INSPIRE
Infrastructure for Spatial Information in Europe

INSPIRE Architecture and Standards Position Paper

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Paul Smits

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Executive summary

The objective of this Position Paper is to provide a suite of recommendations that the Architecture and Standards Working Group believes should be considered for inclusion in the legislative framework. The boundary conditions are set by the common principles that have been presented in the INSPIRE Action Plan. In order to bring these principles to fruition, an architecture is called for that deploys interoperable services that will help to produce and publish, find and deliver, and eventually, use and understand geographic information over the internet across the European Union and Accession Countries. The term architecture is understood as the models, standards, technologies, specifications, and procedures used to represent, transform and generally accommodate the integration, maintenance and use of information in digital format.

The goal is an open, cooperative infrastructure for accessing and distributing information products and services online. INSPIRE, according to its common principles, envisages a distributed network of databases, linked by common standards and protocols to ensure compatibility and interoperability of data and services. In fact, by ensuring that electronic data content and services residing at national and regional organisations are implemented to common standards, they become easily accessible and can be combined seamlessly across administrative borders, thus creating what can be called the technical part of a Spatial Data Infrastructure (SDI).

The current state of the art in information technology makes it possible to realize SDIs based on distributed databases. In a number of Member States, SDIs are being implemented. The fact that there are still difficulties in seamlessly combining data or services from different Member States resides in the differences in how a location on the Earth is defined, how a geographic phenomenon is represented, how data is documented, and how information and services are delivered.

In order to reach agreement on these issues, the Architecture and Standards Working Group recommends the inclusion of the following policy principles in the INSPIRE legislative framework:

1. INSPIRE will define requirements for a European spatial data infrastructure that national or regional spatial data infrastructures will be able to comply with, either directly or by the use of appropriate tools that guarantee compliance.
2. It is the responsibility of each participating country to install and operate a national spatial data infrastructure which will comprise metadata, reference data and thematic data. This data will be made accessible electronically via a catalogue and viewing services.
3. The implementation of the infrastructure shall follow the specifications and guidelines issued and maintained by an INSPIRE-CEN Workshop Agreement. The guidelines shall contain specifications for the reference system, metadata, catalogue and viewing services, etc. They shall be based on the ISO 19100 series of standards for geographic information, and where necessary and appropriate, results of other standardisation initiatives will be included (e.g., the ETRS89 reference system, specifications issued by the OpenGIS Consortium Ltd., the Dublin Core Metadata Initiative). A responsible technical body at EU level will assist the Member States in the implementation of INSPIRE.
4. At EU level a geo-portal will be in place 6 months after the adoption of the legislative framework, and will link to the catalogue services of the Member States.
5. INSPIRE Procurement Guidelines shall be developed, possibly as an integral part of e-government initiatives, assisting public administrations in making choices when dealing with issues that touch information technology and geographic information. In line with this, the INSPIRE common principles should be followed in EU and national funded projects: development of data and technology specifications should be considered in parallel to enable delivery of a specific service. (Data production projects should follow the INSPIRE specifications)

1. Introduction

(Chapter developed by the INSPIRE secretariat/ WG leaders)

1.1 What is the INSPIRE initiative and why is it needed?

1.1.1 Good policy relies on quality information. The increasing complexity and interconnectedness of issues that affect the quality of life today is recognized by the policy-makers and influences the way new policies are being prepared today. The Sixth Environmental Action Programme[1] for instance emphasises the need to base environmental policy-making on sound knowledge and participation, principles that will influence the Union environmental policy-making for the next decade.

1.1.2 INSPIRE is an initiative currently being prepared by the Commission to support the availability of spatial information for the formulation, implementation and evaluation of Union policies. It intends to set the legal framework for the gradual creation of a spatial information infrastructure. INSPIRE will initially focus on environmental policy needs but, being a cross-sectoral initiative, will gradually be extended to other sectors (e.g. agriculture, transport, …) as other interested Commission services participate.

What is a spatial information infrastructure?

The INSPIRE initiative intends to trigger the creation of a European spatial information infrastructure that delivers to the users integrated spatial information services. These services should allow the users to identify and access spatial or geographical information from a wide range of sources, from the local level to the global level, in an inter-operable way for a variety of uses. The target users of INSPIRE include policy-makers, planners and managers at European, national and local level and the citizens and their organisations. Possible services are the visualisation of information layers, overlay of information from different sources, spatial and temporal analysis, etc.

The spatial information infrastructure addresses both technical and non-technical issues, ranging from technical standards and protocols, organisational issues, data policy issues including data access policy and the creation and maintenance of geographical information for a wide range of themes, starting with the environmental sector.

1.1.3 The INSPIRE initiative recognises the fact that most of the quality spatial information is available at local and regional level, but that this information is difficult to exploit in a broader context for a variety of reasons. The situation on spatial information in Europe is one of fragmentation, gaps in availability of geographical information[2], duplication of information collection and problems of identifying, accessing or using data that is available. As a result of these problems, effective Union policy actions suffer because of lack of monitoring and assessment capabilities that take into account the spatial dimension[3].

1.1.4 Fortunately, awareness is growing at national and at EU level about the need of quality geo-referenced information for understanding the complexity and consequently for containing the negative impacts of the ever-increasing human activity on the EU territory. Many regional and national initiatives are being

[1] http://europa.eu.int/comm/environment/newprg/index.htm
[2] For example, only a few pan-European geographical information layers exist, often designed for specific purposes that limit the possibilities of their wider use e.g. CORINE Land Cover and the SABE dataset (Seamless Administrative Boundaries of Europe) from EuroGeographics.
[3] For example: insufficient monitoring capabilities are key obstacles to the further development of a range of priority themes of the 6th Environmental action programme, such as soil, bio-diversity, health and environment and marine policy.

taken[4] and numerous stakeholders both in the Member States and candidate countries collaborate with the Commission services for the preparation of the INSPIRE initiative.

1.1.5 Successful implementation of the INSPIRE initiative would contribute to reach the objectives set out in the Commission's White Paper on European Governance[5]. It would help the Commission to establish more coherence in its policies by better integrating the common territorial dimension. This will also help to improve policy co-ordination, an issue that is identified by the Community Sustainable Development Strategy[6] as part of a new approach to policy-making. It will allow better participation by presenting information in a clear, understandable way at national and local level. Finally, it will help to make European governance more effective by supporting the evaluation of future impact and past experience for EU policies.

1.2 Context and vision

1.2.1 Recent global advances in moving from paper to digital data and information has created hitherto undreamed of opportunities to revolutionise access to data, communication of information and for informed decision-making at all levels of society. This move from back room to open door access to information presents new challenges for those acquiring, handling, and providing access to electronic data and information.

1.2.2 The data are often of unsatisfactory or undefined quality, based on proprietary geographic information systems and not accessible to the public or other users at local, regional, national and international level. Therefore, projects that combine data coming from various sources to provide policy-relevant information and tools are often time consuming and costly. Policies need to be put in place to reduce the duplication in collection, harmonisation efforts and to facilitate and promote wide dissemination of the data. These policies should free funds to be invested in improving the availability and quality of spatial information. The increased availability of data will in turn stimulate innovation among data and information providers in the commercial sector.

INSPIRE Principles

The INSPIRE initiative intends to improve the current situation by triggering the creation of a European Spatial Data Infrastructure for the access and use of spatial information built on the basis of the following principles:

- √ Data should be collected once and maintained at the level where this can be done most effectively
- √ It must be possible to combine seamlessly spatial information from different sources across Europe and share it between many users and applications
- √ It must be possible for information collected at one level to be shared between all the different levels, e.g. detailed for detailed investigations, general for strategic purposes
- √ Geographic information needed for good governance at all levels should be abundant and widely available under conditions that do not restrain its extensive use
- √ It must be easy to discover which geographic information is available, fits the needs for a particular use and under what conditions it can be acquired and used
- √ Geographic data must become easy to understand and interpret because it can be visualised within the appropriate context and selected in a user-friendly way.

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[4] See Examples of regional and national initiatives to create a spatial information infrastructure in GE, UK, PT on the Internet http://www.ec-gis.org/inspire/

[5] COM(2001)428 – European Governance - a White Paper . The White Paper refers to five principles of good governance: openness, participation, accountability, effectiveness and coherence

[6] Presidency Conclusions – Göteborg European Council, 15 and 16 June 2001

1.2.3 The INSPIRE policy vision is to make harmonised and high quality geographic information readily available for formulating, implementing, monitoring and evaluating Community policy and for the citizen to access spatial information, whether local, regional, national or international[7]. This vision is illustrated in the diagram at Figure 1.

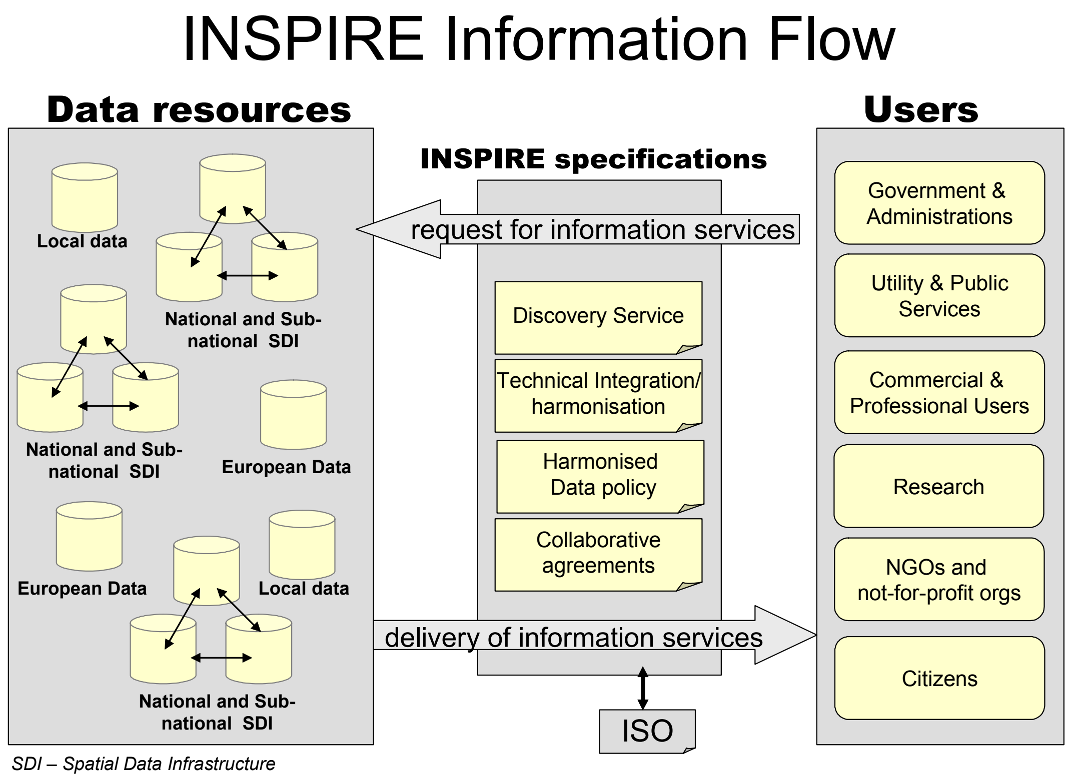

Figure 1-1. *Diagrammatic View of the INSPIRE Vision*

1.3 Stepwise approach

1.3.1 The INSPIRE implementation will follow a step-wise approach, starting with unlocking the potential of existing spatial data and spatial data infrastructures and then gradually harmonising data and information services allowing eventually the seamless integration of systems and datasets at different levels into a coherent European spatial data infrastructure. Achieving this objective will require the establishment of appropriate coordination mechanisms and common rules for data policies. Where relevant, synergies with the GMES initiative will be sought in order to ensure coherence between INSPIRE and GMES [8].

1.3.2 The first step will focus on harmonisation of documenting existing datasets (metadata) and on the necessary tools to make this documentation accessible.

1.3.3 The second step will primarily aim at providing common ways to access the spatial data sets themselves allowing uncomplicated analysis of data on different themes coming from different

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[7] The INSPIRE initiative will link with relevant initiatives at the global level such as the work to develop the Global Spatial Data Infrastructure (GSDI).

[8] Sec(2001) 993 of 16/06/2001 Commission Staff Working Paper – Joint document from Commission services and European Space Agency

sources. An example of such analysis is visual inspection of spatial relations between phenomena by overlay of datasets.

1.3.4 The third step will target the establishment of common models of the objects in the environment for which spatial data is collected, such as transport networks, forests, … This will allow to map existing datasets to a common set of models, the start of the creation of a really harmonised spatial data infrastructure that will facilitate the combination of information of various sources and more advanced analysis work.

1.3.5 The fourth and last step will build upon the previous steps and concentrate on completing the common models and on providing the services to fully integrated data from various sources and various levels, from the local to the European level into coherent seamless datasets supporting the same standards and protocols. This step will allow real time access to up-to-date data across the whole of Europe.

1.3.6 These steps will partly be carried out in parallel, depending on user needs and degree of availability and harmonisation of existing information. All these steps involve actions of standardisation, of harmonisation and integration of data and services.

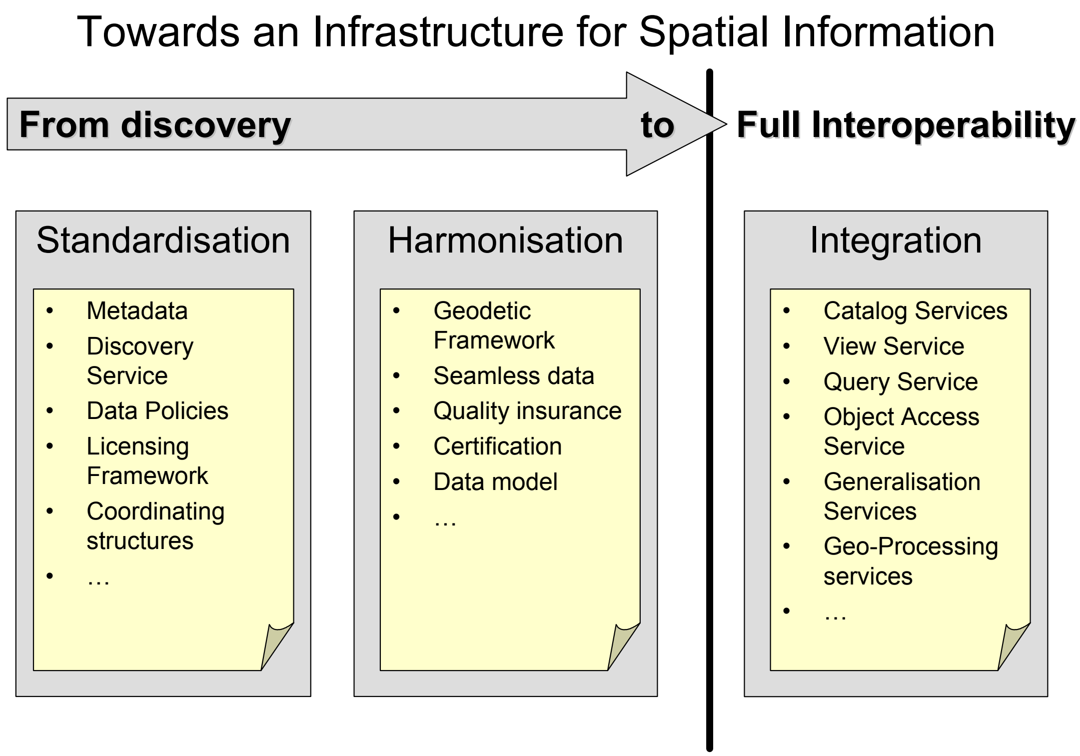


Figure 1-2. *Towards an Infrastructure for Spatial Information*

1.3.7 INSPIRE is conceived as a cross-sectoral initiative covering the main Community sectors with a spatial impact such as transport, energy, agriculture, … but will target initially information needed to support environmental policy. Indeed the 6th Environmental Action Programme highlights the need for better knowledge and sound science in environmental policy-making and geographical information will therefore be increasingly required to achieve this. Therefore, a horizontal framework is needed in order to ensure a coherent approach to information collection and distribution. Moreover, the requirement by the Treaty for all policy sectors to integrate environment concerns will provide a first link from environmental policy to other policy sectors that can be further extended at later stages.

1.4 Users, Producers and other Stakeholders

1.4.1 Users

1.4.1.1 Environmental users are many and various, and include users who need spatial data for planning, management, assessment, monitoring and reporting. Hence the user community is very broad and diverse and includes:

- Governments & Administrations
  - EU
  - National
  - Regional
  - Local
- Utility and Public Services, including
  - Transport
  - Health
  - Emergency services
  - Utilities (e.g. water, telecommunications, gas, electricity).
- Research and development
  - Universities
  - Public and Private Institutes
  - Application Developers for IT Systems
- Commercial & Professional End Users
  - Tourism
  - Value Added Resellers
  - Surveyors
  - Property Developers
  - Insurance
- Non Governmental Organisations (NGOs) and not-for-profit organizations
- Citizens

1.4.1.2 Different user categories must be considered because their requirements in terms of data access can vary significantly.

1.4.2 Producers

1.4.2.1 The producers of spatial information within the public sector include national environmental protection agencies, mapping agencies, national geological surveys, national maritime administrations, cadastral, land registration and other land administration organisations, local authorities and utilities.

1.4.2.2 It should also be noted that, under certain circumstances, private data producers may offer production capacity to public bodies, or possibly sell data directly onto the market themselves. In some Member States there is a thriving private sector geographic information industry supplying data and services directly to the commercial market.

1.4.2.3 Most spatially organised data and information are either used internally by public bodies, or are supplied to other public sector organisations under various types of agreement. A relatively small but growing number of government departments or agencies conduct commercial business with the private sector or with the general public. It is in the area of data use that it is important to recognise the difference between sharing data and trading data.

1.4.2.4 The simplified diagram at Figure 3 clearly shows this distinction in the context of three transaction streams which can be combined in varying proportions by any public sector body developing an overall information sharing and trading strategy, subject to common rules defined under INSPIRE.

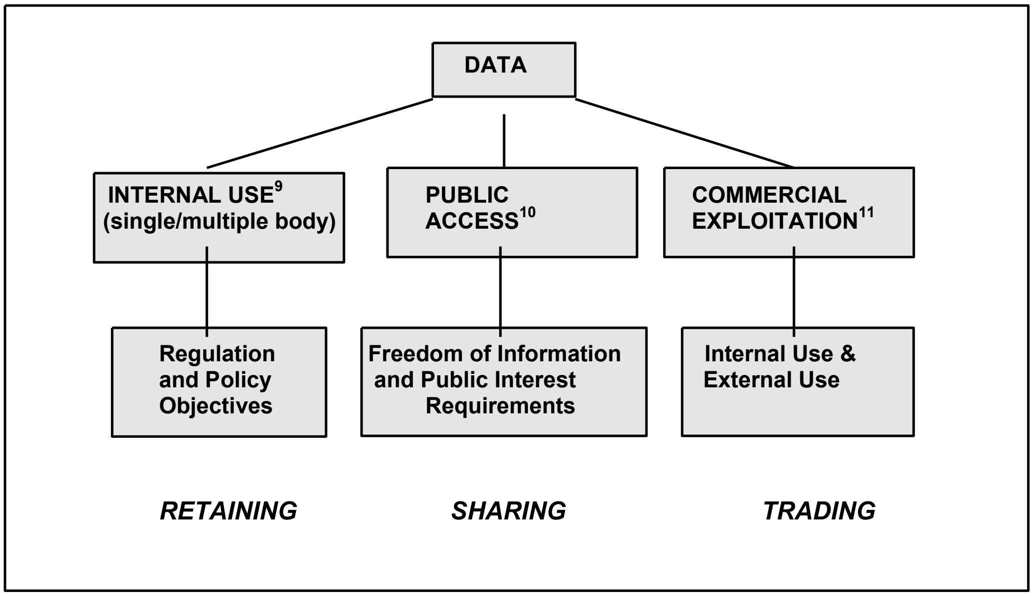


Figure 1-3. *Simplified Diagram Illustrating Public Sector Data Uses*

1.4.3 Other Stakeholders

1.4.3.1 The delivery of INSPIRE, like initiatives such as *e*Europe and *e*Government, is dependent on information technology. It will have a profound impact on a variety of disciplines and professions, affecting many individuals and organizations that cannot be categorised as users or producers. Conversely, this group of other stakeholders will also have an important role in the process of shaping the infrastructure. Examples of other stakeholders are:

- The Information and Communication Technology (ITC) sector, and in particular product providers who offer software, hardware, and related systems, and service providers who offer system development, database development operations support, and consulting services;
- Standardisation bodies like ISO, CEN, and national standardization organizations;
- Co-ordinators and regulators, including European and national associations.

[9] **Internal Use** means spatial information used exclusively within the originating public body, or shared among any public body at local, regional, national or international level.

