SOME ALTERNATIVE SOLUTIONS FOR OPEN SOURCE S.D.I

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ABSTRACT

The INSPIRE directive sets up a new diffusion model of geographical information. This aims at setting up Spatial Data Infrastructures (SDI) in each country of the European Union and using new technologies applications and new architectures of the Internet domain.

Usually, Geographical Information was used on desktop and software, but nowadays more and more Open source tools are available. Public institutions often resort to free tools for their applications thanks to new users and developers communities. The Internet and new behaviors of European citizens explain these new trends. Geographical information storage becomes more complex with the increasing of Internet applications. That's the reason why today we can observe a variety of "open" technologies, tools and online applications that users can adapt according to their needs. New licenses using this kind of applications are developed for the personal use of Internet users.

In that sense, we notice new tools and applications for management of geographical data. Users networks and developers communities are growing up. Hence its significant impact on Geospatial Monitoring and new technical solutions for setting up Spatial Data Infrastructures. They show the dynamic nature of the Web : interactive applications which are changing for the Geospatial web (geoweb) services are installed on servers.

It is not utopian to think that SDI projects might be built using Open Source technologies and tools. The INSPIRE directive enables an implementation of an interoperable application, contributing to better data exchange in Europe. This presentation gives a pragmatic view of some alternative solutions for an Open SDI.

In conclusion, the implementation of INSPIRE does not represent a technical problem; it is a matter of organization and political decisions. It is, above all, a question of responsibility since complete Open Source architecture is available for SDI projects.

Key words: SDI, Open Source, architecture, interoperability, client.

1. INTRODUCTION

The concept of Spatial Data Infrastructure (SDI) is relatively recent with an occurrence at the end of 80's. It was appeared as a tool, able to centralize spatial data of a territory for the best transmission, broadcast and sharing them to the partners of an organism. It was existed in Australia and in the United Stated with the US FGDC: United States Federal Geographic Data Committee.

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In 1994, the Clinton Executive Order was involved for the needs of a system for the coordinating geographical data acquisition and the access. It's a first step for setting up a National SDI (NSDI) in United States.
In 1996, 11 countries responded to Global Spatial Data Infrastructure Association (GSDI Association) survey and they recognized a project like a National SDI. GSDI identifies 53 countries in the world with a project of NSDI (13 in Europe and 21 in America).
The interest to set up an infrastructure like this had grown up in the world and 120 countries were at the seventh GSDI conference in Budapest in 2002.
It's a strategic question to set up a NSDI for the national spatial planning policies in Europe. The creation of EUROGI in 1993 permitted to relay the monitoring actions. The Open Geospatial Consortium (OGC) takes part as a partner because it's supported now by 400 companies in the world. It defines the world interoperability geospatial standards for a common functionality.
The INSPIRE Directive 2007/2/EC was published in the Official Journal of the European Communities (OJEC) on 25 April 2007 and was entered into force on 15 May 2007. It aims to promote the production and the exchange of data necessary to the various European Union policies in the wider environmental range. It proposes to establish an infrastructure of a spatial information in the european member countries and it bases on interoperability beyond the boundaries.
All this context explains the greatest interest to set up a NSDI in the world. It's a response adapted by few needs to modernize the working methods for a greater quality in the daily activities devoted to the use of digital data.
Parallel to this evolution, it's growing up new dynamics encouraged by a remarkable increase of internet users. Communities and projects have been increased and as a result new tools have been created on basis of open source softwares, defined by specific licenses : GNU General Public License.

The first part of this document treats a general SDI architecture and the second part refers to the solutions of open source softwares for the implementation of this architecture. It will be concluded by a synthesis part about some examples of SDI which are built on open source technologies.

2. ARCHITECTURE OF SPATIAL DATA INFRASTRUCTURE

The concept of Spatial Data Infrastructure is recent and able to store the geographical databases. This can take place with the first new applications. In the beginning, it has not been built with a fixed architecture but nowadays it is appeared as a regular model of Spatial Data Infrastructure.

2.1. The concept of Spatial Data Infrastructure

Firstly, it's necessary to present what is a Spatial Data Infrastructure.
“A spatial data infrastructure (SDI) is a framework of spatial data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way.

They are available by internet and they respect interoperability specifications : norms, specifications, protocols... It permits to use services beyond a web explorer and to combine different available services by the SDI" (sources: Wikipedia).

