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OGC Market Report
Open Standards and INSPIRE

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Foreword

This market report was written and reviewed by members of the Open Geospatial Consortium (OGC) to provide a simple guide to the EU INSPIRE Directive from an open standards perspective.

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Overview and Scope

This market report was written and reviewed by members of the Open Geospatial Consortium (OGC) to provide a simple guide to the EU INSPIRE Directive and Implementing Rules from an open standards perspective. Additionally, this report provides an overview of the role that OGC, CEN and ISO standards play in helping public sector bodies across Europe meet their obligations to implement the INSPIRE Directive and Implementing Rules. The audience consists of any person with geospatial policy responsibilities in an INSPIRE stakeholder organization.

The INSPIRE Directive introduces general rules to establish an infrastructure for spatial information in Europe. These rules are related to community environmental policies and policies or activities which impact on the environment. The Directive is taken up and followed by Legally Mandated Organisations (LMOs) operated by the Member States and Spatial Data Interest Communities (SDICs) across Europe. The Directive does not require the collection of new spatial data and aims to improve access to and sharing of spatial data held by or on behalf of a public authority in Europe. There are 34 Spatial Data Themes laid down in 3 Annexes and the Directive entered into force 15 May 2007.

INSPIRE is a Framework Directive where detailed technical provisions are laid down in Implementing Rules relating to a number of technical and policy areas, i.e. metadata, interoperability of spatial data sets and services, network services (discovery, view, download, invoke), data and service sharing (policy) and coordination and measures for monitoring and reporting. Once adopted, the Implementing Rules become European legislative acts and national law in 27 Member States and also in some EFTA countries, such as Switzerland and Norway.

There is an important distinction to be made regarding those aspects and documents that are legally binding and those that are not. The Implementing Rules are legally binding, but do not make any explicit reference to any standards or technologies. Technical Guidance documents accompanying the Implementing Rules are not legally binding documents and provide the necessary implementation details. Technical guidance documents reference OGC, ISO and other standards. Figure 1 below explains this in detail.

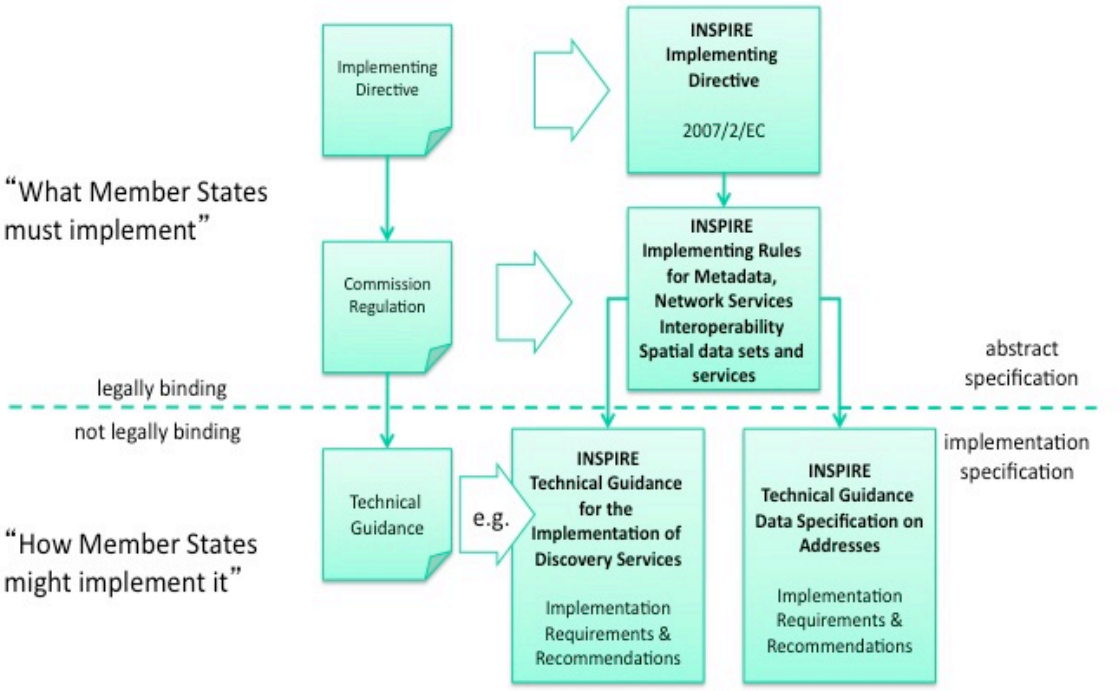

Figure 1 INSPIRE Implementing Rules vs. Technical Guidance[1]

This report should be considered by any organization impacted by INSPIRE. This includes Legally Mandated Organizations (LMOs) and Spatial Data Interest Communities (SDICs) in the first instance, and also users of public sector data, whether from within government departments or commercial organisations. The anticipated readership spans Spatial Data Infrastructure (SDI) coordinators and managers, policy makers, strategists, IT directors and Chief Information Officers. The stakeholders for this report work for public sector bodies mandated by INSPIRE to make their data available, as well as private sector organisations delivering goods and services to assist those bodies. While citizens will primarily use ready-made public sector information portals, individuals involved in application development and who wish to make better use of public sector information to address their own needs may also benefit from the information contained in the report.

> "As OGC members and also the body with responsibility for INSPIRE in Finland, we are very pleased to see one single document that guides INSPIRE stakeholders on the fundamentals of standards in INSPIRE", Jari Reini, National Land Survey Finland.

This report aligns the current OGC standards baseline with the INSPIRE Implementing Rules and Technical Guidance documents. INSPIRE is an environmental directive that mandates the publishing of various types of geospatial public sector data and specifies the way in which this is to be done. The scope is to address community environmental policies and policies or activities which impact on the environment. While only mandated for the EU Member States, INSPIRE is often used as the template for equivalent implementations in other European countries.

[1] http://inspire.jrc.ec.europa.eu/documents/Network_Services/TechnicalGuidance_DiscoveryServices_v3.1.pdf

The INSPIRE Directive sets out a multi-year timetable[2]. EU Member States have already been obligated to transpose the Directive into national legislation and, from these, the first services have appeared during 2011. Most of the formal Regulations (Implementing Rules) have been approved and are already in effect, although their obligations are scheduled for rollout over the period to 2019. These include the data specifications for 25 out of 34 spatial data themes, based on which a draft amendment of the Implementing Rules on interoperability of spatial data sets and services will be created. This work is considerable, but it is scheduled for completion by the end of 2012, with approval and publication in 2013.

> "BRGM is a long-time supporter of the OGC and we also support the OGC France Forum. Creating this type of market report is very timely and incredibly useful." Francois Robida, Bureau de Recherches Géologiques et Minières, France

This report begins with a brief summary of INSPIRE and how this is positioned with other EU data sharing initiatives. It sets out the case for the use of open standards in INSPIRE and the key role that the OGC plays in the collaborative process to assist in the development of these standards. A short description of the relevant standards is also provided to help guide the reader to the most relevant work that has been carried out to date. It has been written with the support of volunteer sponsor organisations from within the membership of the OGC. The OGC is grateful for their support in the creation of this report. Details of these sponsoring organisations appear at the end of this report. Additionally, a number of other expert contributors to the content of this report are recognised for their support.

In order to keep this report to a readable length, links are provided to additional resources should the reader wish to go into more detail.

> "In the Netherlands we have worked collaboratively with the various government organisations responsible for delivering against INSPIRE. This is the type of material related to open standards that helps our cause", Rob van der Velde, Geonovum

[2] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/44

Introduction

The EU INSPIRE Directive[3] was introduced in 2007 with the main aim to improve environmental policy making across Europe. Under INSPIRE, the EU Member States must make available, in a consistent format, spatial datasets that are defined to be within scope by the directive. By creating consistent services to access these datasets it will enable them to be shared more easily. The expectation is that they can be combined for the purposes of Community environmental policies and policies or activities which may have an impact on the environment. Over time, a successful implementation of INSPIRE will result in tens of thousands of public sector bodies in Europe involved in sharing public sector geospatial data. Some will have a legal mandate to do so; others will act where they see a tangible benefit arising from better use of public sector data. By documenting the standards necessary for a successful INSPIRE implementation it will help this large number of public sector bodies take swifter action when they are required to do so. OGC standards are used in many Spatial Data Infrastructures (SDIs) worldwide. INSPIRE will be a driver to enable the European SDI, one of the world's largest SDIs in terms of the breadth and scope. This is another reason for supporting INSPIRE through the creation of this report. It is important to note, however, that using OGC standards does not mean organisations are INSPIRE compliant.

The main objectives of this report are to facilitate the work taking place within the EU Member States to implement INSPIRE, to educate those organisations that are undertaking the work, and at the same time to highlight the role of OGC standards and the work being done by OGC members across Europe and worldwide in support of these standards. Looking forward, INSPIRE regulations will have to be extended and updated over time to reflect best practice and advances in technology. The OGC will be an important partner to accompany this process and ensure backwards compatibility and close interaction with software implementing organisations. A key element of the work between the OGC and the INSPIRE community is to recognise the standards requirements arising from INSPIRE and to include these in the overall international standards developing process. The success of this work depends on communication, cooperation and concerted action within the OGC among the European members of the OGC.