[10] **Public access** means spatial information provided by public bodies free of charge or marginal cost of supply free of charge or marginal cost of supply for viewing or use by citizens of the European Union (including NGOs, academia, and research institutes).

[11] **Commercial exploitation** means the utilisation of public sector spatial information in commercial information products.

1.5 Architecture and Standards Working Group

1.5.1 In order to realize the INSPIRE common principles, an architecture is called for that deploys interoperable services that will help to produce and publish, find and deliver, and eventually, use and understand geographic information over the internet across the European Union and Accession Countries. The term architecture is understood as the models, standards, technologies, specifications, and procedures used to represent, transform and generally accommodate the integration, maintenance and use of information in digital format.

1.5.2 But characterising the boundary conditions for this architecture in the European context as challenging would be an understatement. Diversity of cultural settings, of language, and of technological development call for an approach that respects on the one hand the identified need to improve efficiency, expressed so well by the common principles, and on the other hand the subsidiarity principle. This should be done without forgetting that the architecture components already in place within some Member States should be exploited as much as possible. In addition, technology evolves rapidly which forces INSPIRE to puts more accent on the process that establishes the architecture rather than on the technology to be deployed.

1.5.3 The goal must therefore be to catalyse the creation of a loosely coupled co-operative infrastructure for accessing and distributing information products online. INSPIRE, according to its common principles, envisages a distributed network of databases, linked by common standards and protocols to ensure compatibility and interoperability of data and services. Each information source is managed by custodians with the expertise, incentive, and operational capacity to maintain the database to the standards required by the community and committed to the principles of custodianship.

1.5.4 The remit of the Architecture and Standards (AST) Working Group is to take a clear position on the architecture and the supporting standards to be proposed for the future INSPIRE infrastructure considering all the territorial levels, from local to global.

1.5.5 The objective of this Position Paper is to provide recommendations that the AST Working Group believes should be considered for inclusion in the legislative framework. In pursuing this objective, the paper presents a generic Architecture reference model, provides details about the components that constitute the architecture, and pinpoints the standards existing today that need to be utilised in order to allow the discovery and sharing of geographic information. It also proposes a mechanism by which this set of standards can be maintained in the future.

1.5.6 The organisation of the paper is as follows. Chapter 2 focuses on the architecture model which is recommended for use within INSPIRE, and provides details about the components. Chapter 3 is on Standards and describes the administrative mechanisms to maintain the INSPIRE standards and specifications, and identifies the initial set of standards that will be the basis of INSPIRE profiles and specifications. Chapter 4 is concerned with the implementation of the architecture. Chapter 5 is on impact analysis and chapter 6 identifies the risks and obstacles.

2. Architecture

2.1 Reference Model

2.1.1 The architecture envisaged by AST deploys interoperable services that will help to produce and publish, find and deliver, and eventually, use and understand geographic information over the internet across the European Union and Accession Countries at local, national, and European levels.

2.1.2 It is emphasised that the goal is an open[15] co-operative infrastructure for accessing and distributing information products and services online. INSPIRE, according to its common principles, envisages a distributed network of databases, linked by common standards and protocols to ensure compatibility and interoperability of data and services. These services are a key element as INSPIRE joins the geographic information community in moving from the data paradigm to the service paradigm.

2.1.3 Following the taxonomy of the Reference Model of Open Distributed Processing (RM-ODP, ISO/IEC 10746), the envisaged architecture can be described by different five viewpoints: the enterprise viewpoint[16], the computational viewpoint[17], the information viewpoint[18], the engineering viewpoint[19], and the technology viewpoint[20], all of them addressing different concerns. The description of the architecture given in this chapter is related to the engineering viewpoint, which focuses on the mechanism and functions required to support distributed interaction between the elements of the system. Figure 2.1 shows a generic architecture reference model that allows one to describe any spatial data infrastructure. In this model, which is introduced to provide a common understanding of the technical aspects of spatial data infrastructures, a distinction is made between four major groups of components: user applications, geo-processing and catalogue services, catalogues, and content repositories [1]. In this context, the term component refers to a group of technically similar functionalities within the architecture.

2.1.4 User applications comprise the software usually seen by users; they include general purpose interfaces for query and viewing, a tool for database administrators, and analytical applications tailored to the information needs of the user. Geo-processing and catalogue services may process user queries, draw maps from data, regulate access, perform payment operations, and extract and send data to a user application. Content repositories provide data. Finally, the catalogues allow clients and services to find out what repositories or services are available and appropriate for their use. It is safe to call the catalogues, together with the catalogue services, the heart of INSPIRE's architecture. Naturally, catalogues must be populated with metadata of acceptable quality. Note also that not all components will be required in

2.1.5 As stated earlier, Fig. 2.1 is a generic model for any spatial data infrastructure. Most Member States already have one or more components of the architecture model in place (see Appendix B). Examples are the regional spatial data infrastructure in North Rhine Westphalia, Germany (GDI NRW) or The Netherlands. Although in theory the components of these spatial data infrastructures could be connected, in practice they are not for a number of reasons. So far, cross border information needs are often addressed on an ad-hoc basis.

2.1.6 INSPIRE's vision goes further and foresees that each of the components identified in Fig. 2.1 are part of a networked environment. Figure 2.2 visualizes this concept by giving a hypothetical example. In the example, an analysis application developed for one of the Directorates General makes use of geo-processing services offered by a company in Belgium. These services query French and Italian catalogues for particular geographic information about a specific border region. The geo-processing service then uses these data for the analysis, combines them with related information from

[15] The term "open infrastructure" means that the infrastructure is able to accommodate new geospatial products and services according to the free market principle.
[16] See also ISO 19101
[17] ISO 19119, clause 7
[18] ISO 19119, clause 8
[19] ISO 19119, clause 9
[20] ISO 19119, clause 10

EUROSTAT, and serves the results back to the user. Subsection 2.2 explains the meaning of the terms used in Fig. 2.1.

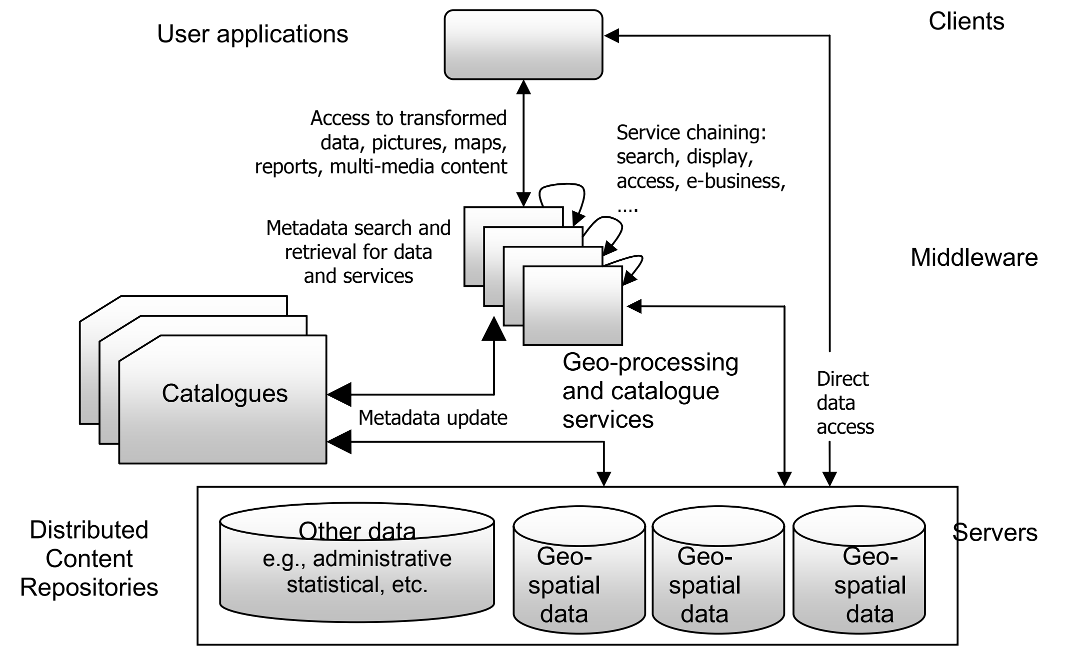


***Figure 2.1**. The architecture reference model for INSPIRE. A distinction is made between four major groups of components within the architecture: user applications, geo-processing and catalogue services, catalogues, and content repositories [1].*

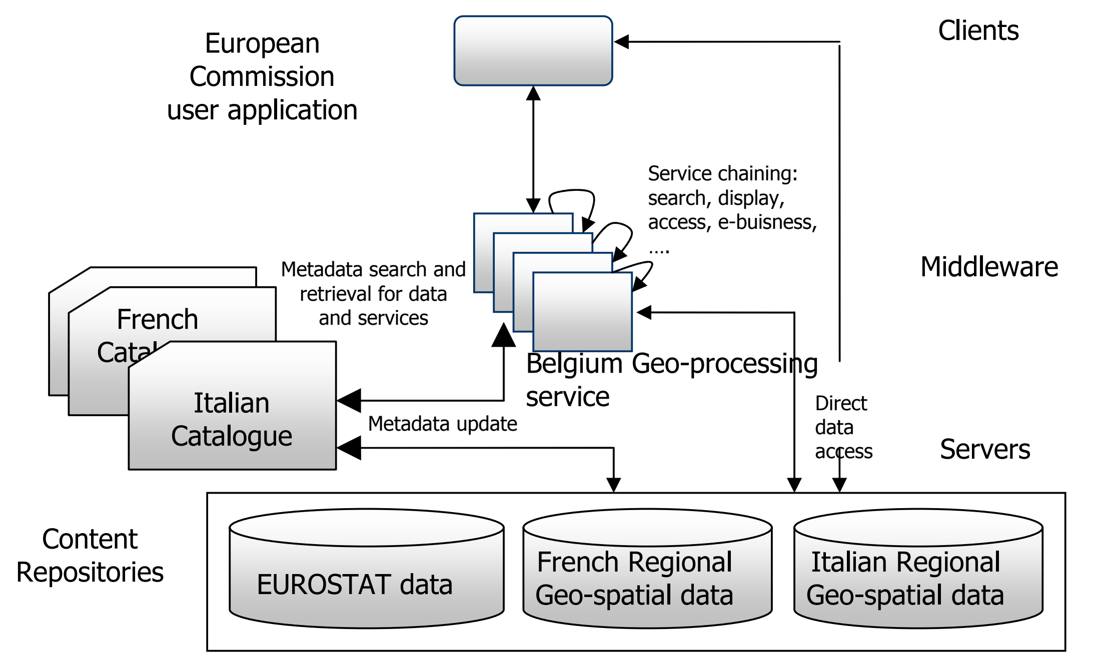


***Figure 2.2**. Hypothetical example that shows how the components of the architecture supporting INSPIRE can reside in different geographical areas and in many different organizations.*

Recommended policies:
INSPIRE will define requirements for an open European spatial data infrastructure that national or regional spatial data infrastructures will comply with, either directly or indirectly by the use of appropriate tools that guarantee compliance.

It shall be the responsibility of each participating country to install and operate national or regional spatial data infrastructures.

The SDI will comprise Metadata, Reference Data, Thematic Data, and derived information products and services which will be made accessible electronically.

2.2 Components

2.2.1 User applications

2.2.1.1 It is important for the definition of the architecture to determine who the users will be, and what functionality they need in support of their day to day affairs. Several different users of the geospatial data can be identified in the INSPIRE vision. These can be segmented into the following main groups:

- Governments and Administrations (institutions of the European Union, National, Regional and Local);
- Critical infrastructure providers, including transport, health, emergency services, and utilities (water, telecommunications, gas, electricity);
- Research and development (Universities, Public & Private Institutes, Application Developers for IT systems, etc.);
- Commercial & Professional End Users (Tourism, Value-added Resellers, etc.);
- Non Governmental Organisations, education and not-for-profit organisations;
- Citizens and the general public.

2.2.1.2 The initial focus of the INSPIRE initiative is on users in Member State that are involved in the formulation, implementation, and evaluation of European Union legislation. These users work for governments and administrations at EU, national, and local level and require consistent and harmonised reference and environmental data. The infrastructure thus supports good governance, while at the same time helping to contain the costs associated with the implementation of legislation by reducing duplication of efforts.

2.2.1.3 Users at European Union level include those institutions that validate the implementation of regulations and agreements. Examples include European Commission DG Environment, DG EUROSTAT, DG Agriculture, DG Regional Development, and the European Environment Agency.

2.2.1.4 The ordinary citizen will be a user of the geographic and environmental information accessible through the infrastructure. They may want to review the impact of spatial planning on their environment. Many people are *unconscious users* of geographic information. They need not be GI literate but many may use for instance post codes and place names to retrieve a report, a video, or other multi-media content about the place of interest. The citizen represents the general interest audience.

2.2.1.5 The policies foreseen by INSPIRE will affect the private sector as value-adders to geographic information held by public bodies. Commercial and public organisations alike will be able to use the infrastructure to get access to these data, add value, and to publish their products.

2.2.1.6 Examples of international bodies using INSPIRE in the future are the United Nations, and other non-governmental organisations. Also initiatives like the Global Spatial Data Infrastructure and Digital Earth will link to INSPIRE.

2.2.1.7 In order to serve the users identified in the previous paragraphs, a number of uses of the infrastructure can be envisaged. Listed in order of priority, the architecture must provide the following functionality:

1. Publish metadata and data;
2. Find geographic information;
3. Context-related viewing of geographic information;
4. Delivery of geographic information;
5. Analyse geographic information;
6. Support multi-lingual queries and viewing of results; and
7. Support e-business for value-adding products and services .

The following paragraphs describe the above-mentioned functionality in more detail.

1. Publish metadata and data

2.2.1.8 Mechanisms will need to be in place that allow "GI search engines" to search the catalogues of producers and custodians. These catalogues will provide a standardised view on metadata. The issue of metadata is paramount to the success of INPIRE[21]. Experience with operational SDIs have made clear that good documentation about the quality of the product, and its intended use, is critical[22]. Producers are responsible for the creation of the metadata, and should be given control over the metadata content. In the context of INSPIRE, the issue of metadata should have an absolute priority; metadata need to be accessible through the INSPIRE portal at an early stage in the implementation of INSPIRE, based as much as possible on existing metadata systems.

As INSPIRE evolves and incorporates the concept of geospatial objects, mechanisms to maintain the consistency between different datasets should be included, i.e. dependant objects must be notified about changes in a base object in the reference data. This brings up the issue of unique identifiers that are required. Also, rules must be established for the lifecycle management of geospatial objects.

2. Find

2.2.1.9 Finding geographic information requires a discovery service for geospatial information (the "GI search engine"). Within the geospatial community various names have been assigned to this concept; examples are "catalogue services" (OpenGIS Consortium), "Spatial Data Directory" (Australian Spatial Data Infrastructure), and "Clearinghouse" (U.S. FGDC). Although they have different names, the goals of discovering geospatial data through the metadata properties they report are the same. These services will be referred to as "catalogue services" [2]. These services will have to support multi-lingual searches with place names, key words, etc. Figures 2.3a and 2.3b show examples of what an EU catalogue might look like allowing the viewing of metadata, and giving access to sample data.

3. Context-related viewing

2.2.1.10 Viewing geographic information over the internet is also referred to as Web Mapping. It includes the presentation of general purpose maps to display locations and geographic backdrops, as well as more sophisticated interactive and customisable mapping tools. The viewing must be supported by simple queries (e.g., show the nearest Natura2000 site to a given postcode).

2.2.1.11 Related to the viewing is the requirement that the geographic information presented (e.g., a dataset with noise measurements) must be given a context, made easy understandable, and be of value to users (i.e., be displayed with the context the user is familiar with, etc.). Understanding thematic geographic information coming from different sources (e.g., different cities, member states) requires standardisation of the way in which the information is portrayed.

2.2.1.12 The technology behind web mapping is aimed at portraying spatial information quickly and easily for most users, requiring only basic map reading skills. [2] ISO 19128 Web Map Server Interface / OpenGIS Web Map Server (WMS) specifications offer a way to enable the visual overlay of complex and distributed geographic information (maps) simultaneously, over the Internet. This information is accessible to the user usually in the form of a picture displayed on the screen. Experience with Web Mapping applications showed that it should also be possible to create larger hardcopy maps and

[21] See for more information about metadata issues the RDM Position Paper. [Online] http://www.ec-gis.org/inspire.
[22] http://tmip.tamu.edu/clearinghouse/docs/gis/maine/

annotated aerial photos to speed up analysis and give a broader view of the data than a computer monitor[23] is able to.

2.2.1.13 Generally the viewing functionality is not suited for more advanced automatic analyses, and is intended for the citizen / general interest.

4. Delivery of data

2.2.1.14 To do more with the data than viewing them, the data need to be delivered. In fact, a clear distinction is made between the viewing and delivery of GI. In many cases viewing thematic data against some form of reference data may provide sufficient information to the user. However, there will be cases where the user requires to be in possession of the data themselves. Delivery of data over the internet can be realized in various ways. Some SDIs transmit data via e-mail; others serve the data through what the OpenGIS Consortium calls a Web Feature Server. Also, large volumes of data, for instance satellite images, may be delivered on off-line media like tape and DVD.

5. Analyse information

2.2.1.15 Related to the concept of web mapping, but going further in terms of functionality, is the use of analysis tools. An increasing number of applications can be realized by combining a series of geospatial services and spatial queries in appropriate work flows over the internet, without having to store the thematic or reference information locally.
Examples of more complex analyses than those supported by viewing services are: show the buildings and access roads that lie on a slope of 10% or more, where the last 24 hours more than 100 mm of precipitation fell. Or: predict the traffic pressure on alternative routes over the Alps when the major highways through Switzerland are blocked. Or: classify a satellite image with a specific set of decision rules and fuse the result with an existing land-cover map to detect changes.

6. Multi-lingual aspects

2.2.1.16 Multi-lingual aspects relate to almost all functionality envisaged. They concern the querying of metadata, viewing of GI (place names, labels), and the results of any analysis (e.g., querying a data set). Multi-lingual support to INSPIRE is therefore imperative. Thesauri and translation services will have to be considered in order to enable users to understand the geographic information being viewed or delivered. Gazetteers and directories of place names, like the TGN initiative, are also part of this topic. Harmonisation of semantic models that document geospatial data sets is required.

7. e-business

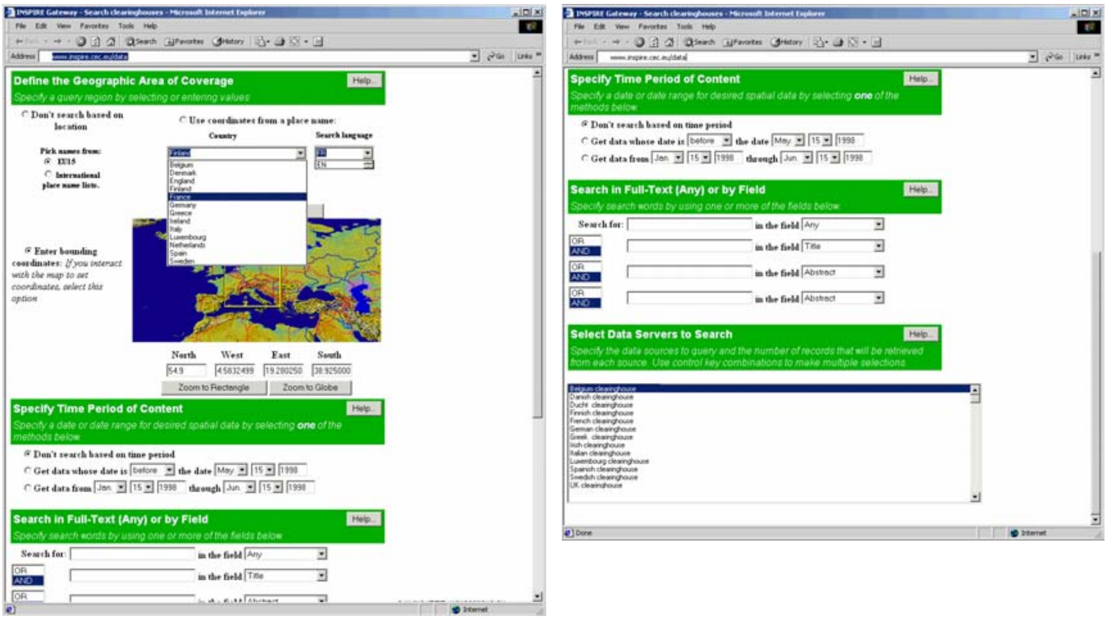
2.2.1.17 The commercial exploitation of geographic information is be a possibility envisaged by INSPIRE. Web payment and ordering services, payment models and license agreements are part of this type of use.

