Metadata in Flanders (Belgium) - The challenge to tune problems and disadvantages into opportunities

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Abstract

In 1995, the Geographical Information System Flanders, or SDI-Flanders was set up as a partnership for the optimal use of geographical information within the Flemish civil services. The Flemish Geographical Information Agency (AGIV), as executive partner of SDI-Flanders, is coordinating the implementation of the INSPIRE Directive at regional level, starting with the topic metadata.

AGIV has converted its existing CEN based metadata repository to an ISO 19115 compliant repository and built an online application to query, edit and manage this repository (http://metadata.agiv.be). Because AGIV could start from its CEN based metadata repository, a comprehensively ISO compliant metadata repository could be built relatively quick. The disadvantage related to this conversion process was that the mapping between metadata elements in the different standards was not easily made. The metadata authors had to upgrade their metadata into the more complex ISO 19115 model and experienced this as very labour-intensive.

The metadata repository is based on the SDI-Flanders metadata profile for spatial data sets (ISO 19115). The SDI-Flanders profile implements the INSPIRE implementing rule for metadata and extends it with extra elements about quality and distribution because these elements are poorly foreseen in the INSPIRE implementing rules. To fulfil user needs, AGIV also implemented metadata for feature catalogues using the ISO standard 19110 as well.

Metadata publishers can describe, create, update, delete, and publish metadata using the online metadata application. Requestors can discover, either by browsing or querying, metadata and view and/or download the metadata set(s) that match with the search terms. Metadata records can be exported to ISO 19139 compliant XML or a PDF document. The metadata repository is centrally managed by AGIV. AGIV is also adopting the implementing rules on discovery services in Flanders. Therefore, an experimental CSW service has been set up which enables querying the metadata repository.

Despite the operational, user-friendly online metadata application, the geodata owners have not sufficiently grown accustomed to this application. The metadata of the data sets owned by AGIV are 100% synchronised, while at present the metadata of other members of GIS-Flanders does often not reach this level. Currently, the

need for metadata services in Flanders is limited as services are currently under development.

Future challenges for AGIV shall be the implementation of the remaining components of the INSPIRE Directive. This includes the integration of the metadata application and metadata services with view (WMS) and download (WFS, WCS) services, and web applications. The integration of metadata services into a portfolio of other services along the lines of typical use-case workflows is expected to raise the usage level of metadata, whilst yielding an increased demand for middleware and end-user services. With a modern bind infrastructure, costs of data distribution for AGIV will be reduced and data will be more accessible for users. These challenges and the modernization of our services are planned in 2009. In addition, AGIV started to develop a Geographic Service Bus based on Enterprise Service Bus principles, enabling secured orchestration, process chaining, data transformation and model mapping.

Keywords: ISO standard, INSPIRE Directive, INSPIRE Implementing Rules, metadata, metadata repository, metadata profile, metadata application, view services, download services, geographic service bus, AGIV, Flanders, Belgium

1. INTRODUCTION

In 1995, the Flanders Region (Belgium) set up a collaborative framework in order to develop and implement a sound communication and management system for geographical information: SDI-Flanders. The overall objective of this partnership between Flemish public authorities, local and regional, is to optimize the use of geographical information within and between these public bodies. The Flemish Geographical Information Agency (AGIV) was established as the executive body of the SDI-Flanders-cooperation. One of the assignments of AGIV is the challenging task to coordinate and organise the accurate and up-to-date metadata supply of the SDI-Flanders data and services.

The first SDI-Flanders metadata repository was created in 1998 and completely CEN based. AGIV anticipated the INSPIRE Metadata Implementing Rule (INSPIRE, 2008) and converted its existing repository in 2007 into an ISO 19115 (ISO/TC 211, 2006) compliant repository with an online application enabling the users to query, edit and manage this repository. The advantages and complications attached to this conversion are described in chapter 2. The SDI-Flanders metadata profile has been adapted to the ISO and INSPIRE profile. Although these profiles include most metadata elements and allow a good description of geodatasets, some adjustments had to be made. They are also discussed in chapter 2.