Note that INSPIRE sets out what has to be done and when, but the more detailed aspects of "how" will still be down to local implementation, with the proviso that the resulting services meet the INSPIRE requirements. One of the main obligations that INSPIRE imposes is the sharing of data sets, and especially, harmonized data sets according to the Implementing Rules on spatial data sets and services. Harmonization in this context means the transformation of data from source schemas or data models to the target INSPIRE data models, which means that data providers can still manage their data unchanged. See Figure2 for an illustrative description. The INSPIRE data specifications defining these data models are highly based on the ISO 19100 series.

[3] http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0002:EN:NOT

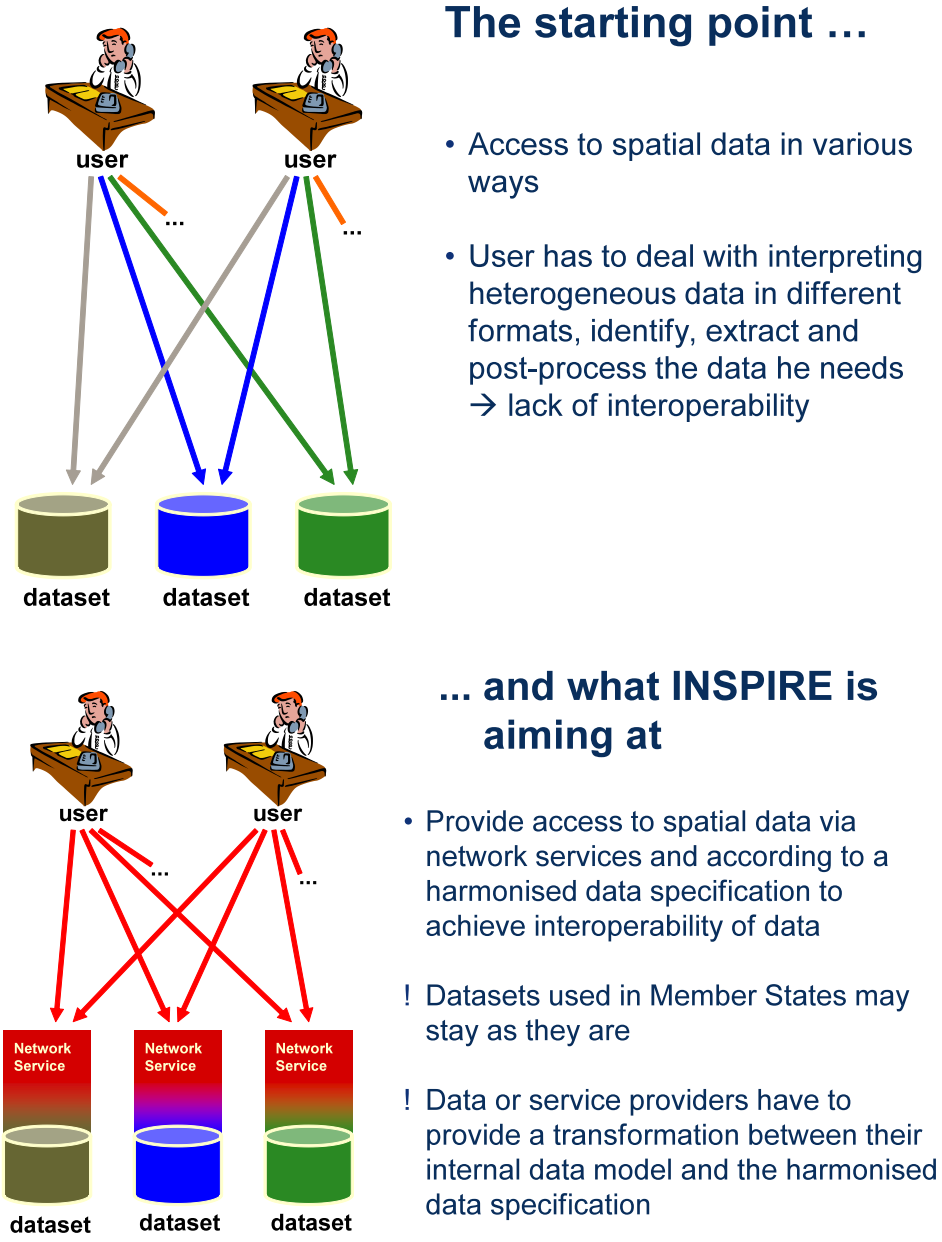

Figure 2 Data interoperability and INSPIRE, image courtesy of JRC

The INSPIRE Implementing Rules defined the service interfaces at an abstract level. As such, at the Implementing Rule level, the service interface specifications do not specify the implementation technology or standards to be used. The Implementing Rules are then the basis for the INSPIRE Technical Guidance. The non-binding Technical Guidance documents describe detailed implementation aspects and relations with existing standards, technologies, and practices. The guidance contains details of what aspects (operations and/or parameters) of specific OGC/ISO standards are to be implemented. However, the defined pattern for a specific interface instance is flexible enough for participating organizations to specify local requirements, such as "Language".

While standards are often seen within the domain of the technologist, this report has been written to highlight the fundamental business benefits arising from INSPIRE. These are closely aligned with the European Commission's Digital Agenda for Europe[4]. The report is therefore aimed at a less technical reader, but provides the necessary links and references for a more technically minded reader to find additional reading on the subject.

INSPIRE should therefore be seen within the context of the wider EU Digital Agenda for Europe initiative, part of the Europe 2020 strategy. The Digital Agenda for Europe sets out a vision for a digital Single Market to give people access to all the potential advantages of the digital society. In doing so it calls for greater interoperability, better Internet trust and security, much faster Internet access, more investment in research and development, enhancing digital literacy skills. Overall, the Digital Agenda focuses on the 21st century technologies and online services that will support job creation, improve economic prosperity and enhance the daily lives of citizens and businesses alike.

What are the components of INSPIRE?

The INSPIRE Directive outlines a phased approach for a Spatial Data Infrastructure (SDI) to enable effective governance and policy for environmental matters or supporting other types of activities that can be seen to have an environmental impact.

When implemented, it will facilitate the discovering, accessing and sharing of public sector data in a much more standardized way allowing the sharing of information within public and private sector organisations and with the citizen. The spatial data actually covered by INSPIRE is categorized into 34 themes split out into three Annexes.

• **Annex I:** Coordinate reference systems, geographical grid systems, geographical names, administrative units, addresses, cadastral parcels, transport networks, hydrography and protected sites

• **Annex II:** elevation, land cover, orthoimagery and geology

• **Annex III:** a wide variety of other environmental areas including soil, land use, human health and safety, agricultural and aquaculture facilities, atmospheric conditions, meteorological geographical features, mineral resources, oceanographic geographical features, habitats & biotopes and species distribution. A full list of themes can be found here[5].

The ability to share and use interoperable spatial data is seen to benefit a wide community and can be categorised into a number of different groups:

• **Government** (EU, National, Regional and Local) bodies will all benefit from an infrastructure to help support improved policy-making, implementation and monitoring. The inclusion of location as the underlying reference base means that many other parts of Government beyond those responsible for the environment will benefit from INSPIRE. There is already a widespread use of spatial data in Government systems and adherence to INSPIRE rules will make them more interoperable. As has been recently witnessed in many regions including Great Britain, there is increasing demand for access to public data and INSPIRE, along with other public data initiatives, will help support this demand. There is also a sound financial case to better use and re-use public

[4] http://ec.europa.eu/information_society/digital-agenda/index_en.htm

[5] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2/list/7

sector data with, traditionally, users spending 80% of their time collating and searching for information and only 20% of their time actually deriving a business benefit from it.[6]

• **Academia** is also likely to make use of spatial data made interoperable in compliance with the INSPIRE Directive; they can also be data providers. The wide range of data types will open up new opportunities for research into understanding many areas of environmental change especially when considered in an international context spanning recognised borders and political boundaries.

• **Commercial organisations** can potentially benefit from the use of the information for their own commercial purposes and in support of the services that they provide to their public sector clients. INSPIRE will generate a business opportunity for software suppliers and data publishers who will be able to target specific markets aligned to the various types of data and the applications that will use it.

• The **general public** is already making more use of spatial information, especially through the growing number of popular public sector information portals now available. As part of the push for wider use and openness of public sector data, achieving wider availability of interoperable datasets will better inform the citizen, and also assist with the decision making process impacting the public at large.

INSPIRE should then enable data from one member state to be seamlessly combined with data from all others. Under INSPIRE, spatial data and services can be located through a discovery service, which then makes the data discovered usable through a number of additional services including 'view', 'download', 'transformation' and 'invoke'. It is for the delivery of these services, that OGC web service and data schema standards may be used. The later section of the report will provide more detail on the structure of these services and the specific OGC standards that underpin them.

To achieve this consistency requires some common "Implementing Rules"[7]. These define the technical means for the interoperability with rules governing the access to the datasets and services and rules defining the technical specifications and requirements that the network services must deliver.