European Union Geo-portal

2.2.1.18 All the uses or applications mentioned in the previous paragraphs will be made available though a so-called geoportal. A portal is a site featuring a suite of commonly used services, serving as a starting point and frequent gateway to the Web (Web portal) for a user community. The EU Geo-portal shall provide facilities that, for selected thematic policies, link to the functionality identified in the previous paragraphs. Trust and authority must become characteristics of the Geo-portal. Where appropriate and possible, the INSPIRE portal will link to national portals, and to sector-specific data and services. The geo-portal will also link to guidance material for the implementation of INSPIRE, including links to data policy and licence agreements.

Recommendations:
At EU level a geo-portal shall be in place 6 months after the adoption of the legislative framework.

[23] http://tmip.tamu.edu/clearinghouse/docs/gis/ncdot/



a. b.

Figure 2.3. *Example of how the search application window may look like. The example is based on the FGDC gateway. a) Search based on geographic area and time period. b) Search based on keywords.*

2.2.2 Geoprocessing services

2.2.2.1 ISO/IEC TR 14252 and ISO 19119 define service as a distinct part of the functionality that is provided by an entity through interfaces. Note that all the services in this subsection refer to web-services (based on www and http protocols). A more detailed description of the cited GI standardisation projects is provided in Appendix A.

2.2.2.2 Please note that the deadlines for the identified functionality are largely determined by the requirements set out in the Environmental Thematic User Needs Position Paper; these are a minimal requirement, and is must be understood that Member States can implement the requirements sooner if they wish. This has consequences for the INSPIRE Guidelines and Best Practice for Architecture and Standards which are discussed in subsection 3.1.

2.2.2.3 Summarizing the above and taking into account the priorities of the types of uses, the following services need to be implemented:

1. Management/administration/Coordinator specific services
2. Catalog service (find data)
3. Catalog service (find services)
4. Map service (WMS)
5. Coverage service (WCS)
6. Feature service (WFS)
7. Gazetteer service
8. Coordinate transformation service
9. Authentication service
10. Analysis / Geospatial Data fusion service

11. Web Pricing and Ordering Service

2.2.3 Catalogues and Catalogue Services

2.2.3.1 Geospatial data that are stored for use in local databases can often be used in external applications once they are published. In the GSDI Cookbook, the concepts and implementation of geospatial data catalogues are presented as a means to publish descriptions of geospatial data holdings in a standard way to permit search across multiple servers.

2.2.3.2 Geospatial data catalogues are discovery and access systems that use metadata as the target for query on raster, vector, and tabular geospatial information. Metadata is the information and documentation, which makes data understandable and sharable for users over time (ISO11179 Annex B). Indexed and searchable metadata provide a disciplined vocabulary against which intelligent geospatial search can be performed.

2.2.3.3 In addition to catalogues that contain metadata about geospatial data, there are catalogues that describe geospatial services.

2.2.3.4 Catalogues are accessible not only to human operators, but also applications and services via appropriate catalogue interfaces.

2.2.3.5 Catalogue Services provide the functionality both to manage and to search catalogues; they are a special case of geospatial processing service. They can be considered the heart of any SDI. The OpenGIS Abstract Specification on Catalogue Services describes the term “Catalogue” as the set of service interfaces which support organization, discovery, and access of geospatial information. Catalogue services help human operators or application software to find information that exists anywhere in a distributed computing environment. A Catalogue can be thought of as a specialized database of information about geospatial resources available to a group or community of users. These resources are assumed to have OpenGIS feature, feature collection, catalogue and metadata interfaces, or they may be geoprocessing services. Catalogues have three essential purposes:

1) to assist in the organization and management of diverse geospatial data and services for discovery and access,
2) to discover resource information from diverse sources and gather it into a single, searchable location, and
3) to provide a means of locating, retrieving and storing the resources indexed by the catalogue.

2.2.3.6 The interface to the catalogue services may give access to samples of the data in order to better judge the fit for purpose.

Recommendations:
Each country participating to INSPIRE shall set-up and maintain at least one catalogue server on which metadata about reference and thematic geographic information be publicly available.
Catalogue services shall be installed 1 year after the adoption of the legislative framework.

2.2.4 Content repositories

2.2.4.1 Content repositories provide geospatial data and other types of data. Other types of data include tabular information with a geographic identifier, and also reports, photographs, and multi-media content about a location. Examples are the regulations or decrees issued by regional governments whose jurisdiction is determined by the government’s administrative boundaries. Spatially-enabled metadata management is the key to discover generic documentation based on a geographic location. Likewise, geospatial data fusion technology will become available to analyse texts and mark the locations mentioned in that text on a map.

2.2.4.2 The geospatial content repositories may contain varous forms of geographic information, of which one form will be “reference data”, i.e. the representation and location of buildings, highways, rivers, height, and imagery. Reference data is widely and often used by many organisations to “reference” information such as “thematic data”, land open for public access, environmental information, occurrence of events (such as crimes) and so on.

2.2.4.3 Content repositories of geospatial data are organized either in coverage or in feature databases. Coverages (also called raster data or image data) refer to gridded data like scanned maps, satellite images or orthophotos. Features refer to points, polylines, polygons, etc.

2.2.4.4 INSPIRE’s common principles envisage that the feature databases evolve into repositories of multi-purpose data, structured in spatially meaningful packets, with persistent identifiers, well-defined life-cycle rules, and appropriate procedures for managing changes. 'Spatially meaningful packets' implies no artificial divisions and hence a service which at least appears to be seamless.

2.2.4.5 The architecture described in this position paper aims at giving users the impression that they are dealing with one database, although in reality they are finding, accessing, reading, and updating a set of different databases. This is referred to as the so-called multiple database problem, to which the interoperability community has developed two approaches: the multibase approach, where independently created and administered databases are to be used together, and the federated database approach [15]. In the former approach databases can be physically and logically different, have different access procedures, protocols, data models, and schemas. The latter approach is a special case of the former. It often uses a common data model, and one single organization is responsible for the integration mechanisms. Given the vision of INSPIRE and the current state of play in geographic information science, both approaches require that a number of issues be attended (see subsection 4.7). In the interim, there may however be value in serving data using current practices.

2.2.4.6 The previous paragraphs make clear that a model-driven approach is needed. Closely related to the model-driven approach is the concept of objects. The long-term vision of INSPIRE, in which data is collected once and used many times, suggests that interoperability must support the multi-scale and multi-application uses. It also seems to imply that all data collected at the most detailed level and generalised. This will not always be possible and approaches to the use of small scale data with large scale data must be considered. Although at this moment the use of objects is a point of discussion for some, the AST Working Group_proposes a gradual implementation in which in the sort term data sets are made available without complying to a common standard for data content; for the long term and for new data collection efforts, standards for data content will have to be followed. This also means that data dictionaries and thesauri need to be developed.

2.2.4.7 The standards for data content recommended for use within INSPIRE and outlined in the next chapter, makes use of the Unified Modelling Language (UML) for application neutral content modelling.

2.2.4.8 It is necessary that for strategic pan-European data collection efforts data models be devised and adhered to. This does not mean that every user community is obliged to use the same data models internally: appropriate crosswalks can be devised that link existing data models to the common European model.

Key-issues to be addressed in INSPIRE Guidance documentation:
Unique features identifiers must be agreed upon for reference data.

Watermarking technologies should be considered as a measure to enforce data policies and legal issues.

For reference data and specific thematic applications (e.g., specific environmental applications), data models will be devised and shall be adhered to.

3. Standards

3.0.1 This chapter gives information about the standards that need to be adopted in order to attain the interoperability of data and services in support of the architecture. The chapter focuses first on current standardisation initiatives in the field of information technology and GI (3.1), and on the organisational solution to the issue of managing the INSPIRE Profile and Guidelines so that changing standards and technology can be accommodated (3.2). Subsections 3.3, 3.4, and 3.5 are to give the reader an overview of what standards are currently available to support the proposed architecture.

3.1 Relevant standardisation initiatives

3.1.1 The International Standardisation Organisation (ISO) defines standards as *documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose* [8]. Standards contribute to making life simpler, and to increasing the reliability and effectiveness of the goods and services we use. They support existing systems and data, thus being a means of securing and protecting investments in data and systems. The *process* of standardisation is aiming at getting people to agree on an acceptable technical solution. This is necessarily an iterative process, building upon existing standards.

3.1.2 Building information infrastructures is not something new. The Internet could be regarded as such an infrastructure, and there are various branches that have set-up information infrastructures to support their primary business processes. Examples of communities that have agreed on standards for the exchange of information are financial institutions and the automotive industry.

3.1.3 INSPIRE wants to integrate the use of internet-based geographic information services in the day to day information needs of policy makers. In order to make this happen, the recommendations related to the architecture and to the standards issued by INSPIRE must carefully consider existing specifications of and experiences with information infrastructures, starting with the World Wide Web Consortium (W3C). W3C drafted the *Web Services Architecture Requirements* [16], which, scaled-down to INSPIRE, provides useful baseline requirements for the architecture. Also relevant to INSPIRE are the activities of the European Committee for Standardisation (CEN). An example of another, more specific standardisation initiative is the Dublin Core Metadata Initiative.

3.1.4 There are currently two major standardisation initiatives in the field of geographic information and geomatics. These are ISO/TC211 and the OpenGIS Consortium Ltd. (OGC). The standards produced by these initiatives may specify methods, tools and services for data management, acquiring, processing, analyzing, accessing, presenting and transferring such data between different users, systems and locations. Being embedded in the field of information technology, the standards link to appropriate existing standards where possible, and provide a framework for the development of sector-specific applications using geographic data.

3.1.5 The mandate of ISO/TC211 is to develop an integrated set of standards for GI. ISO/TC211 safeguards both the development and the deployment processes, which are integrated in ISO's authoritative practice of co-ordination and consensus building, prerequisites for successful standardisation. The vision of OGC is the complete integration of geospatial data and geoprocessing resources into mainstream computing. Both ISO/TC211 and OGC have a strong involvement in industry, government, and academia. The two initiatives are aware of each other's strengths and co-operate (Fig. 3-1).

3.1.6 ISO 19100 series of base standards are implementation neutral. Some of these may be used by the market directly (like ISO 19103 Quality principles, ISO 19109 Rules for Application Schema, ISO 19103 Conceptual Schema Language, etc) while others need to be implemented as software components. Implementation specifications has been mainly been developed by OGC, more and more taking the ISO 191xx implementation neutral base standards as the basis for platform specific implementations (CORBA, COM/OLE, SQL, XML, etc.). This process may result in amendments to the base standards, submitted to ISO, either as technical corrigendum or as new ISO standards, either IS or possibly PAS (Public Available Specifications). In this way, ISO/TC 211 and OGC complement each others efforts to ensure interoperable solutions to GIS. European industry has a role in fostering this co-operation.

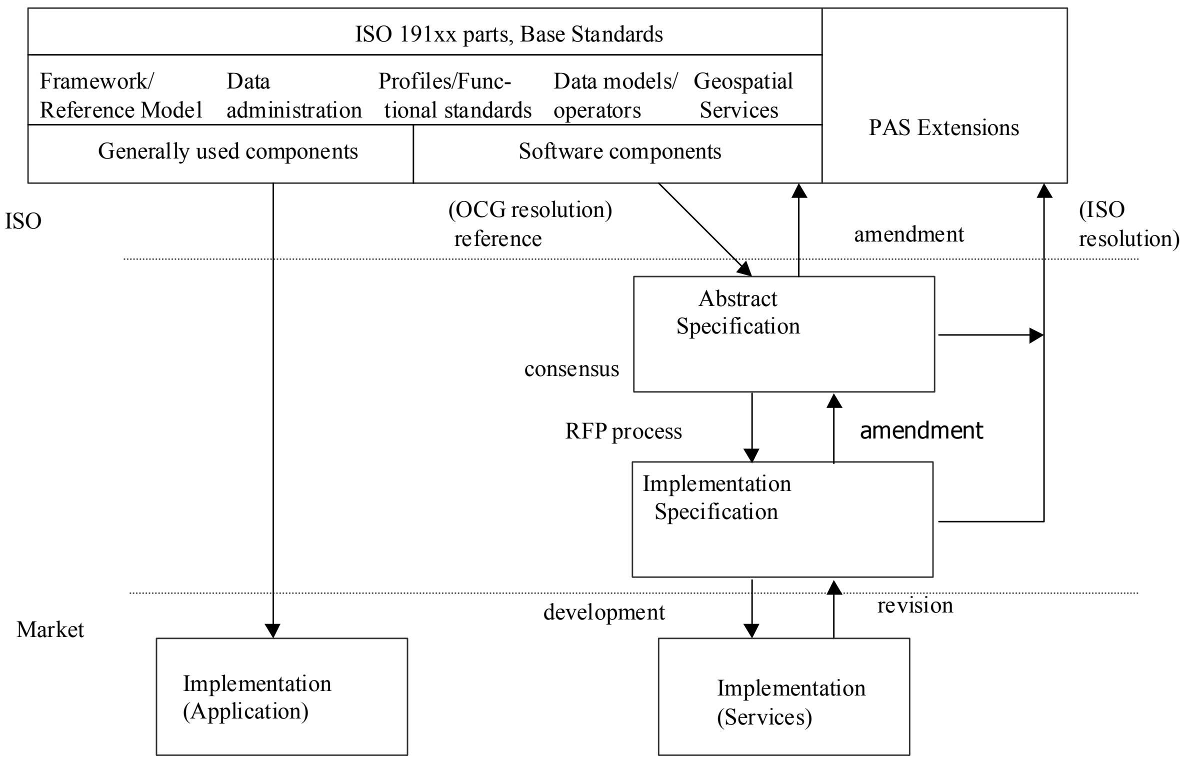


Fig. 3-1. *The relation between OGC and ISO/TC211 (source: OpenGIS Consortium and ISO TC211 secretariat). RFP: Request for Proposals, part of OGC's Specification Program.*

3.2 Administering INSPIRE profiles and guidelines

3.2.0.1 As suggested in the previous subsection, the standards of interest to the INSPIRE initiative are not static but they will evolve as technology changes. Profiles (set of one or more base standards and – where applicable – the identification of chosen clauses, classes, options, and parameters of those base standards that are necessary for accomplishing a particular function) of ISO standards need to be created. Identified standards and profiles require maintenance. Some standards that would fit INSPIRE's needs may not be stable. In addition, it may not always be evident how a specific standard should be applied or implemented in a given context, and guidance will be needed for implementation. Examples are the use of a consistent data modelling approach, encoding guidance, establishment of consistent keyword classification for use in all metadata, etc. These and other issues call for one or more organisations that are responsible, at European Union level, for a range of issues related to the standards.

3.2.1 Technical co-ordination of the ESDI

3.2.1.1 Coordination is one of the most important aspects in the development of any SDI. At European Union level, an organization will be in charge of the coordination of the technical development of INSPIRE. This technical body will have a mandate to:

- Promote the vision of INSPIRE,
- Coordinate the technical development of INSPIRE;

- To create and maintain the “INSPIRE Guidelines and Best Practice for Architecture and Standards”.
- To follow-up, verify, and assist Member States in the implementation of INSPIRE.
- To set-up and maintain the INSPIRE gateway (i.e., central access point on the internet);
- Provide training and set-up an education programme: install and set-up seminars, guidelines, helpdesk, FAQ, interface with universities, provide tools and distribute sample data sets of new layers, etc.
- Create awareness for mission-critical technical issues; e.g., the industry must be made aware of the issues that play a role in coordinate transformation and other services and components of the architecture;
- To validate national and EU projects contributing to INSPIRE.
- Certify conformance to INSPIRE standards, which includes the certification of reference system transformation services;
- Liase with international standardisation initiatives (CEN, ISO, OGC, etc.);

3.2.1.2 Technology is changing, and all the relevant areas of technology are in continuous development. The incorporation of future developments must be viewed from a user perspective. In order to accommodate changes in standards and specifications which are judged useful today, the technical body mentioned above must be prepared to create and maintain the “INSPIRE Guidelines and Best Practice for Architecture and Standards”. This will become the authoritative reference for the implementation of INSPIRE.

3.2.1.3 The guidelines will be created and amended in close collaboration with experts from the Member States, who will meet at regular intervals to discuss identified issues. In subsection 2.2.1 it was mentioned that Member States should be able to implement the architectural components sooner than the recommended timeline states. The guidelines must therefore provide detailed information on all components right from the start, and the first version of the guidelines must be ready at an early stage.

3.2.1.4 Certification will be issued for all components that conform to the INSPIRE specifications. The INSPIRE Guidelines and Best Practice for Architecture and Standards will provide information about he procedure for conformance testing and certification.

Recommended policies:
The implementation of the infrastructure shall follow the specifications and guidelines issued and maintained by the responsible body at EU level; this body will assist the Member States in the implementation of INSPIRE. These guidelines should allow Member States to implement INSPIRE sooner than the time line indicated for the various uses and services.

The INSPIRE profile and guidelines for the implementation shall be based on the ISO 19100 series of standards for geographic information, and where necessary and appropriate, results of other standardisation initiatives can be considered (e.g., Dublin Core, OGC). The guidance material shall also include detailed information about topics related to community-specific topics like data models and data dictionaries.

3.2.2 CEN/ISSS as shepherd of INSPIRE profiles

3.2.2.1 As observed earlier, the suite of INSPIRE base standards will require regular revision, maintenance, and guidance for implementation. Given the European character of INSPIRE, it seems logical to involve in these processes CEN/ISSS, the Information Society Standardisation System of the European Committee for Standardisation (CEN).

3.2.2.2 One instrument that would fit INSPIRE is the so-called CEN Workshop Agreement (CWA). CWAs are consensus-based specifications. They are not formal standards, but can be produced on a rapid basis to meet market needs; they are drawn up on straightforward lines, with minimal bureaucratic rules. CWAs may be the first attempt to prepare a European Standard; they may even contain "competing" solutions, in order to test the market for a technology or interface. They may also contain guidance material of a purely informative nature, such as Guidelines or Codes of Practice, or concern the implementation of existing standards.

3.2.2.3 CWAs are drawn up in an open CEN Workshop environment. The main activity of a CEN WS is the development and publication of the CEN Workshop Agreement. In addition to this main activity, CEN Workshops may be used as a forum to organize other project activities within CEN, such as:

- Exchange of experiences with regard to implementing a specification (implementers' WSs)
- Exchange of views with regard to new technologies and their business opportunities (conferences and seminars), etc.

3.2.2.4 A CEN Workshop is open to all interested parties. For an INSPIRE-CWA, this would mean that data and technology providers, users, and the research community alike can openly participate in the process of advancing the INSPIRE set of profiles and the guidance documents. A group of experts, coming from member states, accession countries, industry, and academia will approve any changes to the CWA. Figure 3-2 illustrates this concept, and shows the relationship with the EU technical body identified in subsection 3.2.1.

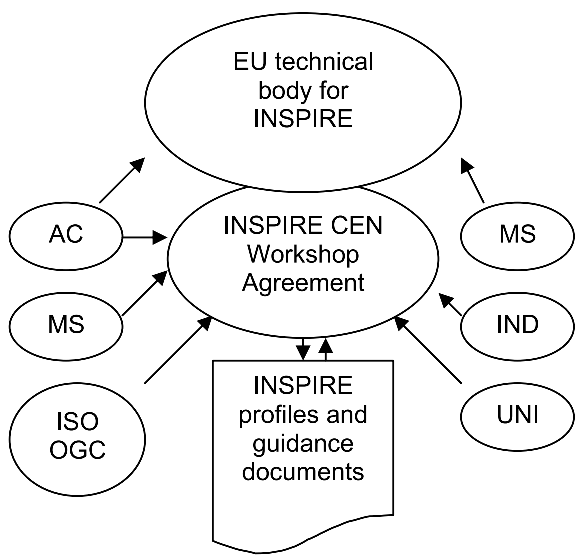


Fig. 3-2. *The proposed INSPIRE CWA (CEN Workshop Agreement) maintains the INSPIRE profiles and is open to all stakeholders. Key to figure: AC – Accession Countries; MS – Member States; ISO OGC – ISO and OGC representatives; IND – industry; UNI – academia.*

Recommended policy:
It is recommended that a European Committee for Standardisation (CEN) Workshop Agreement is established for INSPIRE (INSPIRE-CWA) with the CEN Information Society Standardisation System (ISSS). The remit of the INSPIRE-CWA is to maintain and update the INSPIRE profile and guidelines, and to incorporate evolving user requirements in the specifications.

3.2.3 Teams to support the implementation of INSPIRE at regional and local levels

3.2.3.1 Implementing the components of the architecture is not necessarily an easy task. As a considerable part of the implementation will actually be done at the local and regional levels, multi-disciplinary units are called for, manned with people who are IT, GIS, and interoperability-literate, understand the local culture and the language, and have an understanding of the field of application and the information flows. The role of national GI processing, maintenance and support organisations will be extremely important to facilitate the data processing services before the complete network based infrastructure is available, and to secure the functionality of the wide distributed framework in the future. The national and regional data processing and service centres will create the European network and guarantee harmonised national processing and quality control. In this way, European GI processing needs can be satisfied at an early stage and before the complete 'Europeanised' data sets are available.