Chapter 3 explains the architecture of the metadata application and the catalogue service that has been developed to query the repository.

Although the SDI-Flanders metadata profile is supported by the SDI-Flanders community and despite the availability of an operational, user-friendly online metadata application, the significance of metadata is not always recognized. Chapter 4 dilates upon this issue.

Inspire compliant metadata and the catalogue service were the necessary steps in establishing a real spatial data infrastructure. Future activities related to the full implementation of an SDI for Flanders are outlined in chapter 5.

2. ADAPTING INTERNATIONAL METADATA STANDARDS TO THE REGIONAL REQUIREMENTS

2.1 From CEN prEN 27009 to ISO 19115

At the end of the 90's, the importance to document information on datasets was recognized. The publication of the European draft standard for metadata (CEN prEN 27009) caused a new boost of awareness. The main reason for AGIV to develop a centralized metadata repository was the possibility to manage and maintain metadata information based on an international standard. SPIDI (SPatial Information Directory) was the result of this first metadata initiative and was released in January 1998. SPIDI was based on the CEN prEN 27009.

The final version of the international standard ISO 19115 – Geographic information – Metadata (ISO 19115:2003(E)) (ISO/TC 211, 2003) was published in 2003. The standard has been internationally accepted, is used in almost every European member state and has been adopted by INSPIRE. Already when the first draft of ISO 19115 was published in 2001, a first attempt was made to transform SPIDI to an ISO based metadata repository. Due to the complexity of the subject, technological evolutions and limited personnel capacity, the result was not satisfactory and hence not implemented. A few years later, in 2007, a new 'metadata conversion project' was launched, which resulted successfully in an online application to search, view, edit and manage metadata (http://metadata.agiv.be). The developed metadata repository is compliant to the ISO 19115 standard. However, the choice was made not to implement this metadata standard as a whole, but to make a subset of metadata elements in order to fulfil the needs of the user community, the members of SDI-Flanders. Therefore, at the start of the metadata conversion project, the ISO 19115 standard was screened thoroughly and compared with the existing metadata repository, based on the previous CEN standard. The intention was not to lose existing metadata and to map the entire content of the metadata elements in a new metadata repository, compliant to the valid ISO 19115 standard. Supplementary, AGIV wanted to build its metadata profile as user-friendly as possible. This means a metadata profile without an overload on metadata elements, comprehensible for non-experts and easy to fill in as data-owner.

2.2 Adjustments to the ISO 19115 Standard

To comply with the ISO 19115 standard, the AGIV metadata profile includes the essential basic minimum number of metadata elements required, the core metadata elements, extended with extra metadata elements. These extra metadata elements imply the quality and distribution of the datasets they describe. The extra elements are not only recuperated as an inheritance of the existing CEN based metadata repository, but they are also considered to be very useful and valuable to describe datasets.

Besides the addition of extra metadata elements on quality and distribution, some other well-considered choices were made when implementing the ISO standard. First, a few metadata elements were implemented more strict in multiplicity than the ISO 19115 standard recommends. Table 1 gives an overview of these elements including the motivation for restricting the maximum occurrence.

Table 1: Restriction of the maximum occurrence

Metadata element	ISO 19115:2003 (E)/Cor. 1:2006(E)	AGIV metadata profile	Motivation
Address.delivery Point	N[1]	1[2]	Synchronization with the existing contact repository of AGIV.
featureCatalogue Citation	N	1	The multiplicity (N) of the element featureCalalogueCitation conflicts with the multiplicity (1) of the citation elements (Attribute name, versionNumber and date) of the International standard ISO 19110. Because AGIV also choose to implement the ISO 19110 standard, it was decided to decrease the multiplicity of the element featureCalalogueCitation to 1.
DQ_Element.date Time	N	1	Only 1 dateTime is needed for one DQ_Element

Further, the concept of dataset series is not implemented, because it is not (yet) required by AGIV nor by the SDI-Flanders user community. Until now, datasets are only used within horizontal relations and adding vertical relations via the concept of dataset series is considered as unessential. Therefore, the ISO 19115 elements *parentIdentifier*, *hierarchyLevel* and *hierarchyLevelName* have not been applied. If it would seem significant in the future, these elements shall be added to the AGIV metadata profile.

