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SDI considerations: a European perspective

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Abstract:

Most countries have national, regional and local electronic mapping data collected over many years. While historically acceptable to produce paper maps, the usability of these data is being tested by a new generation of web and enterprise-based location-specific services that require this spatial data to be current, precise and interoperable, internally and with data from other organisations. This is the foundation of Spatial Data Infrastructures (SDIs) – providing improved access and sharing spatial data across the Web.

Over the last two years, more than €2 billion of European Union funds have been committed to Information and Communication Technology (ICT) research projects. This investment has been made with a view to making Europe more competitive on a global scale; this approach can benefit those working in the field of SDIs. Primarily in Europe via the funding and direct involvement in ESDIN (European Spatial Data Infrastructure best practice Network), but also globally for those tracking ESDIN progress and lessons learned.

The ESDIN eContentplus project, co-funded by the European Union sets out to tackle practical elements of the INSPIRE Directive (Infrastructure for Spatial Information in Europe). It will address INSPIRE challenges by testing the theory of integrating National SDIs (NSDIs) to provide Europe with a framework of geographic reference information or in other words a European Spatial Data Infrastructure, for which INSPIRE is the legal instrument. The ESDIN consortium is developing best practice for geospatial data management and is working collaboratively with a large number of national mapping agencies, universities and private companies with EuroGeographics as the project co-ordinator.

Introduction

There are many similarities between India and Europe in the SDI movement. The words contained in the Indian National Spatial Data Infrastructure's Decision Support System (2008) set the tone:

> *"The primary objective is to deploy Decision Support Systems: for agriculture and natural resource assessment; infrastructure planning; disaster planning and recovery, including many other endeavours such as watershed development programmes at National, State and Local levels".*

At the Map World Forum (2007) in marking the 10th anniversary of Map India Dr. R. Siva Kumar, CEO of the National Spatial Data Infrastructure (NSDI), commented that no SDI model was working in operational mode in its totality because there was a need to build consensus first. This involves both institutional and standards consensus for metadata and data exchange, as well as broad agreement over the functioning and organisation of an SDI.

At the very same time in Europe a very similar consensus approach has been taken with the European Commission INSPIRE Directive – to build the Infrastructure for Spatial Information in Europe, notably using a comitology[1] approach. This is where there is informal and voluntary recognition by courts of one jurisdiction of the laws and judicial decisions of another. Stakeholder participation is a very large and important element of INSPIRE and this paper will outline the different players and their roles. INSPIRE is regarded as an environmental directive and has broadly the same goals as the Indian NSDI approach.

Over the next two years more than €9 billion (http://cordis.europa.eu/fp7/ict/) of European Union funds will be committed to Information and Communication Technology (ICT) research projects. This investment is benefitting those working in the field of SDIs, primarily in Europe via the funding and this paper discusses ESDIN[2], one of the projects in order to disseminate lessons learned.

Until recently in India, at least since the time the Superintendent of Great Trigonometrical survey started mapping India, maps (usually in paper form) have been a mainstay for a wide variety of applications and decision-making. Now, a new wave of technological innovation is allowing users to capture, store, process and display an unprecedented amount of geographical and spatial information about society and a wide variety of environmental and cultural phenomena.

India has, over the past years, produced rich maps through systematic topographic, geological, soil, cadastral surveys and various natural resource inventory programmes with the help of satellite images and aerial photographs. With the availability of precision, high-resolution satellite images and GPS, the accuracy and information of these spatial datasets is extremely high. Recently in India the emphasis has been on information transparency and sharing, with the recognition that spatial information is

a national resource and citizens, society, private enterprise and Government have a right to access it, appropriately.

The task force that envisioned the NSDI was composed of geographers, scientists, GIS experts and administrators, mainly drawn from survey, mapping, remote sensing and the Indian space organisations. At the beginning it was purely a Government initiative and therefore had taken a back seat until around 2007. Realising the power and usefulness of an innovative approach, i.e. Public-Private Partnership (PPP), the Indian Union Minister for Science and Technology Kapil Sibal, in his statement published on the website of a magazine, GIS Development on 20th February 2007, said that there will be just a few restrictions on the use of data:

> *"This (the project) will be rolled out through public-private partnerships (PPPs)."*

Since that time both industry and the Government have been working hard on NSDI and various initiatives have now commenced.