Five sets of Implementing Rules are being drafted:

- Metadata[8]
- Network Services[9]
- Data Specifications: Interoperability of spatial data sets and services [10]
- Data and Service Sharing[11]
- Monitoring and Reporting[12]

"Implementing Rules are laying down technical arrangements for the interoperability and harmonisation of spatial data sets and services, rules governing the conditions concerning access to such sets and services, as well as rules concerning the technical specifications and obligations of network services"

taken from the INSPIRE Directive

[6] Source: UK Location Strategy

[7] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/47

[8] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/101

[9] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/5

[10] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/2

[11] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/62

[12] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/182

Who does what in INSPIRE?

The European Commission proposed the creation of the Initial Operating Capability Task Force (IOC TF) consisting of representatives from all Member States. The Task Force is responsible for the architectural design and the service implementation of the National Spatial Data Infrastructures. The purpose of setting up the Task Force is to help and support the implementation of INSPIRE in the Member States notably for INSPIRE network services implementation. The IOC TF initial focus has been the implementation of the INSPIRE Discovery and View Services. Its scope has now been extended to include the implementation of Download Services. Within the European Commission, the Joint Research Centre (JRC) acts as the overall technical co-ordinator of INSPIRE. The JRC ensures the viability and evolution of the technical infrastructure for INSPIRE and guarantees the liaison with the European and international research community. The JRC also initiates and monitors the work with international standardisation bodies for the purposes of INSPIRE and is responsible for the technical coordination with other relevant international initiatives, such as Global Monitoring for Environment and Security (GMES)[13] and Global Earth Observation System of Systems (GEOSS)[14]. The JRC works with OGC members in a number of different ways and in various initiatives. For example, JRC is participating in research projects aiming to streamline standardisation efforts (e.g. GIGAS) or contributing to the development of new standards and solutions (e.g. ORCHESTRA, EuroGEOSS, and others). In addition the JRC works with members of the IOC TF who are often active within the OGC, an example being Geonovum.

The value of open standards in INSPIRE

Geonovum, an OGC member working on the SDI in The Netherlands, outlines several advantages of open standards[15]:

- Vendor independence

Through open standards more parties can care for solutions and the same solutions can work on different platforms.

- Transparency, accountability and manageability

Open standards help provide a clear account to comply with legal provisions, audits and for verification of information security.

- Interoperability

Software independent links and open standards in the fields of relevant applications such as remote sensing, GIS, location based services and others.

- Digital sustainability

Open standards enable solutions to be maintained by others than the initial vendor and there is room for further innovation.

[13] http://www.gmes.info/

[14] http://www.earthobservations.org/geoss.shtml

[15] http://geostandards.geonovum.nl/index.php/Main_Page

Why are open geospatial standards important?

The geospatial world is notable for the wide variance in the types of software, data and systems used. While many other industries may have the challenge of how to standardise on common operating procedures, due to the huge diversity in technologies, data models, licensing, and data formats the challenge in the geospatial industry is greater. A forty-year technology history, and a lack of common policies related to data sharing, has resulted in great diversity in how software and data are delivered. Without standards and consistent policy, there would be an even larger degree of fragmentation stemming from the lack of interoperability. Interoperability and information integration are key issues for the geospatial world. In a large organisation, the geospatial ecosystem will span a large number of software and data providers and as such a key requirement is just to get interoperability between vendor solutions and within that organisation. In the context of INSPIRE, interoperability is key to allowing the sharing of data between public sector bodies within a given Member State or between a number of Member States.

Collaboration in standards

The world of standards is one of collaboration and with that comes the need to align OGC standards with other standards bodies in the geospatial arena, e.g. CEN/TC 287, but also to align with wider IT standards, e.g. those from the Worldwide Web Consortium [W3C]. The OGC actively collaborates with numerous other standards organizations. For example, the OGC has a Class A Liaison relationship with ISO. The linkage with ISO, the International Organization for Standardization, is especially strong as OGC standards are often approved as ISO standards, e.g. OGC's Web Feature Service (WFS), Web Mapping Service (WMS) and Geographic Markup Language (GML) are also ISO standards (ISO 19142, ISO 19128 and ISO 19136).

This work is reviewed and supported by the Joint Advisory Group (JAG) that exists between ISO and the OGC. The JAG, which is currently chaired by the JRC, ensures co-ordination between OGC and ISO as an OGC standard moves through the ISO approval process. There are also examples of ISO standards providing the abstract model or foundation for OGC standards, e.g. for metadata with ISO 19115. This work is carried out within ISO Technical Committee 211 (TC 211), a standards technical committee formed within ISO, tasked with covering the areas of digital geographic information (such as data used by geographic information systems) and geomatics. TC 211 is responsible for preparation of a series of International Standards and Technical Specifications numbered in the 19100 range. Another key area of collaboration is with the European Committee for Standardization (CEN), the officially recognised standards body of the European Union. CEN Technical Committee 287 (TC 287) serves as a European committee adopting international standards. OGC has a strong relationship with CEN; TC 287 is a platform for the OGC to work together with the JRC on areas of mutual interest. TC 287 has approved and adopted some of the ISO 19100-series standards. Once a standard is adopted, e.g. ISO 19142 (WFS, originating in OGC), an EN prefix is put in front of the ISO number, thus becoming EN ISO 19142. More details on the work of CEN in standardization can be found here[16].

Many OGC standards have relevance to the development of other IT and networking standards and vice versa. The Internet Engineering Task Force (IETF) is working on location privacy and has created a working group (Geopriv) recognising that many applications are emerging that require geographic and civic location information about resources and entities, and that the representation and transmission of that information has significant privacy and security implications. This work is using OGC Geography Markup Language (GML) to describe the location element. Other examples with standards bodies include open data and linked data initiatives with W3C, where OGC's

[16] www.gistandards.eu

GeoSPARQL standards working group acts as an extension to the SPARQL recommendation from the W3C. In a similar vein, the Organization for the Advancement of Structured Information Standards (OASIS) has defined XACML for security and authentication in access control. The OGC defined and approved a spatial extension of this in the OGC GeoXACML working group.

Why is OGC's role in developing geospatial standards important?

The OGC is an international member-based consortium that offers return on investment and value around open standards through a consensus-based approach. OGC programs pull together organisations from across public sector, private sector, academia and research enabling a wide range of experts to contribute to the development of open geospatial standards. The work of the OGC relies on the voluntary contribution of these members. The OGC consensus process brings together a community of geospatial experts sharing a common pursuit: interoperability. The OGC represents the collective knowledge and capability of these experts. What differentiates OGC from other standards developing organisations is that it is focused exclusively on geospatial standards and related topics, including the geospatial law and policy committee and business value committee within the OGC. Success is measured in the adoption of OGC standards; there are currently hundreds of products and thousands of references for OGC standards in use worldwide. The other measure of success is how a "baseline" standard can be extended to create a community standard. A good example is in the aviation sector where an application profile of the OGC Geography Markup Language (GML) called Aeronautical Information Exchange Model (AIXM)[17] is used by Eurocontrol in Europe and the Federal Aviation Authority (FAA) in North America for interoperability between aviation datasets.

Why are open, geospatial standards particularly important for INSPIRE?

The business case for interoperability has already been made; the business advantages to be gained from open standards equally support the case for standards in INSPIRE. OGC standards have been adopted in many communities worldwide and therefore were an obvious area for consideration within INSPIRE. The directive has stimulated the use of standards and has led to a number of EU geospatial projects, including GIS4EU[18], HUMBOLDT[19], ESDIN[20] and BRISEIDE[21], all of which have used OGC standards and most of which have been driven by INSPIRE principles.

How is the OGC organised to support the use of geospatial standards in INSPIRE?

The OGC Technical Committee Polices and Procedures (TC P&P) governs the standards work of the OGC. The TC P&P provides a structured approach that encourages a consensus-based standards development process, allowing every interested member as well as the public to be engaged in the process.

The OGC Technical Committee (TC) is comprised of three main groups: the OGC Architecture Board (OAB)[22], Domain Working Groups (DWG)[23] and Standards Working Groups (SWG)[24]:

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[17] http://www.aixm.aero/public/subsite_homepage/homepage.html

[18] http://www.gis4eu.eu/

[19] http://www.esdi-humboldt.eu/home.html

[20] http://www.esdin.eu/

[21] http://ec.europa.eu/information_society/apps/projects/factsheet/index.cfm?project_ref=250474

[22] http://www.opengeospatial.org/projects/groups/oab

[23] http://www.opengeospatial.org/projects/groups/wg

The **OGC Architecture Board** works with the TC and the Planning Committee (PC) to ensure architecture consistency of the baseline and to provide guidance to OGC members to ensure strong lifecycle management of the OGC standards baseline. In order to properly provide such guidance and perform the governance functions as outlined below, the OAB can, at its discretion, evaluate current technology issues and identify gaps in the architecture that need to be responded to by the membership.

Standards Working Groups (SWG) process new candidate standards submissions, as well as Change Proposals for proposed revisions to an approved OGC standard, and then seek approval from the TC and the PC. The SWG process is how existing OGC Implementation Standards are updated and revised.

Each **Domain Working Group** (DWG) focuses on a specific issue of interoperability, such as Architecture or Data Quality, or on an interoperability domain area, such as Hydrology, Meteorology or Sensor Web Enablement. OGC staff provide process facilitation and resources.