Also, some code lists are found to be too extensive. Table 2 shows how these code lists are reduced or specified. Finally the AGIV metadata profile does not comply grid or coverage metadata yet, because at the time of writing the ISO International standard on gridded data (ISO/TC 211, 2009) was not yet available.

Table 2: Specific use of metadata elements or code lists

Metadata element	AGIV metadata profile
verticalCRS	Shall be expressed as 'Tweede algemene waterpassing'.
DS_AssociationTypeCode	The value of crossReference is sufficient.

Regarding data quality indicators, it would have been possible to map all the indicators provided by the CEN standard to the ISO standard. Nevertheless, when converting the CEN based repository to the ISO based metadata repository, only the elements *DQ_CompletenessOmission*, *DQ_AbsoluteExternalPositionalAccuracy* and *DQ_ThematicClassificationCorrectness* were retained. Since other quality indicators, like information on topological consistency, time, actuality, validity, and attribute errors, were rarely completed in the existing metadata sets, it was decided not to preserve these elements.

Further, in the CEN standard a distinction is made between access constraint and use constraint descriptions. In the ISO 19115 standard, access constraint and use constraint limitations are mixed up which would imply a loss of information after the transformation process. For that reason, it was decided to change the

[1] "N" stands for repeating occurrences
[2] "1" stands for single occurrence

implementation of the data model in order to preserve that information. However, when it is exported into ISO 19139 (ISO/TC 211, 2007) XML, the data model is totally conformed to ISO 19115 and its implementation.

There are also some elements that are optional in CEN, but are required by the ISO standard and the new AGIV metadata profile, for example denominator and topicCategory. In this case default values were entered or code lists were extended with an extra “unknown” element. Manual intervention is needed to correct these inconsistencies.

2.3 Metadata for Feature Cataloguing: IS0 19110

The ISO 19115 standard was insufficient to describe features. Therefore it was necessary to implement the International Standard ISO 19110 – Geographic information – Methodology for feature Cataloguing, ISO 19110:2005(E) (ISO/TC 211, 2005) which allows to describe the features of datasets. Although both ISO standards cover most of the items provided in the CEN standard, there was still one essential element missing: information on geometric primitive metadata. Therefore the ISO19110 feature type class was extended with a mandatory geometric primitive attribute.

2.4 Ratification of the Metadata Profile

The selected metadata elements have been described in a recommendation for metadata and a recommendation for feature catalogues, and have been approved by the steering committee of SDI-Flanders. This means that metadata is supported by the SDI-Flanders community and that all participants of SDI-Flanders have to create and/or distribute their metadata and feature catalogues according to these two ratified SDI-Flanders profiles.

2.5 INSPIRE Implementing Rule for Metadata

At last, by the approval of the INSPIRE Implementing Rule for Metadata in Comitology in May 2008, the SDI-Flanders metadata profile was extended with the INSPIRE metadata elements which were not yet included in the ISO standard for metadata. In practice, there was only one additional INSPIRE metadata element: Conformity. This element was included in the AGIV metadata profile, in the metadata repository and the metadata application. The modified AGIV metadata profile was ratified by the SDI-Flanders steering committee as a new version of the recommendation for metadata.

3. IMPLEMENTING THE NEW REGIONAL METADATA RECOMMENDATIONS

To update and convert the existing AGIV metadata repository, first of all a database was built based on the SDI-Flanders metadata profile for spatial data sets. Since research pointed out that a conversion between the CEN standard and the ISO standard had not yet been performed, a mapping table between them had to be prepared. Then a conversion application was written to load the CEN data in the new repository. Approximately 90% of the data was mapped automatically, the other 10% required manual intervention. Overall, the presence of a CEN based metadata repository and the conversion tool facilitated the adoption of an ISO compliant repository in a relative short period of time.

