INSPIRE
Infrastructure for Spatial Information in Europe

# INSPIRE Generic Conceptual Model

| | |
|---|---|
| **Title** | D2.5: Generic Conceptual Model, Version 3.0 |
| **Status** | “Baseline version”] |
| **Creator** | Drafting Team "Data Specifications" |
| **Date** | 2008-06-20 |
| **Subject** | Generic Conceptual Model of the INSPIRE data specifications |
| **Publisher** | Drafting Team "Data Specifications" |
| **Type** | Text |
| **Description** | Baseline version of the Generic Conceptual Model of the INSPIRE data specifications |
| **Contributor** | Members of the INSPIRE Drafting Team "Data Specifications", INSPIRE Spatial Data Interest Communities & Legally Mandated Organisations, INSPIRE Consolidation Teams and other Drafting Teams |
| **Format** | MS Word (doc) |
| **Source** | Drafting Team "Data Specifications" |
| **Rights** | Public |
| **Identifier** | D2.5_v3.0.doc |
| **Language** | En |
| **Relation** | n/a |
| **Coverage** | Project duration |

# Table of contents

# Foreword

INSPIRE is a Directive proposed by the European Commission in July 2004 setting the legal framework for the establishment of the Infrastructure for Spatial Information in the European Community, for the purposes of Community environmental policies and policies or activities which may have an impact on the environment.

INSPIRE will be based on the infrastructures for spatial information that are created and maintained by the Member States. The components of those infrastructures include: metadata, spatial data themes (as described in Annexes I, II, III of the Directive), spatial data services; network services and technologies; agreements on data and service sharing, access and use; coordination and monitoring mechanisms, processes and procedures.

The guiding principles of INSPIRE are that the infrastructures for spatial information in the Member States will be designed to ensure that spatial data are stored, made available and maintained at the most appropriate level; that it is possible to combine spatial data and services from different sources across the Community in a consistent way and share them between several users and applications; that it is possible for spatial data collected at one level of public authority to be shared between all the different levels of public authorities; that spatial data and services are made available under conditions that do not restrict their extensive use; that it is easy to discover available spatial data, to evaluate their fitness for purpose and to know the conditions applicable to their use.

The text of the INSPIRE Directive is available from the INSPIRE web site (http://www.ec-gis.org/inspire). The Directive identifies what needs to be achieved, and Member States have two years from the date of adoption to bring into force national legislation, regulations, and administrative procedures that define how the agreed objectives will be met taking into account the specific situation of each Member State. To ensure that the spatial data infrastructures of the Member States are compatible and usable in a Community and transboundary context, the Directive requires that common Implementing Rules (IR) are adopted in a number of specific areas. Implementing Rules are adopted as Commission Regulations and are binding in their entirety. The Commission is assisted in the process of adopting such rules by a regulatory committee composed by representatives of the Member States and European Parliament[1]. The Committee is chaired by a representative of the Commission (this is known as the Comitology procedure). The committee was established on 15 August 2007.

The IR will be shaped in their legal structure and form by the Commission legal services on the basis of technical documents prepared by especially convened Drafting Teams, for each of the main components of INSPIRE: metadata, data specifications, network services, data and service sharing, and monitoring procedures. For data specifications, the technical documents for each spatial data theme will be prepared by especially convened Thematic Working Groups.

This document represents a contribution of the Data Specification Drafting Team.

The previous version of this document (version 2.0) was published on the INSPIRE web site for public view and commenting by registered SDICs and LMOs. 1176 comments were received and resolved to produce this version. The comment resolution process included a workshop with representatives of SDICs and LMOs. Based on the discussions, the Drafting Team "Data Specifications" proposed comment resolutions that were reviewed by the Consolidation Team. The table containing the comments and the resolution is available on the INSPIRE web-site http://www.ec-gis.org/inspire/reports/ImplementingRules/DataSpecifications/D2_5_Comments-Resolutions-17062008.pdf
This baseline version (version 3.0) is published on the INSPIRE web site and will be used by the Thematic Working Groups to prepare the data specifications for the IR for the interoperability for

[1] The implementing rules for interoperability of spatial data are formally adopted through regulatory procedure with scrutiny according to Council Decision of 17 July 2006 (2006/512/EC). Under this regulation, the Parliament and the Council are on equal footing for all regulatory procedures related to co-decision acts. As a consequence, all measures must be ratified by all three institutions to come into force.

spatial data sets and services. It is expected that the Generic Conceptual Model will be updated during the data specification development process, if requirements for changes are identified.

It is important to note that this document is not a draft Implementing Rule, but a document that is a basis for the development of the thematic data specifications that will serve as technical basis for the legal text of the INSPIRE Implementing Rules. It is foreseen that the Generic Conceptual Model, or at least its requirements, will be normatively referenced from the Implementing Rules.

# Introduction

This document contains the baseline version of the INSPIRE Generic Conceptual Model for INSPIRE (document identifier: D2.5).

