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BSI Standards Publication

Geographic information — Spatial data infrastructures

Part 1: Reference model

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National foreword

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Foreword

This document (CEN/TR 15449-1:2012) has been prepared by Technical Committee CEN/TC 287 “Geographic information”, the secretariat of which is held by BSI.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN/TR 15449:2011.

The present standard comprises the following parts:

— CEN/TR 15449-1, *Geographic information — Spatial data infrastructures — Part 1: Reference model* (the present part);

— CEN/TR 15449-2, *Geographic information — Spatial data infrastructures — Part 2: Best practices*;

— CEN/TR 15449-3, *Geographic information — Spatial data infrastructures — Part 3: Data centric view*;

— CEN/TR 15449-4, *Geographic information — Spatial Data Infrastructure (SDI) — Part 4: Service centric view*.

Introduction

Spatial data infrastructure (SDI) is a general term for the computerised environment for handling data that relates to a position on or near the surface of the earth. It may be defined in a range of ways, in different circumstances, from the local up to the global level.

This Technical Report focuses on the technical aspects of SDIs, thereby limiting the term SDI to mean an implementation neutral-technological infrastructure for geospatial data and services, based upon standards and specifications. It does not consider an SDI as a carefully designed and dedicated information system; rather, it is viewed as a collaborative framework of disparate information systems that contain resources that stakeholders desire to share. The common denominator of SDI resources, which can be data or services, is their spatial nature. It is understood that the framework is in constant evolution, and that therefore the requirements for standards and specifications supporting SDI implementations evolve continuously.

SDIs are becoming more and more linked and integrated with systems developed in the context of e-Government. Important drivers for this evolution are the Digital Agenda for Europe, and related policies (cf. Annex A). This Technical Report takes these developments into account. By sharing emerging requirements at an early stage with the standardization bodies, users of SDIs can help influence the revision of existing or the conception of new standards.

The users of an SDI are considered to be those individuals or organisations that, in the context of their business processes, need to share and access geo-resources in a meaningful and sustainable way. Based on platform- and vendor-neutral standards and specifications, an SDI aims at assisting organisations and individuals in publishing, finding, delivering, and eventually, using geographic information and services over the internet across borders of information communities in a more cost-effective manner.

Existing material about SDIs abounds. The criteria used for determining if a given standard or specification is referred to in this report are that the publication addresses an aspect of an SDI; and the publication is non-proprietary in nature.

Based on these considerations, the following reports have been taken into account:

- legal texts and guidelines produced in the context of INSPIRE;
- documents produced by ISO/TC 211 (and co-published by CEN);
- documents produced by the Open Geospatial Consortium (OGC), including the OpenGIS Reference Model (ORM) (OGC, 2003);
- the European Interoperability Framework and related documents;
- deliverables from the European Union-funded projects (e.g. GIGAS, SANY).

Considering the complexity of the subject and the need to capture and formalise different conceptual and modelling views, CEN/TR 15449 is comprised of multiple parts:

- Part 1: Reference model: this provides a general context model for the other Parts, applying general IT architecture standards.
- Part 2: Best Practices: this provides best practices guidance for implementing SDI, through the evaluation of the projects in the frame of the European Union funding programmes.

- Part 3: Data centric view: this addresses concerns related to the data, which includes application schemas and metadata.

- Part 4: Service centric view (in preparation): this includes the taxonomy of services, concepts of interoperability, service architecture, service catalogue, and the underlying IT standards.

Further parts may be created in the future.

1 Scope

This part of the Technical Report provides a reference model for a Spatial Data Infrastructure (SDI). It covers framework standards and identifies the relevant standards, technical specifications, technical reports and guidelines.

This part of the Technical Report provides a context model for the other parts of this Technical Report applying general architecture standards.

The intended readership of this Technical Report are those people who are responsible for creating frameworks for SDIs, experts contributing to INSPIRE, experts in information and communication technologies and e-government that need to familiarise themselves with geographic information and SDI concepts, and standards developers and writers.

2 Normative references

Not applicable.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
conceptual formalism
set of modelling concepts used to describe a conceptual model

EXAMPLE UML meta model, EXPRESS meta model.

Note 1 to entry: One conceptual formalism can be expressed in several conceptual schema languages.

[SOURCE: EN ISO 19101:2005]

3.2
conceptual model
model that defines concepts of a universe of discourse

[SOURCE: EN ISO 19101:2005]

3.3
conceptual schema
formal description of a conceptual model

[SOURCE: EN ISO 19101:2005]

3.4
conceptual schema language
formal language based on a conceptual formalism for the purpose of representing conceptual schemas

EXAMPLE UML, EXPRESS, IDEF1X.

Note 1 to entry: A conceptual schema language may be lexical or graphical. Several conceptual schema languages can be based on the same conceptual formalism.

[SOURCE: EN ISO 19101:2005]

3.5
conformance
fulfilment of specified requirements

[SOURCE: EN ISO 19113:2005]

3.6
identifier
linguistically independent sequence of characters capable of uniquely and permanently identifying that with which it is associated

[SOURCE: ISO/IEC 11179-3:2003]

3.7
interoperability
capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

[SOURCE: ISO/IEC 2382-1:1993]

3.8
reference frame
aggregation of the data needed by different components of an information system

3.9
resource
asset or means that fulfils a requirement

[SOURCE: EN ISO 19115:2005]

3.10
Spatial Data Infrastructure
SDI
metadata, spatial data sets and spatial data services; network services and technologies; agreements on sharing, access and use; coordination and monitoring mechanisms, processes and procedures, established, operated or made available in an interoperable manner

[SOURCE: INSPIRE]

Note 1 to entry: In the context of this report the term SDI is restricted to a platform- and implementation-neutral technological infrastructure for geospatial data and services, based upon standards and specifications.

3.11
use case
specification of a sequence of actions, including variants, that a system (or other entity) can perform, interacting with actors of the system

[SOURCE: ISO/IEC 19501:2005]

4 Abbreviated terms

API	application programming interface
CORBA	Common Object Request Broker Architecture
EIF	European Interoperability Framework

EN	European Standard (CEN deliverable)
INSPIRE	Infrastructure for Spatial Information in Europe
GI	geographic information
GML	Geography Markup Language
ISO	International Organization for Standardization
ICT	information and communications technology
ODP	Open Distributed Processing
OGC	Open Geospatial Consortium
OLE/COM	Object linking and embedding/ Component Object Model
OMG	Object Management Group
OSE	Open Systems Environment
RM-ODP	Reference Model of Open Distributed Processing
SDI	Spatial Data Infrastructure
SLD	Styled Layer Descriptor
SOA	Service Oriented Architecture
UML	Unified Modelling Language
WAI	Web Accessibility Initiative
WCS	Web Coverage Service interface specification
WFS	Web Feature Service interface specification
WMS	Web Map Service interface specification
W3C	World Wide Web Consortium
XML	eXtensible Markup Language
XSL	eXtensible Stylesheet Language

5 SDI interoperability

5.1 Interoperability Standards

A Spatial Data Infrastructure (SDI) relies on standards and specifications in the field of geographic information and information technology. This chapter systematically identifies standards that are of particular relevance to SDI development and implementation. A necessary condition for the successful establishment of a SDI is that the software industry supports relevant standards in commercial products. At the same time, public authorities are to request the support of standards in public procurement processes.

Many of the standards and specifications are already available. There is, however, a need to systematically identify these standards and to determine whether or not they are sufficiently precise and unambiguous so that their implementation provides interoperability and fulfils requirements of an SDI in Europe.

Standards should make interoperability as easy, simple and reliable as possible. The ISO 19100-series of standards both individually and collectively are quite complex. The risk of different interpretations of the same standard in different implementations exists and has to be minimised as much as possible. The aim must be to establish implementations of the standards which are as unambiguous and precise as possible. Avoiding variations of interpretation can be achieved through the use of suitable, standard based tools for data modelling, interface description, data transfer and quality control.

Recent EU initiatives have brought 'Interoperability' to centre-stage of the European Union's ICT governance framework. A range of stakeholders (governments, industry, consumers, and other social partners) have recognised the need for interoperability and recognise the benefits interoperability could bring. Interoperability has supplemented earlier discussions focused exclusively on open group standards, different software licensing models, or technical specifications under public procurement laws. Interoperability embraces the wider policy perspective to enhance ICT-embedded industries and the information society at large, including the geographic information communities.

Interoperability is the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units. Standardization of geographic information can best be served by a set of standards that integrates a detailed description of geographic information concepts with the concepts of information technology. A goal of the GI standardization efforts is the facilitation of interoperability of geographic information systems, including interoperability in distributed computing environments. Interoperability provides the freedom to mix and match information system components without compromising overall success (OGC, 2003). It is the basis for the successful implementation of a SDI in Europe, and will allow:

a) finding information and processing tools, when they are needed, independent of physical location;

b) understanding and use of the discovered information and tools, no matter what platform supports them; whether local or remote;

c) easier and more cost-effective integration and combination of data originating from heterogeneous sources;

d) support of policies in Europe;

e) control of the evolution of an SDI.