Next, an online application to search, view, edit and manage metadata was built (http://metadata.agiv.be). Requestors can discover metadata and view and/or download the metadata sets that fit the search terms. Four primary use cases are distinguished: search, view, edit and manage metadata.

3.1 Searching Metadata

Regarding the first use case, the online interface allows four methods to search for metadata: by keyword, category, location and by geographic extent. The search interface is service oriented, but does not implement the INSPIRE catalogue service specification yet. The specification was not available at the time of implementation and a Catalogue Service for the Web (CSW) implementation was considered to be too complex.

3.2 Viewing Metadata

When a metadata set is found, it can be viewed online. Presentation controls are bound to the metadata in the database. The presentation layer is not bound to XML. However, users can export the selected metadata set to an ISO 19139 compliant XML format or to a PDF document.

3.3 Editing Metadata

Concerning the editing process, users willing to contribute to the metadata repository are obliged to register as a 'metadata editor' on the AGIV portal. After the registration process, the user is authorized to edit every metadata set, both metadata sets of datasets they own and metadata sets of datasets owned by other data producers. Four edit methods are supported: create, copy, change and delete. When an authorized user starts an edit session the selected metadata set is locked. The locking mechanism prevents simultaneous editing of the metadata set by other users. Subsequently, the metadata set is copied to a staging to prevent possible abuse during the editing process or to avoid the publication of possible mistakes. After validation of the content of the metadata by an administrator, the changes are committed to the production database. Users are required to fill in all metadata elements of the minimum AGIV metadata profile before ending an edit session.

3.4 Managing Metadata

The metadata repository is centrally located at the AGIV. An AGIV metadata administrator inspects the changes made by the metadata editor. The administrator can either reject or accept the changes. If needed, administrators can change the edits made by the editors and validate it after the interference. When validated, the new or revised metadata sets are released into the production database, allowing public access. During the process, the administrator can choose to archive the old version of the metadata set as a PDF document. Finally, the metadata editor is notified by email that the changes are accepted or rejected. If edits are rejected, the editor is requested to make the necessary changes before reposting the metadata set.

The online metadata application was written in .NET; the underlying metadata repository is a Microsoft SQL Server database. After the implementation of this online application, of which the architecture integrates seamlessly in the AGIV ICT infrastructure, a proof of concept implementation of a catalogue service was started. The service was built on the minimum requirements described in the ISO Metadata Application Profile of the OpenGIS CSW 2.0.2 specification (OGC Inc, 2007).

Unfortunately, the test service is not yet INSPIRE compliant since the project was realized before the INSPIRE Implementing Rules for Discovery Services (INSPIRE, 2007) were published[3]. However, a migration to an INSPIRE compliant catalogue service and the integration in a bus architecture is planned in the near future (see chapter 5).

4. METADATA: UNNECESSARY OVERLOAD OR INDISPENSABLE INFORMATION?

The value of metadata is assessed differently by data producers and data users.

4.1 From a Data Producer point of view

The majority of data producers exchanging data with the SDI-Flanders community – mainly public authorities in Flanders – consider metadata as secondary information. Most of their attention goes to the management and maintenance of the data itself. Regrettably, they do not always recognise the value of metadata and are not always willing to put in the extra effort to document or update metadata of the datasets they own. Although it is possible to synchronize a number of metadata elements automatically, building and maintaining reliable metadata still implies an important manual task. Despite the availability of a predefined, well-balanced metadata profile in combination with the availability of a user-friendly web-based metadata editor, data producers need additional stimulation to build metadata of their geodata. Since metadata are often considered as complex information, with formal and precise definitions and standards, it is also important that the data producers are well informed on all the practices which are needed to produce metadata of good quality.