One of the main tasks of the INSPIRE programme is to enable the interoperability and, where practicable, harmonisation of spatial data sets and services within Europe. Here, it is important to note that interoperability has to go beyond any particular community, but take the various cross-community information needs into account. If one takes a look at the huge difference in the scope of the different themes (from reference systems to hydrography and from cadastral parcel to atmospheric conditions), the question does arise about the specific requirements of and for interoperability and harmonisation of the geographic information. These were also the questions faced by the Drafting Team "Data Specification" and one of the contributions of the Drafting Team is the identification of a set of *interoperability components*, which make the concepts of interoperability and harmonisation more tangible. Examples of interoperability components addressed in this document are: rules for application schemas, coordinate referencing and units model, identifier management, multi-lingual text and cultural adaptability, object referencing modelling, multiple representations (levels of detail) and consistency, and more. All these components do apply to (nearly) all themes identified within INSPIRE and this document describes approaches to these shared components. The result is the so-called Generic Conceptual Model. Using the Generic Conceptual Model within the different themes will therefore result in a first level of interoperability.

It is important to note that “interoperability” is understood as providing access to spatial data sets as specified in Article 4 of the Directive through network services in a representation that allows for combining them with other such spatial data sets in a coherent way. This includes agreements about the different interoperability components. In other words, by enabling interoperability data can be used coherently, independent of whether the existing data set is actually changed (harmonised) or “just” transformed by a download service for publication in INSPIRE depending on the approach taken by the Member State. It is expected that these agreements will be based on existing data interoperability or harmonisation activities, whenever feasible and in-line with the environmental requirements.

The first two components mentioned under Annex I (coordinate reference system and geographical grid systems) are special in that they are not represented by spatial objects, but provide basic concepts so that spatial objects in the other themes can be referenced spatially. As a result, core aspects of these two themes are already modelled as part of this document.

The starting point for the development of the generic conceptual model is the input delivered by the LMOs and SDICs with their domain knowledge translated into requirements for the Generic Conceptual Model. Further and more specifically the foundation is formed by the internationally accepted standards reflecting the collective state-of-the-art knowledge (such as the reference model described in ISO 19101).

The individual themes (as defined in the Annexes I, II and III of the Directive and refined in document D2.3 'Definition of Annex Themes and Scope') will be modelled based on this Generic Conceptual Model. In document D2.6 'Methodology for the development of data specifications' the process will be specified how this should be done. The result will then be data product specifications for the individual themes, i.e. conceptual information models that describe the relevant classes, their attributes, relationships, constraints, and possibly also operations as well as other appropriate information like data capturing information or data quality requirements. Care has to be taken that common or shared spatial object types relevant in multiple themes are identified and modelled in a consistent manner. This could then be considered a second level of interoperability: agreement on the shared (formal) semantics between the different themes. Note that the spatial characteristics of a spatial object will be represented by vector geometries, coverage functions and/or references to gazetteer entries.

How the geographic information will actually be encoded for the transfer process will be described in document D2.7 ‘Guidelines for the encoding of spatial data’ (the third level of geographic information interoperability).

The Generic Conceptual Model is applicable for INSPIRE data specifications. It is not required that it will be applied for the modelling of data specifications at the national level. What is important is that each member state is able to transform existing data sets to the INSPIRE data specifications and publish the transformed data via network services. On the other hand, this conceptual model is expected to influence in many cases the modelling activities at the national level, because it adds value to the national spatial data infrastructure and simplifies transformation to the INSPIRE data specifications.

Besides the documents D2.3, D2.6, D2.7 and D2.8.m.n[2], this document is also related to other INSPIRE documents and registers:

- The terms used in this document are drawn from the "INSPIRE Glossary".
- INSPIRE application schemas will be based on the Generic Conceptual Model and maintained in the "Consolidated INSPIRE UML model" that also includes the external schemas, for example, the harmonised model of the ISO 19100 series published by ISO/TC 211. INSPIRE application schemas will be developed for every theme listed in the annexes of the INSPIRE Directive.
- The "INSPIRE Feature Concept Dictionary Register" is used to manage the names, definitions and descriptions of all spatial object types used in INSPIRE application schemas. In the future, the register may be extended to manage properties, too.
- Other registers include a coordinate reference system register, a feature catalogue register and a code list register.
- The implementing rule on metadata and associated guidelines.
- The implementing rules on network services and associated guidelines

Figure 1 below illustrates relationships from the point of view of the data specifications. The boxes denote INSPIRE Implementing Rule documents or supporting documents, the cylinders registries. The arrows denote dependencies, the areas with dashed boundaries denote areas of responsibility.

