetic and cartographic information infrastructure as the main component of the national SDI. It is also responsible for the INSPIRE directive transposition to the Polish law.

The Polish structure of the geodetic and cartographic service consists of three levels (see Figure 2): central, province (16 centers), and county level (379 centers). The central level is under the state administration, but the regional level has a dual nature (it is under the state and local government administration), while the county level remains the local governments domain. There is a data flow specified between these levels, and many of the administrative tasks are based on them.

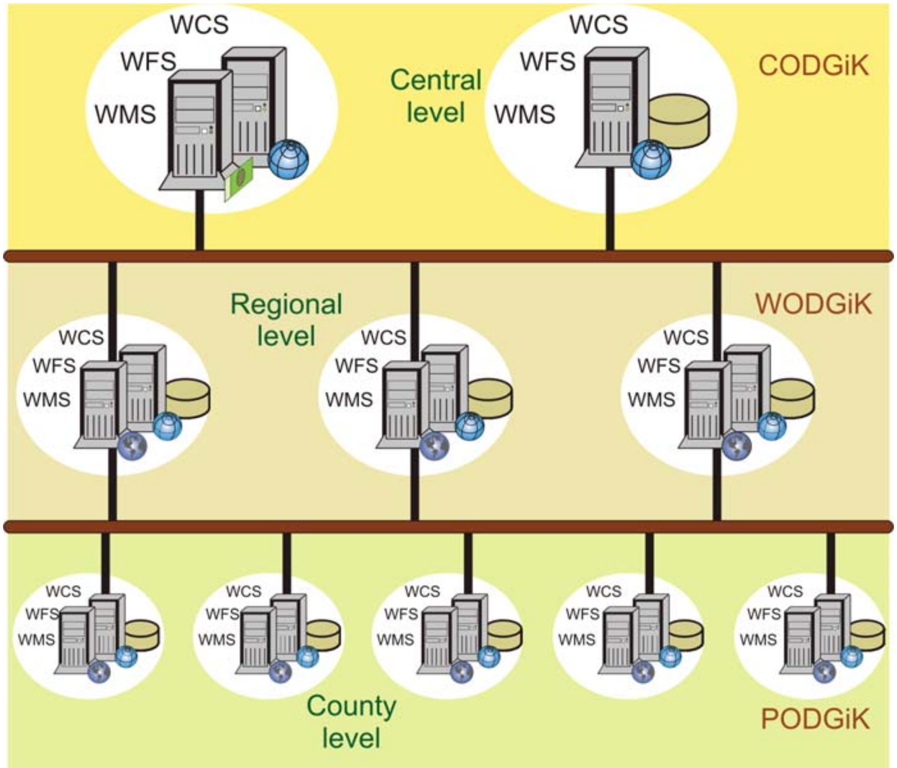

Figure 2. The structure of geodetic and cartographic documentation centers in Poland

The structure of the geodetic and cartographic service is complex and to achieve interoperability between its nodes the widely accepted standards should be used. The Head Office of Geodesy and Cartography of Poland makes efforts to ensure this, for example by creating the working groups: Working Group for National Data Infrastructure, Working Group for Metadata, International and National Standards, and Working Group for Open Software (woGIS).

2.3 The woGIS group

In 2007 the Head Office for Geodesy and Cartography of the Polish Government decided to call upon a working group of experts whose task was to support the Office in promoting the use of free and open source software for spatial application, and the various geodetic and cartographic agencies in Poland in the development and configuration of free software to their needs. The officially stated mission for the group, formed on May 15, 2007, was: “The development and adaptation of free software for: (a) building the information society, (b) building the national spatial data infrastructure, including geoinformation and catalog services, and (c) implementing the INSPIRE directive”. The members of this group have been selected from different organizations which are active in the field: academic, public administration, and commercial.

The group assumed the name “woGIS” (an abbreviation of “free software in GIS” in Polish), and its initial work concentrated around free and open source software implementations in national metadata infrastructure at all levels – from commune to the central/national level. Moreover, the group tested and evaluated open source software packages implementing spatial data services: WMS, WFS, CS-W. They performed tests, experimental implementations, software package localizations, developed installation and configuration scripts, presented survey reports at various conferences and trade meetings, and conducted other activities.