Objectives

The objective of this paper is to explain the European contribution to SDIs in view of the goals of the Indian NSDI. It is argued that these SDI entities will become increasingly important in resource allocation strategies in the next decade. By resource allocation we mean all aspects of the built environment including both disaster management responses and efficient consumption of resources in building infrastructure. We address these matters by reviewing several topics:

1. An overview of the consensus approach used in INSPIRE
2. The ESDIN project, which is building a candidate INSPIRE infrastructure
3. The Network Services architecture.

Consensus building in Europe

In order to determine the key European SDI considerations, an understanding of INSPIRE is required; it is now a legal instrument in Europe as an EU Directive. As such, most European countries are building their NSDIs to address INSPIRE, as well as looking at other topics like PSI reuse[3] and CORINE[4].

The structure of the stakeholder participation in INSPIRE is worth explaining. There are four key groups of stakeholders who often overlap and who also support each other.

i. A Spatial Data Interest Community (SDIC) represents a grouping of skilled users, producers and transformers of spatial information. These are individuals from organisations that can provide technical, commercial and political expertise to

further the needs of INSPIRE. They are a critical element of the spatial data supply chain and often drive the demand for spatial data and spatial information services. Originally it was stated that 'environmental monitoring, reporting and development of applications and services for environmental management are among the main driving forces behind the natural formation of SDICs'. However, today as well as a large number of SDICs that know what spatial data is required for environmental tasks across the supply chain, there are also a number of SDICs with more generic industry knowledge. This community of super users is involved in reviewing the deliverables coming out of INSPIRE, notably the descriptions and associated wording of deliverables, to ensure they meet the requirements of the real world applications. In terms of operational or end user requirements, reference material is submitted, experts are proposed and draft specifications are tested.

ii. The next group of stakeholders is the Legally Mandated Organisations (LMO). Across all EU Member States there are public sector bodies that have been assigned, or will be assigned, components of national and regional SDIs. These organisations may become contributors to INSPIRE for a particular component in a Member State; components can be technical, policy related or of an organisational nature. Again, stakeholders are involved to keep informed, review INSPIRE deliverables, propose experts, submit reference material and/or test draft specifications. Many of these organisations underpin the supply chain since they are providing the core reference data or master data.

iii. There are Drafting Teams working on Implementing Rules (IRs). Five sets of IRs are being drafted to set out how the various elements of the system will operate. The Drafting Teams working on these IRs are composed of international experts and the process works based on a very open consultation – particularly with SDICs and LMOs. They participate in the process of creation of IRs in the fields of metadata, network services, data and service sharing and monitoring and reporting. Bringing together these international experts in this forum is one of the most powerful activities of the INSPIRE community. They analyse and review the reference material provided for a specific topic (from the five areas), to produce draft INSPIRE IRs and to provide recommendations to a Consolidation Team, in case of conflicting technical specifications or issues. These IRs are then sent out to the wider community for review.

iv. Finally, Thematic Working Groups (TWGs) were set up to assist in the drafting of technical specification for the themes covered in Annex I of the INSPIRE directive. 34 spatial data themes have been defined in three Annexes. Annex I datasets cover the basic spatial building blocks covering aspects such as coordinate reference and grid systems, geographical names, administrative units, addresses, cadastral parcels, transport networks, hydrography and protected sites. The TWGs are composed of domain experts who work on these spatial data themes. This 'inside' knowledge is important since there are so many variations and nuances at a local level for each theme. Again, the collaborative nature of the

TWGs is important so that they can streamline standardisation and harmonisation initiatives based on different international, national, regional and local initiatives. The main aim is interoperability and, where practicable, harmonisation of spatial datasets and services. Each TWG is developing technical specifications for the themes where they are responsible. These involve the creation of target schemas for the theme based on UML models.

ESDIN

The ESDIN eContentplus[5] project, co-funded by the European Union sets out to tackle practical elements of the INSPIRE Directive. It addresses the INSPIRE challenges by testing the theory of integrating NSDIs to provide Europe with a framework of geographic reference information or, in other words, a European SDI for which INSPIRE is the legal instrument. The ESDIN consortium is developing best practice for geospatial data management and is working collaboratively with a large number of national mapping agencies and universities, with EuroGeographics as the project co-ordinator. As well as collaboration, knowledge sharing is also key to ensuring the success of any SDI.