4.2 From a User Point of View

Unlike most data producers, data users recognize metadata as a valuable source of information on datasets, for example information on changes in datasets, version information, information on quality etc. In case of authentic geographic datasets, which are legally recognised as official up-to-date and accurate reference datasets, it can be of juridical importance to reference to a specific dataset version.

The INSPIRE implementing rule on metadata caused an obvious revival of the interest in metadata for datasets. INSPIRE creates an opportunity to increase and synchronize SDI efforts in Flanders. As the INSPIRE directive is converted in national and regional legislation, the need arises for harmonizing data, metadata and services. As explained in chapter 3, within SDI-Flanders, AGIV facilitates the production of metadata, and offers a platform to collect and publish metadata. An online application to view and edit metadata of the available datasets within the SDI-Flanders community is accessible to the data users and owners. Besides the availability of metadata through this application, the metadata set is always joined as a separate XML or PDF file when obtaining a SDI-Flanders geodata set, no matter whether the dataset is provided through CD or DVD, or via FTP download. By doing this, the importance of metadata is emphasized.

[3] At the time of writing, the test service is available via http://cswtest.agiv.be/service/, KVP bindings via http://cswtest.agiv.be/kvp/

4.3 The Necessity of Metadata Services

At the time of writing, Web Map Services (WMS) and Web Feature Services (WFS) are in a testing phase within AGIV. The connection between the catalogue service and the view and download services is lacking, which results in an 'isolated' catalogue service. It is thus not yet possible to address the view and download services, or to download the relating datasets through FTP, from the provisional catalogue service, nor through the operational online metadata application. The binding between the metadata and the actual dataset is virtually non-existing. Therefore, at present, the need for metadata services by users of SDI-Flanders geodata is limited. The synchronisation of metadata and data management will be addressed in the near future.

5. THE GEOGRAPHICAL SERVICE BUS: OPPORTUNITY OF THE FUTURE

Although many improvements have been made since the first CEN/TC 287 metadata implementation, there are still some issues to deal with before achieving the final goal: a seamless metadata service, fully integrated with the data management and data publishing cycle, supporting federated searches in a distributed SDI network.

5.1 The Synchronization of Metadata and Data Management and Maintenance

The translation of a generic INSPIRE footprint to national and regional level will be a challenge. In the infrastructure's back-end, where data and metadata resides, the effort will be in synchronizing the management and maintenance of data and metadata. Database schemas for data and metadata will be mapped towards the INSPIRE implementing rules on data specifications and metadata. Since AGIV has its own INSPIRE compatible metadata profile, there are no third party tools available for data/metadata synchronization. To bypass this issue, custom synchronizers will be developed based on database and XML technology.

The availability and accessibility of data and metadata at the client side will be optimized by providing web enabled services with standardised interfaces. INSPIRE promotes the use of Simple Object Access Protocol (SOAP) on top of HTTP as communication protocol and OGC Web Services (OWS) for geospatial interoperability. Momentarily, the SOAP implementation for OGC services is still a work in progress (Villa et al., 2008).

Rather than waiting for the ratification of SOAP enabled OGC services, AGIV has chosen to implement generic, OGC compliant, back-end services that can be draped with KVP, SOAP, REST, SMTP or FTP bindings. This allows a loose coupling between back-end services and different flavours of exchange protocols guarantying a more future-proof infrastructure. In this way, the proposed architecture could be interpreted as a mixture of a Service Oriented Architecture (SOA) and a Resource Oriented Architecture (ROA) or better called a RestFul compliant architecture (Lucchi et al., 2008).