3. Infrastructure implementation

The Head Office of Geodesy and Cartography initiated the GEOPORTAL.GOV.PL project aimed at providing access to the national geodetic and cartographic resources. The main target was to provide georeferential data such as: orthophoto, roads, building, address points, parcels, and catalog services delivering the description of data stored by the service. Following the INSPIRE directive these data should satisfy the needs of local communities and building the information society. Thus there is a requirement for creating SDI facilities at county offices, providing geospatial services with search, view, and access abilities that are reachable from the central geoportal playing the broker role. The resources of central and district levels should be accessible from a central geoportal. It is hoped that the project will assume the role of the main access point to geospatial data in Poland.

3.1 Accepted standards

The main approaches to the SDI modeling are based on (EN) ISO 19100 series of standards, which are meant to standardize all aspects of geographic information, and OGC specifications, which are in many cases predecessors of ISO 19100, but mostly the specifications closely related to the implementation.

The INSPIRE regulations (formal documents along with the implementation rules) use ISO standards and OGC specification, but in a few places extends or adapts them according to the specific needs. The INSPIRE technological view point of services can be mapped onto the ISO model for the information viewpoint. The ISO model defines classes of services based on the semantic type of computation that they provide as follows: geographic human interaction services, geographic model/information management services, geographic workflow/task management services, geographic processing services (spatial, thematic, temporal, metadata), geographic communication services. Additionally, ISO standards structures the types of services of an IT system in a logical way. Each tier can contain both IT-general services and GIS-extended services for that tier. Such model presents the engineering viewpoint focusing on mechanisms for distribution, distribution transparencies, and support services such as security and persistence. The model defines the following services tiers: the human interaction services tier (responsible for physical interaction with the user, through display and input media and an appropriate dialog), the user processing services tier (a part of the processing services responsible for the functionality required by the user), the shared processing services tier (part of the processing services responsible for common services, both domain specific and general, that can be used by multiple users), the model/information management services tier (responsible for physical data storage and data management). And the model specifies the following sets of services: the workflow/task services (that can be viewed as a specialized processing service), the communication services (responsible for connecting the various tiers together), the system management services (orthogonal to the multi-tiered architecture and might be introduced in multiple tiers).

For the successful implementation of interoperable SDI three types of specification are needed: information model description – covering some semantics, conceptual schema and data elements, and the requirements described by a formal, implementation-independent schema (usually expressed as UML diagrams); binding rules – offering an explicit XML binding for the information model for the specific environment (which bridges the model with technology); best practice guidelines - offering examples of implementations. Referring to the standards already mentioned: ISO standards, INSPIRE documents and some OGC specifications provide a model-driven approach and can be seen as a source of information model description. The practical notes on implementations for various techniques (eg. XML file transfer, web services, relational database) and implementation environments (eg. J2EE, .Net) must to be derived from the information model description. This can be done in a more or less automatic way. Some guidelines are provided by the OGC and INSPIRE implementing rules.

3.2 Free and Open Source Software Building Blocks

Free Open Source software could be used as "bricks" for the implementation of the national SDI. The following software for spatial data servers was taken into account: Deegree, Geonetwork Opensource, GeoServer. The work was focused on the software working under the control of Java application servers – like Tomcat – to obtain OS-independent solutions. PostGIS was proposed as a backend in all solutions. Performed tests allows to select solution based on PostGIS, Deegree and GeoServer as fundamental Open Source software. A particular configuration depends on the user's level of knowledge and user's hardware/software. Preferred and advised computer operating system is a Linux distribution but selected software work also under Windows. Testing environment was built under Fedora, Ubuntu, Slackware as well as under Windows XP and Windows 2003 Server.

3.3 Proposed system for the Polish metadata infrastructure

The main assumption of the metadata infrastructure system is to provide access to the metadata storage based on accepted standards and consistent with the INSPIRE directive. There was proposed a schema for the national metadata infrastructure. One central CS-W server operates as an access point to the whole metadata system. The central server obtains data using the harvesting option. The user interface (thin client) to the system is a part of the national geoportal – central point for publishing spatial data (data from national government sources mainly).