Lack of interoperability should be resolved by the support and implementation of international standards by software providers. This will greatly increase the efficiency of the use of geographic information in the future.

5.2 Challenges

5.2.1 Costs

Costs of implementation and operation are an important consideration. Whilst it is possible to establish individual interfaces for or between any systems or databases, the advantage of using standards should be to provide an easier and cheaper implementation. Interoperability gets more difficult for more complex systems, databases and interfaces. Therefore it is important to keep it as simple as possible at least at the level of system and user interfaces.

5.2.2 Quality

Quality issues are also an important consideration. Completeness and consistency of content, e.g. structure, and format of transfer data should be automatically checkable against reference and target data model. Once more tools based on standards are the solution of choice.

5.2.3 Impact and checkpoints

The full impact of standards on interoperability is reached when everything in the whole process from the description of data models to the description of exchange format and quality control can be described and derived unambiguously with a set of standard based tools following the model driven approach. This process should be possible without any complex manual working steps to support straightforward and conformant maintenance of the different system components.

There are several general considerations for achieving interoperability:

- Use the Modelling Driven Approach (MDA) based on standards;
- Be precise;
- Keep things simple;
- Use standard based tools;
- Automate the processes;
- Check the quality.

5.3 The European Interoperability Framework (EIF)

The generic architecture model for geographic information and services aligns with the general requirements for European e-Government Services, as stated in the European Interoperability Framework (EIF)[1)] strategy. This framework identifies the organisational, semantic and technical interoperability aspects.

Interoperable Delivery of European eGovernment Services to public administrations, businesses and citizens (IDABC) uses the opportunities offered by information and communication technologies to encourage and support the delivery of cross-border public sector services to citizens and enterprises in Europe, to improve efficiency and collaboration between European public administrations and to contribute to making Europe an attractive place to live, work and invest.

The European Interoperability Framework comprises five interoperability levels:

- Political Context;
- Organisational Interoperability;
- Legal interoperability;
- Semantic Interoperability;
- Technical Interoperability.

These are illustrated in Figure 1.

1) See http://ec.europa.eu/idabc/.

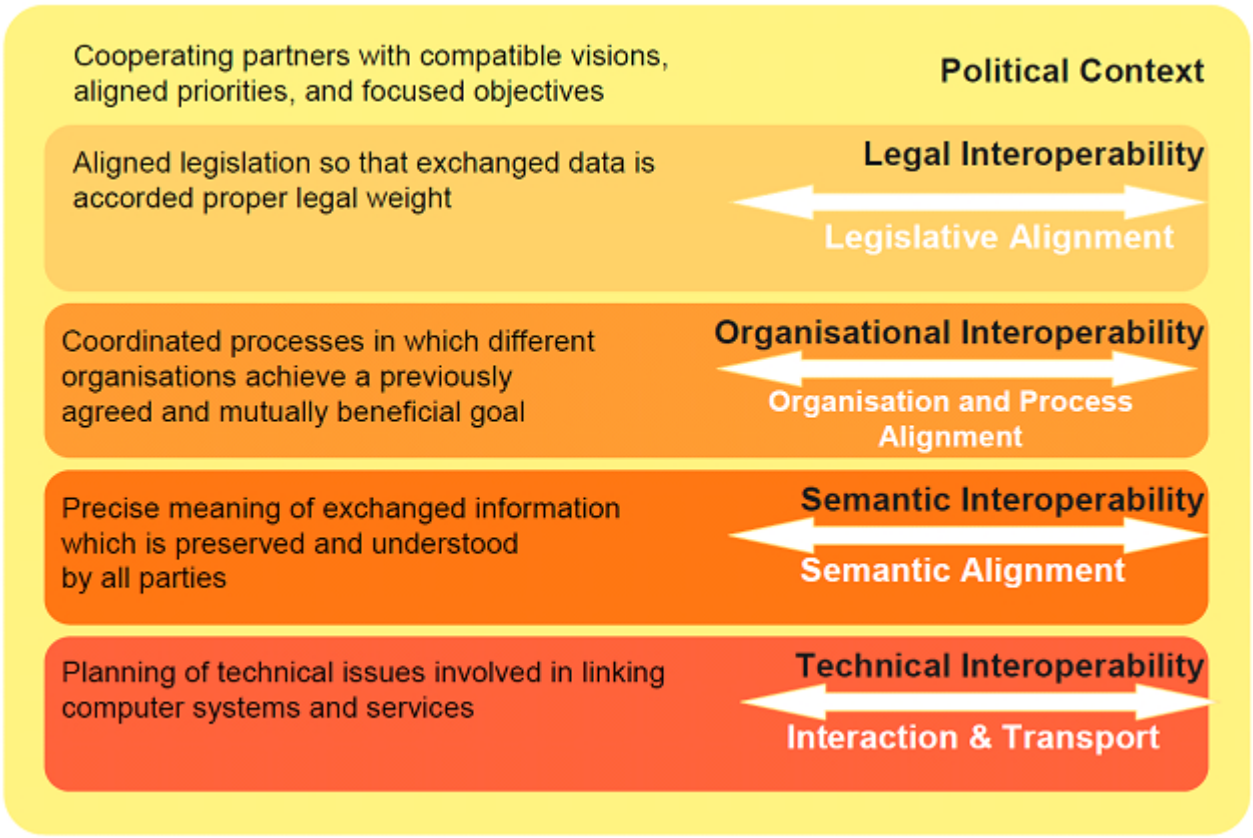

Figure 1 — EIF version 2.0 Interoperability levels

The EIF version 2.0 extended the upper Interoperability levels with political context and legal interoperability in addition to the EIF version 1.0 levels of organisational interoperability, semantic interoperability and technical interoperability.

An Interoperability Framework can be defined as the set of policies, standards and guidelines that describes the way in which organisations have agreed, or should agree, to do business with each other. Consequently, an Interoperability Frameworks architecture model is not a static document and needs to be maintained over time as technologies, standards and administrative requirements change.

This interoperability framework focuses on the following principles:

- **accessibility** – non-discriminating, open and publicly available data, including guidelines for WAI (Web Access Initiative) from the World Wide Web Consortium;
- **multilingualism** – support of a range of languages that are used extensively in Europe today;
- **security** – identification, authentication, non-repudiation, confidential information;
- **privacy** - personal data protection;
- **subsidiarity**;
- use of **open standards**.

To attain interoperability in the context of pan-European e-Government services, a focus on open standards is required. The General Public Services Conceptual Model from EIF in Figure 2 shows main service areas identified in the context of public services.

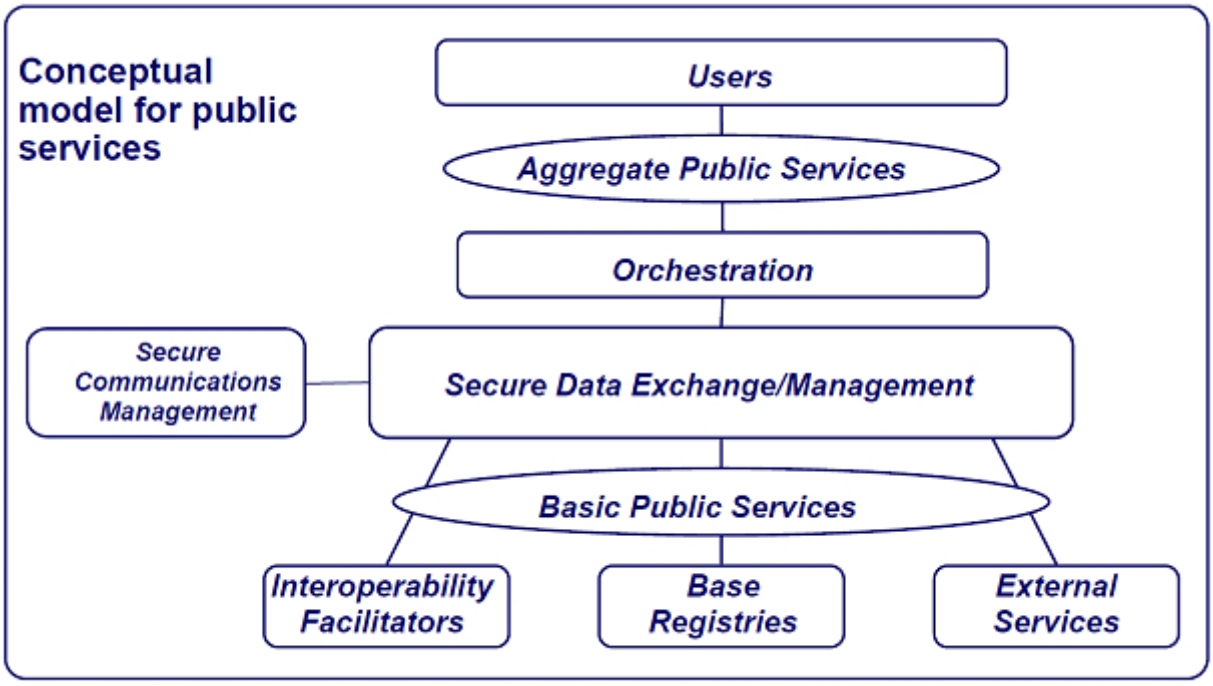

Figure 2 — Public services conceptual model

This interoperability framework implements the recommendations provided by the European Interoperability Framework (EIF). The following service types are recognised:

a) Basic Public Functions:

   1) interoperability facilitating services - transformation, brokering and mediation functionalities, etc.;

   2) base registration services - publication and discovery functionalities, etc.;

   3) external services - business level services, payment services, connectivity services, etc.

b) Aggregate Services, grouping a number of basic public functions to appear as a single service:

   1) composition services;

   2) orchestration services;

   3) workflow services.