5.2 Test Beds

Medium 2009, the INSPIRE compliant catalogue service will be published, serving metadata query results based on a common metadata application profile. Initially, the CSW will publish metadata coming from the AGIV metadata repository. Meanwhile test beds will be developed to verify the feasibility of federated metadata searches. Two architectures will be tested: search on a centralized metadata

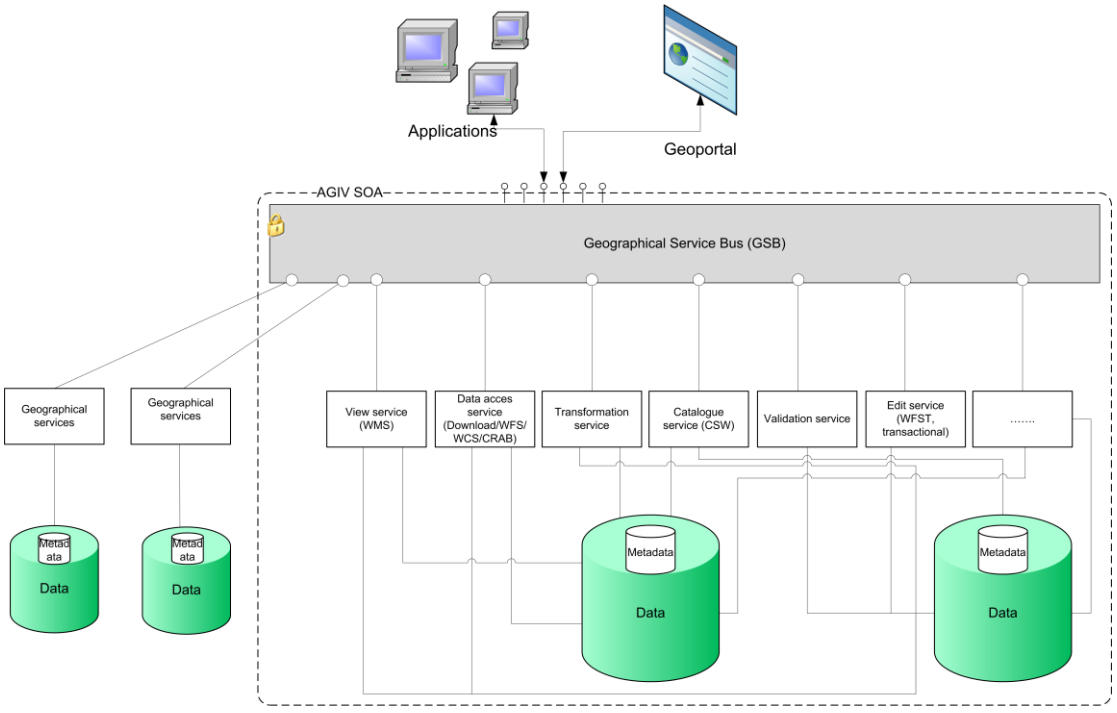
repository, where metadata from partners is gathered through harvesting, and second, real distributed searches through brokering services. Federated search is a key component to leverage regional and local efforts.

Supplementary, test beds will be developed for mapping, feature and coverage services. They will support OWS (WMS, WFS and WCS), SOAP and REST interfaces. The test beds will focus on testing compliance towards INSPIRE, performance risks, and interoperability and management of the system. Apart from these primary goals, the test beds will also have a demonstrative goal. They will show that the implementation of an SDI is about contracts, clear agreements, application profiles, specifications and standards. Regarding the test beds, the basic technology is ready and available but there are still a lot of issues that need to be addressed. Scalability, reliability, performance, namespaces for services, cartographic rendering (SLD) and symbology, service metadata, atomic or composed services (atomic services are better suited for service chaining), security and digital rights management (GeoDRM) are among the most urgent ones.

5.3 The Geographical Service Bus

To manage some of the above issues, AGIV has started to develop an Enterprise Service Bus for geographical information (Geographical Service Bus – figure 1). This GSB will host basic and composed services in line with the Network Services Architecture proposed by INSPIRE.

Figure 1: Geographical Service Bus



Web services and traditional middleware systems such as Java EE (EJB) and .NET focus on a client application accessing services provided by an Application Server. Though distributed services are supported, the fundamental access model is

still point-to-point. Every accessing application must be aware of exactly where and how the service can be accessed; the coupling is very tight.