This framework of spatial data is interactively connected on the web and it works on basis of interoperable system. Interoperability is an important concept that it is more famous now with the INSPIRE directive implementation beyond the european members boundaries.

The INSPIRE Directive 2007/2/EC was published in the Official Journal of the European Communities (OJEC) on 25 April 2007 and was entered into force on 15 May 2007. It aims to promote the production and the exchange of data necessary to the various European Union policies in the wider environmental range. Its transposition into national law of each country is scheduled for May 2009.

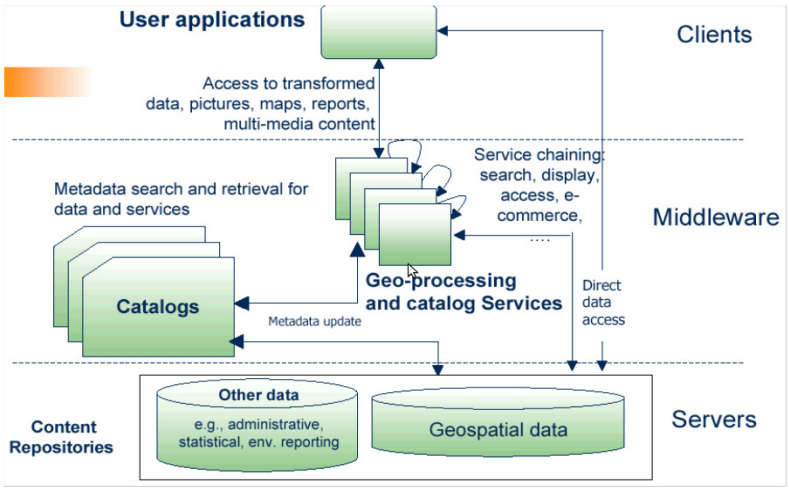
The incorporation into the national law of the INSPIRE Directive shall take place in each country of the European Union. It involves the rules with precision to facilitate exchange and broadcoast of the geographical data in relation with the environmental theme. The European Commission is working up the implementing rules with aim to apply them uniformly in each EU country.

2.2. Architecture

Spatial Data Infrastructure (SDI) is a framework of spatial data and metadata and it manages the data with interactively connected applications. It is composed by:

- Client applications (spatial data viewer, catalog metadata...)
- Middleware (cartographic engine, web services...)
- Servers (databases and geographical databases)

Figure 1. General SDI Architecture



Sources: GRISI project, http://www.grisi.org

The SDI Architecture (table 1) is depended principally from the user needs and the uses of their partners. That's why it is necessary to present the regular needs for setting up a SDI :

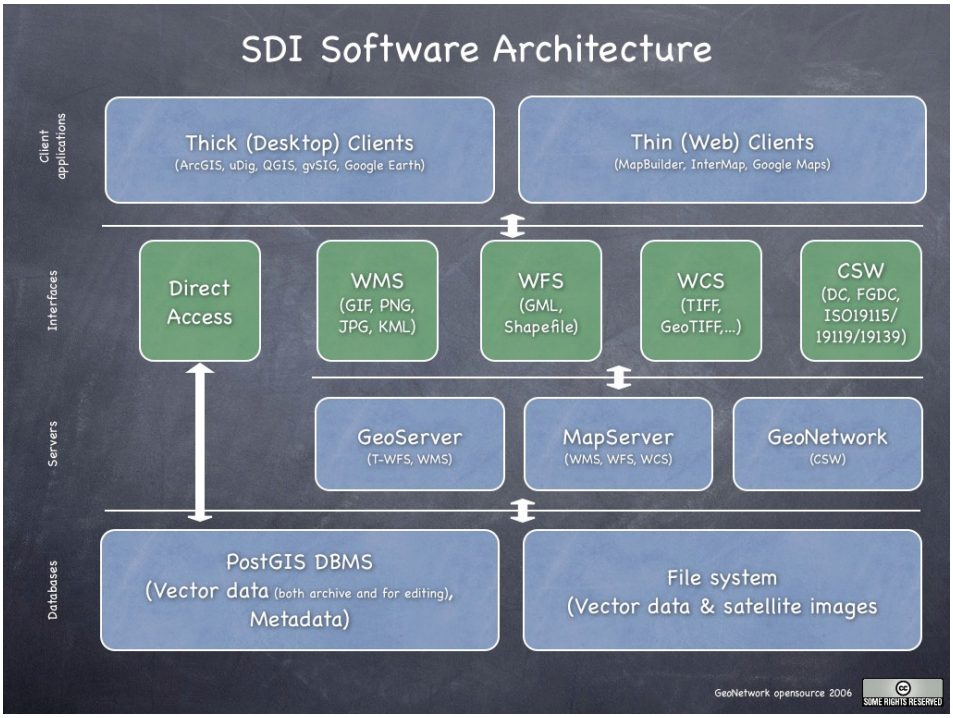
- to collect and to acquire spatial data
- to build, to concentrate and centralize a geographical database
- inventory, catalog and storing of data
- control, harmonization and standardization of data
- development of services for queries, views, visualization and download the spatial data
- to access the geographical data from a unique web portal