Central CS-W server is a backend for CS-W client built into the geoportal. Regional CS-W servers collect metadata at the regional level. A CS-W server at the regional level contains all metadata from the districts in the given region.

There were two options: if it is possible to install regular CS-W server – such server should be installed; if not – the Apache server should be installed to publish metadata as XML files. A special directory structure and an extension of the harvesting functionality should be developed for this operation. The central CS-W server harvests metadata from regional servers. It allows to build central metadata database and increases security and accessibility by data duplication. woGIS made preliminary tests of the free open source software to choose and suggest a metadata information server.

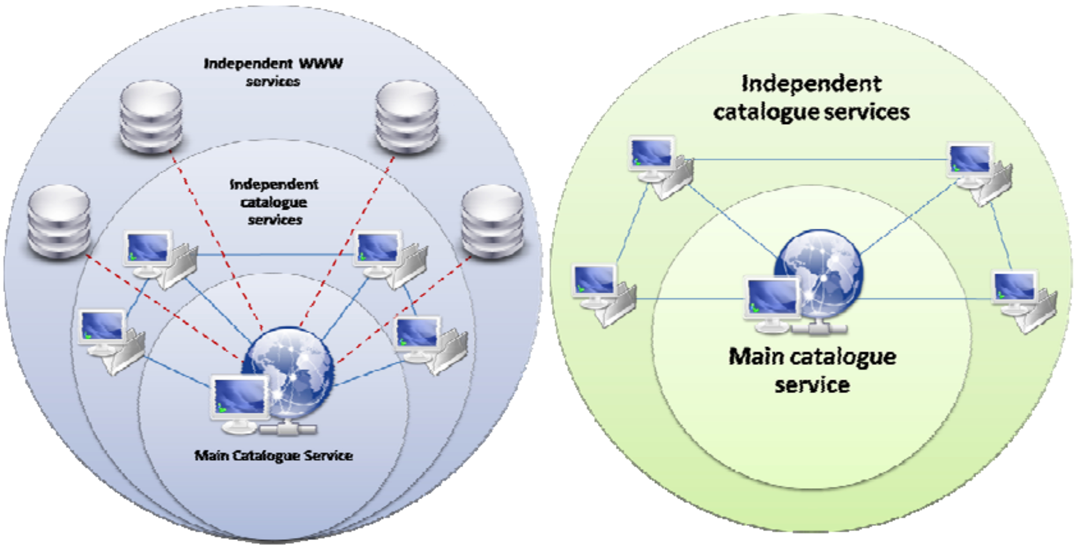

Figure 3. Polish metadata infrastructure

The server should be easy to manage, stable, support the ISO 19115 standard, use OGC CS-W standards for communication and functionality. Two solutions were taken into account: Geonetwork Opensource, and Deegree CS-W. woGIS suggested Deegree CS-W as a more convenient tool for implementing servers in the proposed infrastructure. Deegree CS-W is a "pure" server. There is no GUI which needs extra work with translation and supporting. It is easier to implement Polish national metadata profile (the server can support many different schemas of metadata).

An installation/configuration script was prepared. It allows a fully automatic install and sets up all needed components: the application server (Tomcat), the PostGIS database, and the Deegree CS-W with an extension procedure for harvesting.

3.4 Proposed system for providing geodetic reference points

Government administration at the district level needs a system for publishing geodetic reference points. Members of the woGIS group prepared a reference implementation based on free open source software. The system had to satisfy two requirements: publishing general information about geodetic reference points, and serving precise geodesic information about geodetic reference points with extra graphical and textual information. The first option is addressed to the general public, the second one – to surveyors working in the field.

The solution was based on GeoServer working in the Tomcat Java application server environment. PostGIS was a database backend. A small web portal prepared in JSP technology worked as a thin client. OpenLayers was used for GIS data presentation. A Web portal contained two zones: one for guests and another one for licensed surveyors. The second zone has secure access only for registered users. In addition a transaction tracking system for data access monitoring and logging was implemented.