Within the SDI-Flanders community, there is a wide range of application platforms and environments that are physically and geographically distributed. In such environments, integrating the large number of solution islands forms a major performance and scalability challenge. To address the possible integration scenarios, additional infrastructure components that sit in between the two service ends are needed. This would involve services being "available on" and "accessible from" this GSB infrastructure. The GSB will extend across the organization and all existing solution islands can be made available on this common infrastructure. The business processes and integration applications will also be on the same infrastructure as "consumers" of the available services. If such infrastructure leverages the XML-based wire protocols that are popular in Web Services, then the service requests will flow through the infrastructure as XML documents. As a large number of services become available and get accessed, this infrastructure will start looking like a "bus" transporting these XML documents.

The service bus will provide the necessary capabilities to host services, provides effective communication infrastructure, enables access to the services through this infrastructure and it guarantees a well monitored architecture that is reliable and available. Additionally, the bus will provide the abilities to manage the services and their access. It will facilitate communication between services and other loosely coupled systems by offering a standardised interface. This might include providing abstractions of services in such a way that the location of the services is hidden from the consuming applications and process engines. The infrastructure will take the responsibility of locating and routing the request to the right location.

As a summary, the GSB will support following functions:

- Standardised interfaces and interfaces mapping
- Protocol bridging
- Communication streamlining
- Authentication and authorisation
- Availability, performance and manageability of individual services
- Monitoring, logging, reporting
- Service chaining

5.4 Authentication and Authorization

Since INSPIRE does not indicate whether the European infrastructure will provide authentication and authorization standards, services provided by AGIV use a proprietary solution that supports authentication and authorization for applications (Single Sign On) and web services. The user and role repository for web services and web applications is implemented based on Microsoft's ASP.Net Membership and Role provider. SOAP services are secured with OASIS WSS Username Token Profile and PassWordDigest whereas OGC and REST services are secured using HTTP Digest Access Authentication. This is only a temporary solution until a common European or National infrastructure is available. In Belgium the federal e-id could be used for authentication, but the infrastructure is based on a reverse proxy which implies an interaction with the end-user and can't be used for authenticating web services at this moment in time.

5.5 Timing

The GSB will be built up gradually in time as subcomponents will be added to the system. The GSB implementation has started in 2009 and a first version should be finalized in 2011. The entire system will be based on Microsoft technology and on INSPIRE standards, and will contain ESRI based geographical components. It will be set up as a Flemish INSPIRE SDI node. The implementation and organisation of the GSB will be documented in a SDI cookbook for Flanders, which will serve as a manual for all stakeholders.

6. CONCLUSION

The collaborative framework on geographical information in Flanders (Belgium), SDI-Flanders, has a tradition of centrally managed metadata on geographical information. The first initiatives date from 1998. The implementation of the INSPIRE directive and its implementing rules resulted in a new ISO 19115 compliant metadata profile that was implemented in a central repository. The profile is a compromise between high level metadata quality including the pursuit of completeness, and the practicability for the user community. A well-balanced user friendly profile is essential to convince data producers to provide metadata.

The SDI-Flanders metadata profile was adopted in 2008 by the Flemish SDI-community. The conversion of the existing CEN based metadata to an ISO compliant implementation was needed. A mapping between both systems was made to convert the metadata. In addition, a web interface was developed to search, view and edit metadata. On top of this metadata repository, an INSPIRE-compatible catalogue service was implemented.

Metadata is a major component of the SDI for Flanders which will be build in the near future, and which will comply to all INSPIRE Implementing Rules. The SDI will have a Service Oriented Architecture empowered by a geo-enabled Enterprise Service Bus. In the SDI, management and maintenance of data and metadata will be synchronized. Testbeds are set up, and the required components will be developed, so that the Flemish SDI will serve as an INSPIRE compliant node in the European GI-network.

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