A small number of sub-committees assist the TC Chair on some operational topics (e.g. Naming Authority) or on cross-cutting topics for which the nature of concrete action is not yet clear (e.g. REST).

Within the OGC there are many individuals involved with INSPIRE and this work tends to be specific to individual standards, e.g. Catalogue Services, GML, WMS, WFS. Other areas of collaboration can be seen in OGC members taking an active part in the INSPIRE Thematic Working Groups (TWG) and in the INSPIRE Drafting Teams (DT).

How INSPIRE is being implemented – and where standards are needed

A Phased Implementation

To understand the role that standards play in the delivery of INSPIRE services, it is first important to understand the component parts of a typical INSPIRE implementation and then to examine the way standards, and specifically those from OGC, support each of the component parts. The next section of the report provides more detail on specific standards.

INSPIRE only imposes obligations on data sets and services relating to the themes in Annex I-III. But for these, there are obligations to create metadata and the full range of network services. These published services must comply with the INSPIRE Network Services Regulations[25]. In addition there is a requirement for harmonizing data sets according to the data specification developed for each of the themes. For new data sets that fall under the themes there is an obligation to create metadata and network services for these data sets as well. There are many more spatial data services than the current network services. The Implementing Rules, in this case, are still under development by the drafting team. From a data publisher perspective, the implementation of INSPIRE follows a clear roadmap (see figure 3 below) and can be outlined in a number of steps:

Step 1 -Where a data provider comes under an INSPIRE Theme there is a requirement to document the data according to the INSPIRE metadata implementing rules (by Dec 2010 for Annex I+II, Dec 2013 for Annex III data sets), to make it accessible as it exists now and without any requirement to change or re-format the data.

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[24] http://www.opengeospatial.org/projects/groups/swg

[25] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/5

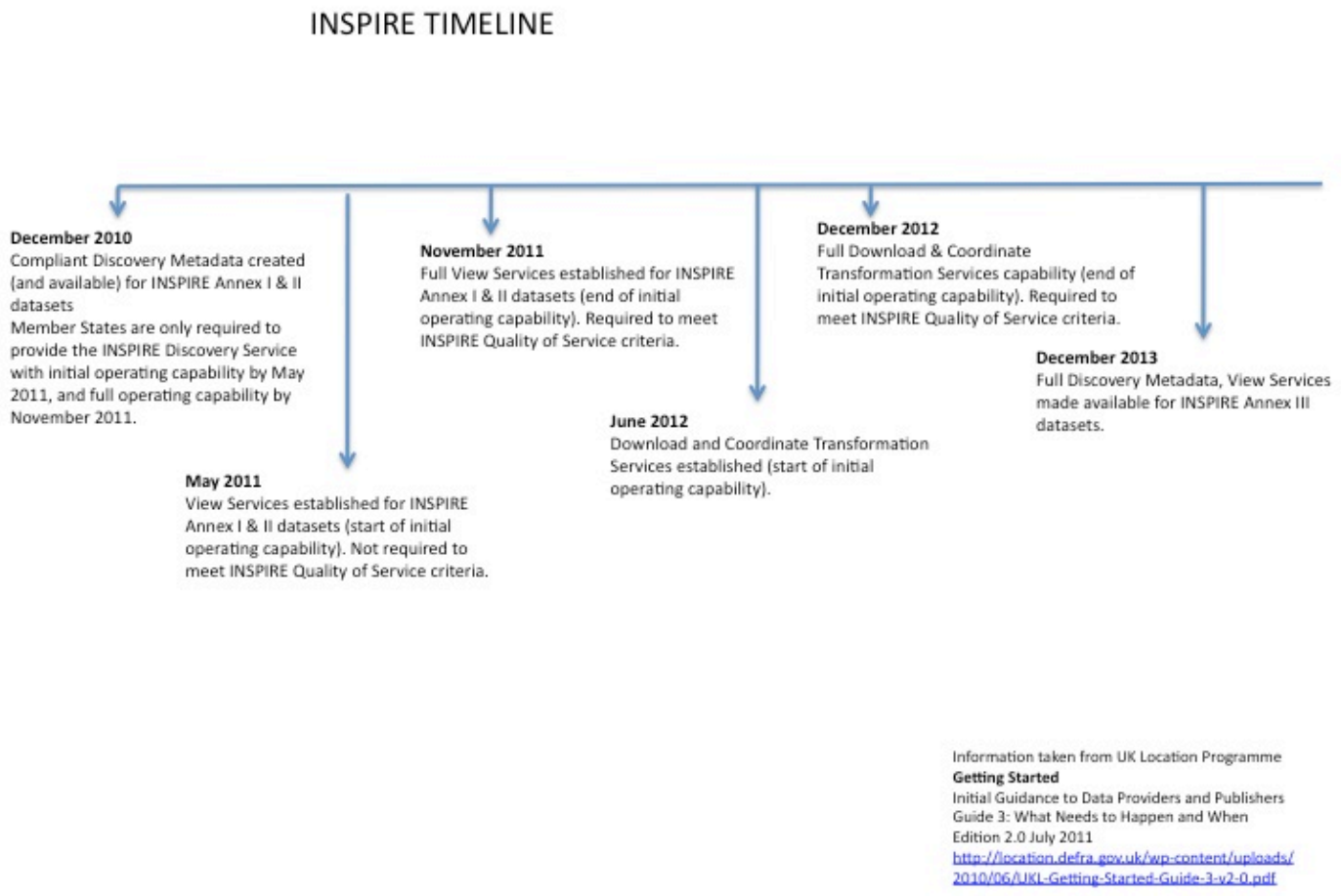
Step 2 -From November, 2011 Metadata Discovery and View service shall be operational as foreseen in the Network Services Implementing Rules.

Step 3 - From December 2012, Download and Transformation service shall be operational.

Step 4 - In time the goal is to publish "INSPIRE compliant" data. The timeframe for this process of data harmonisation is determined by the INSPIRE Annex Theme (I, II or III) into which the data, and its provider, is placed.

The creation of "INSPIRE compliant" data will take many years. The first data (newly created Annex I data sets) are due in Dec 2012 with the last data sets (existing Annex II+III data) around 2020.

Figure 3 INSPIRE schedule until the end of 2013.



Information taken from UK Location Programme
Getting Started
Initial Guidance to Data Providers and Publishers
Guide 3: What Needs to Happen and When
Edition 2.0 July 2011
http://location.defra.gov.uk/wp-content/uploads/2010/06/UKL-Getting-Started-Guide-3-v2-0.pdf

INSPIRE OGC Change Requests

A mechanism exists where INSPIRE requirements can be fed into the OGC change request review process. A fuller description of this process is provided later in the report. A number of change requests for existing OGC standards have already been submitted by the INSPIRE community.

A standard mechanism to specify multilingual content within OGC standards has been established in the OWS Common standard. With the ongoing development and maintenance revisions of OGC Web Services (OWS) standards, future versions of OGC standards will include this language support. As each of the primary OWS and SWE standards (WMS, WFS, WCS, SOS, etc) are updated the approach to support multilingualism in OWS common will be reviewed. Additional Change Requests from users of OGC standards on the topic of Multi-lingual support are encouraged. Any person can post a change request here: http://www.opengeospatial.org/standards/cr.

Another change request relates to the differences between the service metadata of:
• ISO 19119 and ISO 19128 (TC 211)
• OGC WMS 1.3.0 and ISO 19119
• ISO/CD 19115 - ISO 19119 and OGC OWS common.
Differences in service metadata specifications between these standards makes implementation difficult. In the INSPIRE View Service Technical Guidance, these differences became visible in the extended capabilities. The extended capabilities are extra elements needed to align WMS 1.3.0 with ISO 19119 and ISO 19115.

Data Specifications

The data specification process in INSPIRE is a major part of the use of standards within INSPIRE. The development of implementing rules and technical guidance on data specification, including interoperability and harmonization, is by far the largest technical undertaking in INSPIRE.

The development of these thematic specifications is based upon a set of general documents, e.g. the Generic Conceptual Model, the Methodology Document and the Encoding Guidelines.

These documents again, are based on ISO/TC 211 standards in the 19100-series, starting from the ISO 19103 Conceptual Schema Language[26].

Discovery Service

INSPIRE Discovery Services allow users and computer programs to search for spatial datasets and services based on their metadata records. There are two types of metadata to be created:

- Metadata for the dataset being published (referred to as dataset metadata)
- Metadata for the Network Services being published (referred to as service metadata)

The two are closely related and so both need to be managed together; both should reference each other. This tells a user what services have been published for a dataset and, vice versa, what datasets a service supports. This process of linking these is an important part of the way INSPIRE works.

[26] http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/D2.5_v3_3.pdf

Creating Metadata

A Discovery Service is based on the creation of metadata for data and services. Ideally, such metadata is created when data or services are created, and thus the responsibility for creating metadata belongs to the Data Provider. There has often been a tendency for metadata creation to be deferred, coming later in the lifecycle as part of the production of a directory of information resources. Best practice encourages metadata to be produced as part of the data production process itself, using the same tools. It is best when metadata is created by people who are familiar with the data - something more likely to be achieved when created at the time the dataset is created.