5.4 The Architectural reference model

5.4.1 Data

Exchange of and access to spatial data is the principal objective of an SDI. The data are at the heart of an SDI. The spatial data in an SDI are a model of the real world, developed according to well defined methodologies described in different standards. The model is made explicit through a concise description of

data specifications in data specification documents. These specifications can then be used to develop new datasets or to transform existing datasets to the specifications by mapping the existing model to the model described in the specifications. In this way, semantic interoperability can be achieved: i.e. different datasets can be used together and be understood by different users in the same way. Metadata are part of the datasets and should get proper attention during the data modelling. Metadata will play a crucial role in documenting and understanding the content of the data model and data product specification, in achieving technical interoperability.

On top of the data, and by making use of the metadata, services can be built to make the data accessible through the web and to use them in any information system by viewing, downloading, or process them. This is often referred to as a Service Oriented Architecture (SOA). A SOA enables new and existing enterprise systems to share services, information and data across technical platforms, departments and ultimately across organisational, regional and national boundaries. The benefit is that this leads from a stand-alone system-centric view to an enterprise data-centric view of IT. The transition to a data-centric SOA allows an SDI to better leverage new and existing IT investments to support such an infrastructure. The data-centric transition builds a strategy around the organisations and their geospatial data infrastructure both to preserve the IT investment and to provide better access to authoritative data sources.

The model-driven approach follows the concepts developed in the model-driven architecture defined by OMG. The lifetime of a technical implementation is shorter than the lifetime of the information it handles. This makes it necessary to describe the information in a way that allows for new techniques and implementation environments to be applied. The starting point of information modelling is the universe of discourse. There are several aspects to the data specification development: the conceptual schema language used to describe the application schema; the application schema itself; the features which make up these application schemas and the organisation of features in feature catalogues; portrayal aspects to define the way features are visualised; and the implementation through encoding rules. Data management considerations are important for good functioning SDIs and include quality, the use of unique identifiers and metadata. The output of the data modelling is a data product specification that can be used by data custodians for developing new spatial data sets or for transforming existing data towards the data specifications.

The data centric view is further developed in Part 3 of this Technical Report.

5.4.2 Services

The service centric view is further developed in Part 4 of this Technical Report.

The architectural service reference model related to different types of services is adapted from the EN ISO 19119 service architecture standard. This standard describes an architectural based taxonomy of services, with six main service categories:

- **Interaction services** (Human Interaction Services) are services for management of user interfaces, graphics, multimedia and for presentation of compound documents.

- **Composition and Orchestration** (Workflow/Task Services) are services for support of composed and orchestrated services including specific tasks or work-related activities conducted by humans. These services support use of resources and development of products involving a sequence of activities or steps that may be conducted by different services and/or persons.

- **Processing Services** are services that perform large-scale computations involving substantial amounts of data. Examples include services for providing the time of day, spelling checkers and services that perform coordinate transformations (e.g., that accept a set of coordinates expressed using one reference system and converting them to a set of coordinates in a different reference system). A processing service does not include capabilities for providing persistent storage of data or transfer of data over networks.

- **Data and Things Management services** (Data/Model/Information Management Services) are services for management of the development, manipulation and storage of metadata, conceptual schemas and datasets. It also relates to access to sensors and actuators (and Internet of Things).

- **Communication Services** are services for encoding and transfer and system/service interaction including data handling across communications networks.

- **System and Security Management Services** are services for the management of system components, applications and networks. These services also include management of user accounts and user access privileges, including security rights management.

These are illustrated in Figure 3. For each of these categories it is relevant to consider SDI specific extensions for areas where generic IT functionality and supported is not meeting all requirements.

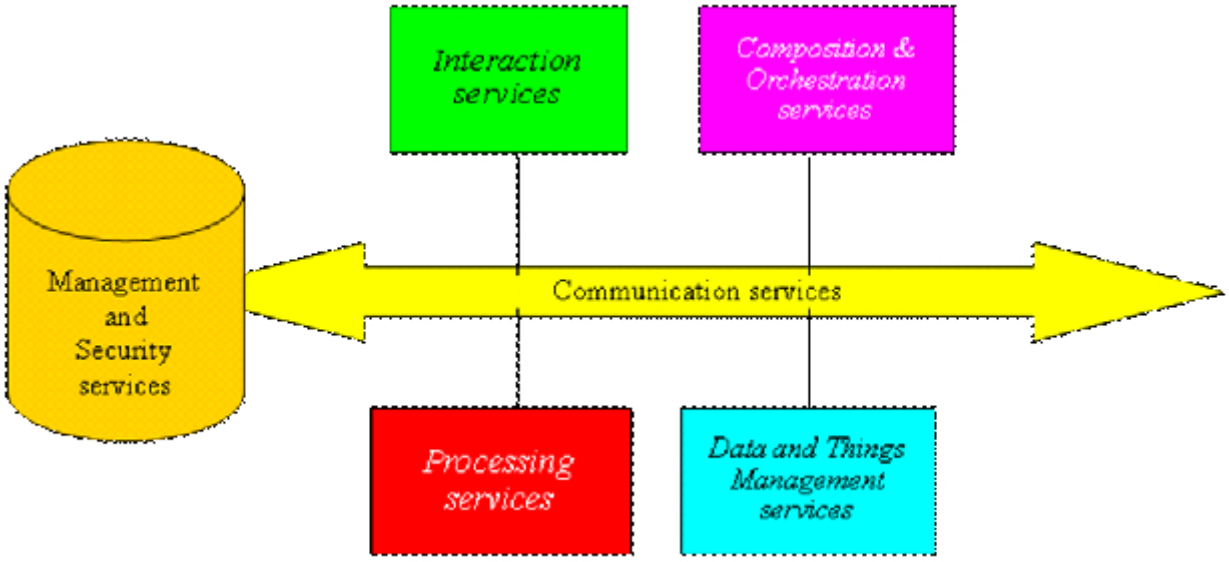

Figure 3 — Architectural service reference model

Figure 4 shows see how these categories have been used to identify SDI and Geographic specific services within each of the categories.