3.2.3.2 The mandate of these so-called Implementation Support Teams is to assist, within a well-defined geographic area, local and regional administrations with the implementing of the INSPIRE legislative framework and the daughter legislations. The assistance shall concern the technical aspects of the implantation. Implementation Support Teams shall have direct communication links with their peers if cross-border issues so require. They also constitute an extra communication channel between INSPIRE technical bodies at EU level and local level for signalling problems. For instance, problems with the INSPIRE profile and guidelines will be directly reported back to the EU technical body.

3.2.3.3 The Member States shall assign the task of Implementation Support Team to an appropriate organisation (e.g., local industry, a governmental department).

It is recommended that the Member States foster the creation of implementation support teams which interface with the INSPIRE technical body at EU level. These units assist local and regional authorities in implementing the INSPIRE policies, report to the EU technical body for INSPIRE, and directly interact with other teams may that be necessary.

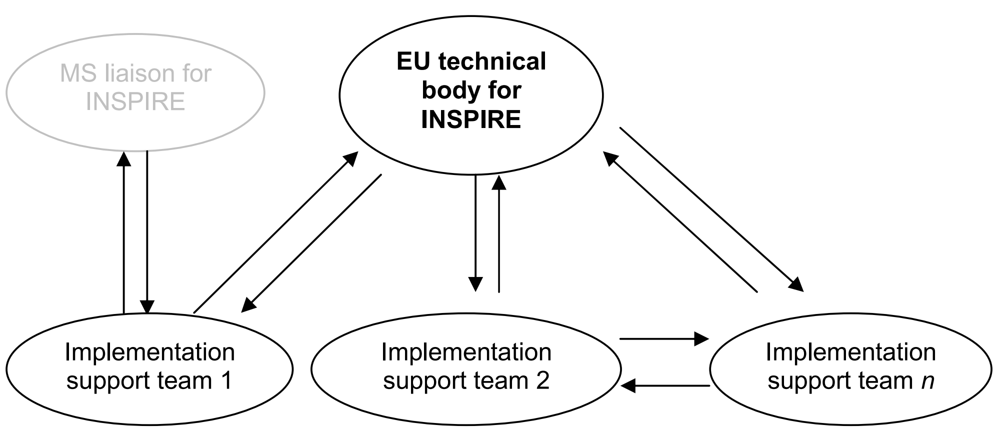


Fig. 3-3. *Implementation teams will be required to assist the local and regional authorities in implementing INSPIRE's technical and organizational recommendations.*

3.3 Base technologies for information infrastructures

3.3.1 The components of the INSPIRE architecture are embedded in the field of information technology services (see fig. 3-4). The ISO and OGC standards and specifications for GI specific components refer to the appropriate standards that are needed for the underlying technology. Examples of standards that relate to the base technologies are W3C specifications (HTML, XML, IP, FTP, etc), generic image formats (e.g., JPEG and TIFF), vector graphics formats (SVG), etc.

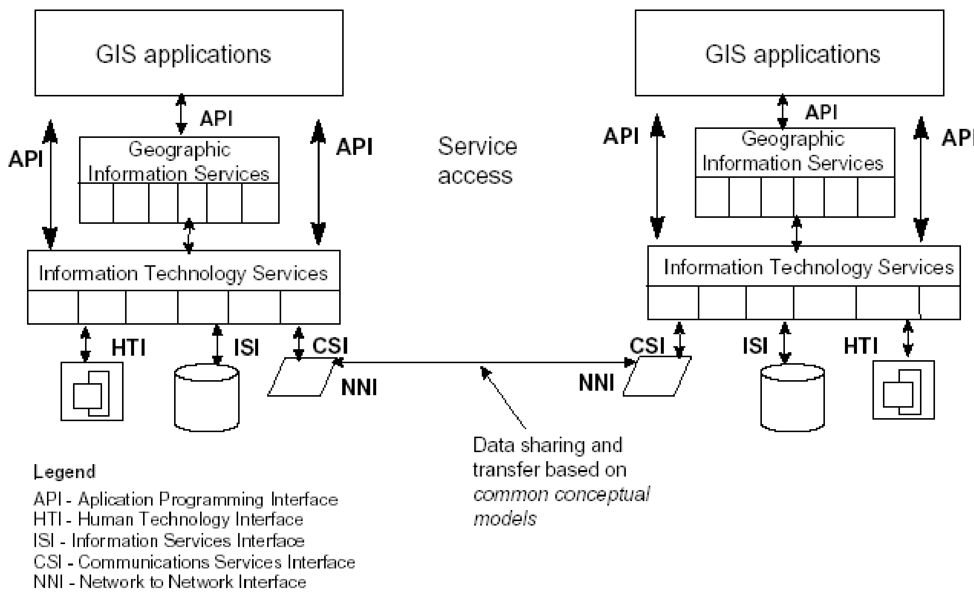


Fig. 3-4. *The Open Systems Environment (OSE) Reference Model worldview of geographic information services in distributed computing environments (from IS 19101; © 2002 ISO).*

Table 3.I provides examples of non-GI standards or specifications that will be important. The INSPIRE Profiles and Guidelines / Guidance documentation will further elaborate on these issues.

Table 3.I. Examples of generic information technology standards and specifications and their relation to the identified uses. Key to table: Man – mandatory. Inf– relevant information to understand better a particular use.

Standard or specification	**Publish & manage**	**Find**	**View**	**Delivery**	**Analyse**	**Multi-lingual**	**e-Business**
XML	Inf					Inf	
HTTP							
TP							
Dublin Core Metadata Initiative (DCMI)	Man	Man				Man	
GeoTIFF			Inf	Man			
SVG			Inf				
PNG			Inf				
JPEG			Inf				
Translation services						Inf	
WPOS							Inf
Services for management and administration, including authentication	Inf		Inf	Inf	Inf		Inf

3.3.2 One specification that needs attention is the Dublin Core Metadata Initiative. Dublin Core promotes the use of metadata for discovery purposes across the information technology domain. It is important that the INSPIRE catalogue services are also able to provide a Dublin Core “view” on provided information and services. This requires an agreed crosswalk between the ISO 19115 metadata elements and the Dublin Core metadata elements.

3.4 Standards for geographic information and geomatics

3.4.1 Overview

3.4.1.1 This subsection concerns the standards that relate specifically to interoperability of geographic information and geospatial services. The AST working group recommends that these standards be not mentioned explicitly in the legislative framework. The aim is to inform the reader about the direction the INSPIRE Profile and Guidelines will take.

3.4.1.1 Table 3.II provides an overview of the standards and specifications currently (16 September 2002) available or being developed, and maps them against the functionality described in subsection 2.2.1. The aim is to pinpoint the standards and specifications existing today that need to be utilized in order to warrant the interoperability needed for discovering and sharing of geographic information and services. Appendix A provides a short description of each of the mentioned standards or specification.

Table 3.II. *List of currently (2002-09-09) available GI standards and specifications and their relation to the identified uses. Key to table: Man – mandatory for the INSPIRE profile. Inf – relevant information to understand better a particular use.*

Project	Publish & manage	Find	View	Delivery	Analyse	Multi-lingual	e-Business
ISO / TC211 Geographic Information - Geomatics							
ISO 19101 - Reference model	Inf	Inf	Inf	Inf	Inf	Inf	Inf
ISO 19102 - Overview							
ISO 19103 - Conceptual schema language							
ISO 19104 – Terminology							
ISO 19105 - Conformance and testing							
ISO 19106 - Profiles							
ISO 19107 - Spatial schema Identical to OGC topic 1, feature geometry.	Inf			Man	Inf		
ISO 19108 - Temporal schema					Inf		
ISO 19109 - Rules for application schema					Inf		
ISO 19110 - Feature cataloguing methodology	Inf						
ISO 19111 - Spatial referencing by co-ordinates	Man	Man	Man	Man	Man		
ISO 19112 - Spatial referencing by geographic identifiers	Inf		Inf	Inf		Inf	
ISO 19113 - Quality principles							
ISO 19114 - Quality evaluation procedures	Inf			Inf	Inf		
ISO 19115 – Metadata Additional material in OGC document 01-111	Man	Man	Man	Man	Man	Man	Man
ISO 19116 - Positioning services					Inf		
ISO 19117 - Portrayal			Man				
ISO 19118 - Encoding					Inf		
ISO 19119 - Services		Inf	Inf	Inf	Inf	Inf	Inf
ISO/TR 19120 - Functional standards							
ISO 19120 Amendment 1 Geographic information - Functional standards - Amendment 1							
ISO/TR 19121 Imagery and gridded data							
ISO/TR 19122 - Qualifications and certification of personnel							
ISO 19123 - Schema for coverage geometry and functions	Inf				Inf		
ISO 19124 - Imagery and gridded data components							
ISO 19125 - Simple feature access – Common architecture	Inf						
ISO 19125 - Simple feature access - SQL option							
ISO 19125 - Simple feature access – COM/OLE option				Inf			
ISO 19126 - Profile - FACC Data Dictionary							
ISO 19127 - Geodetic codes and parameters							
ISO 19128 - Web Map Server Interface	M		M				
ISO 19129 – Imagery, gridded data framework							
ISO 19130 – Sensor and data models for imagery and gridded data							
ISO 19131 - Data product specification							

Project	**Publish & manage**	**Find**	**View**	**Delivery**	**Analyse**	**Multi-lingual**	**e-Business**
ISO 19132 - Location based services possible standards							
ISO 19133 - Location based services tracking and navigation							
ISO 19134 - Multimodal location based services for routing and navigation							
ISO 19135 - Procedures for registration of geographic information items							
ISO 19136 Geographic information - Geography Markup Language (GML)				M			M
ISO 19137 Geographic information - Generally used profiles of the spatial schema and of similar important other schemas							
OpenGIS Abstract Specifications:							
Topic 0 - Overview (version 4)							
Topic 1 - Feature Geometry (version 4) Identical to ISO 19107 - Spatial schema							
Topic 2 - Spatial Reference Systems (version 4)							
Topic 3 - Locational Geometry (version 4)							
Topic 4 - Stored Functions and Interpolation (version 4)							
Topic 5 - The OpenGIS Feature (version 4)							
Topic 6 - The Coverage Type (version 4) Includes ISO 19123 plus additional material							
Topic 7 - Earth Imagery (version 4) Includes ISO 19124, 19129, 19130 plus additional material.							
Topic 8 - Relations Between Features (version 4)							
Topic 9 - Accuracy (version 4)							
Topic 10 - Feature Collections (version 4)							
Topic 11 - Metadata (version 4)							
Topic 12 - The OpenGIS Service Architecture (version 4.1)							
Topic 13 - Catalog Services (version 4)							
Topic 14 - Semantics and Information Communities (version 4)							
Topic 15 - Image Exploitation Services (version 4)							
Topic 16 - Image Coordinate Transformation Services					Inf		
OpenGIS Implementation specifications							
OpenGIS Catalog Service Interface Specification (Approved)		M	M		M		
OpenGIS Coordinate Transformation Services Specification (Approved)					Inf		
OpenGIS Geography Markup Language (GML 2.0) (Approved) GML 3.0 is a planned implementation specification				M			M
OpenGIS Grid Coverages (Grid, Image, DEM) Specification (Approved)							
OpenGIS Simple Features Specification (Approved)							
OpenGIS Web Map Server Interface (WMS 1.1.0) Specification (Approved)			Man		Man		
OpenGIS Web Feature Server Specification (WFS) (Approved)				Inf			
OpenGIS Basic Services Model (BSM) Specification (Candidate)							
OpenGIS Gazetteer Service Interface Specification (GAZ) (Candidate)			Inf			Inf	
OpenGIS Geocoder Service Specification (Geocoder, or GeoC) (Candidate)							
OpenGIS GeoParser Service Specification (Geoparser, or GeoP) (Candidate)							
OpenGIS Location Organizer Folder Specification (LOF) (Candidate)							
OpenGIS Image Coordinate Transformation Specification (ICT) (Candidate)				Inf			
OpenGIS Stateless Catalog Specification (Cat S) (Candidate)							
OpenGIS Styled Layer Descriptor Specification (SLD) (Candidate)							
OpenGIS Web Coverage Server (WCS) Specification (Candidate)					Inf		
OpenGIS Web Registry Service Specification (Candidate)	Inf	Inf		Inf	Inf		
OpenGIS XML Imagery Mark Up Language Specification (XIMA) (Candidate)			Inf				
EPGS database & CRS IDs							

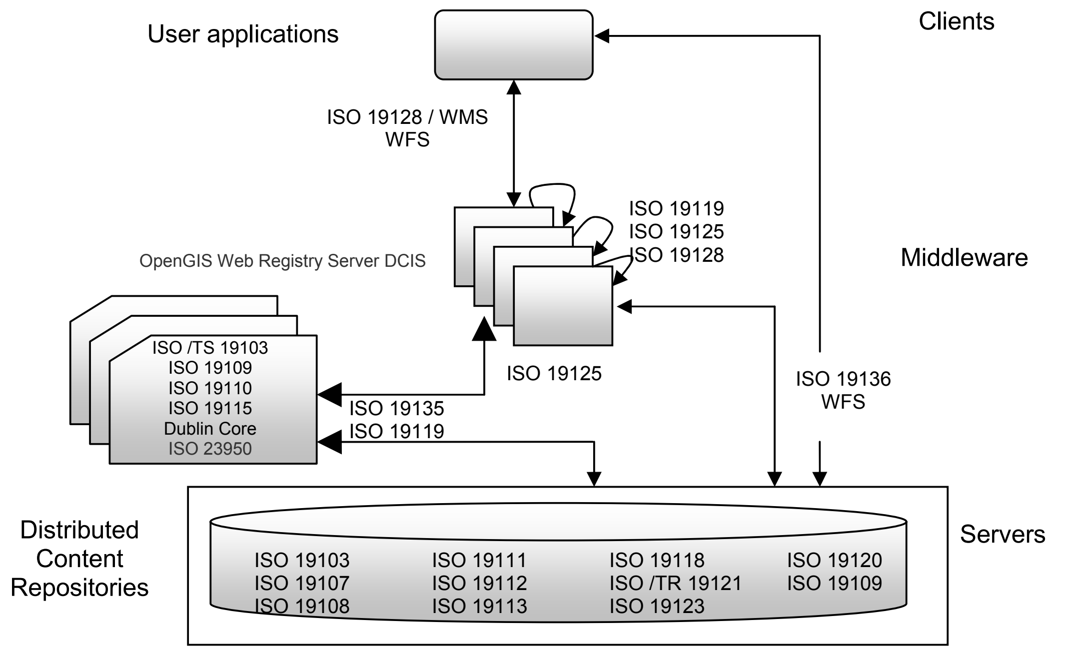


Figure 3-5*. The architecture reference model of Fig. 2-1 with some of the standards of Table 3.II assigned to the components.*

3.4.2 European Coordinate Reference Systems

3.4.2.1 The Spatial Reference Workshop, 29-30 November 1999 in Marne-La-Vallée and the Cartographic Projection Workshop, 15-16 December 2000 in Marne-La-Vallée prepared the ground for the definition of a common European Coordinate Reference System and its use for geo-referencing the data of the European Commission (EC) and for future specifications of the products to be delivered to the EC, within projects, contracts etc, and the promotion of wider use of the system within all member states by appropriate means [3].

3.4.2.2 An on-line information system has been set-up for European Coordinate Reference Systems (http://crs.ifag.de/). This information system is a common initiative of EuroGeographics, the IAG Subcommission for European Networks (EUREF) and as acting institution the Bundesamt für Kartographie und Geodäsie.

The Information System contains:

- the descriptions of national Coordinate Reference Systems of European countries and the descriptions of Transformations to European Terrestrial Reference System ETRS89
- the descriptions of European Coordinate Reference Systems

3.4.2.3 *Coordinate reference system (CRS) at regional level*

From the European point of view Coordinate Reference Systems (using ETRS89 and additional projections) will be used both in GIS and in geodesy. Both applications correspond to different accuracy classes (one or more meters in GIS; several decimetres or less in geodesy).

At regional level also GIS information moves to smaller accuracy (like cadastre) with (adequate) regional geodetic reference systems becoming more important.

All these regional CRS will be characterized by
- a (national) unique name or identifier including aliases and
- authoritative transformation parameters between these CRS and ETRS89.

3.4.2.4 An authoritative national transformation service will deal with regional GIS for nation-wide purposes. Each Member State will have a national body responsible for providing the formulae and parameters for the transformation services. This organisation will certify commercial products for coordinate transformation (on-line and off-line) that comply with stated accuracy limits.

The following statements will be included in the INSPIRE Guidance documentation:
Use ETRS89 as geodetic datum and to express and store, where allowed by accuracy limits, positions in ellipsoidal co-ordinates, with the underlying GRS80 ellipsoid [ETRS89]. To further use EVRF2000 for expressing practical heights (gravity-related). [17]

Use ETRS89 Lambert Azimuthal Equal Area coordinate reference system of 2001 [ETRS -LAEA], for pan-European statistical analysis and display.

Use ETRS89 Lambert Conic Conformal coordinate reference system of 2001 [ETRS –LCC] for conformal pan-European mapping at scales smaller or equal to 1:500,000.

Use ETRS89 Transverse Mercator coordinate reference systems [ETRS-TMzn], for conformal pan-European mapping at scales larger than 1:500,000.

Each country shall have authoritative coordinate transformation services;

Certification shall be required for the coordinate transformation services.

3.4.3 Data documentation and data content

3.4.3.1 For data documentation, the following standards shall be used to be compliant with INSPIRE specifications:

- ISO/TS 19103 Conceptual schema language
- ISO 19109 Rules for application schema
- ISO 19110 Feature cataloguing methodology
- ISO 19115 Metadata
- Dublin core metadata standard for information discovery

Unique identifiers must be agreed upon for reference data.

Watermarking technologies should be considered as a measure to enforce data policies and legal issues.

For the transfer of geographic information, GML shall be used for feature data, and GeoTiff, HDF-EOS, BIIF ISO 12087-5, or CEOS for coverage data.

For specific thematic applications (e.g., specific environmental applications), data models will be devised that shall be used for communication purposes.

In order to realize the long term vision of INSPIRE, more research and development is required to reach acceptable standards for the seamless integration of spatial objects from multiple SDIs. Also object inheritance needs to be addressed.

The following statements should be included in the INSPIRE Guidance document:

For data documentation, the following standards shall be used:
- ISO/TS 19103 Conceptual schema language
- ISO 19109 Rules for application schema
- ISO 19110 Feature cataloguing methodology
- ISO 19115 Metadata
- Dublin core metadata standard for information discovery

For the transfer of geographic information, GML shall be used for feature data, and GeoTiff, HDF-EOS, BIIF ISO 12087-5, or CEOS for coverage data.

For the transfer of geographic information, GML shall be used.

3.4.4 Services

3.4.4.1 Unlike complex and tightly bundled software packages, Web Service systems encourage significant decoupling and dynamic binding of components: When all components in a system are services, they encapsulate behaviour and publish a messaging API to other collaborating components on the network. Services are organized by applications that use a service discovery to dynamically bind these services so they can collaborate. Thus, Web Services reflect a new service-oriented architectural approach, based on the notion of building applications by discovering and orchestrating network-available services – essentially just-in-time integration of applications.

3.4.4.2 The INSPIRE Guidance document will have to address a number of specific services, including:
- Client Services (e.g., Viewers & Editors)
- Catalog & Registry Services
- Data Services (e.g. Web Feature Server)
- Application Services (e.g. Geocoder Service)

3.4.4.3 Catalogue services and viewing services are considered key components and should be in place at an early stage. The INSPIRE Guidance document shall describe these services based on:
- ISO 19119 Service architecture
- ISO 19128 Web Mapping Service (OGC WMS 1.1.1)
- OGC WFS
- OGC Catalogue services [6],[7]

Also, guidelines for change notifications services will have to be created.

4. Implementation

4.1 Project-wise approach

4.1.1 Before considering the implementation of the architecture it is useful to step back for a moment and look at the broader picture. The graphic of Fig. 4-1 shows the typical breakdown of a project in project phases: initiative, definition, design, preparation, realisation, introduction (usual in Information and Communication Technologies [ICT]), and its use and maintenance. The objective of each phase is to ensure a smooth execution of the successive phase, with as an ultimate goal the use and maintenance of the result of the project. With the finalization of the Position Papers, the INSPIRE initiative is preparing the ground for the Definition Phase. The INSPIRE initiative itself can be subdivided into a number of sub-projects, which correspond more or less to the mandate of the working groups.