Organisation	Sector	Location
1Spatial	Private	UK
Bundesamt fuer Eich und Vermessungswesen (BEV)	Government	Austria
Bundesamt fuer Kartographie und Geodaesie (BKG)	Government	Germany
Finnish Geodetic Institute (FGI)	Academic/research	Finland
Geodan	Private	Netherlands
Helsinki University of Technology	Academic/research	Finland
IGN Belgium	Government	Belgium
IGN France	Government	France
Institute of Geodesy, Cartography and Remote Sensing	Academic/research	Hungary
interactive instruments	Private	Germany

Kadaster	Government	Netherlands
Kort & Matrikelstyrelsen	Government	Denmark
Lantmateriet	Government	Sweden
National Agency for Cadastre and Real Estate	Government	Romania
National Data Centre, University of Edinburgh	Academic/research	UK
National Land Survey Finland	Government	Finland
National Technical University of Athens (NTUA)	Academic/research	Greece
Statens kartverk	Government	Norway
University of Muenster	Academic/research	Germany

Table 1 – ESDIN contributors and collaborators

ESDIN is addressing some long-standing industry problems, such as data consistency and integrity, by looking at possibilities for online data quality validation. There are also some specific data lifecycle maintenance topics of interest to organisations across the supply chain, such as:

• Cross-border data consistency methodologies for edge-matched maintenance; important for combining spatial data of adjacent regions seamlessly from different sources;

• Stable Unique Identifiers (UIDs); workable at a European level in a data maintenance framework for regional or national data holdings;

• Incremental update deliveries at a European level; assessing methodologies and best practice for change-only updates. This need arises directly out of the ongoing maintenance needs of the EuroMap series at the 1:250k and 1:1m scales.

ESDIN Methodology

ESDIN consists of 12 work packages. In the project, 1Spatial deals with methodologies in two of these for Metadata and Quality, and Data Maintenance and Business Processes in National Mapping and Cadastre Agencies. ESDIN will help Member States, candidate countries and EFTA States (European Free Trade Association) to prepare their data (and maintenance processes) for INSPIRE Annex I data themes and improve access to them.

Specifically the project will:
• Aggregate data through the development of web-based services for several INSPIRE themes at different levels of resolution from European to local level;
• Implement services that will support the aggregation of 'interoperable' data in a more cost effective and efficient way;
• Build sustainable best practice networks to ensure the organisational development necessary to achieve the goals of the project and its continuation afterwards;
• Spread best practice in the integration of local (large scales) reference information with pan-European (medium/small scales) reference information, and interoperability with other data themes;
• Test INSPIRE IRs and specifications in a live operational environment and recommend improvements where identified.

ESDIN will enable agencies, technology providers, academics, professionals, value added resellers and end users to significantly raise the prospects of success for the European SDI. The solution will result in the provision of data for a number of INSPIRE Annex I themes at a range of scales, from a European view down to a local view. The project will also assess the suitability of this information as a basis for linking to other information themes (INSPIRE Annex II-III). Achieving interoperability of data within a theme, between themes, across borders, for different applications and at different resolutions will require some basic components of interoperability being put in place, including services capable of transforming data and providing access to the data, such as; transformations to European data specifications, providing common semantics, support for multi-lingual aspects, transformation of coordinates (to common coordinate reference systems), generalisation (from 'large' to 'small' scales) and edge-matching (to address inconsistencies at national borders). ESDIN aims to develop, test and implement these.