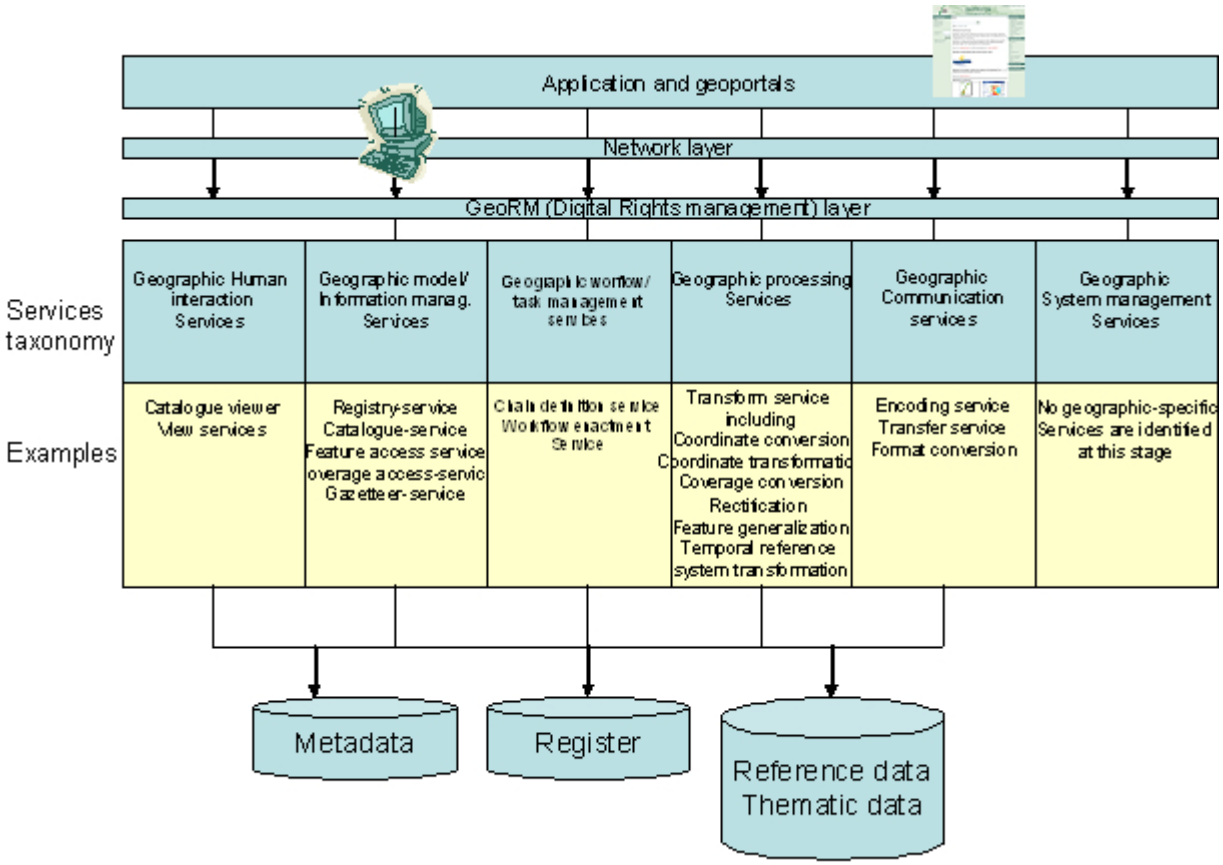

Figure 4 — ICT Interoperability framework from INSPIRE

The ICT Interoperability Framework has been defined in the context of INSPIRE, and illustrates relevant examples different possible types of services in the services taxonomy, accessed through applications and geoportals and a digital rights management layer.

This taxonomy does not introduce a strict classification; an aggregated service can belong to more than one type (or class), depending on the context in which it is applied.

5.5 Combining EIF and the Architectural service reference model

Figure 5 shows how the different service types identified in the ICT Interoperab<ility Framework can be the target for both technical and semantic interoperability in the context of the EIF. A detailing in the areas of semantic and technical interoperability can be made with respect to each of the identified service categories.

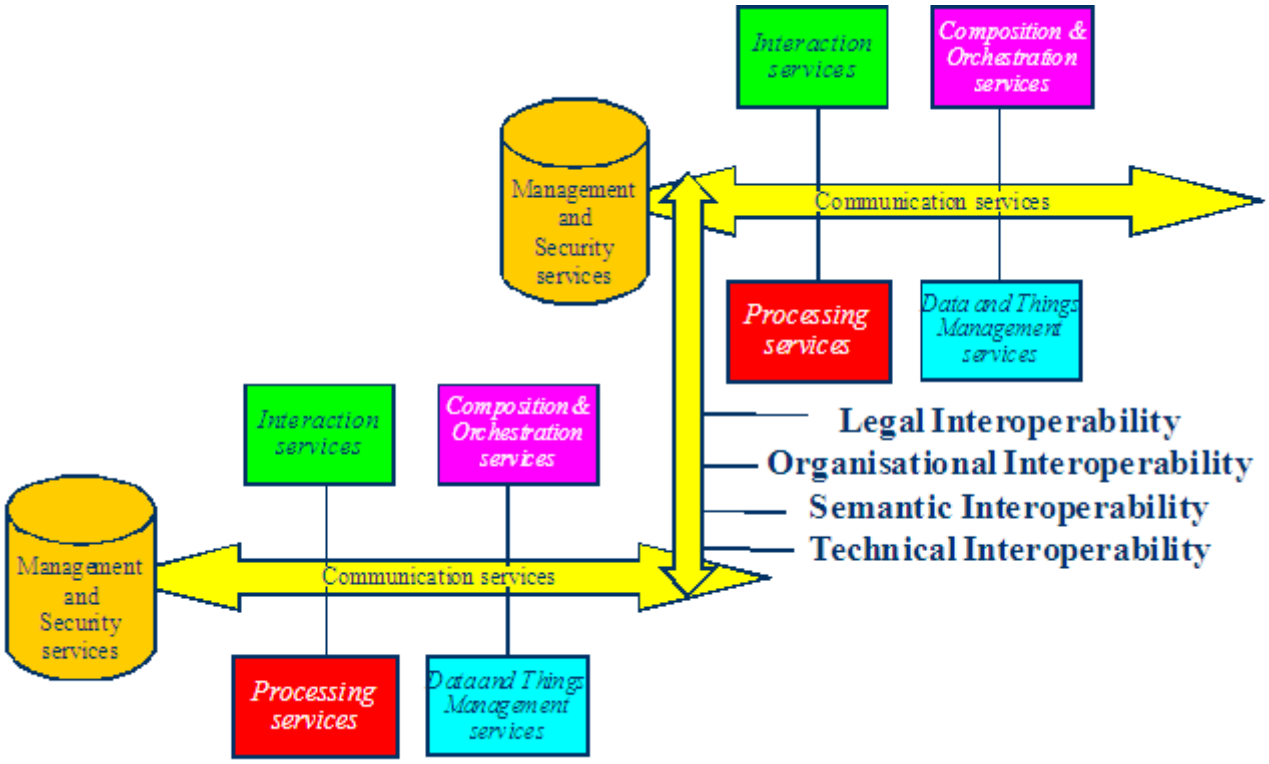

Figure 5 — Combining EIF and the ICT Interoperability Framework

5.6 SDI as a dynamic framework

A SDI should not be considered as a static framework that will offer solutions for a fixed set of requirements. Rather, it is a dynamic framework that satisfies current requirements while at the same time generating new requirements and solutions. It also permits creation of new services and applications, and stimulates the creation of new standards and specifications. Once an SDI is in place, there are four activities:

1) specification and standardisation,

2) development,

3) deployment,

4) invocation.

In each activity there are standards of interest. With this in mind, an SDI can be described in terms of a set of high-level activities that reflect its evolutionary character. These activities are:

- establish the core SDI,
- create new specifications,
- develop new services and applications,
- deploy services and applications, and
- invoke application instances.

These activities are described in Table 1. The activity diagram in Figure 6 suggests how the SDI activities interact, thus driving the evolution of SDIs.

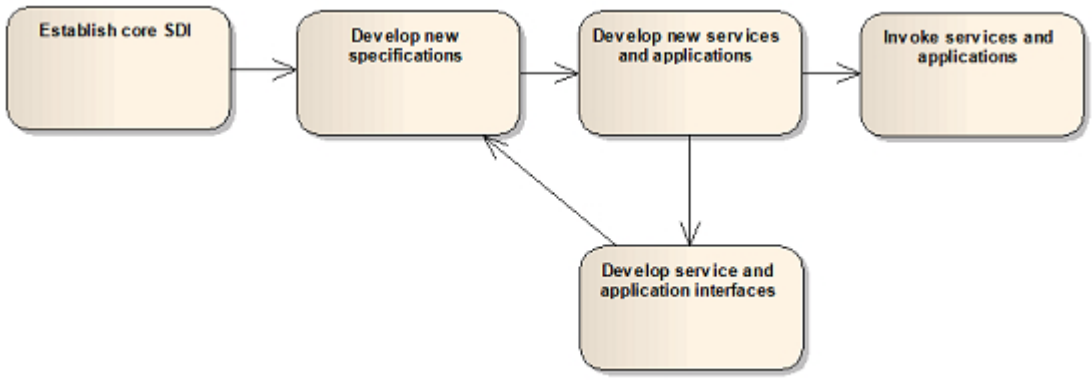

Figure 6 — Generic SDI activity diagram

Table 1 — SDI Activities

	Activity	Description	Example
1	Establish the "core" SDI	Certain basic services, fundamental for the SDI, have to be developed and launched according to standards and specifications. Pre-condition: standards for metadata content (services and data). Post condition: human-readable catalogues	Data, metadata content, metadata catalogues, service catalogues.
2	Develop new specifications	Service interfaces are specified and published by *interface providers*.	Standards required for description of features and coverage: modelling language, spatial representation etc. standards for description of presentation aspects, portrayal.
3	Develop new services and applications	Based on published interface specifications, services (for example a WFS for roads) and applications (for example an application for goods delivery) are built by *service providers* and *application providers*.	Standards for certain servers: WMS, WFS, gazetteer, transformation etc. Standards for encoding. Standards for finding services. Standards for security.
4	Deploy service and application instances	The services are published by the service providers. The applications are provided to the users and installed. Standards for describing and publishing services	
5	Invoke application instances by users	The user uses the application that finds and calls appropriate services.	Standards for evaluation.

6 Reference Model for a SDI

This section provides a reference model based around EN ISO 19101 and the Reference Model for Open Distributed Processing (RM-ODP).