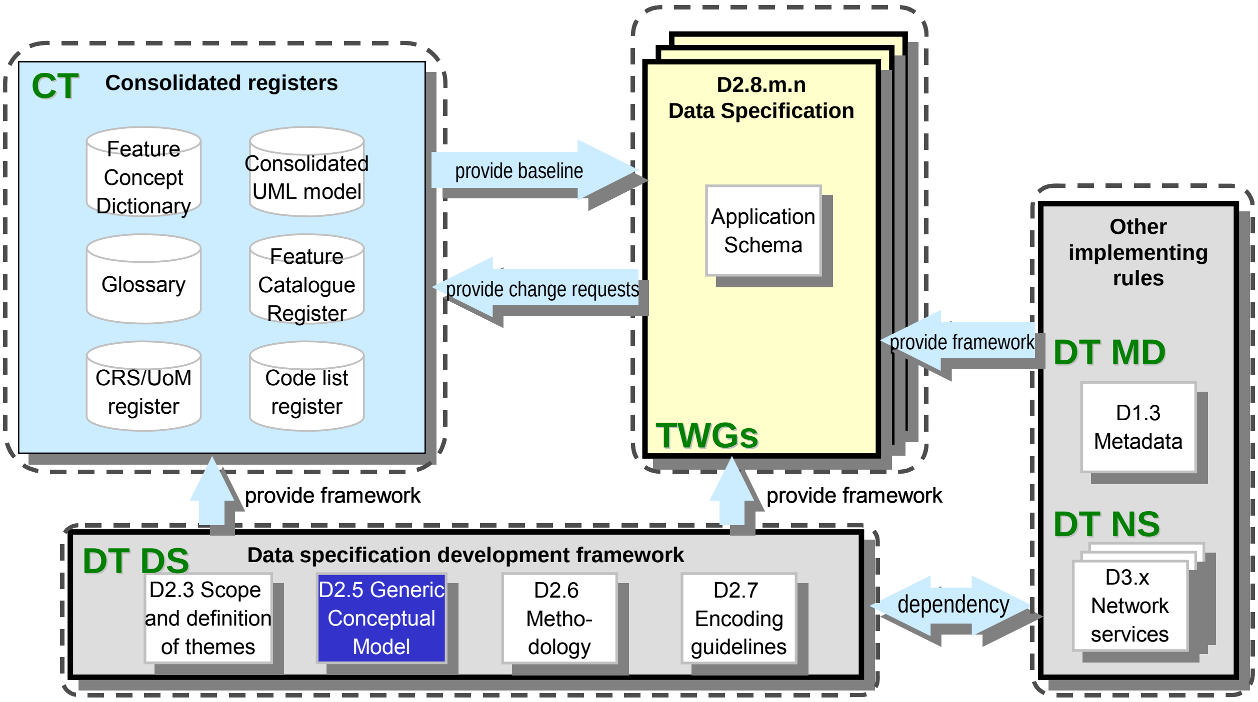



**Figure 1 – The Generic Conceptual Model as part of the data specification development framework**

Since the conceptual modelling framework of INSPIRE is based in the ISO 19100 series of International Standards, in-depth knowledge about this series is required in every team developing an INSPIRE data specification.

[2] "m" is the number of the annex and "n" the sequential number of the theme within the annex.

# 1 Scope

This document specifies the Generic Conceptual Model for INSPIRE.

It provides a framework within which harmonised data specifications for the spatial data themes listed in the Annexes of the INSPIRE Directive will be developed. Within scope are requirements and recommendations in particular regarding the following aspects:

- INSPIRE application schemas
- spatial and temporal representations of spatial objects across different levels of detail
- spatial and temporal relationships between spatial objects
- unique object identifiers
- constraints
- reference to common spatial and temporal reference systems
- controlled vocabularies
- support for multilingual aspects

The specification of theme-specific spatial object types or properties is out of scope for this document.

The first two themes of Annex I of the INSPIRE Directive (coordinate reference systems and geographical grid systems) are special in that they are not represented by thematic spatial objects, but provide basic concepts so that spatial objects in the other themes can be referenced spatially. As a result, core aspects of these two themes are within scope of this document, too.

This document is applicable to the Thematic Working Groups developing the INSPIRE data specifications that will become the technical basis for the legal text of the INSPIRE Implementing Rules for the interoperability of spatial data sets and services.

This document does not provide a methodology and process for developing harmonised data specifications for INSPIRE. It also does not specify how spatial data will be encoded.

# 2 Normative references

EN ISO 19101:2005, Geographic information — Reference model

ISO/TS 19103:2005, Geographic Information — Conceptual schema language

EN ISO 19107:2005, Geographic information — Spatial schema

EN ISO 19108:2005, Geographic information — Temporal schema

EN ISO 19109:2006, Geographic Information — Rules for application schemas

EN ISO 19110:2006, Geographic information — Methodology for feature cataloguing

EN ISO 19111:2007, Geographic Information – Spatial referencing by coordinates

ISO 19111-2:--[3], Geographic Information – Spatial referencing by coordinates – Part 2: Extension for parametric value

EN ISO 19112:2005, Geographic information — Spatial referencing by geographic identifiers

EN ISO 19115:2005, Geographic information — Metadata

ISO 19115:2003/Cor 1:2006, Geographic information — Metadata — Technical Corrigendum 1

EN ISO 19123:2007, Geographic information — Schema for coverage geometry and functions

[3] to be published, currently in “Committee Draft” stage

OGC 06-103r3, Implementation Specification for Geographic Information - Simple feature access - Part 1: Common Architecture v1.2.0

NOTE This is an updated version of "EN ISO 19125-1:2006, Geographic information – Simple feature access – Part 1: Common architecture". A revision of the EN ISO standard has been proposed.

prEN ISO 19126:--[4], Geographic Information – Feature concept dictionary and registers

ISO 19131:2007, Geographic Information – Data Product Specification

EN ISO 19135:2007, Geographic information — Procedures for item registration

ISO 19136:2007, Geographic Information – Geography Markup Language

ISO/TS 19139:2007, Geographic Information – Metadata – XML Schema implementation

UML 2.1.2, Unified Modelling Language (UML) Superstructure and Infrastructure, Version 2.1.2