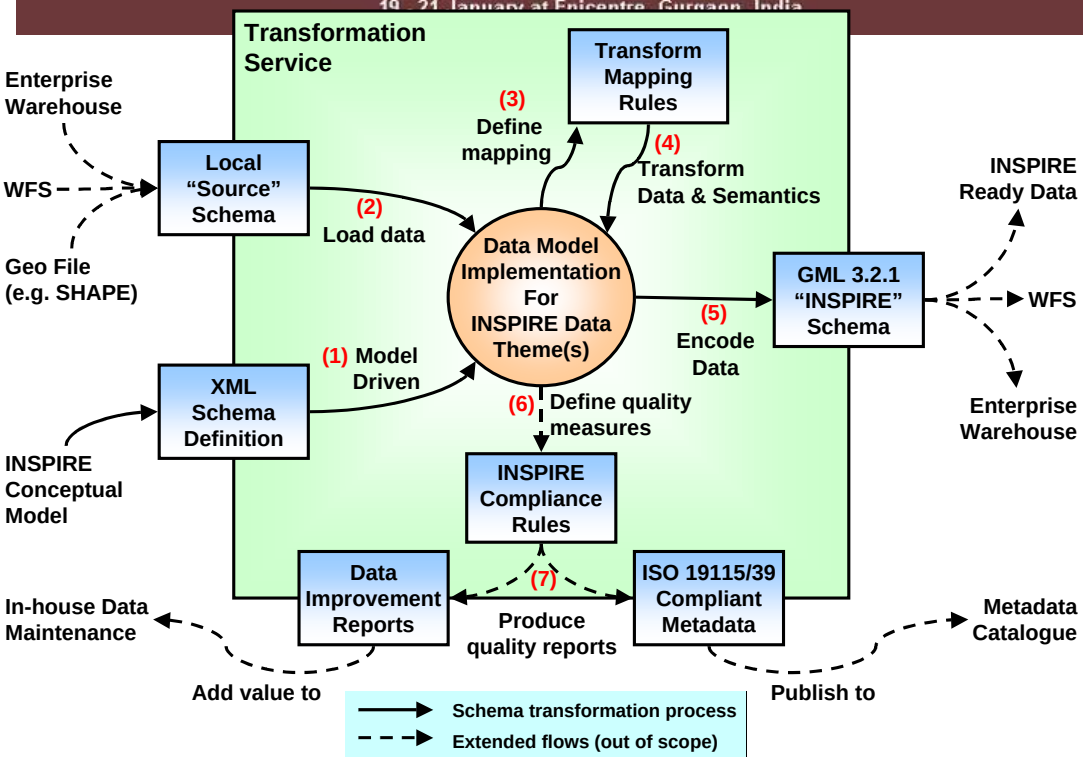
The project will also address the challenge of 'business interoperability'. Across Europe there are a number of different business models and associated pricing and licensing policies. Management of intellectual property rights, with simple data licensing, digital geo-Rights Management providing fast and easy user access to data, will be important components of the proposed solution delivered in this project. Finally, quality of data is also a prime concern of users and there is a need to establish a standard approach for reporting data quality in a manner understood by users and for a range of data. This project will prepare guidelines for the creation of discovery metadata and data evaluation for the data providers of reference information and develop a quality model based on best practices at the data providers in Europe and on international standards. By following supply chain principles, where communication and activity needs to take place with multiple participants across the whole supply chain, there should ideally be a feedback mechanism in place. This means that data consumers or end users can feed back inconsistencies or perceived errors in the data for the original data creator or provider to assess and resolve, if appropriate.

ESDIN Framework

Although the results have yet to be finalised, 1Spatial has defined a working framework to share data. This is being used as the basis for sharing and reuse. This is shown in Fig 1 and the numbered steps to exchange data without disrupting the existing practices or technologies used by organisations in the supply chain are described below:

(1) Deploy an implementation model of the target schema. Embracing the philosophy of "point-and-go" applications (an underlying goal of ISO TC/211, GML and INSPIRE), the object-oriented geo-processing environment is able to automatically define and deploy an implementation data model representing the rich data structures of the INSPIRE data specifications. This is deciphered from the machine-readable XML schema definition files.
(2) Following translation to a pre-determined data format (such as Oracle Spatial or GML 3.2.1), the data is loaded into the schema transformation environment, in “as is” source schema, ready for data model transformation.
(3/4) Rules describing the required mapping are (pre-) authored and executed automatically to transform the data from its source model to the target INSPIRE model.
(5) The transformed data is encoded (in GML 3.2.1) for returning to the data consumer. This step, in effect, ends the transformation process.
(6/7) To complement the transformation process, rules describing specific quality measures to which the transformed data should conform can be expressed and applied to the data. This provides an optional quality control element to the process. ISO 19115 and 19139 compliant quality metrics, resulting from the data evaluation, can extend existing metadata, to describe how good the data is in respect of the INSPIRE data specifications. Where data is non-conformant, data providers have the option to receive data improvement reports to assist in future data maintenance activities.