SDIs can be described by different five viewpoints: the enterprise viewpoint, the computational viewpoint, the information viewpoint, the engineering viewpoint, and the technology viewpoint, all of them addressing different concerns (see Table 2). This section makes primarily use of the Computational Viewpoint and the Information Viewpoint.

Table 2 — RM-ODP viewpoints

Viewpoint	Definition of RM-ODP Viewpoint (ISO/IEC 10746-1)
Enterprise viewpoint	A viewpoint of an ODP system and its environment that focuses on the purpose, scope and policies of that system.
Computational viewpoint	A viewpoint on an ODP system and its environment that enables distribution through functional decomposition of the system into objects which interact at interfaces.
Information viewpoint	A viewpoint on an ODP system and its environment that focuses on the semantics of information and information processing.
Engineering viewpoint	A viewpoint on an ODP system and its environment that focuses on the mechanisms and functions required to support distributed interaction between objects in the system.
Technology viewpoint	A viewpoint on an ODP system and its environment that focuses on the choice of technology in that system.

The Reference Model brings together standards at two different levels of abstraction, and under two different architectural viewpoints, as summarised in Table 3.

- **Implementation Specifications** tell software developers how to express information or requests within a particular distributed computing environment (e.g. World Wide Web, CORBA, .NET). Implementation Specifications generally include access protocols, object models, and naming conventions. Such specifications are specific to, and directly usable within, their target computing environment.

- **Abstract models** specify what information or requests are valid in principle, irrespective of individual computing environments. They define essential concepts, vocabulary, and structure (type hierarchy) of geospatial services and information transfer. These models set the stage for creating implementable specifications, and for extending existing ones to new environments.

Deciding which of these to apply depends on the design lifecycle, and on the intended computing environment. Earlier design stages often draw on abstract models to sketch a system concept; whereas later implementation stages follow implementation specifications in detail. When it comes to writing software, if a suitable implementation specification already exists for the applicable computing environment, it should be the standard of choice. Otherwise, the relevant abstract model(s) should guide the design of a new implementation specification for that environment.

Table 3 — Viewpoints and levels of abstraction applied in the Reference Model

Viewpoints	**Computation viewpoint** *Service invocation*	**Information viewpoint** *Information transfer*
Abstract models (what)	Behaviour	Content
Implementation Specifications (how)	Interface	Encoding

At either the abstract or the implementation level, standards of two different kinds may apply:

- **service invocation**: these standards define the interfaces that allow different systems to work together, or the expected behaviour of software systems. The RM-ODP calls this the computation viewpoint; its focus is on invoking services effectively and unambiguously;

- **information transfer**: these standards define the content of geospatial information or its encoding for transfer between different processing systems. In RM-ODP parlance, this is the information viewpoint, emphasizing efficient, lossless communication.

For distributed computing, the service and information viewpoints are crucial and intertwined. For instance, information content is not useful without services to transmit and use it. Conversely, invoking a service effectively requires that its underlying information be available and its meaning clear. However, the two viewpoints are also separable: one may define how to represent information regardless of what services carry it; or how to invoke a service regardless of how it packages its information.

In a given context, either the computation view (behaviour implemented as interfaces) or the information view (content implemented as encodings) may take priority, depending on the diversity of the target community, the expected complexity of data and data processing, the pre-existence of related standards, and so on.

The OGC Abstract Specification, Topic 0 (Overview, Section 2) explains the roles of abstract and implementation models, and the interdependence of service invocation and information transfer. The EN ISO 19101, Geographic information — Reference Model provides additional background on conceptual models and their role in specification design using UML.

7 SDI Components

7.1 SDI core component

Standards and specifications are available in support of most SDI aspects. In order to help the reader in maintaining an overview, a so-called SDI Components Reference Model is adopted. It focuses on mechanisms for effective cooperation between software components in a SDI setting. The components have here been identified and described from a life cycle point of view – from the perspective of resources providers in terms of data and service providers. Parts 3 and 4 of this Technical Report offer different approaches (data centric and service centric) to the identification of the various Reference Model components introduced in this section.

The primary organizing structure is determined by the following SDI core components:

- Data: the information resource.

- Register: support for the activity of describing and publishing resources.

- Discovery: making it possible to search for spatial data sets and services on the basis of the content of the corresponding metadata and to display the content of the metadata.

- View: making it possible to display, navigate, zoom, pan or overlay viewable spatial data sets, and to display legend information and any relevant content of metadata.

- Invoke: chaining services together to provide added–value services.

- Download: enabling copies of spatial data sets. Or parts of such sets, to be downloaded and, where practicable, accessed directly.

- GeoRM Rights Management: support for the activity of managing access rights for resources.

- Orchestration and Composition: support for the activity of providing aggregated resources including in particular workflows for service composition.

These are illustrated in Figure 7.

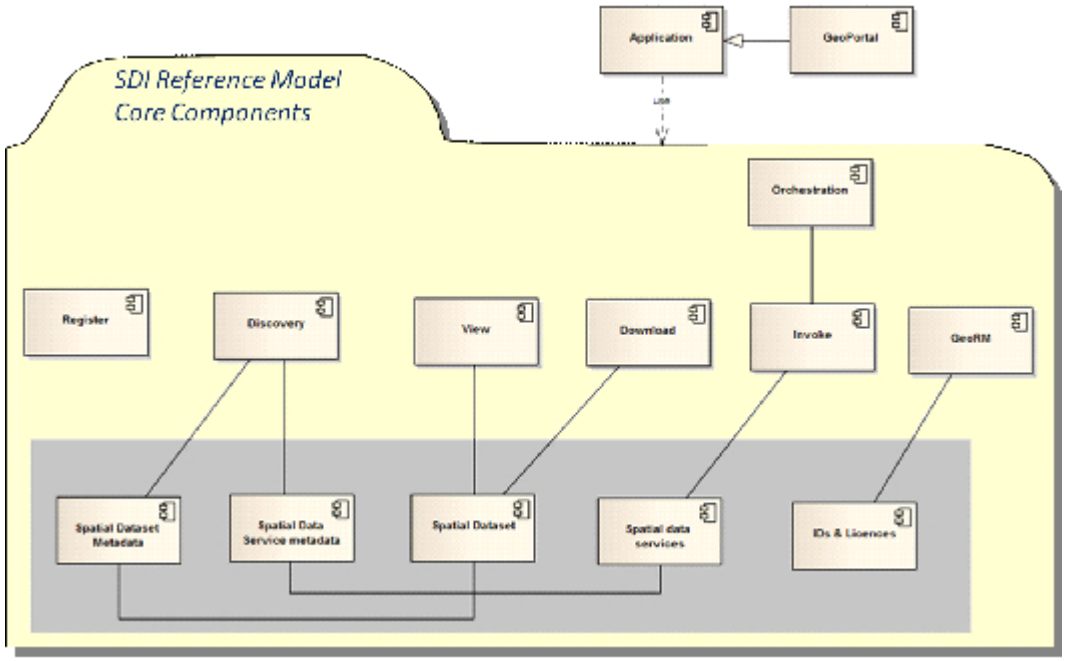

Figure 7 — Core Components of the SDI Reference Model

7.2 Application and Geo-portal components

A portal is a web-based application that provides content aggregation from different sources. The technologies underlying a portal should allow aggregating information provided by other web sites (e.g. html pages, jsp pages, XML + XSL documents) and in particular by services. Web services have standard interfaces, expose behaviour, and are granular (i.e. have specific well-defined functions), whereas web applications (and portals) are full blown browser-based applications that also include a user interface. Portals typically offer a search engine and links to useful pages, as well as news and electronic services.

The development of a portal occurs in three generic steps:

1) define the technological framework. There are currently many products, both commercial and open source, that can implement portal technology;

2) define the layout and information structure;

3) develop the aggregator of different services or web sources.

From the above it is clear that a geo-portal is a web application that aggregates geospatial information or geospatial services (and other, non-GI specific, information and services). This Technical Report does not regard particular applications (and therefore geo-portals) as a part of a SDI. However, they are the most interesting use-case for a SDI and actually are an important driver for SDI development, which justifies this sub section. A geo-portal is an application aggregating a number of instances of specific GI services, thereby integrating many a SDI component described in the previous clauses. The categories of geo-services that are included in a geo-portal may vary according to the user community and scope of the portal.

There are no specific rules for portal development, although in some countries public bodies are bound to national regulations regarding the creation of internet sites. An example of a specification that has found its way into e-government programmes is the Web Accessibility Initiative (WAI).

WAI is an initiative from W3C. It is stated in several e-government documents that electronic services in the near future will replace many of the manual proceeding for the citizens that today are handled by human beings. This requires specific focus on how these services should be implemented. The WAI describes strategies, guidelines, and resources to help make the web accessible to people with disabilities. These strategies and guidelines are further described in http://www.w3.org/WAI/.

Users of geographic information – and users of geo-portals - tend to have two major requirements:

4) they need to be able to see a map, and

5) they need to be able to interact with the map through use of a mouse or similar locator.