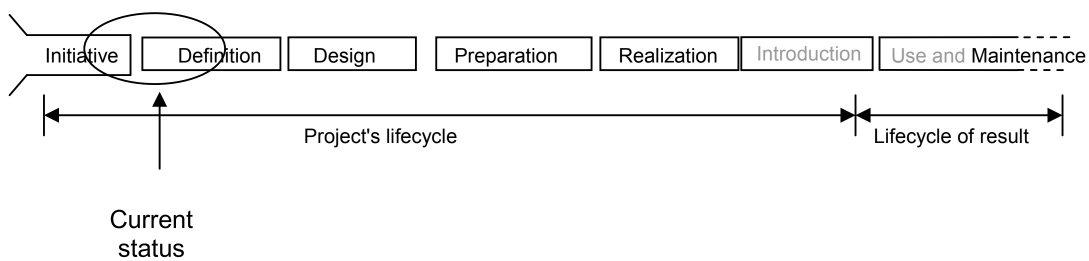


Fig. 4-1 *The project's lifecycle vs. the lifecycle of the result (after [10] and [12]).*

4.1.2 The aim of the Definition Phase is to formulate as clear and unambiguous as possible the result of the project. The target groups are policy makers and financers. At the end of this phase it will be known what the result of the project will look like. In addition, the activities in the design phase are being defined.

4.1.3 The main goal of the design phase is to find solutions for the problems which the project is to solve. After the design phase is must be clear what the project result will look like, both in terms of contents and form. Also, it must be shown that the chosen design responds in the best way to the identified problems. In ICT communities, design is split into coarse design and detailed design. The end-user needs to be involved in the coarse design; the detailed design is primarily intended for communication between programmers and their leaders.

4.1.4 The aim of the preparation phase is to do everything needed to smoothly execute the realization phase. In the realisation phase the result of the project is being implemented and produced. This phase integrates all the work of the previous phases. In ICT this is followed by an additional step of the introduction of the product in the end-user's environment. The whole project is to create the right conditions for a good maintenance phase. After all, all the project activities took place to make sure that the project result can and will be used and maintained. The lifetime of the outcome of the project is directly determined by the investment put into the maintenance phase.

4.1.5 The use of existing standards and specifications greatly speeds up the definition and coarse design phases. However, the realisation and introduction phases should not be underestimated and require a considerable effort in which industry plays the major role.

4.2 Architecture follows organization

4.2.1 It is emphasised that INSPIRE will fully realise its potential only when the information system envisaged here is embedded in the daily processes of the users. The flow of geographic information must be understood, and for each type of geospatial data and for the geographic jurisdiction custodians must be identified. The custodians must then ensure that they have the institutional capacity to handle the issues associated with their tasks. As the designated authority for specific data, they will also have an important role in the definition of unique identifiers, and will have to liaise with multiple provides if the situation so requires.

4.2.2 Administrative interoperability should precede geospatial interoperability. This means that in the long run it should be made clear beyond any doubt who is the custodian for what data set, up to the feature level. "Projects that ignore improving processes cost more and become unattractive".[24]

4.3 Phased implementation

4.3.1 The components of each member state, as described in Figure 2.1, will be brought together in a pan European model (Fig. 2.2). At the time of writing this Position Paper there are as many models as there are countries and it will take some time to develop a consistent approach. There is a significant difference in terms of work involved and methodologies needed, between countries that already have a NSDI in place and the ones that did not initiate that process. While reference data can often be held centrally (though is not always the case), thematic data is normally stored and held where it is collected. In both cases the maintenance of these datasets will vary across organisations.

4.3.2 The task of simply bringing together such data (i.e., reference data and thematic data) is a significant one in itself. The task of conflating these datasets into a robust model which is sufficiently reliable for policy making, decision making, planning, emergencies, etc. is significant. This applies both to the architecture of a) the data and b) the serving systems. It will therefore be necessary to adopt a phased approach to harmonisation over the short, medium and longer term.

4.3.3 Long term harmonization requires also data models to be compatible with EU data models. As each nation establishes the minimum specified components it will be incorporated Into a European-wide network of information.

4.3.4 The implementation model breaks down the architecture model into smaller components and defines the scope of the technology decisions, deployment platforms, building and reusing components, and performance and networking decisions. The detailed specification of the implementation model is entirely the responsibility of the INSPIRE development team. It should be ensured that implementations will and should interact with each other according to the related sub models.

4.3.5 The initial focus will be on a catalogue server for the discovery of reference data and environmental thematic geographic information. However, most countries do not have a homogenous access system yet, and often semantic problems often exist even at national levels. These issues need to be addressed as part of the INSPIRE implementation.

4.3.6 There are other considerations which need to be taken into account relating to the IT infrastructure underlying INSPIRE. How well is the Internet diffused in the participating countries? What is the level of computer literacy of the local authorities? What is the network speed available, what network speed is needed for the different uses of the infrastructure? And what performance level is needed for the users of INSPIRE? The answers to these questions are important as the success of a fully operational SDI depends on state-of-the-art computer power and high capacity networks (c.f. Fig. 4-2). It should also be noted that increasing bandwidth on the Internet backbones alone says nothing about what individual users see. There are capacity issues that have to do with the topology of the network, and the last-mile connections in rural or under-served metropolitan areas.

[24] Bruce Cahan, Keynote speech at EC-GIS workshop [Online] http://www.ec-gis.org/Workshops/8ec-gis/.

***Table 4.I** Summary of current architecture status against phased objectives.*

	SHORT (2003)	MEDIUM (2005)	LONG (2010)
Objectives	Demonstrate benefits of standard approach. Support evolution towards SDIs: electronically delivered. Thematic data to be based on common reference data, maintained to meet needs.	Focus of needs for European wide information services based on customer driven priorities (e.g., environment, agriculture..)	Built on the established strength of the emerging infrastructure and reinforce by exploiting a wider variety of commercial developments.
SDI status	Loose associations exist but are rarely recognised SDIs at this time	SDIs emerging as the above elements form components of a consistent framework.	SDIs established and collectively form a European SDI
Reference Data Status	Responsibility often assigned to several organisations in a country (e.g.,NMA, military, cadastre, municipalities etc)	Greater consistency	Key layers of reference data integrated, all essential layers under maintenance.
Thematic Data Status	Thematic data is normally held by the organisation responsible, it may/may not use the reference data and may, may not be maintained.	Thematic data required for European needs made accessible, consistent and referenced to common base.	Wider variety of thematic data now documented and made available with some form of maintenance regime.
e-business Status	Current e-delivery models are limited and variable for reference data and rarely exist for thematic data providers.	Objective: to establish portal for each member state for reference data and priority thematic data (environmental +).	In addition to EC needs the national and pan European datasets form the backbone of e-commerce information services exploited by the private sector.

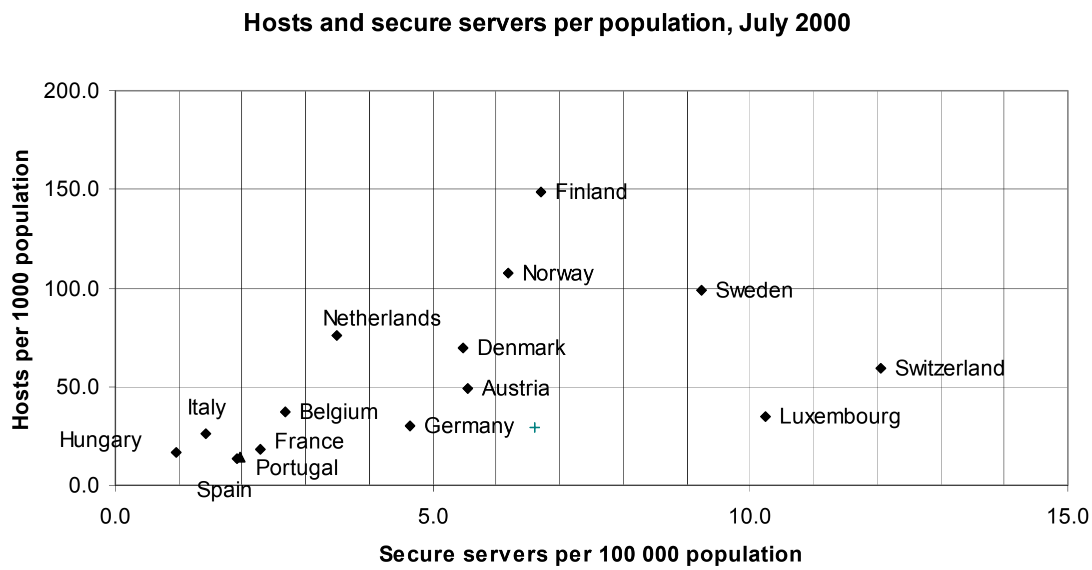


***Fig. 4-2.** Hosts and secure servers per population, July 2000 (Source: OECD, 2001 [9]).*

4.3.7 Also security is a concern. Many of the pressures right now in the security world are concentrated on proper authentication for the purposes of e-commerce. The certificate system for identifying sites is largely predicated on the assumption that the user wants to be sure they are communicating with a given company before sensitive information is provided (e.g., a credit card number). The business' need to authenticate who the user is, is typically much less than the user's need as long as they are presented with a valid credit card number. This is not true if the user accesses an information resource with highly sensitive information. Suddenly authentication of that individual becomes extremely important, and that places extra burdens on the whole security infrastructure [13, p. 109].

4.4 Community-based strategies

4.4.1 Numerous information communities will be affected by the INSPIRE initiative. The common denominator that creates a community may vary widely; it can be geography and culture (e.g., local and regional authorities), or a thematic policy area (e.g., forest, agriculture), or an industrial sector (e.g., information technology providers).

4.4.2 It is these communities that will be playing a major role in INSPIRE. They will populate content repositories with data and documents, and they will benefit from the information and services the architecture is giving access to.

4.4.3 The success of INPSIRE depends largely on how these communities interpret and address the policies INSPIRE is proposing. These communities must be involved at an early stage in the implementation of INSPIRE. The Implementation Support Teams mentioned in chapter 3 will have to have a close relationship with the various communities and play a crucial role in the deployment of INSPIRE at the local and regional levels.

4.4.4 But much can already be done by directing new projects in the direction of INSPIRE. Multi-lingual guidelines for the procurement of GI products and services for local and regional administrations that are in line with at least some of the common principles of INSPIRE would create direct benefit the evolving approach of INSPIRE.

Recommendation
INSPIRE Procurement Guidelines shall be developed, possibly as an integral part of e-government initiatives, assisting public administrations in making choices when dealing with issues that touch information technology and geographic information.

4.5 Monitoring the implementation of the architecture

Milestone	Description	Date	Responsible
1.	INSPIRE CEN Workshop Agreement	2003-03-31	EU Technical body
2.	European metadata profile of ISO 19115	2003-06-30	INSPIRE-CWA
3.	EU Geo-portal prototype	2004-03-01	EU Technical body
4.	INSPIRE Guidelines, draft	2004-06-30	INSPIRE-CWA
5.	Catalogue services operational	LF+1Y	Member States
6.	Gazetteer service	LF+1Y	Member States
7.	EU Geo-portal operational	LF+1Y	EU Technical body
8.	EU data models added to INSPIRE guidance documents	LF+1Y	INSPIRE-CWA
9.	Viewing service (Web map service) operational	LF+2Y	Member States
10.	Coordinate transformation service	LF+2Y	Member States
11.	Multi-language support to search facilities	LF+3Y	Member States
12.	Delivery service (includes Web Feature Server and web coverage server)	LF+3Y	Member States
13.	Authentication service	LF+3Y	Member States
14.	Analysis / Geospatial data fusion service	LF+3Y	Member States
15.	Web pricing and ordering service	LF+3Y	Member States

4.6 Migration of existing data and systems

4.6.1 The lion's share of the investments for an SDI concerns the geographic information and the metadata – which are crucial to INSPIRE. Using standards is a way to secure these investments as the maintenance and re-usability of geographic information becomes easier, even when computing platforms and application software change. This holds good for a private sector organisation and a governmental administration alike.

4.6.2 The complexity of the migration of legacy data and systems to make them compliant with the identified standards depends much on the local situation. However, it is in general possible to migrate without major efforts. Connectors can be built upon existing software to become "INSPIRE" compliant. Similar statements hold good also for the data, although here more work may be involved, for instance in the case of existing map series that can be digitised.

4.6.3 For a number of cases migration plans will have to be developed. Industry will play a major role in the implementation of INSPIRE, and therefore also in the migration plans.

4.6.4 Data and metadata investments remain if standards and specifications are evolving. This would be the case if, for instance it is recommended today that OpenGIS Catalog Service 1.0.0 is to be used, while in 5 years from now we may have other mature technology.

4.6.5 In addition, there is a significant difference in terms of work involved and methodologies needed between countries that already have a NSDI in place and the ones that have not initiated that process. For example, in terms of INSPIRE Architecture, centralised and decentralised data catalogues should be considered to be able to accommodate different member states situations. Decentralised data catalogues can be a better option but, at the present stage, both options should be considered, as long as it is possible to integrate them.

4.7 Further research and development

4.7.1 Semantic interoperability

4.7.1.1 The use of existing large data collections for many applications, which were not initially thought of, is a crucial step in promoting economic and social development in the information age. Space related information systems are in a unique position in that the meaning of their terminology can be connected to physical objects and operations on them (so called 'semantic grounding') and therefore becomes independent of national natural languages. This is the stepping-stone to build metadata, which does not only supports discovery, but can be accessed by applications and visualization tools ('intelligent' data).
Related to this topic are data dictionaries, thesauri, and multilingual aspects.
Research on the semantics of spatial data is closely connected to user community (e.g., environment, transport, agriculture, …). The pan-European dimension in addressing the issue is of utmost importance.

4.7.1.2 Very important and related to the aforementioned topics is the issue of data re-engineering. There are limits to what can be done with existing data. These need to be researched, together with re-engineering issues and techniques. Semantics are key to both. In practice, much of the data currently held will need to be re-engineered in order to achieve the desired levels of Interoperability (e.g., the Ordnance Survey Digital National Framework experience and the upcoming data migration in the German Laender).

4.7.1.3 Also the extraction of geographic information from image data should be addressed.

4.7.2 Unique identifiers

4.7.2.1 Combined with web services, the unique identifier provides a very powerful tool to dynamically link any information. By adopting unique identifiers across geographic information, that data is then able to integrate a variety of information.

4.7.2.2 Unique geographic identifiers form the primary reference for each item of geographic information. To the identifier attribution can be assigned (classification, version, co-ordinates, dimensions, time etc). The role of the identifier is to:

- Reference each geographic information item discretely for data access, management and supply purposes
- Provide a mechanism for cross referencing to support reference data interoperability (e.g., road centre line network with road surface area features, addresses with buildings etc)
- Support aggregation of detailed objects to form larger features (e.g., fields and other features to form farms, developed land parcels to form urban areas, etc.).
- Support consistent lower resolution datasets automatically derived.
- Provide a mechanism to link thematic data to reference data and support interoperability and update of thematic data (e.g., cadastral parcels with topographic features, crop types with field parcel etc)

4.7.2.3 Reference data Identifiers should have no inbuilt intelligence or logic. This will ensure that they are free of fundamental design changes over time. The most common form is a range of integers such as the 16 digit TOID e.g., <1101 2303 3030 3899> being adopted and used in Britain and Ireland. In Germany URNs are being used with 16 characters with the following structure: 1-2 DE = Germany 3-4 state within Germany, e.g. NW for Northrhine-Westfalia, or BU for federal agencies; positions 5-8 identify the data-server; positions 9-16 identify the feature within the data-server.

4.7.2.4 **Thematic data identifiers** would ideally follow the same principle. However many thematic datasets have been in existence for several decades and are unlikely to change now e.g.,cadastral parcel numbers, etc.

4.7.2.5 Such cases need to be supported and included in any cross referencing. There must be some sort of structure in the identifiers that gives the possibility to find the object/feature in a net of servers. What will be needed is a so called "lookup-service", which takes as an input the identifier and gives a URL of the WFS-server back, where the feature can be found. For example:

```
<cadastral title number "HPAWQ-12345">
is cross referenced with topographic features:
<land parcel reference number ~ TOID  "1223330944044894">
<land parcel reference number ~ TOID  "3939303999403983">
<building reference number ~ TOID  "4778302020002333">
```

An example of a German identifier, expressed in GLM, is the following:

```
<parcel gml:id="DENWK123aaaaaaaa">
        <!-- ... -->
        <hasOwner xlink:href="urn:adv:DENWK124bbbbbbbb">
        <!-- ... -->
</parcel>
```

Identifiers have been used extensively and successfully in business and commercial systems for many years for example in banking, credit card transactions and this experience and knowledge should be extended where possible in linking in geographic information.

There are also areas that are unique to geography and some areas that require further research. This includes:

For the immediate term:

- Integrating non harmonious pan European datasets with a consistent form of identifier.

For the medium-longer term

- Multi-scale databases and automated updating;
- Exploration of Identifiers as URLs or URNs;
- Temporal Links – maintaining links with superseded versions of features and collections of features.

4.7.3 Change-only updates and versioning

4.7.3.1 Actuality and completeness are properties of Geo-datasets that are of great importance to most of the users. Keeping datasets up-to-date is a never ending process and is therefore worthwhile organising this as efficient as possible. In the process of updating of datasets it is still the habit to collect the changes in the real world for each registration separate. So for different scales of datasets this work is done several times in a certain area. It is needless to say that this approach results in a considerable amount of duplication.

4.7.3.2 By collecting topographical mutations in the real world just once and applying them to the datasets on different scales the work is done much more efficiently. Having datasets available describing the previous and the current content makes it possible to update datasets easier.
In an object-oriented datastructure it is possible that just once the mutation is applied at the object(s) the presentation at the different scales is always of the same actuality. This so called process of mutation propagation has been studied in the Netherlands and in Germany, but needs further investigation. Especially the presentation out of one set of geometric-data is still problematic.
Also attribute-information or features linked to objects can be updated in this way. Changes in the object-information signal in most cases changes in attribute data or thematic data.

4.7.3.3 It is therefore necessary that the architecture of INSPIRE has to able to cope also with datasets that only contain information about mutations.

4.7.3.4 Related to this topic is the issue of the version of datasets. Up to now geodesists only try to keep the datasets of reference data they maintain as actual as possible. In most case there is no storage of history or versions for a particular moment. As there will be a differentiation between reference data and thematic data problems will appear in combining reference data with thematic data.

Beside the obligation of describing the version or actuality-date of a dataset for analysis and combining of datasets it will be necessary to have more versions of the same datasets available.
A solution to this problem could be the storage of the initial dataset together with the was/is information at different epochs. In this way it is possible to access datasets of different moments and combining them with thematic datasets of the same age.
A way of standardisation for this problem or service from the different data-servers is needed and needs considerable research effort.

4.7.4 Generalisation of data models

4.7.4.1 The question is not whether geographic information should be made available at multiple levels of abstraction, but *how* it should be made available. Automatic generalization is one way of doing this. Some of the real-life results reported in the literature show that after an automatic or batch process of a generalization routine, time consuming manual editing is often needed to meet the user's requirements. The issue of generalization is strongly related to activities currently going on within international standardisation initiatives. In the technical specifications of the OpenGIS Consortium, for instance, an explicit distinction is made between the data and the *behaviour* of the data. In this light generalization should be seen as a complex behaviour of the data, where the data has self-awareness and awareness of the application context. The technical solutions to questions of how data should behave and "display themselves" overlap those related to generalization. The recommendations are:

- Launch studies to investigate the usefulness of automatic map generation for specific applications. Application-oriented research is needed to test the available approaches.
- Consider automatic data model generalization in the development of a medium/long term vision for future services and products. This will become important if the concept of INSPIRE moves towards direct access of on-line local databases.

4.7.4.2 Related to research on generalisation is the issue of error propagation in generalisation. Multi-scale and multi-application uses means that uncertainty information will also be crucial. This uncertainty information will also need to be scale dependent and dynamic.

Recommended topics for further research:
Further research and development is needed for the following areas
- Incremental (change-only) updating (which includes versioning of geographic information)
- Semantic interoperability, including data dictionaries and multi-lingual aspects
- Generalization of data models
- Unique identifiers

5. Impact Analysis

5.1 Effects of a Spatial Data Infrastructure

5.1.1 In projects on geo-information applications 60-80% of the time is spend on collecting and gathering together the data. With a well-developed SDI this time can be reduced considerable. This will cause:

- Strong improvement of the labour-productivity;
- Integration and exchange of geo-information is much easier;
- Accessibility improves;
- New possibilities for product-development and product-innovation

The effects can be divided in direct effects and indirect effects.

5.1.2 **Direct effects:**

- efficiency improvements for citizens, companies and governments;
- reducing the costs of buying data;
- less spending on data-management;
- less spending on due to re-use of data;
- potential of outturn in exposing the data.
- having a common and standardised set of indicators about the state of the environment, thus being able to document the success of a policy towards sustainable development and further on becoming enabled to compare sustainable development at a European level.