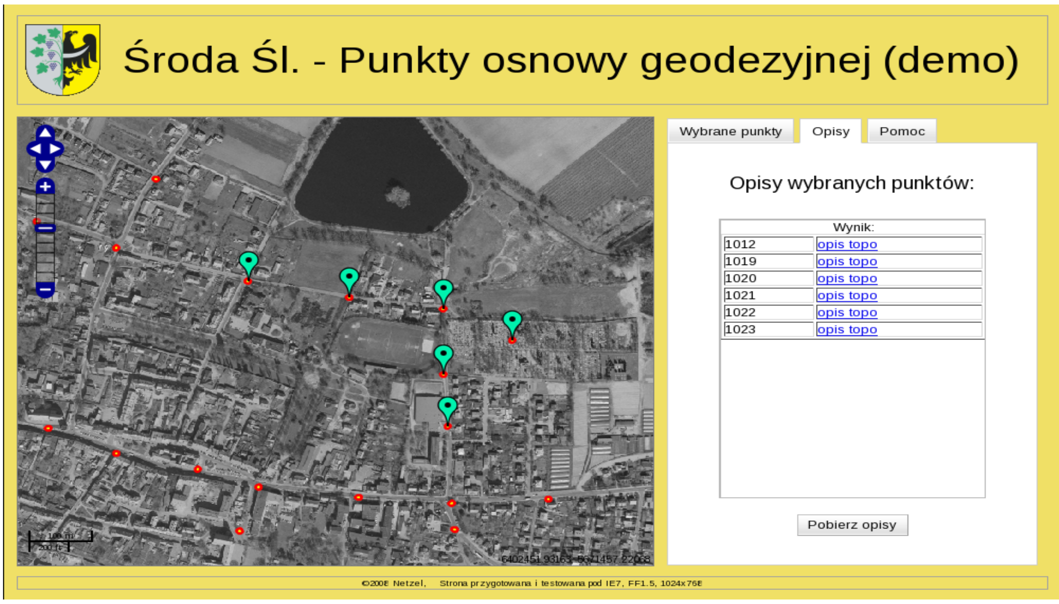

Figure 4. Screen shot of the user interface page to the system providing geodetic reference points

4. Conclusion

The popularity of open-source solutions in the context of building spatial information infrastructure in Poland is still at the early stage. The activities started by the woGIS group has opened the gate for open-software implementation at the different levels of geodetic and cartographic infrastructure. Therefore the efforts of the Surveyor General who established the woGIS initiative has to be given a high mark.

The valuable effect of the woGIS work is the consolidation of passionates and others around the subject of establishing nodes of spatial information infrastructure based on open-source software. Thanks to that the chances are up for making popular the standards whose wide use is a key factor for achieving interoperability. Open-source software is an attractive alternative to the commercial software, especially for the documentation centers at the local level, which do not have extensive resources, including financial, nor trained staff. Additionally, the adaptation of the open-source software for the particular application might also accelerate the process of INSPIRE implementation.

Acknowledgments

The work described in this paper has been supported in part by the Ministry of Science and Higher Education of Poland through the grant number R09 011 03, situated at the Institute of Geodesy and Geoinformatics, Wroclaw University of Environmental and Life Sciences.

References

INSPIRE Network Services Architecture, 2007, v.2.0, Network Services Drafting Team

ISO 19119 INTERNATIONAL STANDARD, 2005, First edition, Reference number ISO 19119:2005(E)

OpenGIS® web services architecture description, 2005, Version: 0.1.0, Whiteside A (Ed.), Open Geospatial Consortium Inc.

Paluszyński W, Iwaniak A, Śliwiński A, Kubik T, 2007, *Building spatial data infrastructure at county level using open software*, in: Cartography for everyone and for you, XXIII International Cartographic Conference, Moscow

Smits, P, Dufourmont, H, de Groof, H, Toth, K, Craglia, M, Kanellopoulos, I, Millot, M, Pauknerova, E, Annoni, A, Nunes de Lima, V, Fullerton, K and Lihteneger D, 2007, INSPIRE Work Programme Transposition Phase 2007-2009, v.1, INSPIRE Consolidation Team