WAI does not mention GI-related matter at all, but it does provide indications on how to structure interaction with the user. For instance, WAI indicates to "provide client-side image maps instead of server-side image maps except where the regions cannot be defined with an available geometric shape" and in case of server-side implementations to "provide redundant text links for each active region of a server-side image map".

WAI does not mention the inability of some people to perceive differences between some or all colours, which has a greater impact than some technical issues like JavaScript-disabled browsers.

7.3 Relations among service components

The relations between the various service components are illustrated in Figure 8.

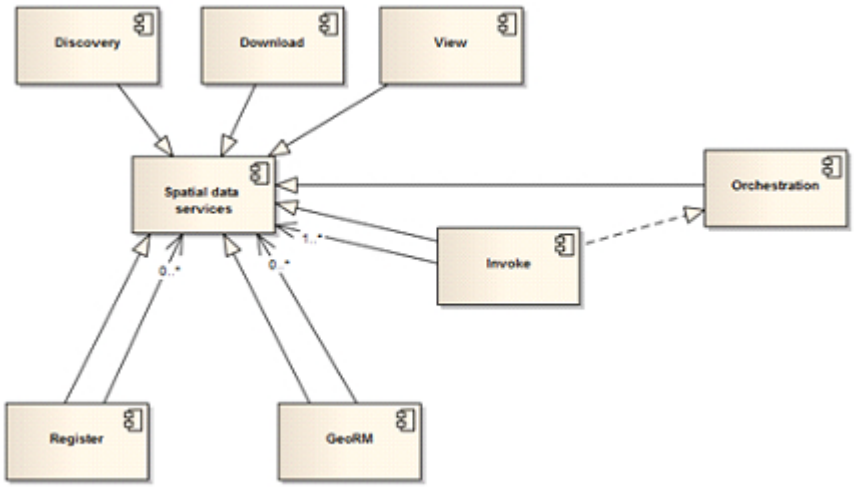

Figure 8 — Relations among the service components of the SDI Reference Model

Within a particular geospatial topic, each component can be specified focusing on the computational or information viewpoint (i.e. service centric or data centric approach).

Within a given topic and viewpoint, each component can be specified working out either an abstract model or an implementation specification – or both.

8 Standards to implement the Core components

8.1 Framework standards

ISO/TC 211 and OGC have developed several standards and specifications relevant to SDIs. These are listed in Annex D. Further details of ISO/TC 211 Standards can be found on their website: http://www.isotc211.org/ Further details of OGC standards and specifications can be found on their website: http://www.opengeospatial.org/standards

A framework standard is a standard that describes concepts that could be used to specify and define data and services in the context of a SDI. ISO/TC 211 and OGC have developed several framework standards and specifications.

NOTE 1 EN ISO 19115 is regarded a framework standard as it also contains information on how to extend the standard, making new metadata elements.

NOTE 2 ISO 19139 is listed as a framework document as it includes some UML extensions of EN ISO 19115 which should be considered as part of the framework. These are the extensions for the web, the multilingual extension, and the interchange by transfer.

8.2 Relevant standards

Tables D.1 and D.2 indicate which standards, projects, specifications and reports are considered to be framework standards.Table 4 shows standards relevant to the various aspects described above. These are described further in the annexes.

Table 4 — Relevant standards

Reference Model Core Component	Aspect	Other ISO 19100 relevant standards	Other International Standards and Specifications
Reference model	Geographic Human Interaction and Model/Information management	see Table D.1	
Data	Geographic Human Interaction and Model/Information management	see Table D.1	
Register	Geographic Human Interaction and Model/Information management	see Table D.1	ISO 11179
Discovery	Geographic Human Interaction and Model/Information management	see Table D.1	ISO 15836 OGC Catalogue Services Specification
View	Geographic Human Interaction and Model/Information management	see Table D.1	Tbd
Invoke	Geographic processing services	see Table D.1	ISO 11578 OGC Web processing Services Specification
Download	Geographic communication services	see Table D.1	tbd
GeoRM	Geographic System management services	see Table D.1	tbd
Orchestration and Composition	Geographic workflow/task management services management	see Table D.1	tbd

Annex A
(informative)
EU policy documents relevant to standardisation and interoperability

A.1 Introduction

This annex provides an overview of European Union (EU) policy documents, frameworks, and guidelines that are applicable to the general domain of standardisation and interoperability. These documents provide a context that may influence the current and future development of standards, technical reports, and guidelines relevant for an SDI.

This annex does not address thematic areas such as the environment, energy or transport.

A.2 Policy documents

- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions: A Digital Agenda for Europe - COM(2010)245/2 final

- Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions - Towards interoperability for European public services - COM(2010) 744 final

- Communication from the Commission to the European Parliament, the Council, and the European Economic and Social Committee - A strategic vision for European standards: Moving forward to enhance and accelerate the sustainable growth of the European economy by 2020 - COM(2010)0311

- COM(2010)308 final Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions “Action Plan on Global Navigation Satellite System (GNSS) Applications”

A.3 Strategy and framework documents

- European Interoperability Strategy

- European Interoperability Framework

NOTE 1 EU Member States have committed to apply the European Interoperability Framework at national level by 2013 .

NOTE 2 EU Member States to implement commitments on interoperability and standards in the Malmö and Granada Declarations by 2013.

NOTE 3 The Interoperability Solutions for European Pubic Services (ISA) programme (http://ec.europa.eu/isa) is an instrument aimed at implementing the policy, strategy and framework documents mentioned above.

Annex B
(informative)
Directive 2007/2/EC Infrastructure for Spatial Information in the European Community

B.1 General

This annex provides an overview of documents produced in the context of INSPIRE. All documents can be accessed through http://inspire.ec.europa.eu/. Note that some of these documents are under development.

B.2 Legal acts

Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) was published in the official Journal on the 25th April 2007. The INSPIRE Directive entered into force on the 15th May 2007/

- Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) 14.03.2007
- INSPIRE Metadata Regulation 03.12.2008
- Commission Decision regarding INSPIRE monitoring and reporting 05.06.2009
- Commission Regulation (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the Network Services 19.10.2009
- Corrigendum to INSPIRE Metadata Regulation 15.12.2009
- Regulation on INSPIRE Data and Service Sharing 29.03.2010
- Commission Regulation amending Regulation (EC) No 976/2009 as regards download services and transformation service 10.12.2010
- COMMISSION REGULATION implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services 10.12.2010
- COMMISSION REGULATION amending Regulation 1089/2010 as regards interoperability of spatial data sets and services 05.02.2011

B.3 Metadata Implementing Rules

B.3.1 Legal acts

- INSPIRE Metadata Regulation 03.12.2008
- Corrigendum to INSPIRE Metadata Regulation 15.12.2009

B.3.2 Guidance Documents

- INSPIRE Metadata Implementing Rules: Technical Guidelines based on EN ISO 19115 and EN ISO 19119 (Version 1.2) 16.06.2010

B.4 Data Specifications Implementing Rules

B.4.1 Legal acts

- COMMISSION REGULATION (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services

- Commission Regulation (EU) No 102/2011 of 4 February 2011 amending Regulation (EU) No 1089/2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services

The Data Specifications are published as Guidelines for the spatial data themes referred to in Annex I, II and III of the INSPIRE Directive and supplement the Implementing Rule for interoperability of spatial data sets and services and allow for preparation for implementation. Together with the relevant materials (GML application schemas, UML models and registries), they will support the implementation and provide a better understanding of the requirements of the Implementing Rule.

B.4.2 Guidance Documents

NOTE These Guidelines represent the status at the date of their publication.

B.4.2.1 Framework documents

- Guidelines for the Encoding of Spatial Data (D.2.7, Version 3.2) 02.08.2010

- INSPIRE Generic Conceptual Model (D 2.5, Version 3.3) 18.06.2010

- Definition of Annex Themes and Scope (D 2.3, Version 3.0) 03.10.2008

- Methodology for the development of data specifications: baseline version (D 2.6, Version 3.0)

- Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development - Draft Guidelines 22/06/2011

B.4.2.2 Annex I data specifications

- INSPIRE Data Specification on Administrative Units - Guidelines v3.0.1 03.05.2010

- INSPIRE Data Specification on Cadastral Parcels - Guidelines v 3.0.1 03.05.2010

- INSPIRE Data Specification on Geographical Names - Guidelines v 3.0.1 03.05.2010

- INSPIRE Data Specification on Hydrography - Guidelines v 3.0.1 03.05.2010

- INSPIRE Data Specification on Protected Sites - Guidelines v 3.1.0 03.05.2010

- INSPIRE Data Specification on Transport Networks - Guidelines v 3.1 03.05.2010

- INSPIRE Data Specifications on Addresses - Guidelines v 3.0.1 03.05.2010
- INSPIRE Specification on Coordinate Reference Systems - Guidelines v 3.1 03.05.2010
- INSPIRE Specification on Geographical Grid Systems - Guidelines v 3.0.1 03.05.2010