# 3 Terms and abbreviations

## *3.1 Terms*

The terms in this sub-clause are taken from the “Glossary of Generic Geographic Information Terms in Europe” that specifies the terminology used in the INSPIRE Implementing Rule documents. The glossary is managed as a register in accordance with ISO 19135. It is published on the INSPIRE website: http://www.ec-gis.org/inspire/ds/

**(1) application schema**
**conceptual schema** for data required by one or more applications [ISO 19101]

**(2) class**
description of a set of **objects** that share the same properties, constraints, and semantics [UML 2.1.2 - modified]

**(3) code list**
value domain including a code for each permissible value [ISO 19136]

**(4) conceptual model**
model that defines concepts of a universe of discourse [ISO 19101]

**(5) conceptual schema**
formal description of a **conceptual model** [ISO 19101]

EXAMPLE ISO 19107 contains a formal description of geometrical and topological concepts using the conceptual schema language UML.

**(6) conceptual schema language**
formal language based on a conceptual formalism for the purpose of representing **conceptual schemas** [ISO 19101]

EXAMPLE UML, EXPRESS, ORM and INTERLIS are examples of conceptual schema languages.

**(7) coordinate reference system**
systems for uniquely referencing spatial information in space as a set of coordinates (x,y,z)

---

[4] to be published, currently in “Draft International Standard” stage

and/or latitude and longitude and height, based on a geodetic horizontal and vertical datum [INSPIRE Directive]

NOTE 1 ISO 19111 defines coordinate reference system as a coordinate system that is related to an object by a datum. For geodetic and vertical datums, the object will be the Earth.

EXAMPLE 1 A national coordinate system with the datum ETRS89.

NOTE 2 Although the definition in the INSPIRE Directive is strictly seen restricted to spatial reference systems, temporal and parametric coordinate reference systems are nevertheless understood within INSPIRE as covered by the term coordinate reference systems as well, because temporal information has to be associated with a reference system just like spatial information. ISO 19111 also recognises temporal reference systems explicitly and provides mechanisms to specify spatio-temporal coordinate reference systems. A revision of ISO 19108 is foreseen to specify the conceptual model for temporal coordinate reference systems. Parametric coordinate reference systems are currently being standardised in ISO 19111-2.

EXAMPLE 2 The Gregorian calendar is a temporal reference system.

**(8) coverage**
**spatial object** that acts as a function to return values from its range for any direct position within its spatial, temporal or spatiotemporal domain [ISO 19123 - modified]

EXAMPLE Orthoimage, digital elevation model (as grid or TIN), point grids etc

**(9) data interoperability component**
individual aspect that will be addressed to support the **interoperability** of **spatial data sets**

EXAMPLE Rules for application schemas, identifier management, terminology, etc. are examples of the components.

**(10) data interoperability process**
process of developing **harmonised data product specifications** and implementing the necessary arrangements to transform **spatial data** into **interoperable spatial data**

NOTE Two general options exist: The reference version of the spatial data set may either be changed/restructured itself (“harmonised”) or it may be kept as-is and the transformation may occur on-the-fly whenever a spatial data service operating on the spatial data set is invoked. In cases where the location of a spatial object has to be changed to comply with Article 10 (2), it is expected that the location information in the reference version of the spatial data set is updated to reflect the mutual consent.

**(11) data product**
**data set** or data set series that conforms to a **data product specification** [ISO 19131]

**(12) data product specification**
detailed description of a **data set** or data set series together with additional information that will enable it to be created, supplied to and used by another party [ISO 19131]

**(13) data set**
identifiable collection of data [ISO 19115]

**(14) data specification**
(used as a synonym to data product specification)

NOTE If the context is unambiguous, “data specification” is often used instead of “INSPIRE data specification” to improve readability.

**(15) entity**
real-world phenomenon

**(16) enumeration**
data type whose values are enumeration literals [UML 2.1.2 - modified]

**(17) endonym**
name of a **spatial object** in one of the languages occurring in that area where the **spatial object** is situated [UNGEGN Glossary of Terminology - modified]

**(18) exonym**
name used in a specific language for a **spatial object** situated outside the area where that language is spoken, and differing in its form from the name used in an official or well-established language of that area where the **spatial object** is located [UNGEGN Glossary of Terminology - modified]

**(19) external object identifier**
**unique object identifier** which is published by the responsible body, which may be used by external applications to reference the **spatial object**

**(20) feature**
abstraction of real world phenomena [ISO 19101]

NOTE The term "(geographic) feature" as used in the ISO 19100 series of International Standards, in other specifications like IHO S-57, and in this document is synonymously with **spatial object** as used in this document. Unfortunately "spatial object" is also used in the ISO 19100 series of International Standards, however with a different meaning: a spatial object in the ISO 19100 series is a spatial geometry or topology.

**(21) feature catalogue**
catalogue(s) containing definitions and descriptions of the **spatial object types**, their attributes and associated components occurring in one or more **spatial data sets**, together with any operations that may be applied [ISO 19110 – modified]

**(22) feature concept**
concept that may be specified in detail as one or more **spatial object types** [ISO/DIS 19126 – modified]

EXAMPLE The feature concept 'road' may be used to specify several different spatial object types, each with a different set of properties appropriate for a particular application. For a travel planning application, it might have a limited set of attributes such as name, route number, location and number of lanes, while for a maintenance application it might have an extensive set of attributes detailing the structure and composition of each of the layers of material of which it is composed.