Publishing Metadata

Publishing data and services metadata into a Spatial Data Infrastructure is the task of the data publisher using a central registration service. The data publisher can be the data provider or the publisher may be a 3rd party providing a publishing service, typically for multiple data providers. A single organisation featuring multiple data providers is likely to use a single data publisher. Publishing is then a simple process of registering the URL for the data and service metadata resources into a registry or catalogue service. There are already numerous EU implementations of discovery services based on the OGC Catalogue Services - Web (CSW) Interface Standard. However, the OGC CSW is not required as part of any obligation under INSPIRE.

View Service

INSPIRE View Services allow users and computer programs to view spatial datasets. The View service provides the ability to display, navigate, zoom in/out, pan, and display map legends and relevant metadata. The INSPIRE Implementing Rules for View Services define the operations that the service needs to support and the quality of service criteria that need to be met. The technical guidance for implementing the View Service Regulation is based on the OGC Web Map Service (WMS) or Web Map Tiling Service (WMTS), however these do not meet all the requirements. There are extensions relating to additional elements in the capabilities and support for multilinguality[27]to allow data to be easily merged. The View Service needs to support at least the Coordinate Reference Systems defined in the INSPIRE Annex I Theme. The INSPIRE View Service Technical Guidance includes INSPIRE profiles for WMS and WMTS.

The INSPIRE View Service must support at least one of the following image formats:

- Portable Network Graphics (PNG)
- Graphics Interchange Format (GIF), without compression.

Note that these formats provide graphical portrayals of the data, and do not provide data in a form suitable for additional processing or modelling.

Download Service

A Download Service gives users access to the full information content captured and maintained as spatial objects and collected into spatial data sets. The Download Services provide the capability to integrate geospatial data with other types of business information and to support decision making through more detailed analysis of the data. It may operate in one of two ways; it may be a direct access download service or a pre-defined dataset download service. At a minimum the latter is required although the former is actively encouraged wherever possible. The pre-defined dataset download service serves a pre-defined (part of a) data set, while the direct access download service

[27] p14 http://inspire.jrc.ec.europa.eu/documents/Network_Services/TechnicalGuidance_ViewServices_v3.0.pdf

is based on using a query which results in a set of objects that meet certain user specified criteria, which is a subset of the total data available. The service metadata will specify if the service is a direct access download service or not.

INSPIRE defines draft Download Service Technical Guidance[28] to ensure that online services of EU Member States are compatible in a cross-boundary context. The draft guidance refers to the ISO19142 (OGC Web Feature Service[29]). Accordingly, this preliminary Technical Guidance has potential for improvement. The task of revising it is now under the IOC TF. According to needs in Annex II-III it will probably be extended to cover additional OGC standards, such as the OGC Web Coverage Service (WCS) Interface Standard and, potentially, also the OGC Sensor Observation Service (SOS) Interface Standard.

Transformation Services

Transformation Network Services can be categorised into different areas of functionality, for example, transforming data formats (e.g. from a proprietary format to OGC Geography Markup Language), coordinate reference systems (CRS) and logical schemas. Schema Transformation is an important part of INSPIRE as it helps support the ultimate end goal of INSPIRE to have harmonised datasets. So the Schema Transformation applies to Legally Mandated Organisations who wish to take the first step and publish their data "as is" based on an existing logical schemas, but also make provision for users of the data to transform the data as part of a download request. The technical challenges of schema transformation are typically greater than for the other forms of transformation listed in this section. This is because of the enormous variety of data models, encodings and formats and many other factors required in order to achieve harmonisation of data in a common format as mandated by INSPIRE.

It should be noted that data providers in the Member States can choose whether they want to provide data in compliance with the data specifications by adapting existing data sets (e.g. through offline transformation) or through INSPIRE transformation services. If they choose the former option, they are not obliged to provide a transformation service.

OGC Standards in Support of INSPIRE

This section of the report expands upon the references to OGC standards in the previous section, providing a short paragraph on each standard. Those wishing to gain a more detailed appreciation for any of the OGC standards are advised to refer to the OGC website[30].

OGC Geography Markup Language (GML) Encoding Standard

The OGC Geography Markup Language (GML) Encoding Standard is an XML grammar for expressing geographical features. GML serves as a modeling language for geographic systems as well as an open interchange format for geographic transactions on the Internet. As with most XML based grammars, there are two parts to the grammar – the schema that describes the document and the instance document that contains the actual data. A GML document is described using a GML Schema. This allows users and developers to describe generic geographic data sets that contain points, lines and polygons.

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[28] http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/network/Draft_Technical_Guidance_Download_Services_v1.0.pdf

[29] http://www.opengeospatial.org/standards/wfs

[30] http://www.opengeospatial.org/standards

Information communities increasingly use GML to define community-specific application schemas [31]that are specialized extensions of GML. Using application schemas, users can refer to roads, highways, and bridges instead of points, lines and polygons. If everyone in a community agrees to use the same schemas they can exchange data easily and be sure that a road is still a road when they view it. Clients and servers with interfaces that implement the OGC Web Feature Service Interface Standard[32] read and write GML data. GML is also an ISO standard (ISO 19136:2007)[33]. See also the GML pages[34] on the OGC Network.

OGC Web Map Service (WMS) Interface Standard

Services that implement the OGC Web Map Service (WMS) Interface Standard present location information in an image format that can then be displayed in a map viewer, typically overlaid against a base map layer. The OGC WMS standard defines a standard interface through which users can access and view maps from a diverse range of data providers through a single application. A user application can readily request a map to be delivered based on the location of interest. These web client applications are able to request the maps from a WMS server via simple and familiar URLs. A 'map' delivered via the WMS is a visual portrayal of the data rather than the actual mapping data.

Extending from the display of a single map, WMS enables two or more maps with equivalent geographic parameters and output size to be accurately overlaid to produce a composite map. Overlay requires image formats that support transparent backgrounds so that underlying layered maps are visible. WMS also operates in a truly distributed manner allowing individual maps to be located and requested from different servers. WMS thus enables the creation of a network of distributed map servers from which clients can build customized maps.

A service implementing WMS classifies its geographic information holdings into "Layers" and offers a finite number of predefined "Styles" in which to display those layers. Three WMS operations are defined, giving access to: (i) service-level metadata, (ii) a map with the requested geographic parameters, and (iii) information about specific features based on their location in the map. The WMS "Get FeatureInfo" operation enables it to be displayed alongside a map image. This would typically be some associated text about the feature in question, e.g. an animal disease outbreak might be shown as regions on a map, with associated details of the outbreak being displayed as the feature information. Implementing GetFeatureInfo is optional, so not all map viewers will support this function.

The OGC WMS standard is one of the standards referred to in the INSPIRE Technical Guidance to deliver an INSPIRE View Service. It has also been adopted as an ISO standard, ISO 19128.

OGC Catalogue Service – Web (CSW) Interface Standard

Catalogue services support the ability to publish and search collections of metadata for data, services and related information objects. Metadata held in catalogues can be queried and evaluated either by the user using a specialised user interface or from within another software application. Catalogue services help to support the discovery of registered information resources and should provide enough information to allow a client application to connect to the service. Catalogue

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[31] http://en.wikipedia.org/wiki/GML_Application_Schemas

[32] http://www.opengeospatial.org/standards/wfs

[33] www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=32554

[34] http://www.ogcnetwork.net/gml

services support the use of alternative query languages to find and return results using known content models (referred to as "metadata schemas"). The metadata repository, managed through the catalogue, can store a multitude of resource descriptions that can also hold information to allow arbitrary linking between resources. For example, the EC GeoPortal will use this protocol to collect metadata from the discovery services of the EU Member States.

OGC Web Feature Service (WFS) Interface Standard

The OGC Web Feature Service (WFS) Interface Standard provides access to geographic information at the level of features and feature properties using Web services. This may be contrasted with earlier approaches to transfer of geographic data at the file level using, for example, the File Transfer Protocol (FTP). WFS allows clients to retrieve or modify the data they are seeking, rather than retrieving a large file that not only contains the data they are seeking but potentially a lot more, additional data that it is not required.

This standard specifies the behaviour of a service that provides transactions on and access to geographic features in a manner independent of the underlying data store. A variety of operations are defined, including:

Discovery operations allow the service to be interrogated to determine its capabilities and to retrieve the application schema that defines the feature types that the service offers.

Query operations allow features or values of feature properties to be retrieved from the underlying data store based upon constraints, defined by the client, on feature properties.

Transaction operations allow features to be created, changed, replaced and deleted from the underlying data store. This is also supported by:

Locking operations, which prevent other users making modifications at the same time.

Stored query operations allow clients to create, drop, list and describe parameterized query expressions that are stored by the server and can be repeatedly invoked using different parameter values.