SDI architecture must be conformed of particular specifications for storing the geographical data, for using the webservices and managing the metadata. The interoperability capacities of a SDI are depended of the OGC norms. The web services are:

- Web Map Service (WMS),
- Web Feature Service (WFS)
- Web Catalog Service (CS-W).
- Web Featured Service Transactional (WFS-T)

A general SDI architecture is proposed by the Open Source GeoNetwork community with this scheme:

Figure 2. Open source SDI Architecture



Sources: http://geonetwork-opensource.org

It identifies four different elements (client applications, interfaces, services, databases) like the precedent scheme (figure 1) on basis of Open source softwares.

2.2.1 Client applications

They are easily available by the SDI users. They work with a simple web explorer from the computer desktop. Generally, the SDI uses a particular environment with a specific client application for launching the spatial data.

2.2.2 Interfaces

Interface assures a link between a client's application and a database where the spatial data of the SDI is stored. It permits a direct access to the application of the client and it manages the information stream from the web services (icons, raster, data, metadata...).

2.2.3 Services

They transmit the information from the database of SDI to the user. They have an important place in the SDI architecture because they transmit information by an

adaptable interpretation of the user queries while it uses the client's application. There is an analysis of this query in a specific response.

3. TECHNOLOGY OF OPEN SOURCE SOFTWARES FOR S.D.I

It is more important to present the components of a Spatial Data Infrastructure in order to discuss about the technology of open source software that is used by an S.D.I.
This part shows how the general technology is used for every functionality of an S.D.I. In this way, it is justified that the open source technology steers from a standard construction.

3.1 Discover the data

The client applications permit to discover the data in SDI. In relation with the last paragraph, the client applications are composed of two parts. The first is available to the SDI's user and these client's applications are independent of the SDI architecture. They are helpful tools for using again the spatial data.
Other client applications are directly connected with the SDI architecture and they are totally depended of this system.

The search of spatial data in a SDI is available with different open source softwares and these applications are often used like :

– Mapbuilder, cartoweb, ka-Map, pmapper
– OpenLayers

They are interfaces between the user and the SDI content. A good interface permits a better use of the SDI. There are many open source client applications using a cartographic engine like Mapserver. Technically it is a Simple Object Access Protocol architecture (SOAP) and it is largely used in the SDI architectures. It is a robust technology and it is presented like the most famous application to respond at the needs of setting up a SDI. Many editors software companies use this technology for their cartographic engine solutions.

3.2 Exchange of metadata

A SDI proposes access to the geographical data and metadata. These metadata are implemented in a SDI by a standard profile certified in international organizations like the ISO (http://www.iso.org/).
A lot of open source tools are ready-to-use for archiving the metadata. Their origin appears from non-governmental organizations necessities (ONU, UNICEF...).
These tools are GeoNetwork, MDWEB, GeoSource (basis of Geonetwork), EXPIRE, Reports...
The functionalities of these tools are very specific and they are according to the international specifications of interoperability norms. In this case, they are available to be connected with others external metadata catalogs for harvesting them data.

Users and developers are strongly implicated by these open source communities. They identify the necessities and they intervene dynamically for an evolution of the tools. That's why, the GeoNetwork open source metadata catalog is especially completed to the ONU needs. It is a precious software to fit out a National SDI (NSDI) for example.

3.3 Interoperability

The interoperability is a key-word in the domain of the SDI. The SDI necessities are explained by spatial data exchange and a transversal approach. In this case, SDI must be adapted for connections and access to the others SDI. It is not depended of the application level : National, regional or local.
Each SDI must be interoperable with every other SDI without constraint of location, language or framework system.

Open source softwares solutions use international standards like the OGC web services The metadata profiles are used by the metadata catalogs where they are according to the ISO-19115 and ISO-19119 norms like the INSPIRE implementation specifications. The rules of metadata harvesting between the open source metadata catalogs are conformed with the international interoperable standards : OGC web service CS-W.