**(23) feature concept dictionary**
dictionary that contains definitions of and related descriptive information about concepts that may be specified in detail in a **feature catalogue** [ISO/DIS 19126]

**(24) gazetteer**
directory of instances of a class or classes of features containing some information regarding position [ISO 19112]

NOTE A gazetteer can be considered as a geographical index or directory.

**(25) general feature model**
meta-model for **spatial object** types and their property types specified by ISO 19109

**(26) geographic identifier**
spatial reference in the form of a label or code that identifies a location [ISO 19112]

EXAMPLE 1 Place names: Paris, Rhine, Mont Blanc

EXAMPLE 2 Postal codes: 53115, 01009, SW1, IV19 1PZ

**(27) geographical grid system**
harmonised multi-resolution grid with a common point of origin and standardised location and size of grid cells [INSPIRE Directive]

NOTE 1 Geographical grid systems are not limited to rectified grids or grids using cell axes parallel to the meridians.

NOTE 2 This document adopts the definition of the 2003 Workshop on European Reference Grids, which includes not only the grid describing the domain of a coverage but also its range. Thus, a 'geographical grid' is equivalent to an ISO 19123 coverage. The unqualified term 'grid' may refer either to a grid geometry or a geographical grid (coverage) depending on the context.

**(28) geographical name**
Proper noun applied to a topographic **spatial object** on Earth [UNGEGN Glossary of Terminology - modified]

**(29) harmonised data product specifications**
set of **data product specifications** that support the provision of access to **interoperable spatial data** through spatial data services in a representation that allows for combining it with other **interoperable spatial data** in a coherent way

NOTE 1 The harmonised data product specifications will be based on the data interoperability components.

NOTE 2 The harmonised data product specification is not intended to replace or deprecate existing data specifications that are currently in use.

**(30) homologous spatial objects**
set of **spatial objects** that correspond to the same real-world phenomenon, but are described by different information according to the different levels of details or point of views

**(31) identifier**
linguistically independent sequence of characters capable of uniquely and permanently identifying that with which it is associated [ISO 19135]

**(32) INSPIRE application schema**
**application schema** specified in an INSPIRE data specification

**(33) INSPIRE data specification**
**harmonised data product specification** for a **theme** adopted as an Implementing Rule

**(34) internal object identifier**
**unique object identifier** which is used internally and is not intended to be used to identify or reference the **spatial object** by external applications

**(35) interoperability**
possibility for spatial data sets to be combined, and for services to interact, without repetitive manual intervention, in such a way that the result is coherent and the added value of the data sets and services is enhanced [INSPIRE Directive]

**(36) interoperable spatial data**
**spatial data** conformant to the **harmonised data product specifications**

**(37) life-cycle information <spatial object>**
set of properties of a **spatial object** that describe the temporal characteristics of a **version** of a **spatial object** or the changes between **versions**

**(38) life-cycle rules <spatial object>**
rules that specify the types of changes to a **spatial object** that result in either the creation of a new **version** or in the deletion / retirement of the **spatial object**

**(39) linear reference system**
reference system that identifies a location by reference to a segment of a linear **spatial object** and distance along that segment from a given point [ISO 19116 - modified]

EXAMPLE kilometre markers along a motorway or railway, references along the centre line of a river spatial object from the intersection with a bridge spatial object

NOTE synonymous with linear referencing system

**(40) linguistic text**
text consisting of or related to language

**(41) metadata**
information describing **spatial data sets** and spatial data services and making it possible to discover, inventory and use them [INSPIRE Directive]

NOTE A more general definition provided by ISO 19115 is "data about data"

**(42) multicultural**
multiplicity in systems of values held by different groups: ethnic, regional, or professional [Hofstede G. 1980. Culture's Consequences, Sage: London – modified]

**(43) multilingual**
in or using several languages [Oxford Dictionary]

**(44) multiple representation**
representation of the relationship between **homologous spatial objects**

**(45) object**
*in this document used synonymous with **spatial object***

**(46) object referencing**
consistent method of referencing **spatial data** to location using existing **spatial objects**

**(47) ontology**
representation of a set of concepts within a domain and the relationships between those concepts [Wikipedia]

**(48) profile**
set of one or more base standards or subsets of 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 [ISO 19106]

NOTE A profile is derived from base standards so that by definition, conformance to a profile is conformance to the base standards from which it is derived.

**(49) reference data**
**spatial objects** that are used to provide location information in **object referencing**

NOTE Typical reference data are topographic or cadastral data.

**(50) reference model**
architectural framework for a specific context, e.g. an application or an information infrastructure

EXAMPLE ISO 19101 and the OGC Reference Model are reference models

**(51) register**
set of files containing identifiers assigned to items with descriptions of the associated items [ISO 19135]

**(52) registry**
information system on which a **register** is maintained [ISO 19135]

**(53) spatial data**
data with a direct or indirect reference to a specific location or geographic area [INSPIRE Directive]

NOTE The use of the word “spatial” in INSPIRE is unfortunate as in the everyday language its meaning goes beyond the meaning of “geographic” – which is considered by the Drafting Team as the intended scope – and includes subjects such as medical images, molecules, or other planets to name a few. However, since the term is used as a synonym for geographic in the Directive, this document uses the term “spatial data” as a synonym for the term “geographic data” used by the ISO 19100 series of International Standards and which is defined as “data with implicit or explicit reference to a location relative to the Earth.”