WFS can be used to meet the INSPIRE direct Download Service requirements as defined within the INSPIRE Download Service Technical Guidance[35]. The requirements specified in the INSPIRE Download Services specification are largely met by the OGC's WFS standard. For example, INSPIRE defines a "Get Spatial Objects" capability in the Download Service which may be implemented by the *GetFeature* operation of WFS. Additionally, the "Describe Spatial Object Types" may be implemented by the *DescribeFeatureType* operation of WFS. The Technical Guidance for Download service is currently in revision. The next revision will include two proposals – Atom syndication and WFS – for implementing the Download Service. At the time of writing this is under discussion in the IOC-TF.

35 http://inspire.jrc.ec.europa.eu/documents/Network_Services/INSPIRE%20Draft%20Technical%20Guidance%20Download%20%28Version%202.0%29.pdf

The following descriptions relate to OGC standards that are not currently in line with INSPIRE Technical Guidance, but may have relevance and application for INSPIRE over time.

OGC Web Processing Service (WPS) Interface Standard

The OGC Web Processing Service (WPS) Interface Standard defines a standardized interface that facilitates the publishing of geospatial processes, and the discovery of and binding to those processes by clients. The standard also defines how a client can request the execution of a process, and how the output from the process is handled.

The term *Processes* includes any algorithm, calculation or model that operates on spatially referenced data. *Publishing* means making available machine-readable binding information as well as human-readable metadata that allows service to be discovered and used. A WPS can be configured to offer any sort of GIS functionality, including access to pre-programmed calculations and/or computation models that operate on spatially referenced data. This may be as simple as subtracting one set of spatially referenced numbers from another, for example in monitoring pandemic numbers or as complicated as found in a global climate change model. This interface specification provides mechanisms to identify the spatially referenced data required by the calculation, initiate the calculation, and manage the output from the calculation so that the client can access it. This Web Processing Service can process both vector and raster data. The WPS specification is designed to allow a service provider to expose a web accessible process in a way that requires clients have no specialized knowledge of the underlying physical process interface.

OGC Web Coverage Service (WCS)

The OGC Web Coverage Service Interface Standard (WCS) defines a standard interface and operations that enables interoperable access to geospatial "coverages". The term "grid coverages" typically refers to content such as satellite images, digital aerial photos, digital elevation data, and other phenomena represented by values at each measurement point.

A WCS provides access to potentially detailed and rich sets of geospatial information, in forms that are useful for client-side rendering and input into scientific models. The WCS may be compared and contrasted to the OGC Web Map Service (WMS). Like WMS, the WCS allows clients to choose portions of a given information holdings based on spatial constraints. However, unlike WMS which portrays spatial data as static maps rendered as pictures by the server, the Web Coverage Service provides available data together with detailed descriptions, syntax and semantics to allow the data to be processed rather just portrayed.

The Web Coverage Service provides three operations: *GetCapabilities, DescribeCoverage, and GetCoverage*. The *GetCapabilities* operation returns an XML document describing the service and brief descriptions of the coverages that clients may request. The *DescribeCoverage* operation lets clients request a full description of one or more coverages served by a particular WCS server. The *GetCoverage*operation returns a coverage encoded in a well-known coverage format and bears some similarities to the WMS *GetMap* and WFS *GetFeature* requests.

OGC Symbology Encoding (SE) and Styled Layer Descriptor (SLD) Encoding Standards

The importance of the visual portrayal of geographic data cannot be overemphasized. The skill that goes into portraying data is what transforms raw information into an explanatory or decision-support tool. Fine-grained control of the graphical representation of data is a fundamental requirement for any professional mapping community.

The current OGC Web Map Service (WMS) standard supports the ability for an information provider to specify very basic styling options for a given data set. However, while a WMS currently can provide the user with a choice of style options, it cannot tell the user what the portrayal will look like on the map. Furthermore, the user has no way of defining styling rules. These rules require a styling language that the client and server can both understand. Defining this language is called the Symbology Encoding (SE). This language can be used to portray the output of services that implement the WMS, WFS and WCS standards.

There are two basic ways to style a dataset. The simplest one is to colour all features the same way. This type of styling requires no knowledge of the attributes or "feature types" of the underlying data, only a language with which to describe these styles. The FeatureTypeStyleelement in the Symbology Encoding description addresses this requirement.

A more complicated requirement is to style features of the data differently depending on some attribute. Accomplishing this requires the user to be able to find out what attribute of the data set represents the feature's type. The Styled Layer Descriptor (SLD) profile of WMS defines the operation that fulfils this need, called *DescribeLayer*. This operation returns the feature types of the layer or layers specified in the request, and the attributes can be discovered with the *DescribeFeatureType* operation of a WFS interface or the *DescribeCoverageType* of a WCS interface.

OGC City Geography Markup Language (CityGML) Encoding Standard

CityGML is an information model for the representation of 3D urban objects that can be shared across different applications. This capability is especially important with respect to the cost-effective and sustainable maintenance of 3D city models. The target applications include city planning, architectural design, tourism, environmental simulation, telecommunication, disaster management, real estate, navigation training simulators and many more.

CityGML is designed as an open data model and XML-based data format for the storage and exchange of virtual 3D city models. It is implemented as an application schema of GML3, the extensible international standard for encoding spatial data for exchange, issued by the OGC and the ISO/TC211.

The use of 3D provides an important input into various INSPIRE Thematic Working Groups. By using experience in 3D world modelling within INSPIRE it will facilitate tighter integration with the 2D world. For end users this means that terrain models or buildings can more easily be used in traditional 2D information systems, as well as in 3D environments.

For example, CityGML is already used successfully in EU Noise Mapping[36] which is an INSPIRE thematic topic. Here buildings, roads and railways are modelled in 3D to calculate the noise impact on the citizens. This requires 3D visualisation and rapid 3D data access via web services.

CityGML is based on a number of standards from OGC, ISO 191xx family, the W3C Consortium, the Web 3D Consortium and OASIS.

[36] http://ec.europa.eu/environment/noise/mapping.htm

OGC Web Map Tile Service (WMTS) Interface Standard

A WMTS enabled server application can serve map tiles of spatially referenced data using tile images with predefined content, extent, and resolution. The Web Map Tile Service (WMTS) described in this standard builds on earlier efforts to develop scalable, high performance services for web based distribution of cartographic maps. WMTS is inspired by the Open Source Geospatial Foundation (OSGeo) Tile Map Service Specification[37].

WMTS complements earlier efforts to develop services for the web based distribution of cartographic maps. The OGC WMTS provides a complementary approach to the OGC Web Map Service (WMS) for tiling maps. WMTS trades the flexibility of custom map rendering, as used in WMS, for the scalability possible by serving of static data (i.e. base maps) where the bounding area and scales have been constrained to discrete tiles. The fixed set of tiles allows for the implementation of a WMTS service using a web server that simply returns existing files. The fixed set of tiles also enables the use of standard network mechanisms for scalability such as distributed cache systems.

Observations and Measurements (O&M) and the OGC's Sensor Web Enablement (SWE) Activity

Several of the INSPIRE Annex Themes include measured, modelled or simulated data. The ISO 19156 standard on Observations and Measurements (O&M)[38], developed and maintained in cooperation with the OGC, was designed for this purpose and so can be used in INSPIRE to cover these requirements. Whether from in-situ sensors or dynamic sensors, measurements made from sensor systems contribute most, by volume, of the geospatial data used in geospatial systems today.

O&M is one of the OGC Sensor Web Enablement (SWE)[39] standards. The OGC's SWE activity has provided a unique and increasingly utilised framework of open standards for exploiting web-connected sensors. This spans sensor systems of all types including flood gauges, air pollution monitors, stress gauges, mobile heart monitors, webcams, satellite-borne earth imaging devices and countless other sensors and sensor systems. Location is usually a critical parameter for sensors on the web, and this is the reason that the OGC membership chose to develop the SWE standards platform.

The goal of SWE is to enable all types of web-based sensors, instruments and imaging devices to be accessible and, potentially, controllable via the Web. SWE standards enable "plug-and-play" Web-based sensor networks. Specific elements of OGC's Sensor Web Enablement address Observations and Measurements and the Sensor Observation Service (SOS).

The OGC work on Observations and Measurements (O&M) is targeted at providing a standard model for representing and exchanging observation results. O&M provides standard constructs for accessing and exchanging observations, alleviating the need to support a wide range of sensor specific data formats. For further information please refer to OGC document, The Observations and Measurements (O&M) Best Practices.

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[37] http://wiki.osgeo.org/index.php/Tile_Map_Service_Specification

[38] http://www.opengeospatial.org/standards/om

[39] http://www.opengeospatial.org/domain/swe

The following INSPIRE themes have identified Observations and Measurements (O&M) as relevant to their thematic domain and are including elements of O&M in their data specifications:

- Geology
- Oceanographic geographical features
- Atmospheric conditions and meteorological geographical features
- Environmental monitoring facilities
- Soil

In addition to these themes, several further INSPIRE themes have been identified where observational information, while not at the core of the data specification, is relevant.

The goal of Sensor Observation Service (SOS) is to provide access to observations from sensors in a standard way that is consistent for all sensor systems. SOS provides an open interface, or API, for managing deployed sensors and retrieving sensor data and specifically "observation" data. This forms a critical element of the Sensor Web Enablement architecture, defining the data representations and operations for accessing and integrating observation data from sensor systems. For further information please refer to the OGC Sensor Observation Service Interface Standard[40].