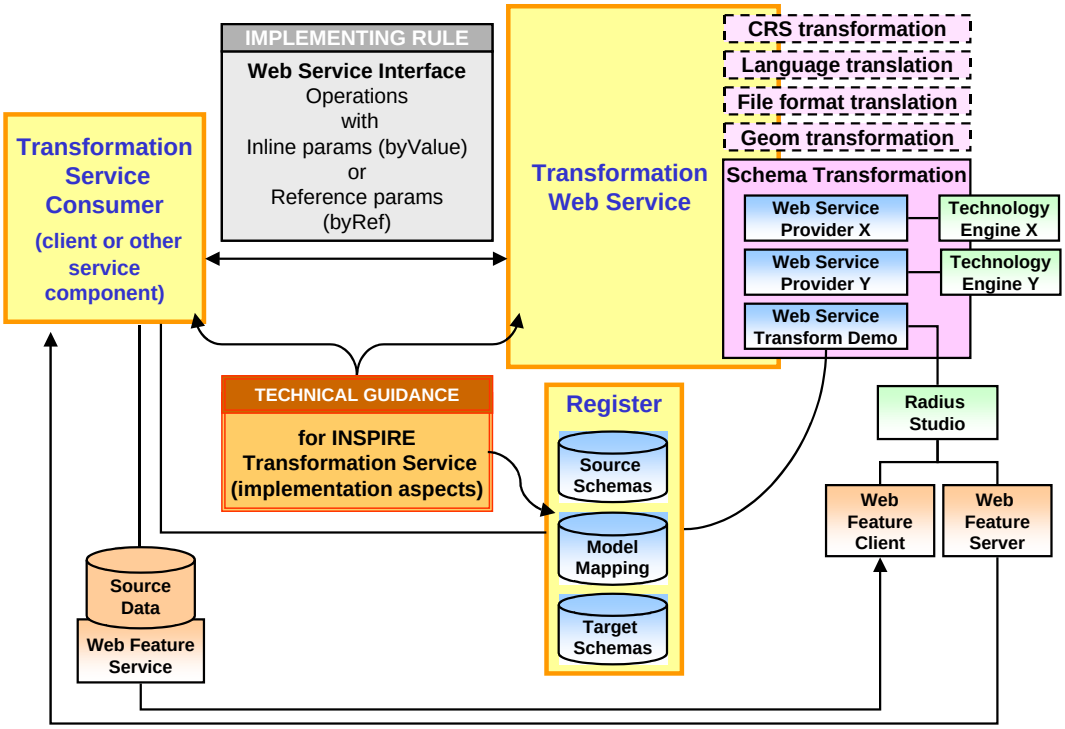
Fig 1 INSPIRE Transformation Framework



The Network Services Architecture

The EU has conceptualised an architecture, which will form the basis of spatial data exchange. Principally this will see each LMO and SDIC being responsible for creating INSPIRE compliant data using Web2.0 approaches and not seeking to create a single data warehouse. Our experience in ESDIN has led directly to 1Spatial being involved in providing a best practice technical guideline for INSPIRE transformation services. The key problems to solve are those with cross-boundary implications. These include national boundaries and all other administrative boundaries. Solving these issues assists the achievement of the goal to ensure that resource management becomes more efficient. Our current approaches mean that data do not flow across administrative boundaries and therefore artificially restricts resource allocation. The candidate architecture is shown in Fig 2.

Fig 2 A Transformation Web Service



In this initiative we will look at cadastral parcels, hydrography and transport networks with the partners identified in Table 2. The cadastral theme will build on the domain expertise we obtained whilst working on the Digital Mapping System (DMapS) to the Property Registration Authority for Ireland (PRAI). The PRAI objectives were to improve business processes, eliminating reliance upon paper maps and continuously improving customer services. Having industry experts from a range of organisations involved in such projects is invaluable for INSPIRE, especially when you have more than 200 stakeholder organisations for the cadastral parcels theme alone.

Data Partner	Data Theme
Ordnance Survey Ireland	Transport
Land & Property Service (Northern Ireland)	Transport
Statens Kartverk (Norway)	Hydrography
National Land Survey Sweden	Hydrography/Cadastral Parcels
National Land Survey Finland	Cadastral Parcels

Table 2 Transformation Services Collaborators

Conclusions

In order to make resource allocation more efficient and meet carbon restriction goals, spatial information has to flow more effectively across artificial administrative boundaries. Activities are underway in both India and Europe to set up SDIs, which will become the basis for transnational collaboration entities.

1. This term was introduced with the Council of the European Union decision from June 28, 1999 relating to procedures for the exercise of implementing powers conferred on the Commission (1999/468/EC ; OJ L 184/23 of 17.7.1999) ("the Comitology Decision").
2. www.esdin.eu
3. In 2003, the EU adopted the Directive on the reuse of public sector information (PSI). It has introduced a common legislative framework regulating how public sector bodies should make their information available for re-use in order to remove barriers such as discriminatory practices, monopoly markets and a lack of transparency.
4. CORINE – European Commission programme - Coordination of information on the environment, includes aspects like land cover mapping.
5. The eContentplus programme is concerned with the reuse (by sharing) of public sector data. Spatial data is the largest category of public sector data.

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Websites: www.1spatial.com, www.esdin.eu and http://inspire.jrc.ec.europa.eu/