**(54) spatial data set**
identifiable collection of spatial data [INSPIRE Directive]

**(55) spatial object**
abstract representation of a real-world phenomenon related to a specific location or geographical area [INSPIRE Directive]

NOTE It should be noted that the term has a different meaning in the ISO 19100 series. It is also synonymous with "(geographic) feature" as used in the ISO 19100 series.

**(56) spatial object type**
classification of **spatial object**s

EXAMPLE Cadastral parcel, road segment, or river basin are all examples of potential spatial object types.

NOTE In the conceptual schema language UML a spatial object type will be described by a class with stereotype <<FeatureType>>.

**(57) spatial reference system**
system for identifying position in the real world [ISO 19112]

NOTE Spatial reference systems do not necessarily use coordinates to identify a position.

EXAMPLE Geographic coordinates describing positions on the Earth surface (coordinate reference system), linear measurements along a river centreline from the intersection of a bridge (linear reference system), postal codes identifying the extent of postal zones (gazetteer).

**(58) spatial schema**
**conceptual schema** of spatial geometries and topologies to be used in an **application schema**

**(59) temporal reference system**
reference system against which time is measured [ISO 19108]

**(60) temporal schema**
**conceptual schema** of temporal geometries and topologies to be used in an **application schema**

**(61) thematic identifier**
descriptive **unique object identifier** applied to **spatial objects** in a defined information **theme**

EXAMPLE an administrative code for administrative area spatial objects in the administrative units theme, a parcel code for parcel spatial objects in a cadastral theme

**(62) theme**
grouping of **spatial data** according to Annex I, II and III of the INSPIRE Directive

**(63) unique object identifier**
**identifier** associated with a **spatial object**

**(64) unit**
defined quantity in which dimensioned parameters are expressed [ISO 19111]

**(65) version <spatial object>**
particular variation of a **spatial object**

NOTE A version of a spatial object is associated with a version identifier allowing to distinguish two versions of the same spatial object. Versions are usually also associated with temporal information allowing a user to analyse the evolution of a spatial object.

EXAMPLE If a spatial object type Building has an attribute functionalUse, the value of the attribute changes due to a change in the way the building is used, and the life-cycle rules of the data set specify that a change in this attribute value will result in a new version, then a new version will be created and the existing version will be marked as superseded in its life-cycle information – often by specifying an end date/time for the lifespan of the version.

## 3.2 Abbreviations

| | |
|---|---|
| CEN | European Committee for Standardisation |
| CRS | Coordinate Reference System |
| CSL | Conceptual Schema Language |
| CT | Consolidation Team |
| D2.3 | INSPIRE – Definition of Annex Themes and Scope |
| D2.5 | INSPIRE – Generic Conceptual Model |
| D2.6 | INSPIRE – Methodology for Specification Development |
| D2.7 | INSPIRE – Guidelines for Encoding |
| DIS | Draft International Standard |
| DFDD | DGIWG Feature Data Dictionary |
| DGIWG | Digital Geospatial Information Working Group |
| DIS | Draft International Standard |
| DNS | Domain Name System |
| DS | Data Specifications |
| DT | Drafting Team |
| EC | European Commission |
| EN | European norm (standard) |
| EPSG | European Petroleum Survey Group *(now OGP Surveying & Positioning Committee)* |
| ESDI | European Spatial Data Infrastructure |
| EU | European Union |
| EUREF | REference Frame sub commission for Europe (IAG Commission I) |
| FACC | Feature and Attribute Coding Catalogue |
| GI | Geographic Information |
| GML | Geography Markup Language |
| GMT | Greenwich Mean Time |
| IAG | International Association of Geodesy |
| ICAO | International Civil Aviation Organization |
| ICT | Information and Communication Technology |
| IEC | International Electrotechnical Commission |
| IHO | International Hydrographic Organisation |
| INSPIRE | INfrastructure for SPatial InfoRmation in Europe |
| IR | Implementing Rule |
| ISO | International Organisation for Standardisation |
| LMO | Legally Mandated Organisation |
| LoD | Level of Detail |

| | |
| --- | --- |
| MAC | Media Access Control |
| MD | Metadata |
| NERC | Natural Environmental Research Council |
| NS | Network Services |
| NUTS | Nomenclature of Territorial Units for Statistics |
| OCL | Object Constraint Language |
| OGC | Open Geospatial Consortium |
| OGP | international association of the Oil & Gas Producers |
| SDI | Spatial Data Infrastructure |
| SDIC | Spatial Data Interest Community |
| SI | International System of Units |
| SOSI | Samordnet Opplegg for Stedfestet Informasjon (Systematic Organisation of Spatial Information) |
| TC | Technical Committee |
| TIN | Triangulated Irregular Network |
| TR | Technical Report |
| TS | Technical specification |
| TWG | Thematic Working Group |
| UML | Unified Modelling Language |
| UNGEGN | United Nations Group of Experts on Geographical Names |
| URN | Uniform Resource Name |
| UTC | Coordinated Universal Time |
| UUID | Universal Unique Identifier |
| WMO | World Meteorological Organization |
| XML | eXtensible Markup Language |