5.1.3 **Indirect effects:**

- reducing the burden of taxation for citizens, companies and governments;
- making better decisions at governments and companies;
- developing new applications (product-innovation and market-development)

5.1.4 **Benefits for the users**

1. Due to standardisation
2. Due to easier access
3. Due to known value of the data
4. Due to lower pricing of the data (multi-use)
5. Due to better quality of the data

5.1.5 **Benefits for the offering organisation**

1. Due to more use of the offered data
2. Due to just once collection of data (less costs of collecting)
3. Due to a more efficient use of personnel
4. Due to the use of standards
5. Due to easier exposure of available data

5.1.6 The open architecture makes it possible that with fewer changes to national initiatives a complete European SDI can be easily put together.
Even search engines can be put through the different nodes.

5.1.7 For countries which have no SDI or parts of an SDI yet available, it gives the advantage of knowing which standard has to be chosen to fit in the European SDI.
Also, the knowledge is available of which architecture and components are the best for searching, accessing and using geo-information.

5.1.8 For the industry it has the advantage of developing products that fit the European standard on Geo-information and makes them available for a wide market (pan-Europe).

5.2 Effects of standards

5.2.1 The International Standardisation Organisation (ISO) defines standards as *documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes and services are fit for their purpose*. Standards contribute to making life simpler, and to increasing the reliability and effectiveness of the goods and services we use.

5.2.2 The existence of non-harmonised standards for similar technologies in different countries or regions can contribute to so-called "technical barriers to trade". Export-minded industries have long sensed the need to agree on world standards to help rationalize the international trading process. This was the origin of the establishment of ISO. ISO standards are developed according to the following principles:

- Consensus **-** The views of all interests are taken into account: manufacturers, vendors and users, consumer groups, testing laboratories, governments, engineering professions and research organizations.
- Industry-wide **-** Global solutions to satisfy industries and customers worldwide.
- Voluntary **-** International standardisation is market-driven and therefore based on voluntary involvement of all interests in the market-place.

5.2.3 The fact that ISO's member states vote on any draft standard before it is accepted as an International Standard makes ISO a world-wide recognized authority.

5.2.4 In the 1990s, many organisations world-wide started standardisation processes that concern geospatial information. Examples of these initiatives are TC 287 of the European Committee for Standardisation (CEN), the Federal Geographical Data Committee (FGDC), the OpenGIS Consortium (OGC) Inc., and TC 211 of ISO. All these initiatives build on the expertise of many organisations.

5.2.5 Why are organisations putting so much effort in standardising geographic information and geomatics? Firstly, there are strong economical driving forces, initiated by three major markets that require GI standards [5]: The traditional GIS market, business support systems, and personal productivity. Secondly, the visibility of GI in government practices is increasing as national and international authorities are working on legislative frameworks that require that GI be made available. This should facilitate the transparency of governmental political decisions, directives, and measures. Spatial Data Infrastructures (SDIs) are being put in place to help achieving this.

5.2.6 Furthermore, being coherent with the very successful strategy of the W3C is attractive for administrations at the different levels because of the following advantages:

- less error prone than closed shop software because of easy peer review and fast bug fixes
- easy to adopt by commercial software producers too because no hidden functionality has to be re-engineered
- low migration costs when platform independent
- low total cost of ownership because of cheapest possible price

5.3 Cost estimates

5.3.0.1 Figure 5-1 shows a relative resource allocation to the different project phases as frequently occur in the development of large information systems. Approximately 50% of the resources is dedicated to the realization phase; the remainder is spread among the other phases. For the implementation of the various architecture components of INSPIRE at national and regional levels, a similar distribution may be expected.

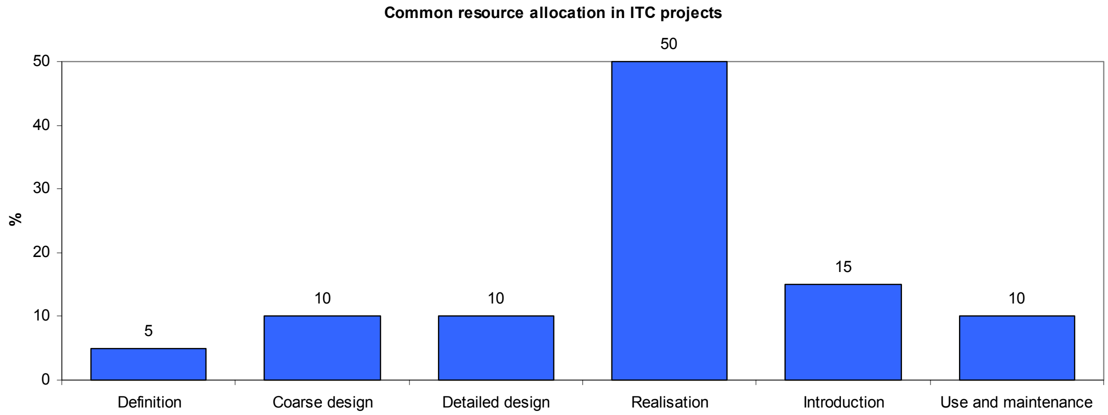


Fig. 5-1. *Relative resource allocation to phases of project for information systems development (after [12]).*

5.3.0.2 Using the distribution of Fig. 5-1, and given the experience with the implementation of SDI components in the US and EU, and the proposed deadlines for the implementation of the components in subsection 2.2.1, it is possible to give a rough estimate of the investments that would be needed in Member States over the next three years (Fig. 5-2), if they start from scratch. Note that the investments only relate to the principal uses identified in 2.2.1.

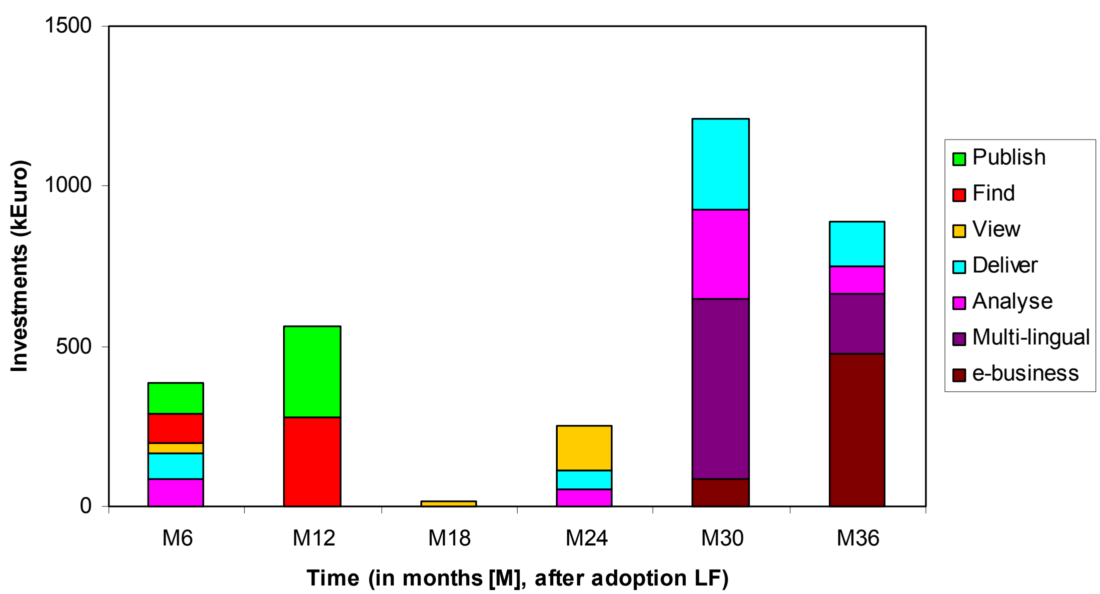


Fig. 5-2. *Rough estimate of required resources in the next three years for the realization of the uses in a small Member State for region. The investments relate to the components of the architecture and not to the collection or harmonization of geographic information. See text for details.*

5.3.1 Metadata service

5.3.1.1 A technical implementation of a metadata service could be implemented within a budget of 150 kEUR (hardware, software, technical personnel, etc.) Introducing this to relevant organizations (as a national or regional service) could easily double this amount, i.e. a total of 300 kEUR. In addition comes the physical establishment of metadata, i.e. the uploading of metadata records, which depends on how well the metadata content is prepared. If the metadata content is already established in an organization, conversion and loading are simple tasks. If one has to establish metadata content from scratch, one may end up with much larger costs.

5.3.1.2 Experiences with clearinghouse and other applications showed that 1.5-1.9 MEuro/year were needed. This included management costs, GIS and internet application development, training, hardware, network server, and the pilot project.[25]

5.3.2 Delivery services

5.3.2.1 Some of the same considerations as above apply. It is important here that we have a distributed environment of services. This means that the figures must be multiplied by the number of participants. As a rule of thumb, implementation of a WMS-service should be possible within 150 kEUR technically. Introduction to the organization could add 50 - 100 kEUR. If in addition aspects of e-commerce are taken into account (e.g. if we are talking about an organization that normally charges for data), then the amount will grow.

5.3.2.2 Although we have less experience with other types of services, (WFS, WCS, etc.), it is likely that some of the same figures could be used. It must be expected that, as support for the standardised services grows with the vendors, some costs will be smaller in the future.

[25] Case Study #1: Southern California Association of Governments - Access Project, U.S. DOT, September 1998.

6. Risks and obstacles

Risk	Description	Proposed solution
1. Weak legislation	The main risk in the eyes of AST is of a political rather than a technical nature: the risk is that the Legislation is published with weak (fuzzy) language, which allows Member States to escape taking real action	Create a strong legislation.
2. Incompatible standards	INSPIRE could conceivably choose, and recommend, standards that are not appropriate to the manner of implementing SDI technology in a particular Member State, due to a particular information infrastructure already in place, a competing standard already implemented, etc.	Ad-hoc connectors and interfaces need be build for the SDIs for which this is an issue. Appropriate resources must be allocated.
3. Superseded standards	INSPIRE could recommend a standard which, during the process of passing/publishing the legislation, is discontinued or superseded. An example might be the previous adoption/implementation of CEN metadata, during the maturation of ISO standards, and which now will need to migrated to ISO/DIS 19115.	Create an authoritative organisation that is responsible for the technical implementation of INSPIRE. This organisation shall release profiles based on well known standards.
4. Acceptance	No acceptance of the standards	Collaborate with membership of international standardisation initiatives to release identified draft standards; provide tools that facilitate the implementation of standards; assist Member States at different administrative levels. Provide Training and education.
5. Technological development	INSPIRE could recommend standards or practices which immediately become not superseded but made irrelevant due to new methods which are simpler and more accessible. A concrete example is the recommendation to connecting to catalogs via z39.50 only to encounter within a few months a host of solutions for utilizing simple HTTP/SOAP messaging; this is a real case which may occur over the coming 12 months.	See solution for risk 3.
6. Separation of Coverage and Feature data	It may be that few Member States are equipped to deal with a separation of Coverage and Feature data, as the Ordnance Survey has done to some extent. This may cause problems...	Introduce sufficient flexibility in the architecture of INSPIRE in order to accommodate these situations.
7. Data migration	Adoption of GML might raise issues; it is believed that the trick to not scare off possible SDI implementors, will be to specify that SDIs be compatible with GML (for example) and not force them to convert en masse all their data to that format. The same goes for coordinate systems: perhaps it would be risky to demand certain ellipsoids and coordinate systems, when we have the chance to state that implementors should *either* store in such formats, or facilitate automatic conversions. This refers to the possibility to use style sheets and other	The legislative framework should define as much as possible the dual option connect existing SDIs to the INSPIRE: provide either the data in the right format / coordinate system, or provide a service that translates the data to the right format / coordinate system.

	"automatic" transformers, which can be placed anywhere within the data processing (component) chain, which would allow local use of whatever format is most relevant or accepted, while permitting on-the-fly compatibility in the case that an outsider requests their data but in another format.	
8. Cooperation	No progress due to lack of cooperation and support	Create an atmosphere of collaboration; use as much as possible existing organizations and architectural components
9. Acceptance	No acceptance of the regulations	Put INSPIRE into a broader political context.
10. Timetable	No support for the time-table (takes too long to reach the goal);	See proposed solution for 9.
11. Top-down	No acceptance of the top-down approach, in the way of laws and regulations of the EC (too prescriptive); Some aspects within INSPIRE will give member states the perception of INSPIRE being a top-down approach.	See proposed solution for 9.
12. Lead	It becomes a political battle which country takes the lead and prescribes the standard	Involve Member States in the technical coordination body
13. Propriety systems	There is a tension between the desire to use data (and systems) 'as-is' and the need for an open, extensible and scaleable architecture for INSPIRE. This is particularly the case since many existing systems are proprietary and use techniques (e.g.,proprietary file structures, BLOB's, etc) which are inherently not open.	
14. Feasibility of INSPIRE for local level	If the local level is going to chose between the INSPIRE recommendation [on coordinate reference systems] and something their partners/customers can use, then it is extremely likely that they will chose the later one.	Make tools available that assist the local level in realising INSPIRE's common principles

Obstacles	Description
1.	Too tightened regulations of the standards
2.	Too less benefits for the offering organisations (in other words to less return on investment of the making available and giving access to the owned data).
3.	Much afford has to be made for building metadata registries. And is this worthwhile to the use of the data. There is also the problem of abuse of data.
4.	It takes too long to achieve the total coverage of Europe to be of use for policy making. Still policy decisions have to be taken about areas, not covered by information or from which no information is available. Most environmental problems don’t stop at the border of countries.

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7. Glossary

Architecture	The models, standards, technologies, specifications and procedures used to represent, transform and generally accommodate the integration, maintenance and use of information in digital format
Bandwidth	The amount of data that can be passed along a communications channel in a given period of time
Catalogue services	Services designed to help users of application software to find information that exists anywhere in a distributed computing environment. Also called Clearinghouse.
Certification	The issue of a formal statement attesting a fact, usually the achievement of a standard. It is usually considered essential for the approval thus given to be subject to independent verification
Change-only update	The supply only of data which have been created or changed since a specified date
Conflation	The process by which two geographic data sets of the same area, usually from different time periods or different themes, can be matched and merged together
Co-ordinate reference system	Co-ordinate system which is related to the real world by a datum
Co-ordinate transformation	Change of co-ordinates from one reference system to another
Coverage	Set of spatial locations described in terms of attribute values
Custodian	Individual or group with a specific guardianship responsibility for a dataset. See ANZLIC's seven principles
Data dictionary	A repository of information about the definition, structure and usage of data. It does not contain the actual data.
Data model	A generalised view of data representing the real world
DERM	Digital Earth Reference Model
EbXML	Electronic Business using XML. A modular suite of specifications that enables enterprises to conduct business over the Internet
Feature collection	Term used by OGC synonymously with Dataset as defined by ISO TC 211
Federated database	Distributed databases that have different access procedures, protocols, and schemas, but that uses a common data model, and one single organization is responsible for the integration mechanisms.
Gateway	An interface between an external source of information and a web server, See also Portal
Geographic data	The locations and descriptions of geographic features; the composite of spatial and descriptive data
Geographic feature	Abstraction of a real world phenomenon associated with a location relative to the Earth
Geographic information	Information that is referenced to the earth's surface, whether by co-ordinates or by identifiers such as addresses
Geoprocessing services	Operations accessible through an interface that allows a user to evoke a behaviour of value to the user
Geospatial data catalogues	Discovery and access systems that use metadata as the target for querying raster, vector and tabular information. See also Catalogue services
GML	Geography Mark-up Language, a derivation of XML by OGC, particularly suitable for digital map transmission
Harmonise	Render in line with, in accordance with or in conformity with each other two or more concepts, ideas or specifications
HTML	Hyper-text Mark-up Language. The most common Internet data communication protocol
HTTP	Hyper Text Transfer Protocol. The simple request/response protocol that allows web browsers to access files on any web server
Information Community	A group of individuals or bodies who share a common information language, features & usages
Interoperability	The ability of two or more systems to operate in conjunction with each other. The coherent exchange of information and services between systems.
ISO	International Standards Organisation
ISO TC 211	The ISO Technical Committee 211, responsible for GI matters

Metadata	Summary information or a description of the characteristics of a set of data. Often referred to as "data about data", metadata is the information and documentation which makes data understandable and sharable for users over time (ISO 11179 Annex B)
OASIS	Organisation for the Advancement of Structured Information Standards
Object orientation	A data model that treats components of a program or database as individual entities which encapsulate knowledge about how the entity responds and reacts to the system and inherits functionality
OMG	Object Management Group
Open infrastructure	A dynamic and growing interoperable infrastructure accommodating both certified and uncertified information products and services.
Open source software	Software that shipped with its source code, and that subject to the nine policies of the Open Source Organisation (see p. 56)
Platform	Computer hardware and operating systems, but not including application software
Policy	Guidelines that either constrain or enable action. A plan or course of action.
Profile	Set of one or more base standards and, where applicable, the identification of selected clauses, classes, options and parameters of those base standards that are necessary for accomplishing a particular function (ISO 19101)
Protocol	A formally agreed standard for communication between computers (OSGB)
Query	The process of selecting records in a database. Can be achieved through a query language directly on the data.
Reference data	Data necessary to identify the position of physical features in relation to other information in a geospatial context
Registration authority	An organisation responsible for maintaining a registry
Semantic interoperability	General agreement on the meaning that is given to labels assigned to features
Service	A distinct part of the functionality that is provided by an entity through interfaces (ISO/IEC TR 14252 and ISO 19119)
Service registry	A software component that supports the run-time discovery and evaluation of available service offers
SNA	Systems Network Architecture
SOAP	Simple Open Access Protocol
Spatio-temporal information	Time-series spatial information
Stakeholder	A person or body having an interest in an entity or project, sometimes Implying financial involvement
Standards	Documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines or definitions of characteristics to ensure that materials, products, processes and services are fit for their purpose
Tabular data	Data arranged in tables or lists
TCP / IP	Transmission Control Protocol / Internet Protocol, the common communication protocol of the Internet.
Thematic data	Application data such as environmental data
TIFF	Tagged Image File Format. A popular image file format for storing scanned images.
UML	Unified Modelling Language, an OO notation for expressing analysis and design.
URL	Universal Resource Locator. A form of unique Internet address identifier or location reference
Watermarking	An invisible or semi-visible design built into an image to identify its owner
Web mapping	Viewing geographic information over the internet, including the presentation of general purpose maps to display locations and geographic backdrops
Web service	A software application indentified by a URI, whose interfaces and bindings are capable of being defined, described and discovered as XML artifacts, supporting interactions with other software agents using XML messages exchanged via internet protocols
WPOS	Web payment and ordering service
WSDL	Web Service Description Language
XML	eXtensible Mark-up Language, increasingly used as a common standard for Internet data communication

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Appendix A. GI standards and specifications - overview

The table below serves as a guide to understand better the various standards and specifications that have been referenced in this Position Paper. The descriptions have been collected from the websites of ISO/TC211 and the OpenGIS consortium and reflect the state of the art on August 4, 2002.

Most of the documents listed are not publicly available. International Standards and Draft International Standards can be obtained through the national standardisation bodies. Other working documents are available to participants to ISO/TC211.

Approved OpenGIS specifications are available from the OpenGIS webpage. Access to working documents and the detailed description of web mapping testbeds require OGC membership.