OGC Change Requests (CRs)

Standards are not static. An important aspect of maintaining standards and responding to suggestions is to have a robust change request procedure. A brief summary of how this works within the OGC is provided here.

There is a formal procedure for an OGC member to submit a change request. Once the submission has been verified for completeness, a relevant OGC Standards Working Group (SWG) is notified of a new CR submission. Once the CR is approved for further processing, it is posted to both the public CR archive and to the Members' "Pending Documents" archive. The appropriate SWG reviews and prioritises the request and either considers the CR for incorporation into the new revision of the standard or defers work until a future revision of a standard. The SWG then votes to accept the CR, accept it with modification, or reject it. The requester is then notified of the decision and, in the case of rejection, the reasons for rejection.

All OGC standards work is performed based on volunteerism and so the time to review depends on how much time participants in the SWG can invest in the work. Processing a change request can take from several weeks to several months. The complete revision process for a specific standard can take 12 to 18 months, but it can also be accomplished in as little as six weeks if the SWG gives it a high priority. The one exception is for a change request that reports an error or schema bug. In this specific case, the OGC can review and process a revision in as little as one month. The OGC standards revision process is as fast, or faster, than those in other standards organizations.

Sometimes a SWG does not exist for the standard for which a CR was submitted. In this case, it is normal to wait until there are several outstanding change requests for a specific standard. Once this level has been reached, the members form a new Standards Working Group (SWG) whose scope of the work includes responding to all outstanding change requests for that standard. The formation of a new SWG in the OGC usually takes 6 to 8 weeks. Once formed, the processing of change requests progresses in the SWG as defined above. Again, the one exception is for a change request that reports an error. In this case, the change request is processed without the need to form a SWG and the change request goes through the formal revision process.

[40] http://www.opengeospatial.org/standards/sos

It is important to keep in mind that processing of changes requests, like almost everything else in the OGC, is performed by members who are working together to achieve common goals. The time it takes to process change requests depends on the willingness of those requesting the change to communicate with SWG members about tasks and timelines. With respect to changes that are requested to meet INSPIRE requirements, Europe has a higher number of OGC members than any other world region, and thus Europe is well positioned to influence standards progress in the OGC through concerted development work and voting.

Conclusions and guidance to implementers

The EU INSPIRE Directive has been a major step towards the creation of a common SDI across EU Member States. It sets out implementing rules to ensure commonality and interoperability. However, this is really only a part of the "standards" picture. INSPIRE is also equally dependent on other standards to deliver upon its promise and this is why the OGC standards outlined in this report are important.

It is also important to stress the role of the vendor community in support of INSPIRE. Within each member state there are many public sector organisations working hard to meet the dates set down for their adherence to INSPIRE. While much of this may end up being translated into work for the Legally Mandated Organisation concerned, there are many ways in which the products and services from geospatial suppliers can support and accelerate that work.

This report has been compiled with the support of the vendor community and, while it has remained outside of the scope of the report to document the products and services available, there are numerous areas in which the vendors can provide assistance. The vendor community brings not only valuable expertise but also a set of software tools that have been created to meet the needs of data providers. Vendors provide GML/XML expertise, metadata tools, data mapping, web services & platforms, data validation, security and workflow management to name but a few. Additionally, it should be noted that while a data provider may have certain obligations under INSPIRE, depending on the Annex into which they fit, they can turn to the services of a data publisher to make their data publicly available.

Looking to the future there remains much to be done to deliver on the true promise of INSPIRE, given the multi-year roadmap set out by the EU. Like many other infrastructures, INSPIRE exists in order to improve standards of living and to benefit society at large. INSPIRE will truly be a success when the data is being used to help organizations – from the largest to the smallest – make better decisions. While today the focus is on delivery of INSPIRE data services, the focus will soon turn to consuming this newly available INSPIRE data to make better decisions. With that will come the true measure of the return on investment (ROI) and the benefits of INSPIRE be seen in the many ways that geospatial information touches on the everyday life of EU citizens.

Examples of EU Member State INSPIRE SDIs

This section shows a few examples of INSPIRE implementations across the EU Member States and, as such, examples of the use of OGC standards in support of INSPIRE in the real world.

Even within the EU Member States, the extent of implementation will vary with some countries opting for a minimal approach in order to meet their statutory obligations; others will fully embrace what INSPIRE can bring and so extend well beyond the legal minimums. All Member States are required to report annually on their implementation progress to the EU. This information is then collated into a EU wide Monitoring and Reporting summary[41].

Germany

The GDI-DE, which is the German Spatial Data Infrastructure (SDI), is based on OGC standards. It was created as a national initiative in 2004 and was driven initially only by national needs. It is co-ordinated by a steering group - the LG GDI-DE, made up of representatives from the federal government, the federal states and the communal head associations.

Since 2007 it has been guided by the INSPIRE with direction from an appointed INSPIRE Task Force (ITF). Furthermore, the development of GDI-DE has been influenced by the EU project Global Monitoring for Environment and Security (GMES). Components of the GDI-DE include the spatial portal site (GeoPortal.DE) and the National Geo Database (NGDB). The SDI enables federal state agencies, municipal authorities and private companies to present their data and services, forming an excellent example of interoperable service architecture. Within INSPIRE, protected sites (e.g. nature protection sites, landscape protection sites, biosphere reserves, nature parks, national parks) has been a high priority. The metadata is managed by the data providers themselves using a variety of metadata client tools as part of an administrative framework. The GDI-DE uses a range of OGC standards including GML, WMS, WFS, Catalogue Services and CityGML.

Netherlands

The Dutch geo-standards are based on international standards, and OGC standards play a key role. They are managed by Geonovum, the National Spatial Data Infrastructure (NSDI) executive committee in the Netherlands, which is committed to providing better access to geographical information in the public sector. Already referenced in this report, Geonovum is an active member of the OGC. Their stated objective has been to use geo-standards to make it easier and more efficient for parties in the public sector and outside to find, share and use geographical information.

Following an announcement in late March 2011, geospatial standards have also been added to what is referred to as the 'comply or explain' list of open standards of the Dutch Standardisation Board (College Standaardisatie[42]). This means, where applicable, that all Dutch government organisations must now incorporate and implement these standards.

They state numerous usages in daily Dutch life, including weather maps and route planners. In a more professional capacity it has helped the public sector meet their needs for geographical information for such tasks as town planning. The geo-standards have also been designed to facilitate the exchange of geographical information between the different organisations with reference to a particular location. Examples being usage by government organisations such as the

[41] http://inspire.jrc.ec.europa.eu/index.cfm/pageid/182/list/indicators

[42] http://www.forumstandaardisatie.nl/

Land Registry (Kadaster)[43], the Ministry of Infrastructure and the Environment (Rijkswaterstaat)[44], the water boards and provinces, and also by private-sector players such as property developers.

United Kingdom

The UK has had a number of Spatial Data Infrastructure initiatives over the years with the emergence of INSPIRE in 2007 adding renewed impetus. In 2008, the UK Location Programme (UKLP) was created to deliver on the mandate of INSPIRE and to fulfil the opportunities documented in the "Place Matters: the Location Strategy for the United Kingdom"[45] published that year by the Department for Communities and Local Government (CLG). The UKLP was placed under the direction of Defra, the Department for Environment, Food and Rural Affairs, given that INSPIRE had been issued as an environmental directive. The UKLP was tasked to deliver the infrastructure necessary to meet the needs of INSPIRE and originally set out to deliver a UK Geoportal into which metadata related to data and services would be loaded. In parallel, there was a major push towards making all public data open and accessible. In geospatial terms, this led to significant changes in the way data was made available by Ordnance Survey (OS), the national mapping agency, leading to the creation of the OS OpenData family of products, made freely available to download. But the drive to make all public data, not just that covered by INSPIRE, more readily available, led to the creation in early 2010 of the data.gov.uk initiative which, in itself, created a portal for public data. The data.gov.uk and UK Geoportal initiatives were merged to a single data portal. OGC standards have underpinned the work of the UKLP.

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For more information go to www.autodesk.co.uk/bim

[43] http://www.kadaster.nl/english/

[44] http://www.rijkswaterstaat.nl/en/about_us/

[45] http://www.communities.gov.uk/publications/communities/locationstrategy

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For more information please visit www.bentley.com

BRGM

BRGM is the French geological survey. Interoperability has been identified in the BRGM corporate strategy since 2000, as a mean to better achieving its missions of subsurface information provider. BRGM has been a member of the OGC technical committee since 2003, it has initiated and coordinates the French OGC Forum which groups the French OGC members. BRGM has been involved in the design phase of the INSPIRE Directive since its inception, and has provided experts for different working groups setup by the Commission (including the chair of the Network Services Drafting Team for INSPIRE). It also coordinates the work the INSPIRE experts of the Geological Surveys of Europe. In France, BRGM is providing support and expertise for the implementation of the Directive under the responsibility of the Ministry in charge of Environment, and is in charge of the development and management of the French INSPIRE Géocatalogue.