B.4.2.3 Annex II draft data specifications

- Data Specification on Geology – Draft Guidelines 26/08/2011
- Data Specification on Population distribution - demography – Draft Guidelines 13/07/2011
- Data Specification on Agricultural and Aquaculture Facilities – Draft Guidelines 22/06/2011
- Data Specification on Area management/restriction/regulation zones and reporting units – Draft Guidelines 22/06/2011
- Data Specification on Atmospheric Conditions and Meteorological Geographical Features – Draft Guidelines 22/06/2011
- Data Specification on Bio-geographical Regions – Draft Guidelines 22/06/2011
- Data Specification on Building – Draft Guidelines 22/06/2011
- Data Specification on Elevation – Draft Guidelines 22/06/2011
- Data Specification on Energy Resources – Draft Guidelines 22/06/2011
- Data Specification on Environmental Monitoring Facilities – Draft Guidelines 22/06/2011
- Data Specification on Habitats and Biotopes – Draft Guidelines 22/06/2011
- Data Specification on Human Health and Safety – Draft Guidelines 22/06/2011
- Data Specification on Land Cover – Draft Guidelines 22/06/2011
- Data Specification on Land Use – Draft Guidelines 22/06/2011
- Data Specification on Land Use – Draft Guidelines 22/06/2011
- Data Specification on Mineral Resources – Draft Guidelines 22/06/2011
- Data Specification on Natural Risk Zones – Draft Guidelines 22/06/2011
- Data Specification on Oceanographic Geographical Features – Draft Guidelines 22/06/2011
- Data Specification on Orthoimagery – Draft Guidelines 22/06/2011
- Data Specification on Production and Industrial Facilities – Draft Guidelines 22/06/2011
- Data Specification on SOIL – Draft Guidelines 22/06/2011
- Data Specification on Sea Regions – Draft Guidelines 22/06/2011
- Data Specification on Species Distribution – Draft Guidelines 22/06/2011

- Data Specification on Statistical Units – Draft Guidelines 22/06/2011
- Data Specification on Utility and governmental services – Draft Guidelines 22/06/2011

B.5 Network Services Implementing Rules

B.5.1 Legal acts

- Commission Regulation amending Regulation (EC) No 976/2009 as regards download services and transformation service 10.12.2010
- Commission Regulation (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the Network Services 19.10.2009

B.5.2 Guidance Documents

- Technical Guidance for the implementation of INSPIRE Discovery Services 30.03.2011
- Technical Guidance for the implementation of INSPIRE View Services 30.03.2011
- Technical Guidance for the INSPIRE Schema Transformation Network Service 15.12.2010
- Draft Technical Guidance for INSPIRE Coordinate Transformation Services 15.03.2010
- Draft Technical Guidance Download Services (version 2.0) 25.09.2009

B.6 Spatial Data Services Implementing Rules

- Position Paper on the Implementing Rules for INSPIRE Services allowing Spatial Data Services to be invoked (Invoke Spatial Data Services Services)

B.7 Data and service sharing Implementing Rules

B.7.1 Legal acts

- COMMISSION REGULATION (EU) No 268/2010 of 29 March 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the access to spatial data sets and services of the Member States by Community institutions and bodies under harmonised conditions

B.7.2 Guidelines and good practice documents

- INSPIRE Good practice in data and service sharing 31.01.2011
- Guidance on the 'Regulation on access to spatial data sets and services of the Member States by Community institutions and bodies under harmonised conditions' 03.12.2010

B.8 Monitoring and reporting Implementing Rules

B.8.1 Legal acts

- Corrigendum to Commission Decision 2009/442/EC of 5 June 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards monitoring and reporting (OJ L 148, 11.6.2009)

- 2009/442/EC: Commission Decision of 5 June 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards monitoring and reporting

B.8.2 Guidelines, justification document and templates

Several documents have been developed by the drafting team in order to support Member States in implementing this Commission Decision.

- Guidelines for filling in the Excel Template for Monitoring INSPIRE 18.02.2011

- INSPIRE Monitoring Indicators – Guidelines Document (version 5.0) 18.01.2011

- Template for monitoring INSPIRE 14.02.2011.

Annex C
(informative)
Description of referenced ISO standards

Table C.1 gives a description of the ISO projects not developed in ISO/TC 211 that are referenced in the Technical Report.

Table C.1 — Description of relevant non-GI standards

Standard, Initiative or project	Description
ISO 639, Codes for the representation of names of languages	Codes for the representation of names of languages Part 1: Alpha-2 code (2002); Part 2: Alpha-3 code (1998)
ISO/IEC 2382-1:1993, Information technology — Vocabulary — Part 1: Fundamental terms	First of a rather large series of standards on vocabulary.
ISO 3166, Countries and subdivisions	Codes for the representation of names of countries and their subdivisions Part 1: Country codes (1997); Part 2: Country subdivision code (1998); Part 3: Codes for formerly used names of countries (1999)
ISO 6709:(2008 Corrigendum1 2009), Standard representation of latitude, longitude and altitude for geographic point locations	Lat-Long encoding; specifies a syntax for expressing express latitude, longitude, and altitude values
ISO/IEC 10746, Information technology — Open distributed processing — Reference model	Reference Model of Open Distributed Processing (RM-ODP) Part 1: Overview (1998)
ISO/IEC 11179, Information technology — Metadata registries (MDR)	Information technology — Metadata registries (MDR) Part 3: Registry metamodel and basic attributes (2003); Part 5: Naming and identification principles for data elements (1995)
ISO/IEC 11578:1996, Information Technology - Open Systems Interconnection - Remote Procedure Call (RPC)	Facilitates the specification and development of distributed applications based on extending the well-known remote procedure call paradigm to operate between application processes on two separate real open systems in the OSI environment.
ISO/IEC 12087-5, Information technology — Computer graphics and image processing — Image Processing and Interchange (IPI) — Functional specification — Part 5: Basic Image Interchange Format (BIIF)	ISO Basic Image Interchange Format, or BIIF is used by the US National Imagery and Mapping Agency (NIMA) to support defence and intelligence operations. It is based on NIMA's National Image Transfer Format (NITF).

Standard, Initiative or project	Description
ISO/IEC/TR 14252, Information technology — Guide to the POSIX® Open System Environment (OSE)	Defines a general Open System Environment model.
ISO/IEC 15444, Information technology — JPEG 2000 image coding system	ISO/IEC 15444-1:2004 | ITU-T Rec. T.800 defines a set of lossless (bit-preserving) and lossy compression methods for coding bi-level, continuous-tone grey-scale, palletised colour, or continuous-tone colour digital still images. The first three parts are: Part 1: Core coding system (2004); Part 2: Extensions (2004); Part 3: Motion JPEG 2000 (2002)
ISO 15836, Information and documentation — The Dublin Core metadata element set	ISO 15836 is applicable to the Dublin Core metadata element set which deals with cross-domain information resource description. For Dublin Core applications, a resource will typically be an electronic document. ISO 15836 is for the element set only, which is generally used in the context of a specific project or application. Local or community based requirements and policies may impose additional restrictions, rules, and interpretations. It is not the purpose of ISO 15836 to define the detailed criteria by which the element set will be used with specific projects and applications.
ISO/PAS 16739, Industry Foundation Classes	Industry Foundation Classes (IFCs) have been endorsed by the International Standards Organisation as a Publicly Available Specification (PAS) under the ISO label ISO/PAS 16739.
ISO/IEC/TR 19764, Information technology — Guidelines, methodology and reference criteria for cultural and linguistic adaptability in information technology products	ISO/IEC TR 19764:2005 defines a methodology and a guided check-list for evaluation of cultural adaptability in software, hardware and other IT products. The check-list and guidelines are not only applicable to all IT products, but also can be expanded to meet the requirements of specific cultural environments.
ISO 23950, Information and documentation — Information retrieval (Z39.50) — Application service definition and protocol specification	ISO 23950 is identical in text to ANSI/NISO Z39.50-1995. The standard is one of a set of standards produced to facilitate the interconnection of computer systems. It is positioned with respect to other related standards by the Open Systems Interconnection (OSI) basic reference model (ISO 7498). It defines a protocol within the application layer of the reference model, and is concerned in particular with the search and retrieval of information in databases. The protocol specifies formats and procedures governing the exchange of messages between a client and server, thus enabling the client to (a) request that the server search a database and identify records that meet specified criteria, and (b) retrieve some or all of the identified records.
ISO/IEC JTC 1 Procedures, Annex E	The Directives for the technical work of JTC 1 give instructions for the procedures to be followed in the preparation of International Standards (IS), Technical Reports (TR), International Standardized Profiles (ISP) and International Workshop Agreements (IWA), and for the working methods to be used by JTC 1 and its subsidiary bodies. http://www.itscj.ipsj.or.jp/sc29/directives.pdf

Annex D
(informative)
CEN/TC 287 and ISO/TC 211 standards

Table D.1 shows for each relevant CEN/TC 287 and ISO/TC 211 standard, report or project what topics it addresses. European Standards (ENs) are listed in bold typeface. Please note that the table is only indicative, and that it serves as a guide to quickly identify relevant documents. By virtue of the model driven approach adopted by ISO/TC 211 (and at the same token by CEN/TC 287), all standards are related.