Initiative or project	**Description**
ISO 19101 - Reference model	The reference model describes the environment within which the standardisation of geographic information takes place, the fundamental principles that will apply, and the architectural framework for standardisation. The reference model defines and relates all concepts and components needed for this standardisation. Structured within information technology standards, the reference model will be independent of any application, methodology, and technology.
ISO 19102 - Overview	An overview of the ISO/TC 211 family of standards.
ISO 19103 - Conceptual schema language	Adoption of a conceptual schema language (CSL) for use in development of conceptual schemata in the field of geographic information.
ISO 19104 – Terminology	A harmonised set of all specific terms that relate to the ISO/TC 211 family of standards.
ISO 19105 - Conformance and testing	The framework, concepts, and methods for testing and criteria to be achieved to claim conformance to the ISO/TC 211 family of standards.
ISO 19106 - Profiles	Definition of guidelines for defining a profile/product within the ISO/TC 211 family of standards.
ISO 19107 - Spatial schema	Definition of the conceptual schema defining the spatial characteristics of object types. A consistent suite of geographic information schemata will allow geographic information to be integrated with information technology. The goal of this work item is to produce a conceptual schema for the spatial characteristics of geographic information, particularly the geometry and topology. Geometry and topology form two main aspects of geographic information and standardisation in this area will be the cornerstones for other geographic information standards.
ISO 19108 - Temporal schema	Definition of the conceptual schema defining the temporal characteristics of object types. Geographic information is not confined to a three-dimensional spatial domain. Many geographic information systems require data with temporal characteristics. A standardised conceptual schema for temporal characteristics will increase the ability of geographic information to be used for certain types of applications such as simulations and predictive modelling. The schema will be used by geographic information system and software developers and users of geographic information to provide consistently understandable temporal data structures. Probably the most challenging part of this problem will be the current lack of standardised terminology.
ISO 19109 - Rules for application schema	Definition of the rules for defining an application schema, including the principles for classification of geographic objects and their relationships to an application schema. Defining schemata for applications in a consistent way will increase the ability to share data between applications and allow for real-time interaction between applications.
ISO 19110 - Feature cataloguing methodology	Definition of the methodology for creating geographic object, attribute and relationship catalogues and the determination of the feasibility of setting up a single international multilingual catalogue and its administration. Many applications of geographic information include a predefined catalog of object definitions, attribute definitions, and relationship definitions used within the application. These catalogues are derivatives of the application schemata. Including these catalogs, when moving geographic information from one application to another is common. Providing a consistent methodology for defining these catalogs will enhance the ability to map one catalog to another. Such a mapping may be required to use the information.
ISO 19111 - Spatial referencing by co-ordinates	Definition of the conceptual schema and guidelines for describing geodetic reference systems. This work will include references to selected international reference systems.
ISO 19112 - Spatial referencing by geographic identifiers	Definition of the conceptual schema and guidelines for describing indirect spatial (non-coordinate) reference systems. An increasing number of geographic information applications use non-coordinate-based methods of referencing location. This are called indirect referencing systems. In these systems, location is often identified only by a code. A standardised conceptual schema for indirect reference systems will increase the ability of geographic information using these types of reference systems to be integrated with other geographic information. The schema will be used by geographic information system and software

Initiative or project	Description
	developers and users of geographic information to provide data with consistently defined reference systems.
ISO 19113 - Quality principles	Definition of the schema for quality applicable to geographic data. Quality information is essential to both the use and reuse of geographic information. A standardised conceptual schema for quality characteristics will increase the ability of geographic information created for one application to be properly evaluated for use in another application. The schema will be used by geographic information users add quality parameters to data being created and to evaluate the data received from other sources. Geographic information system and software developers will use the schema to provide applications that provide consistent methods of handling quality information.
ISO 19114 - Quality evaluation procedures	Development of guidelines for the methods of specifying/evaluating data quality. Consistent methods of reporting the quality of geographic information will not be enough to assure consistent evaluation of data set quality. The quality information reported for a geographic information data set will also depend on a consistent application of standardised methods for measuring the quality of geographic information. The results of one method of measuring quality may not be readily comparable to another although each is valid. A standardised set of evaluation criteria and procedures will guarantee that the relative quality of one data set versus another can be determined. For the most part, this standard will be used by geographic information users when they create data of when they evaluate data from other sources. Geographic information system and software developers may also use this standard to build tools for carrying out quality procedures within their application software.
ISO 19115 - Metadata	Definition of the schema required for describing geographic information and services. Data describing a data set is becoming ever more important for locating and accessing information of all kinds. A standardised conceptual schema for geographic information metadata will increase the ability of geographic information created for one application to be found and properly evaluated for use in another application. The schema will be used by geographic information users to add metadata in a consistent and verifiable form to data being created and to evaluate quickly and accurately the data being selected from other sources. Geographic information system and software developers will use the schema to provide applications that provide consistent methods of handling metadata.
ISO 19116 - Positioning services	Definition of a standard interface protocol for positioning systems. Modern positioning technologies allows a more global determination of position of a geographic object. A standardised interface of geographic information with position will allow the integration of position data into a variety of geographic information applications, such as navigation, fleet management, and surveying. This standard will benefit geographic information system users, but will be used by geographic information systems and software developers to provide such capability within their systems.
ISO 19117 - Portrayal	Definition of a schema describing the portrayal of geographic information in a form understandable by humans including the methodology for describing symbols and mapping of the schema to an application schema. This work does not include the standardisation of cartographic symbology. In many applications the portrayal of geographic information will be a matter of taste and personal preference of the user. There are, however, many applications of geographic information where the symbolization of the information must be consistent from one system to another; for example, navigational charts. A standardised schema for describing how geographic information is to be portrayed will allow symbology to be described in a consistent way when required. This will promote the appropriate use of geographic information for some applications. The schema will be used by geographic information system and software developers and users of geographic information to provide consistently understandable descriptions of symbology and other portrayal information.
ISO 19118 - Encoding	Selection of encoding rules compatible with the conceptual schemata that apply to geographic information and definition of the mapping between the conceptual schema language and the encoding rules.
ISO 19119 - Services	Identification and definition of the service interfaces used for geographic information and definition of the relationship to the Open Systems Environment model. While specialized services will appropriately remain an arena for proprietary products, the interfaces to those services will be standardised. Geographic information system and software developers will use these standards to provide general and specialized services that can be used with all geographic information. It is important that work in this area is integrated with the approaches being developed within the more general world of information technology.
ISO/TR 19120 - Functional standards	The scope is: To develop a taxonomy, in the form of a type 3 report, of recognized functional standards in the field of geographic information/geomatics developed in other international or multi-national standardisation fora. To identify the components of those recognized functional standards and to identify elements that can be harmonised between these standards and with the TC211 base standards. To provide assistance with the development of profiles, when the base standards of ISO/TC211 are available, which correspond to these recognized functional standards. The actual development of profiles is not included in this scope.
ISO 19120 Amendment 1 Geographic information -	The ISO TR 19120 Geographic information - Functional standards report seeks to identify areas where the developing ISO 15046 base standards should be influenced or guided by the

Initiative or project	Description
Functional standards - Amendment 1	experience of the functional standards communities. A functional standard has been identified as an existing geographic information standard, in active use within the international community. National standards have not been considered within scope. This initial edition of ISO TR 19120 provides a starting point for a feedback cycle between the functional standards communities and the ISO/TC 211 component project teams. This process will continue and develop as the draft standards mature, as such it should not be considered to be the 'final' statement of requirements, this will be a dynamic and ongoing process.
ISO/TR 19121 Imagery and gridded data	To develop a type 3 report, which addresses the manner by which TC 211 should handle imagery and gridded data in the context of the field of Geographic information/Geomatics. To identify those aspects of imagery and gridded data that have been standardised or are being standardised in other ISO committees and external organizations that influence or support the establishment of raster and matrix data standards for geographic information. To identify the components of those identified ISO and external imagery and gridded data standards that can be harmonised with the TC 211 Geographic information/Geomatics standards. To develop a plan for TC 211 to address Imagery and gridded data in an integrated manner, within the suite of TC 211 base standards.
ISO/TR 19122 - Qualifications and certification of personnel	To develop a Type 3 report, which describes a system for the qualification and certification, by a central independent body, of personnel in the field of Geographic Information Science / Geomatics. To define the boundaries between Geographic Information Science/ Geomatics and other related disciplines and professions. To specify the technologies and tasks pertaining to Geographic Information Science / Geomatics. To establish skill sets and competency levels for technologists, professional staff and management in the field. To research the relationship between this initiative and other similar certification processes performed by existing professional associations. To develop a plan for the accreditation of candidate institutions and programs, for the certification of individuals in the workforce, and for collaboration with other professional bodies
ISO 19123 - Schema for coverage geometry and functions	Definition of a standard conceptual schema for describing the spatial characteristics of coverages. Coverages are mappings from a spatial domain to attribute values where attribute types are common to all geographic positions within the spatial domain. A spatial domain consists of a (usually infinite) collection of points in a coordinate space. Examples of coverages include rasters, triangulated irregular networks, point coverages, and polygon coverages. Coverages are the prevailing data structures in a number of application areas, such as remote sensing, meteorology, and bathymetric, elevation, soil, and vegetation mapping. This work item will satisfy in part the new work identified in PDTR 16569 on imagery and gridded data. A standardised conceptual schema for coverage geometry will increase the ability of geographic information to be shared among applications. The schema will be used by geographic information system and software developers and users of geographic information to provide consistently understandable spatial data structures. This project will be conducted in cooperation with the Open GIS Consortium (OGC). Part 6 of the OGC Abstract Specification: The Coverage Type and its Subtypes (OGC 98-106R2) will be used as the base document. Work can begin immediately; completion will be necessary to support the final development of other geographic information standards.
ISO 19124 - Imagery and gridded data components	To standardise concepts for the description and representation of imagery and gridded data in the context of the ISO 15046 suite of standards. This includes new work on the following aspects of such data: Rules for application schemas, Quality principles and Quality evaluation procedures, Spatial reference systems, Visualisation, and Exploitation services. The work will also identify aspects of existing parts of the family of standards that need to be expanded to address imagery and gridded data. New metadata elements will be defined using the extension mechanism of ISO 15046-15. Methods of encoding imagery and gridded data will be identified for inclusion in ISO 15046-18
ISO 19125 - Simple feature access – Common architecture	
ISO 19125 - Simple feature access - SQL option	This International Standard will: - provide an implementation specification for the SQL environment conformant with the Simple feature access - abstract specification (Currently a New Work Item Proposal); - specify an SQL schema that supports storage, retrieval, query and update of simple geospatial feature collections; - establish an architecture for the implementation of feature tables; - define terms to use within the architecture; - apply to both SQL Components and SQL with Geometry Types Components; - describe a set of SQL Geometry Types together with the SQL functions on those types; - not attempt to standardise any part of the mechanism by which the Geometry Types are added to and maintained in the SQL environment.
ISO 19125 - Simple feature access – COM/OLE option	This International Standard will: - provide an implementation specification for the COM/OLE environment conformant with the Simple feature access - SQL ISO 19125 - specify a COM/OLE schema that supports storage, retrieval, query and update of simple geospatial feature collections; - establish a architecture for the implementation;

Initiative or project	Description
	- define terms to use within the architecture;
ISO 19126 - Profile - FACC Data Dictionary	This International Standard is a profile. It is based on rules and methods defined in ISO CD 19110 (15046-10) Geographic information - Feature cataloguing methodology, in the context of DGIWG. It defines a Data Dictionary and includes the definition of Features and Attributes only, which may be of use to the wider international community.
ISO 19127 - Geodetic codes and parameters	To develop a Technical Specification on geodetic codes and parameters that defines rules for the population of tables of geodetic codes and parameters and identifies the data elements required within these tables, in compliance with ISO 19111, Geographic information - Spatial referencing by co-ordinates, and makes recommendations for use of the tables. These recommendations should address the legal aspects, the applicability to historic data, the completeness of the tables, and a mechanism for maintenance.
ISO 19128 - Web Map Server Interface	This International Standard will: - describes a Web Map Server (or just Map Server). A Map Server can do three things. It can: 1. Produce a map (as a picture, as a series of graphical elements, or as a packaged set of geographic feature data), 2. Answer basic queries about the content of the map, and 3. Tell other programs what maps it can produce and which of those can be queried further. Vendors already have products complying with this standard. This standard will ensure control over interoperability.
ISO 19129 – Imagery, gridded data framework	To standardise concepts for the description and representation of imagery, gridded and coverage data in the context of the ISO 19100 suite of standards. This New Work Item Proposal is for a Technical Specification to define the framework for imagery, gridded and coverage data and those elements that require standardisation that are not identified in other ISO 19100 standards.
ISO 19130 – Sensor and data models for imagery and gridded data	This International Standard will cover the following areas: 1. It will specify a sensor model describing the physical and geometrical properties of each kind of photogrammetric, remote sensing and other sensors that produces imagery type of data. 2. It will define a conceptual data model that specifies, for each kind of sensor, the minimum content requirement and the relationship among the components of the content for the raw data that was measured by the sensor and provided in an instrument-based coordinate system, to make it possible to geolocate and analyze the data.
ISO 19131 - Data product specification	This International Standard will provide requirements for the specification of geographic data products. These will include the application schema, spatial and temporal referencing systems, quality and data capture and maintenance processes.
ISO 19132 - Location based services possible standards	This Stage 0 report will investigate the need for the following LBS standards: Format for the expressions of location (including orientation). Co-ordinates. Addresses. Route "mile markers". Orientation expressions (angle, bearings, offset angle). Formats for the expression of routes. Segment sequences. Turning instructions. Formats and rules for the expression of navigational "commands". Formats for the expression of choice by clients of forms of commands; potentially expression of personal preferences. Formats for the expression of traffic conditions. Formats for the transfer between client and servers of request and responses for each of the above applications. The scope will include the consideration of both local (server side) and client aspects of cultural and linguistic adaptability.
ISO 19133 - Location based services tracking and navigation	This International Standard will specify 'web' based services in support of (mobile) clients that will enable: Route finding or traversal (navigation) between two targets (find a "best" route from the primary to a secondary one; and then to potentially calculate a set of procedural "navigation decisions" or route following commands that will execute that route. Route as conditions along the route, or nearby alternate routes change. Route Instruction traversal; ability to synchronize the target's position through its network; to allow scrolling through route commands as appropriate. How to maintain a tracking database in support of this application, including conditions along potential routes such as Traffic Monitoring
ISO 19134 - Multimodal location based services for routing and navigation	This proposed International Standard will specify: Route finding or navigation between two targets using two or more modes of transportation, i.e. finding the most desireable route from an origin to a destination using various available modes of transportation; and calculating a set of procedural "navigation decisions" or route following commands that will execute that route on a single network or on multimodal networks. Rerouting as conditions along the route, or nearby alternate routes of alternative modes change. Route Instruction traversal; ability to synchronize the target's position through its networks; to allow scrolling through route commands as appropriate.

Initiative or project	**Description**
	How to maintain a multimodal database in support of this application, including conditions along potential routes such as Traffic Monitoring on multi networks.
ISO 19135 - Procedures for registration of geographic information items	The development of a single standard or multi-part standard, which specifies procedures to be followed in preparing, maintaining, and publishing a register or registers of unique unambiguous and permanent identifiers, and meanings that, under the direction of ISO/TC 211, are assigned to geographic information items. Registries enhance interoperability by making instances of classes defined in technical standards available for re-use by standards developers and implementers.
19136 Geographic information - Geography Markup Language (GML)	The Geography Markup Language (GML) is an XML encoding in compliance with ISO 19118 for the transport and storage of geographic information modelled according to the conceptual modelling framework used in the ISO 19100 series and including both the spatial and non-spatial properties of geographic features. This specification defines the XML Schema syntax, mechanisms, and conventions that: Provide an open, vendor-neutral framework for the definition of geospatial application schemas and objects; Allow profiles that support proper subsets of GML framework descriptive capabilities; Support the description of geospatial application schemas for specialized domains and information communities; Enable the creation and maintenance of linked geographic application schemas and datasets; Support the storage and transport of application schemas and data sets; Increase the ability of organizations to share geographic application schemas and the information they describe. Implementers may decide to store geographic application schemas and information in GML, or they may decide to convert from some other storage format on demand and use GML only for schema and data transport.
19137 Geographic information - Generally used profiles of the spatial schema and of similar important other schemas	Develop a set of profiles of the spatial schema to provide a minimal set of geometric elements necessary for an efficient creation of application schemata. These profiles will include components from ISO 19107 Spatial schema, ISO 19108 Temporal schema, ISO 19109 Rules for application schema development, ISO 19111 Spatial referencing by co-ordinates and shall clarify the corresponding encoding rules in ISO 19118 Encoding. The profiles shall suppport many of the spatial data formats and description languages already developed and in broad use within a group of nations or liaison organizations.
OpenGIS Abstract Specifications:	
Topic 0 - Overview (version 4)	Introduction to all of the topic volumes comprising the Abstract Specification and for editorial guidance, rules and etiquette for authors (and readers) of OGC specifications.
Topic 1 - Feature Geometry (version 4)	This part of the Abstract Specification specifies conceptual schemas for describing the spatial characteristics of geographic features, and a set of spatial operators consistent with these schemas. It treats only 3 dimensional vector geometry and computational topology that can be derived from the underlying geometry. It defines standard spatial operators for access, query, management, and processing of geographic information. Other parts of this international standard will deal with the geometry of coverages, with network topology, and with spaces of more than three dimensions, including time.
Topic 2 - Spatial Reference Systems (version 4)	This part specifies the spatial/ temporal reference system.
Topic 3 - Locational Geometry (version 4)	This Topic Volume 3, Locational Geometry, provides essential and abstract models for technology that is used widely across the GIS landscape. Its first heavy use is in support of Simple Feature geometry specification and their Spatial Reference Systems. Additional use is expected to occur in support of Coverage specifications (see Topic 6, The Coverage Type).
Topic 4 - Stored Functions and Interpolation (version 4)	This Topic Volume, Stored Functions, provides essential and abstract models for used widely technology. Its first heavy use is expected to occur in support of Coverage specifications (see Topic 6, The Coverage Type).
Topic 5 - The OpenGIS Feature (version 4)	The OpenGIS™ Abstract Specification begins by building literally from the ground up. Using the concept of reference systems, attribute primitives such as geographically registered geometry are tied to the real world. Feature objects are then decorated in a controlled manner with attributes.
Topic 6 - The Coverage Type (version 4)	GIS coverages (including the special case of Earth images) are two- (and sometimes higher-) dimensional metaphors for phenomena found on or near a portion of the Earth's surface. Fundamentally, coverages (and images) provide humans with an n-dimensional (where n is usually 2, and occasionally 3 or higher) "view" of some (usually more complex) space of geographic features. In our setting, the "view" will be geospatially registered to the Earth.
Topic 7 - Earth Imagery (version 4)	There are many initiatives addressing portions of the overall scope of this Topic Volume. Important among them is the ISO TC/211 initiative to add a work item to address raster and image data types. OGC and ISO TC/211 intend to work closely to achieve common specifications. This Topic Volume, Earth Imagery, will provide essential and abstract models for technology that is already used widely (but not interoperably) across the GIS landscape. This technology properly depends on the more general technology that supports Coverages.
Topic 8 - Relations Between Features (version 4)	Topic 5 of the Abstract Specification introduces features, an abstraction of the entities in the real world. Entities in the real world do not exist in isolation. Typically an entity in the real world is related to other real-world entities in a variety of ways. This Topic introduces an abstraction

Initiative or project	Description
	for the relationships between entities in the real world. This abstraction is modeled as relationships between the features introduced in Topic 5.
Topic 9 - Quality (version 4)	This abstract specification is submitted in response to recurring requests in OGC meetings for someone to detail how quality and accuracy should be handled. The specified extensions support recording the position accuracy of Feature objects, and recording the accuracy and quality of other Feature properties. Such feature quality and accuracy data is one category of metadata, and this specification includes partial capabilities for recording other metadata associated with each Feature.
Topic 10 - Feature Collections (version 4)	Feature Collections seem to need important interfaces in order to support the needs of Catalogs and Catalog Services. These interfaces seem to be tightly coupled with Feature Collection Metadata.
Topic 11 - Metadata (version 4)	Discusses the use of metadata in the framework of OGC specifications. Definitions are left to other organizations like ISO/TC 211.
Topic 12 - The OpenGIS Service Architecture (version 4.1)	Description of the OpenGIS™ Services Architecture requires the establishment of a technical reference model in order to structure discussion. This topic presents one of many possible technical reference models.
Topic 13 - Catalog Services (version 4)	This topic covers OpenGIS services for both data discovery and data access.
Topic 14 - Semantics and Information Communities (version 4)	The OpenGIS™ notion of Information Communities was devised to enable groups such as ecologists and civil engineers to efficiently manage the semantics (or feature schema mismatches) of their own geodata collections and get maximum benefit from each other's geodata collections, despite semantic differences. An Information Community is a collection of people (a government agency or group of agencies, a profession, a group of researchers in the same discipline, corporate partners cooperating on a project, etc.) who, at least part of the time, share a common digital geographic information language and share common spatial feature definitions. This implies a common world view as well as common abstractions, feature representations, and metadata. The feature collections that conform to the Information Community's standard language, definitions and representations belong to that Information Community.
Topic 15 - Image Exploitation Services (version 4)	Image exploitation services are required to support most aspects of image exploitation, including precision measurement of ground positions and of object dimensions. Although the focus of this document is on services for using images, many of these services are expected to also be applicable to using other types of grid coverages and some non-grid coverages.
Topic 16 - Image Coordinate Transformation Services	This topic volume is the portion of the OpenGIS™ Abstract Specification that covers image coordinate conversion services. That is, this part of the abstract specification describes services for transforming image position co-ordinates, to and from ground position co-ordinates. These services might alternately be called "Image Geometry Model Services."
OpenGIS Implementation specifications	
OpenGIS Catalog Service Interface Specification (Approved)	The OpenGIS Catalog Service Interface Specification defines a common interface that enables diverse but conformant applications to perform discovery, browse and query operations against distributed and potentially heterogeneous catalog servers. Spatial Catalog servers typically contain metadata about spatially referenced information such as maps, schematics, diagrams, or textual documents. The specification uses metadata and spatial location to identify and select layers of interest, and provides for interoperability in catalog update, maintenance, and other Librarian functions. The specification is designed for catalogs of imagery, geospatial information, and mixtures of the two. (Future versions of the specification may also support services.) It specifies open APIs that provide discovery services, access services and interfaces for catalog managers, including a complete Catalog Query Language. Detailed implementation guidance is provided for establishing and ending a stateful catalog session to: query the catalog server properties, check the status of a request, cancel a request, issue a query, present the query results, and get the schema of a discovered collection.
OpenGIS Coordinate Transformation Services Specification (Approved)	This Implementation Specification provides interfaces for general positioning, coordinate systems, and coordinate transformations. In the specification, co-ordinates can have any number of dimensions, so this specification can handle both 2D and 3D co-ordinates as well as higher orders. Earth co-ordinates, such as the co-ordinates provided by a GPS receiver or by traditional surveying or navigation methods, are meaningful only as offsets from the origin in a particular spatial reference system. Many people outside the geospatial professions assume that longitude and latitude are universal and sufficient, but in fact there are a number of distinctly different longitude- latitude spatial reference systems in common use. A key requirement for overlaying views of geodata ("maps") from diverse sources is the ability to perform coordinate transformation in such a way that all spatial data use the same spatial reference system. Since there cannot be an assumption that all spatial data sources will be in the same projection or coordinate system, it is necessary for the client or application to be able to specify what coordinate system the data servers should deliver the spatial data to the application in. Therefore, put simply, OGC's OpenGIS Coordinate Transformation Services Specification provides a standard way for software to specify and access coordinate