A perfect compatibility of open source softwares with the international specifications, explains exactly that more and more SDI projects are set up with these alternative solutions and not with "ready-to-use" softwares.

4. EXAMPLES OF ALTERNATIVE OPEN SOURCE SOLUTIONS

The next part presents some examples of S.D.I which is built with open source tools. The previous part was also important; however it presented the common practices for a right open source S.D.I. The following sections make a treatment of the pragmatic project which uses open source tools. In this way, it is justified that it is possible to build a National or Regional SDI with an open source technology.

4.1 Open Source National SDI

Furthermore, there are organisms which prefer the enterprise packaged solutions in response of their needs to setting up a NSDI. But also, it is remarkable to note an important increase of open source softwares solutions that are used for the new SDI project. It is a new tendency as this trend didn't exist a few years ago.

Effectively, more and more SDI projects use open source solutions and they are presented at the international and national geomatics conferences. A first example is the SDI of Venezuela (http://www.geoportal.gob.ve) which was built with open source tools from the Representational State Transfer (REST) technology. It uses the OpenLayers (View Service client) solution like the SDI pilot of Finland (http://www.paikkatietoikkuna.fi)

These two projects use the same solutions for their spatial data storage: PostgreSQL-PostGIS. Metadata management works with GeoNetwork (the catalog metadata of the Finnish SDI http://www.paikkatietohakemisto.fi).

In parallel with these characteristics, each project works with others open source solutions in relation with its specific need. That's why, SDI of Venezuela uses OpenLayers like client application and it's implemented in a Mapfish framework.
TileCache tool is added for a better management of the rasters files in the client application. Finally, it's a Mapserver solution that is the cartographic engine with a connection to the GeoNetwork and to the GeoServer. This tool is in the responsibility of OGC web services generation: WMS et WCS.

Another example is the pilot NSDI of Finland. It regroups 20 themes and 50 layers of spatial data. Technically, Shibboleth solution will manages the user rights of the SDI and the basic CMS portal software is Liferay: This last tool is an open source solution which manages the interface and the discovering data functionalities of the SDI.

These two examples present clearly the capacity of setting up a robust SDI with open source solutions. They are so much robust that they could fit on National SDI.

4.2 Open source regional SDI

A part from NSDI, many regional projects exist like pilot opportunities for setting up SDI on a territory, like a Regional SDI with new tools based on open source solutions. It is the case of the project of Brittany's Region in France. This project is named of GeoBretagne and it is based on open source solutions like Mapfish (Application client). This SDI is under construction but it is available now in a source forge with the name GeOrchestra (http://demo.georchestra.org/). As it is under construction, it will be freely available to download from the website.
This practice to store the packages of the solution is a new trend. It is an example of participating share with web communities.

Some European projects like eSDI Net+ in 2007 or GRISI (http://sdi.grisi.org) aim to set up SDI. The last and the CASCADOSS project (http://www.cascadoss.eu) use open source softwares solutions for local SDI. In Greece, the INTERREG IIIB MEDOCC project has permitted to set up a Regional SDI (http://www.ideunivers.eu/) on basis of only open source softwares solutions :

- a metadata catalog GeoNetwork,
- a client application based on the Mapserver engine,
- a OGC webservice (WMS) for connecting the two previous applications .

4.3 Communities and SDI projects

A few years ago there was a specific period with many new projects of open source tools which were sponsored by users, developers and companies. They intervene

generally for one solution that it can be a client solution and it forms an element of an SDI architecture.

Nowadays, a new tendency is appeared with packaged solutions. In this case, it is a global solution with a few tools that they build a software solution like a SDI project. It proposes an easy installation of a software solution like the SDI. For example, the easySDI project proposes to set up a SDI on basis of an universal open source tool : the Content Management System Joomla! The EasySDI project can profit of a great community, this is Joomla! This open source solution is based on modules in addition of a general engine: Joomla! It aims to set up a geoportal and each module is :

- a user right management service
- a metadata catalog service
- a spatial data viewer
- a data management service(download...)
- a security management service for web services
- a data publish service for web services

This new project is an example of a new trend because the previous projects are open source solutions that they don't cover all the SDI functionalities. For example, there were softwares like ETL (Extract, Transform, Load) software or catalog metadata that can manage the metadata, a spatial data viewer and webservices.
Now, a project like easySDI is more progressive because it covers more needs and it offers a global solution for setting up a complete SDI for each territory.