## 3.3 Verbal forms for the expression of provisions

In accordance with the ISO rules for drafting, the following verbal forms shall be interpreted in the given way:

- "shall" / "shall not": a requirement, mandatory for every data specification
- "should" / "should not": a recommendation, but an alternative approach may be chosen for a specific case if there are reasons to do so
- "may" / "need not": a permission

To make it easier to identify the mandatory requirements and the recommendations for INSPIRE data specifications in the text, they are highlighted and numbered.

| Requirements are shown using this style. |
| --- |

| Recommendations are shown using this style. |
| --- |

NOTE This document identifies a number of required support actions by the European Commission in order to establish the necessary operational infrastructure or requirements for spatial data sets. These are not stated as requirements (although they technically are requirements, but not for INSPIRE data specifications) and are consequently not highlighted in the style shown above to avoid confusion.

## 3.4 References within the document

In accordance with the ISO rules for drafting, references to highest level of the document structure include the word "Clause" (or "Annex" in case of an annex).

EXAMPLE "Clause 2", "Annex A"

References to lower levels within the document structure are given without this qualifier.

EXAMPLE 7.1, 7.1.8.4, A.1

References to ISO standards are in general given without the full title.

EXAMPLE "ISO 19101" instead of "ISO 19101 – Geographic Information – Reference Model" or "ISO 19101 (Reference Model)

# 4 Background and principles

## 4.1 Requirements as stated in the INSPIRE Directive

### 4.1.1 Articles of the Directive

#### 4.1.1.1 General remarks

This sub-clause provides an overview of the articles in the Directive which are addressed by this proposal and describes how they are addressed. To make this sub-clause easier to read, the articles from Chapter III "Interoperability of spatial data sets and services" are repeated in the text in italics.

#### 4.1.1.2 Article 7(1)

*Implementing rules laying down technical arrangements for the interoperability and, where practicable, harmonisation of spatial data sets and services, designed to amend nonessential elements of this Directive by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 22(3). Relevant user requirements, existing initiatives and international standards for the harmonisation of spatial data sets, as well as feasibility and cost-benefit considerations shall be taken into account in the development of the implementing rules. Where organisations established under international law have adopted relevant standards to ensure interoperability or harmonisation of spatial data sets and services, these standards shall be integrated, and the existing technical means shall be referred to, if appropriate, in the implementing rules mentioned in this paragraph.*

This document, together with documents D2.3, D2.6 and D2.7, is intended to facilitate the drafting process of the implementing rules referenced above. In particular, this document and document D2.6 provide a common framework for developing the various INSPIRE data specifications in a harmonised way. The harmonised data product specifications are the approach taken to enable interoperability by creating views to existing spatial data sets. Interoperability of spatial data is understood as providing access to spatial data through network services in a representation that allows for combining it with other spatial data in a coherent way. This includes agreements about coordinate reference systems, grids, classification systems, application schemas, etc. The relevant aspects to consider are documented in the data interoperability components described in 4.3.

In other words, by enabling interoperability, spatial data appears to a user as if it has been harmonised - even if that is not the case and the underlying spatial data is transformed for publication in INSPIRE. This is explained in more detail in 4.3.1.

The general issue about the lack of a clear definition of which pieces of information are part of INSPIRE and which are not has already been discussed in detail in conjunction with document D2.3. This applies also to this document. (Article 1(1) simply refers to "[spatial information] for the purposes of Community environmental policies and policies or activities which may have an impact on the environment.")

In relation to the last sentence of Article 7(1), it is the understanding of the Drafting Team "Data Specifications" based on guidance by the Consolidation Team that organisations will also be required to provide INSPIRE compliant spatial data sets and services within the scope of the themes listed in the Annexes of the Directive, i.e. their offerings may need adaptation on the service interface level to the common technological framework for spatial data sets and services as specified in the Implementing Rules. However, the implementation of INSPIRE shall not require these organisations to adapt their data production workflows.

#### 4.1.1.3 Article 7(2)

*As a basis for developing the implementing rules provided for in paragraph 1, the Commission shall undertake analyses to ensure that the rules are feasible and proportionate in terms of their likely costs and benefits and shall share the results of such analyses with the committee referred to in Article 22(1). Member States shall, on request, provide the Commission with the information necessary to enable it to undertake such analyses.*

Article 7(2) will be addressed by the Commission. Feasibility and cost/benefit considerations are part of the development process for implementation rules for Data Specifications and shall be available before these implementation rules become effective. This is also taken into account in the methodology for developing the implementing rules (document D2.6), which, for example, includes recommendations to validate the technical feasibility of a draft implementing rule in real-world tests.

In addition, the review of documents related to the development of INSPIRE data specifications by SDICs and LMOs is also an opportunity to raise any concerns about feasibility or proportionality of any decisions.

#### 4.1.1.4 Article 7(3)

*Member States shall ensure that all newly collected and extensively restructured spatial data sets and the corresponding spatial data services are available in conformity with the implementing rules referred to in paragraph 1 within two years of their adoption, and that other spatial data sets and services still in use are available in conformity with the implementing rules within seven years of their adoption. Spatial data sets shall be made available in conformity with the implementing rules either through the adaptation of existing spatial data sets or through the transformation services referred to point (d) of Article 11(1).*

Article 7(3) will not be addressed by the implementing rules but by the Member States. However, the transformation aspect is considered by this document (see, e.g., the support for existing identifier management schemes) and is considered in more detail by document D2.6 describing a methodology for developing harmonised INSPIRE data specifications.