Initiative or project	**Description**
	transformation services for use on specified sets of spatial data.
OpenGIS Geography Markup Language (GML 2.0) (Approved) GML 3.0 is a planned implementation specification	The Geography Markup Language (GML) is an XML encoding for the transport and storage of geographic information, including both the geometry and properties of geographic features. As with the OpenGIS Simple Feature Specification, GML utilizes the OpenGIS Abstract Specification geometry model. However, unlike the Simple Features Specification, the GML Specification includes the ability to handle complex properties. GML is positioned as an open data exchange standard, well suited for transmitting small to medium-sized volumes of information. GML is usable with all standard XML tools. Of particular note in this respect are the tools designed to filter XML (XSL) and to turn XML into a visual presentation (XSLT). Using the XSL tools, a fully functional GML database can be published into more limited versions. For example, in order to satisfy regulatory requirements, a subset of the data, perhaps with lower fidelity, can be automatically extracted. To share data with a supplier who is also a potential competitor, the data can first be filtered and adjusted on the basis of what the supplier needs to know.
OpenGIS Grid Coverages (Grid, Image, DEM) Specification (Approved)	This specification was designed to promote interoperability between software implementations by data vendors and software vendors providing grid analysis and processing capabilities. Within the OGC context, a Coverage is a function or any set of entities that exhaustively cover a plane. A grid coverage is a specific case of coverage in which a set of grid values covers the surface. Examples of a grid coverage are satellite images, digital elevation models, and digital orthophotos. The OpenGIS Grid Coverages Implementation Specification APIs provide for basic image access for purposes of requesting and viewing a grid coverage and performing certain kinds of analysis such as histogram calculation, image covariance and other statistical measurements. The specification provides a number of interface features for dealing with color palettes, byte organization, metadata, and coordinate systems (as set forth in the OpenGIS Coordinate Transformation Specification).
OpenGIS Simple Features Specification (Approved)	The Simple Feature Specification (version 1.x) focuses on the interface for OpenGIS Simple Features. A Simple Feature is defined by the OpenGIS Abstract specification to have both spatial and non-spatial attributes. Spatial attributes are geometry valued, and simple features are based on 2D geometry with linear interpolation between vertices. The base Geometry class has subclasses for Point, Curve, Surface and Geometry Collection. Each geometric object is associated with a Spatial Reference System, which describes the coordinate space in which the geometric object is defined. The supported geometry types include points, lines, linestrings, curves, and polygons. Feature-to-feature relations are not supported. The OpenGIS Simple Feature Specification application programming interfaces (APIs) provide for publishing, storage, access, and simple operations on Simple Features. The APIs take into account such tasks as the establishment of linear and angular units, spheroids, datums, prime meridians, and map projections. Included are interfaces for common geometric and topological constructs such as convex hull, symmetric difference, closure, intersection, buffer, length, distance, and dozens of others. At the GIS feature level, the API's provide for the creation and management of feature collections (such as the set of all roads in Howard County, or regions where ground cover is hardwood forest), and the ability to access features from such collections using geometric, topological, or attribute modifiers.
OpenGIS Web Map Server Interface (WMS 1.1.0) Specification (Approved)	The OpenGIS Web Map Server Specification (WMS) is a set of interface specifications that provide uniform access by Web clients to maps rendered by map servers on the Internet. Thus, WMS is a service interface specification that: • Enables the dynamic construction of a map as a picture, as a series of graphical elements, or as a packaged set of geographic feature data; • Answers basic queries about the content of the map; • Can inform other programs about the maps it can produce and which of those can be queried further.
OpenGIS Basic Services Model (BSM) Specification (Candidate)	The BSM consists of encoding specifications for representing services metadata, service capabilities and service interfaces. In an operational BSM environment, one could use this encoding for platform and implementation independent discovery and access and application of loosely-coupled distributed services. That is, one could find desired services without prior knowledge of their existence.
OpenGIS Gazetteer Service Interface Specification (GAZ) (Candidate)	A gazetteer is an online "dictionary" of geospatial words/terms (vocabulary), with or without applicable feature geometries. The GAZ is the interface specification for services that support the transformation of a set of place names into a set of stored geometry. The geometry is specific with respect to the coordinate reference system. The OpenGIS Gazetteer Service Interface Specification is a specialization of the Web Feature Server Specification. The GAZ provides for multi-lingual environments.
OpenGIS Geocoder Service Specification (Geocoder, or GeoC) (Candidate)	Geocoding is the process of linking words, terms and codes found in a text string to their applicable geospatial features, with known locations. (Locations are defined as geometry; usually points with x, y co-ordinates.) The most commonly known type of geocoding is converting an address to a geographic location. The current Geocoder Interface Specification allows for a request providing an address or set of addresses and returns them along with the corresponding geometry (usually a point relative to a requested spatial reference system.) The request is "sent" to a geocoding service which processes the request and returns the result.

Initiative or project	Description
OpenGIS GeoParser Service Specification (Geoparser, or GeoP) (Candidate)	Geoparsing refers to the capability to process a textual document and identify key words and phrases that have a spatial context. A GeoParsing Interface implementing this specification works in the context of two bodies of information: a reserved vocabulary (usually of place names) and a text source (e.g., a newspaper, or voice track.) The GeoParser returns all occurrences of the use (in the text source) of any word in the reserved vocabulary. Each occasion establishes a geolink between the source and the location associated with the reserved word. For example, your home might be Geolinked with your water bill through their common address.
OpenGIS Location Organizer Folder Specification (LOF) (Candidate)	A LOF is a sharable "container" of contextually-rich, organized, structured, and inter-related multi-source information. The LOF is essentially a sharable, spatially enabled folder/shoebox. The LOF is a special kind of feature that supports spatial associations with other features. For example, in a real estate environment, an LOF could form links between a listing, map co-ordinates in both large and small scale maps, photograph co-ordinates, and occasions of textual descriptions of the listing, an address, points in small or large scale maps and photographs, and textual descriptions of the dwelling at the address. A real estate salesman might have an LOF full of properties for sale. LOFs are packable (an LOF can contain multiple LOFs). The real estate agent has a file of listings, homes sold, maps, aerial photography, terrestrial photos, lot numbers, etc. When a client asks for an address, information about the property at that address can be retrieved. The LOF provides the ability to expose behavior that would have been hidden, e.g. activity at a site during Tuesdays.
OpenGIS Image Coordinate Transformation Specification (ICT) (Candidate)	Interfaces that implement this specification will provide the capability for a client to invoke a service that generates measurements of ground objects by making measurements of their images. Such interfaces will also allow services that perform image rectification and orthorectification.
OpenGIS Stateless Catalog Specification (Cat S) (Candidate)	A stateless catalog allows clients to invoke arbitrary catalog services without reference to previous invocations. It avoids the need for lengthy sessions, which are difficult to manage in wireless, mobile, and distributed environments.
OpenGIS Styled Layer Descriptor Specification (SLD) (Candidate)	A basic tenet of OpenGIS Specifications is the separation of information from presentation. However, presentations are nevertheless of critical importance, so interfaces must be developed that enable a client to express that a particular "view" be created of a feature collection. The SLD is an encoding specification for associating presentation rules with properties of features.
OpenGIS Web Coverage Server (WCS) Specification (Candidate)	The OpenGIS Web Coverage Server extends the Web Map Server (WMS) interface to allow access to geospatial "coverages" that represent values or properties of geographic locations, rather than WMS generated maps (pictures). That is, both the WMS and the WCS provide for the generation and delivery of raster-based information, but the WMS returns an "image" which is an array of pixel values ready for portrayal. The WCS returns a collection of vectors that inform the client of values of interest, such as temperature, ownership, average rainfall, and so on. In contrast to the WMS, where only visualization is accomplished, the coverage server provides for analysis involving the evaluation/manipulation/combination of multiple coverages to answer specific questions. These values must be further processed if they are to be portrayed. This access to intact, unprocessed geospatial information is needed for client side processing, multi-valued coverages, and input into scientific models and other clients beyond simple viewers. The Web Coverage Server specifies two operations: GetCapabilities and GetCoverage.
OpenGIS® Web Feature Server Specification (WFS) (Candidate)	The purpose of the Web Feature Server Interface Specification (WFS) is to describe data manipulation operations on OpenGIS Simple Features (feature instances) such that servers and clients can "communicate" at the feature level. Therefore, a Web Feature Server request - like those supported in many GIS and RDBMS packages - consists of a description of the query and data transformation operations that are to be applied to WFS enabled spatial data warehouses on the Web. The request is generated on the client and is posted to a WFS server. The WFS Server "reads" and executes the request returned in a feature set as GML. A GML enabled client then can use the feature set. Therefore, whereas WMS delivers a picture, WFS implemented in a client supports the dynamic exploitation and access of feature data and associated attributes on the web from any server product that implements WFS. This capability opens the door to enhanced spatial analysis, modeling and other operations based on the intelligence of the attributed data. Beyond feature access, there is an additional set of interfaces in the WFS for supporting simple transactions: Create a Feature, Delete a feature, and Update a feature.
OpenGIS Web Registry Service Specification (Candidate)	The OpenGIS Web Registry Service Specification provides for a registry of parameters, e.g. parameters for converting a Mercator projection to a Lambert projection, for specific datums, etc. This meets the need for a service on the web to manage the business of accepting a request for these parameters and issuing them along with information about the confidence we can have in these parameters. NATO, for example, could stand up a registry for DIGEST, which is a list of all object types of interest to NATO, in 7 languages, and all the attributes that are required, optional, and forbidden for a feature. With such a registry, it will be necessary to have a server that makes it possible to add a feature. A registry service will tell what attributes are required, optional, etc. It will also be necessary to have a registry of data sources, and registries of symbols. Each

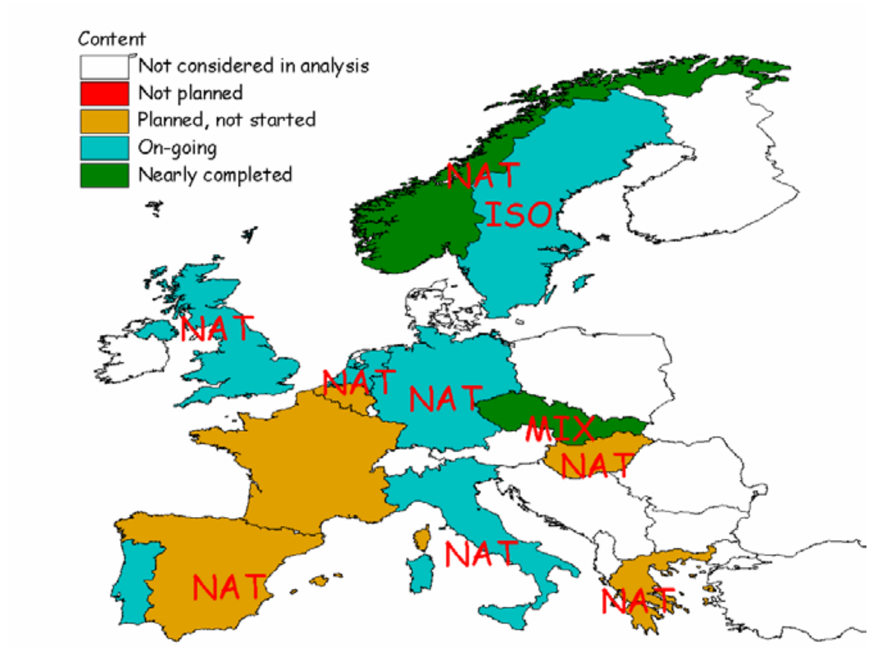
Initiative or project	Description
	registry will need a registrar with tools that accept/reject/note. Other authorities tell the registrar what to do, and that implies interfaces for these authorizations. The registry server hosts information of various types and makes the information available across the web in authoritative fashion, with appropriate authorizations and appropriate metadata. Registries are recursive.
OpenGIS XML Imagery Mark Up Language Specification (XIMA) (Candidate)	The OpenGIS XIMA Specification provides a vocabulary to express annotations on imagery, maps, and other geospatial data. This encoding uses the Geography Markup Language (GML) to express the positions of these annotations in geographic or pixel co-ordinates. It also uses the GeoLink (see below) syntax to associate each annotation with the geospatial resource(s) it describes. This encoding will allow Web-GIS users to interchange annotated maps and images, integrate image interpretations with raw imagery, and converse geographically over images and maps.
Translation services	
WPOS	
OASIS/ebXML Registry Information Model v2.0, December 5, 2001	

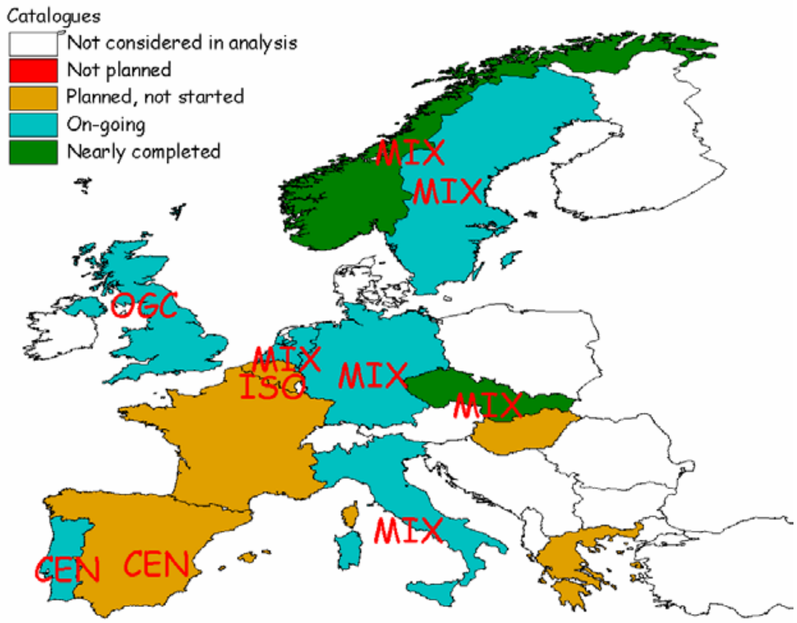
Appendix B. Architecture and Standards in Europe

Many regional and national SDIs initiatives are already taking place. The aim of this appendix is to give a feel for the direction these SDIs are taking as far as architecture and standards are concerned.

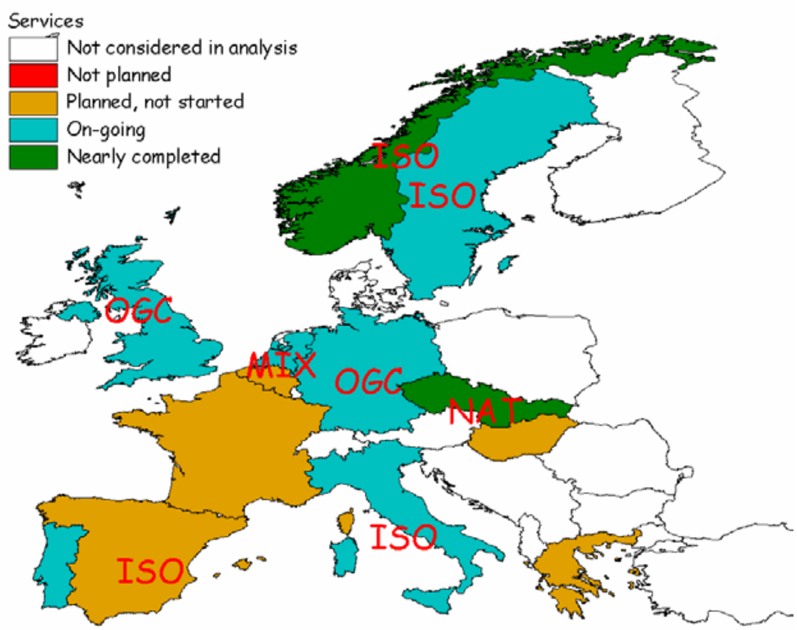
The material for this state of play in Europe has been provided by members of the AST Working Group, and in some cases from other sources.

It is recognized that the picture is not complete. However, it is quite evident already now that most initiatives are very much in line with the concepts and directions proposed by ISO/TC211 and the OpenGIS Consortium, and thus in principle compliant with the architecture reference model and foundation standards proposed in this Position Paper. However, this does not mean that there is no need for considerable work to be done in getting regional and national SDIs interoperable, thus creating INSPIRE.

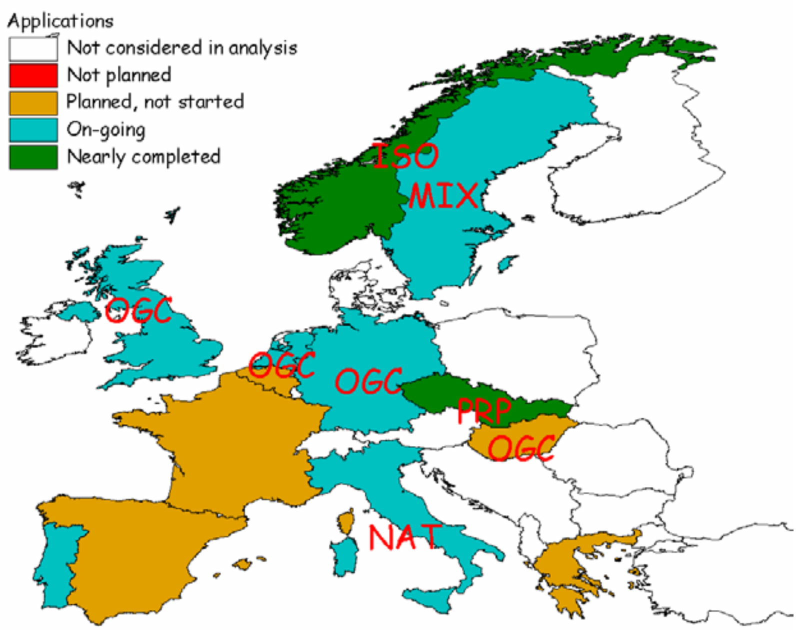




Catalogues
Not considered in analysis
Not planned
Planned, not started
On-going
Nearly completed
MIX
MIX
OGC
MIX
ISO
MIX
MIX
MIX
CEN
CEN



Services
Not considered in analysis
Not planned
Planned, not started
On-going
Nearly completed
ISO
ISO
OGC
MIX
OGC
NAT
ISO
ISO



Applications
Not considered in analysis
Not planned
Planned, not started
On-going
Nearly completed
ISO
MIX
OGC
OGC
OGC
PRP
OGC
NAT

Appendix C. Open source initiatives

C.1 What is Open Source?

The Open Source Organisation (http://www.opensource.org/) provides a definition of open source. Open source doesn't just mean access to the source code. The distribution terms of open-source software must comply with the following criteria:

1. Free Redistribution	The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale.
2. Source Code	The program must include source code, and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost–preferably, downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program. Deliberately obfuscated source code is not allowed. Intermediate forms such as the output of a preprocessor or translator are not allowed.
3. Derived Works	The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software.
4. Integrity of The Author's Source Code	The license may restrict source-code from being distributed in modified form only if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.
5. No Discrimination Against Persons or Groups	The license must not discriminate against any person or group of persons.
6. No Discrimination Against Fields of Endeavour	The license must not restrict anyone from making use of the program in a specific field of endeavour. For example, it may not restrict the program from being used in a business, or from being used for genetic research.
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C.2 Initiatives related to geospatial information

- Metadata creation and distribution (there are several building blocks in US and Canada, but a European version is needed).
- Gateway and search (must be user-friendly)
- WMS servers (there is a solution – University of Minnesota's Web Map Server)
- WFS servers (there is some interesting pieces, PostGIS and Geoserver, but they both need further development and support)

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