5. CONCLUSION

The open source solutions are the alternative solutions for the broadcast of the products. They are valid on the market of GIS and geomatics, that's why many companies are emerging from the traditional business of selling proprietary software. Indeed, they provide exclusively a service on basis of the integration of open source solutions. It is a new dynamic with the strong development of the "open source" community. It is explained from a research of economics and abilities to be freed from all the licenses and company's rights. These rights are generally exploited by many big companies of GIS software.

"Open source" community is more mature today with a sufficiently large variety of tools which are supported by dynamic communities and a technical support.
Many solutions which are composed in a open source SDI architecture depend on the user needs but it is clear that a demarcation line shows between editors softwares and open source softwares. The first is ready to use but the second recommends a period of development in order to be ready and totally operational.
These last solutions involve many sponsors with a both ways approach for development monitoring and the tool customizations.
Maybe the sponsors desire this and as a result it could explain the open source success. Generally, sponsor wants a participatory approach for setting up its SDI project.

5. REFERENCES

Arnaud DELEURME, 8th -10th July 2009, L'opportunité des outils libres au sein de l'entreprise grecque Infodim, International Opensource Geospatial Research Symposium OGRS 2009, Nantes, France.

Arnaud DELEURME, 27th March 2009, A variety of technologies for setting up an Inspire S.D.I: an alternative solution, Skopje, F.Y.R.O.M.

Antti Rainio, 24th september 2009, INSPIRE Implementation – Building SDI in Finland, Nordic GIS Conference, Stockholm.

J.V Higon, Infraestractura de datos espaciales de Venezuela, una IDE 100% de software libre, http://www.sigte.udg.edu/jornadassiglibre/uploads/Presentacions/Comunicacions/a5.odp

Ian Masser, 2005, Global and Regional Spatial Data Infrastructure Initiatives, GSDI Association, http://www.ec-gis.org/ginie/final_conference/masser.pdf.

Douglas S. Noonan, Paul M.A. Baker, and Nathan W. Moon, 2008, Open Source Software potential index (OSPI) : Development considerations, considerations, RedHat / Georgia Tech OSPI Project, http://www.redhat.com/f/pdf/OSSI_Research.pdf .

JRC - CSPV - University of Catalunya, 2007, Study of the socio-economic impactof the Spatial Data Infrastructure in the Region of Catalunya: Executive summary, Barcelona, Spain. Online report : http://www.idee.es/resources/leyes/SDI_Catalunya_Execsummary.pdf .

GRISI Project, 2008, GRISI Best practices report, Toulouse, France, http://cap.grisi.org/index.php?option=com_docman&task=doc_download&gid=94&Itemid=67.

JRC, 2007, Draft guidelines - INSPIRE metadata Implementating rules based on ISO 19115 and ISO 19119, http://inspire.brgm.fr/Documents/MD_IR_and_ISO_20080425.pdf .

Wikipedia, 25 april 2009, Definition of Open Geospatial Consortium, http://fr.wikipedia.org/wiki/Open_Geospatial_Consortium .

Wikipedia, 25 april 2009, Definition of Spatial Data Infrastructure, http://en.wikipedia.org/wiki/Spatial_data_infrastructure .

OGC, 25 april 2009 Definition of the standards OGC, http://www.opengeospatial.org/standards .

Wikipedia, 26 april 2009, Definition of Global Monitoring for Environment and Society, http://en.wikipedia.org/wiki/Global_Monitoring_for_Environment_and_Security

GINIE, Geographic Information Network in Europe, IST-2000-29493, http://www.ec-gis.org/ginie/doc/PG_SDI_fr.pdf

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He has worked in different public authorities in France for setting up GIS applications. He was an assistant of the Project Manager for the GRISI European Project and he worked about different European projects in relation with the interoperability of the spatial data like GRISI, PYRED in the Chamber of Commerce of Gers in France (CCI Gers).
He is specialized in geomatics with the webmapping technologies on basis of the Open Source tools. He has worked in a greek company in Thessaloniki (Greece) for setting up Geographical On-line applications. Now, he is a freelancer as a Geomatics consultant (evkartenn) for the Balkans areas with a particular interest in Open source geospatial technologies. He furnishes advices and consultancy services for implementation of geographical applications in public authorities (universities...) and private organizations. Its activity as a consultant permits to make training sessions and cartographic works in relation with the personal needs of efficients solutions and spatial data management.