For more information please visit www.brgm.fr

Cadcorp

Cadcorp is a UK based developer and supplier of industry leading web mapping and geographic information systems (GIS) software. The Cadcorp SIS® - Spatial Information System® software suite – is an integrated family of standalone, web, developer and mobile GIS products. Our cost-effective solutions help organisations in the public and private sectors maximise their investment in geographic information by making it easier to share spatial data between people and between systems. As a long-standing technical member of the Open Geospatial Consortium (OGC), Cadcorp has been at the forefront of the application of open technologies and standards-based solutions. Cadcorp is an ISO9001:2008 and ISO/IEC 27001:2005 certified company and an Oracle® Partner. In the UK, Cadcorp is an Ordnance Survey® Developer Partner; Northern Ireland Land & Property Services® (LPS) Licenced Partner; corporate member of the Association for Geographic Information (AGI) and a corporate member of the British Cartographic Society (BCS).

For more information visit www.cadcorp.com

DigitalGlobe

DigitalGlobe is a leading global provider of commercial high-resolution earth imagery products and services. Sourced from our own advanced satellite constellation, our imagery solutions support a wide variety of uses within defense and intelligence, civil agencies, mapping and analysis, environmental monitoring, oil and gas exploration, infrastructure management, Internet portals and navigation technology. With our collection sources and comprehensive ImageLibrary (containing more than two billion square kilometers of earth imagery and imagery products) we offer a range of on- and off-line products and services designed to enable customers to easily access and integrate our imagery into their business operations and applications.

For more information, visit www.digitalglobe.com

Envitia

Envitia is a leading provider of geospatial information services, software and systems for defence, government and system integrators. We are a trusted advisor and provider of consultancy & research services and play an active role in projects that build upon open geospatial standards and best practices. Envitia continually develop high performance technologies that provide geospatial tool sets and integrated architectures built on OGC standards. Envitia also participates in OGC Web Service (OWS) testbeds and standards working groups, thereby contributing to standards development. Envitia is actively involved in initiatives to deliver improved operational effectiveness by undertaking research and development of demonstrators for Spatial Data Infrastructures, through to the delivery of timely geospatial information and by exploiting open standards. COTS products available include the MapLink Pro software developer toolkit, delivering fast and flexible OGC compliant geospatial data handling, display and visualisation in more than 5,000 tactical systems around the world.

For more information visit www.envitia.com

Esri

Esri develops GIS that supports the work of OGC and INSPIRE. Esri has implemented many OGC standards in ArcGIS. ArcGIS is an integral component in 350,000+ organizations around the world and several million GIS users are utilizing OGC standards when they use Esri software. Each stage in Esri's evolution has involved major technology changes. OGC and ISO TC211 standards are supported in Esri's integrated server, desktop, mobile, web and developer solutions as these have evolved. Today most people are engaged with maps online, so Esri has integrated the online experience into ArcGIS technology. Esri is also taking advantage of cloud computing to help make GIS available to anyone, anywhere. ArcGIS.com is Esri's online experience that brings content, tools, and the GIS community together in one Web portal.

For more information please visit www.esri.com and http://www.esri.com/software/arcgis/arcgis-for-inspire/

GE Smallworld

GE is an advanced technology, services and finance company taking on the world's toughest challenges. Dedicated to innovation in energy, health, transportation and infrastructure, GE operates in more than 100 countries and employs about 300,000 people worldwide. GE also serves the energy sector by providing technology and service solutions that are based on a commitment to quality and innovation. The company continues to invest in new technology solutions and grow through strategic acquisitions to strengthen its local presence and better serve customers around the world. The businesses that comprise GE Energy—GE Power & Water, GE Energy Services and GE Oil & Gas—work together with more than 90,000 global employees and 2010 revenues of $38 billion, to provide integrated product and service solutions in all areas of the energy industry including coal, oil, natural gas and nuclear energy; renewable resources such as water, wind, solar and biogas; as well as other alternative fuels and new grid modernization technologies to meet 21st century energy needs.

For more information, visit the company's Web site at www.ge.com

Intergraph

A founder member of the OGC, Intergraph has acquired extensive domain expertise through participation in INSPIRE Working Groups, leading EU research projects and SDI implementations around the world, including INSPIRE (national, regional and local nodes), the United Nations SDI, Canadian Geospatial Data Infrastructure and the US National SDI. Transforming experience into marketing leading technology, Intergraph server and geospatial portal solutions offer tremendous flexibility and power for building and deploying a spatial data infrastructure (SDI). Through the incorporation of ERDAS, APOLLO has added management and delivery of unstructured geospatial data, automated discovery and publishing, and unrivalled image streaming performance. The combined offering delivers a geospatial management platform that enables organisations to maximise the value derived from their spatial data assets by: providing consistent and simple access to up-to-date enterprise information resources; facilitating data sharing and collaboration with customers and partners, and reducing administrative overheads.

For more information visit www.intergraph.com/govt/sdi.aspx and www.erdas.com/solutions/Standards-Based/INSPIRE.aspx

Oracle

Oracle is the world's most complete, open, and integrated business software and hardware systems company. With more than 370,000 customers—including 100 of the Fortune 100—in more than 145 countries around the globe, Oracle is the only vendor able to offer a complete technology stack in which every layer is engineered to work together as a single system. Oracle's industry-leading products give customers unmatched benefits including unbreakable security, high availability, scalability, energy efficiency, powerful performance, and low total cost of ownership.

For geospatial solutions Oracle offers a wide range of Spatial capabilities in database and middleware, which are based on OGC and ISO standards. These functionalities, including OGC Web services, are used by numerous 3rd party tools, components and solutions as well as by Oracle's enterprise applications. They provide a powerful infrastructure for SDI implementations or INSPIRE conformant solutions and are ideally used in conjunction with so called engineered systems to reliably run highly performant infrastructures very cost-effectively.

For more information, visit www.oracle.com

Pitney Bowes Software

Pitney Bowes Software helps organizations make more strategic business decisions by providing proven solutions to carry out analysis and visualize spatial data delivering actionable business insight. Our enterprise GIS platform provides a centralized view for identifying business growth and optimization opportunities as well as improving information sharing throughout departments, employees and to external customers via the web. With our innovative location intelligence technology and industry expertise, organizations can achieve more valuable & long standing customer relationships built on trust, relevancy and outstanding customer experiences as well as delivering significant operational efficiencies for enhanced profitability.

For more information visit www.pbinsight.com/welcome/mapinfo/

Planetek

Planetek Italia is a leading multidisciplinary Geographical Information Services and Earth Observation company, focused on exploiting the value of geodata through viable, desirable and feasible solutions for storage, processing and delivery. Pioneered in 1994, Planetek Italia provides solutions for GMES-INSPIRE implementation in Europe, with a great experience in Land monitoring solutions and in Spatial Data Infrastructures compliant with OGC/ISO standards and INSPIRE implementing rules. The company has been awarded the tender for the "Development of the technical components of the INSPIRE Geoportal at European Level", of the Joint Research Centre (JRC). Its high concern is testified by the unceasing cooperation with European Union, Universities, Space Agencies, Research Centres, National-Local Public Administrations, and internationally known Companies. Planetek italia is an Open Geospatial Consortium (OGC) Associate Member and is involved with the INSPIRE initiative as a Spatial Data Interest Community (SDIC), founder of the Italian INSPIRE Forum, founder member of AIPAS, Italian Small and Medium Aerospace Enterprises Association.

For more information visit www.planetek.it/eng

Star-Apic

STAR-APIC is a leading European supplier of geo-spatial software technology for managing land, property and infrastructure. With more than 25 years experience we help government, utilities and the private sector to make the best use of map and geographic information to improve efficiency and derive real business benefits. Our customers include major cities and local administrations, National Governments and Mapping Agencies, multi-national Utility companies and private companies. We offer standard software products for web, desktop, mobile and enterprise platforms; a range of services including development of bespoke systems and training; and complete solutions for specific markets including Utilities and Cartographic production. Our products are based on Information Technology and Open Geospatial Consortium (OGC) standards and have been widely used to manage, maintain and publish data to INSPIRE standards.

For more information visit our website www.star-apic.com

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Additional references

Wherever possible, embedded references have been included in the body of the report text. The following are additional standalone references for further reading for those wishing to gain additional information on the subject.

INSPIRE Directive

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32007L0002:EN:NOT

INSPIRE Conference 2011

http://inspire.jrc.ec.europa.eu/events/conferences/inspire_2011/

Interoperability between INSPIRE, GMES and GEOSS

http://inspire.jrc.ec.europa.eu/events/conferences/inspire_2011/presentations/workshops/242/1_Nativi-Presentation.pdf

INSPIRE Architecture and Standards Position Paper

http://inspire.jrc.ec.europa.eu/reports/position_papers/inspire_ast_pp_v4_3_en.pdf

GEOConnexion International Article: OGC Standards support SDI Development

http://www.geoconnexion.com/uploads/OGCstandards_intv10i6.pdf

AGI Conference 2009: Standards in INSPIRE – IST36 Workshop

http://www.agi.org.uk/storage/events/090922-standards/RobinWaters.pdf

INSPIRE GMES Information Brochure

http://www.rtg.bv.tum.de/images/stories/downloads/projektarbeit/projekte_topaktuell/INSPIREGMES/INSPIRE-GMES-Brochure_V7_en.pdf