Table D.1 — Relevant CEN and ISO standards

Standard or project	Reference Model	Data	Register	Metadata and Discovery services	View services	Download services	Invoke services	GeoRM	Orchestration and composition
EN ISO 19101, Geographic information — Reference model.	X	X	X	X	X		X	X	X
ISO/TS 19101-2, Reference model - Part 2: Imagery	X	X		X					
ISO/TS 19103, Geographic information — Conceptual schema language	X	X							
ISO/TS 19104, Geographic information — Terminology	X								
EN ISO 19105, Geographic information — Conformance and testing	X	X		X	X		X		X
EN ISO 19106, Geographic information — Profiles	X	X		X	X		X		
EN ISO 19107, Spatial schema (identical to OGC topic 1, feature geometry)	X	X		X	X		X		
EN ISO 19108, Geographic information — Temporal schema		X		X			X		
EN ISO 19109, Geographic information — Rules for application schema	X	X					X		
EN ISO 19110, Geographic information — Feature cataloguing methodology	X	X	X	X			X		
EN ISO 19111, Geographic information — Spatial referencing by co-ordinates	X	X		X			X		X
ISO 19111-2, Spatial referencing by coordinates - Part 2: Extension for parametric values	X	X		X	X		X		X
EN ISO 19112, Geographic information — Spatial referencing by geographic identifiers	X	X		X	X		X		
EN ISO 19113, Geographic information — Quality principles	X	X							
EN ISO 19114, Geographic information — Quality evaluation procedures		X		X			X		

Standard or project	Reference Model	Data	Register	Metadata and Discovery services	View services	Download services	Invoke services	GeoRM	Orchestration and composition
EN ISO 19115, Geographic information — Metadata	X	X	X	X			X		X
ISO 19115-2 Metadata - Part 2: Extensions for imagery and gridded data	X	X		X			X		X
EN ISO 19116, Geographic information — Positioning services							X		
EN ISO 19117, - Geographic information — Portrayal (To be amended to be useful for SDI development)	X			X	X				
EN ISO 19118, Geographic information — Encoding	X	X		X		X	X		
EN ISO 19119, Geographic information — Services	X			X	X		X		X
ISO/TR 19121 Geographic information - Imagery and gridded data	X	X		X			X		X
EN ISO 19123, Geographic information — Schema for coverage geometry and functions		X					X		
EN ISO 19125-1, Geographic information — Simple feature access — Common architecture		X					X		X
EN ISO 19125-2, Geographic information — Simple feature access — SQL option		X					X		X
EN ISO 19126 Geographic information -- Feature concept dictionaries and registers.	X	X	X			X			
ISO/TS 19127 Geographic information — Geodetic codes and parameters									
EN ISO 19128, Geographic information — Web map server interface					X	X	X		
ISO/TS 19129 – Imagery, gridded data framework	X	X		X			X		X
EN ISO 19131, Geographic information — Data product specification		X							
EN ISO 19132, Geographic information — Location based services possible standards							X		
EN ISO 19133, Geographic information — Location based services tracking and navigation							X		
EN ISO 19134, Geographic information — Location based services — Multimodal routing and navigation							X		
EN ISO 19135, Geographic information — Procedures for registration of geographic information items	X		X						
EN ISO 19136, Geographic information — Geography Markup Language (GML)		X		X			X		X

Standard or project	**Reference Model**	**Data**	**Register**	**Metadata and Discovery services**	**View services**	**Download services**	**Invoke services**	**GeoRM**	**Orchestration and composition**
EN ISO 19137, Geographic information — Core profile of the spatial schema		X							
ISO/TS 19138, Geographic information — Data Quality Measures		X		X					
ISO/TS 19139, Geographic information — Metadata — Implementation specification	X			X					
EN ISO 19141, Geographic information — Schema for moving features		X							
EN ISO 19142, Geographic information — Web feature service		X		X	X	X	X		
EN ISO 19143, Geographic information — Filter encoding		X		X	X	X	X		
EN ISO 19144-1, Geographic information - Classification systems - Part 1: Classification system structure	X	X							
EN ISO 19146 Geographic information – Cross-domain vocabularies	X		X						

Annex E
(informative)
Open Geospatial Consortium specifications

Table E.1 shows for each OGC specification what topics it addresses.

Table E.1 — Relevant OGC Abstract Specifications

Specification or report	Reference Model	Data	Register	Metadata and Discovery services	View services	Download services	Invoke services	GeoRM	Orchestration and composition
Topic 0 - Overview	X								
Topic 1 - Feature Geometry (identical to ISO 19107)		X							
Topic 2 - Spatial Referencing by coordinates (Identical to ISO 19111)		X							
Topic 3 - Locational Geometry Structures		X							
Topic 4 - Stored Functions and Interpolation		X							
Topic 5 - Feature		X							
Topic 6 - Schema for coverage geometry and functions		X							
Topic 7 - Earth Imagery (includes ISO 19124, ISO/TS 19129, ISO/TS 19130 plus additional material)		X							
Topic 8 - Relationships Between Features		X							
Topic 10 - Feature Collections		X							
Topic 11 - Metadata				X					

Specification or report	Reference Model	Data	Register	Metadata and Discovery services	View services	Download services	Invoke services	GeoRM	Orchestration and composition
Topic 12 - The OpenGIS Service Architecture	X				X	X	X		
Topic 13 - Catalogue Services			X						
Topic 14 - Semantics and Information Communities	X								
Topic 15 - Image Exploitation Services					X		X		
Topic 16 - Image Coordinate Transformation Specification		X			X	X			
Topic 18 - Geospatial Digital Rights Management Reference Model								X	
Topic 20 – Observations and Measurements (identical to ISO 19156)	X	X							

Table E.2 — OG Implementation specifications

Specification or report	Reference Model	Data	Register	Metadata and Discovery services	View services	Download services	Invoke services	GeoRM	Orchestration and composition
OGC Catalogue Service Implementation Specification				X					
OGC City GML		X							
OGC Coordinate Transformation Service Implementation Specification							X		
OGC Filter Encoding					X				
OGC Geography Markup Language (GML 3.0) Encoding Standard		X				X	X		
OGC KML		X							
OGC Simple Features Implementation Specification for OLE/COM		X				X			
OGC Simple Features Implementation Specification for CORBA		X				X			
OGC Simple Features Implementation Specification for SQL		X				X			
OGC Web Map Service Interface (WMS) Specification					X				
OGC Web Feature Service Implementation Specification (WFS)		X		X		X			
OGC Web Processing Service (WPS)						X	X		
OGC Styled Layer Descriptor Implementation Specification (SLD)					X				
OGC Web Coverage Server (WCS) Specification		X			X				
OGC Styled Layer Descriptor Profile of the Web Map Service Implementation Specification					X				

Specification or report	Reference Model	Data	Register	Metadata and Discovery services	View services	Download services	Invoke services	GeoRM	Orchestration and composition
Catalogue Services Standard 2.0 Extension Package for ebRIM Application Profile: Earth Observation Products			X						
GeoAPI 3.0 Implementation Standard							X		
Georeferenced Table Joining Service Implementation Standard		X					X		
Geospatial eXtensible Access Control Markup Language (GeoXACML) Corrigendum 1.0.1	X								
GML in JPEG 2000 for Geographic Imagery Encoding Specification		X							
Observations and Measurements - XML Implementation	X	X							
Location Services (OpenLS): Tracking Service Interface Standard		X					X		
Network Common Data Form (NetCDF) Core Encoding Standard	X	X							
OGC Web Service Common Implementation Specification	X								
Open GeoSMS		X							
Order Service for Earth Observation Products						X			
Sensor Model Language (SensorML)		X							
Sensor Planning Service Implementation Standard					X				
Sensor Observation Service		X		X					
SWE Service Model Implementation Standard	X								
SWE Common Data Model Encoding Standard	X								

Specification or report	Reference Model	Data	Register	Metadata and Discovery services	View services	Download services	Invoke services	GeoRM	Orchestration and composition
Symbology Encoding Implementation Specification					X				
Web Coverage Service 2.0 Interface Standard - KVP Protocol Binding Extension 1.0		X							
Web Coverage Service 2.0 Interface Standard - XML/POST Protocol Binding Extension 1.0		X							
Web Coverage Service 2.0 Interface Standard - XML/SOAP Protocol Binding Extension 1.0	X						X		
Web Coverage Processing Service (WCPS) Language Interface Standard	X						X		
Web Map Context Implementation Specification	X	X		X	X				
Web Map Tile Service Implementation Standard		X			X				

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British Standards Institution (BSI)

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