#### 4.1.1.5 Article 7(4)

*Implementing rules referred to in paragraph 1 shall cover the definition and classification of spatial objects relevant to spatial data sets related to the themes listed in Annex I, II or III and the way in which those spatial data are geo-referenced.*

Article 7(4) is addressed by using the rules of the ISO 19100 series and will be addressed in more detail in the data specification for each theme. In particular, the types of spatial objects that are relevant to INSPIRE will be defined and maintained in a feature concept dictionary.

The feature concept dictionary will cover the spatial objects of all themes and will include a classification of all spatial objects into spatial object types. For each spatial object type, the dictionary will provide a definition.

Spatial properties will be specified for each of the spatial object types in the INSPIRE application schemas following the rules of ISO 19109 (Rules for application schemas) and ISO 19107 (Spatial schema).

It is also possible that different application schemas may specify different spatial object types for the same feature concept, but with a different set of attributes depending on the application view or the required level of detail.

EXAMPLE A spatial object of type “building” may be spatially referenced by a point in one application schema or by a surface in another application schema.

In addition to specifying the spatial/temporal location of a spatial object using geometries with coordinates associated with a spatial/temporal coordinate reference system, the generic conceptual model supports two additional ways in which spatial objects may be geo-referenced:

- using a geographic identifier which can be translated into a location in space by way of a gazetteer;
- referencing another spatial object and "inheriting" its location in space and time.

NOTE The life-cycle rules of spatial objects has to be considered when referencing other spatial objects; i.e., if the referenced spatial objects changes its life-cycle rules may trigger the retirement of a spatial object and the creation of a new one - which may break the reference.

#### 4.1.1.6 Article 7(5)

*Representatives of Member States at national, regional and local level as well as other natural or legal persons with an interest in the spatial data concerned by virtue of their role in the infrastructure for spatial information, including users, producers, added value service providers or any coordinating body shall be given the opportunity to participate in preparatory discussions on the content of the implementing rules referred to in paragraph 1, prior to consideration by the Committee referred to in Article 22(1).*

Article 7(5) is addressed by the drafting, consultation, and testing processes involving SDICs and LMOs.

#### 4.1.1.7 Article 8(1)

*In the case of spatial data sets corresponding to one or more of the themes listed in Annex I or II, the implementing rules provided for in Article 7(1) shall meet the conditions laid down in paragraphs 2, 3 and 4 of this Article.*

See comments in paragraphs 2, 3 and 4 below.

#### 4.1.1.8 Article 8(2)

*The implementing rules shall address the following aspects of spatial data:*
*(a) a common framework for the unique identification of spatial objects, to which identifiers under national systems can be mapped in order to ensure interoperability between them;*
*(b) the relationship between spatial objects;*
*(c) the key attributes and the corresponding multilingual thesauri commonly required for policies which may have an impact on the environment;*
*(d) information on the temporal dimension of the data;*
*(e) updates of the data.*

Article 8(2)(a) is addressed by data interoperability component "identifier management" described in 4.3. The common system aims at supporting existing identifiers, but adds a namespace identifying the data provider.

Article 8(2)(b) is addressed by using ISO 19109 (Rules for application schemas) as the basis. Note that relationships may be explicit associations or they may be implicit spatial or temporal relationships based on the values of the individual spatial and temporal properties of spatial objects.

See also the sub-clause on modelling object references.

Article 8(2)(c) is addressed by providing guidelines for capturing attributes based on ISO 19109 (Rules for application schemas) and will be addressed in more detail in the data specification for each theme. At this stage, document D2.3 gives a first idea of key attributes.

Article 8(2)(d) is addressed by specifying temporal properties for each of the spatial object types in the INSPIRE application schemas following the rules of ISO 19109 (Rules for application schemas) and ISO 19108 (Temporal schema).

While Article 8(2)(e) is not specifically addressed by this document and will be addressed by document D2.7 and by the implementing rules on network services, it should be noted that unique object identifiers and life-cycle rules as discussed in this document play an important facilitating role in exchange of updates.

#### 4.1.1.9 Article 8(3)

*The implementing rules shall be designed to ensure consistency between items of information which refer to the same location or between items of information which refer to the same object represented at different scales.*

Article 8(3) is only addressed in a general sense by this document. The relevant constraints between spatial objects across different spatial object types or levels of detail will be specified in the INSPIRE data specifications.

See also the description of data interoperability components "consistency between data" and "multiple representation" described in 4.3.

NOTE Based on its wording, article 8(3) uses “object” in the sense of “phenomenon in the real-world” and not in the sense of “spatial object”. A spatial object is, by definition, an abstraction of and not the same as the phenomenon itself.

#### 4.1.1.10 Article 8(4)

*The implementing rules shall be designed to ensure that information derived from different spatial data sets is comparable as regards the aspects referred to in Article 7(4) and in paragraph 2 of this Article.*

Article 8(4) is addressed by the data interoperability components described in 4.3 and the uniform use of ISO 19131 (Data product specification) for the individual INSPIRE data specifications.

#### 4.1.1.11 Article 9

*The implementing rules provided for in Article 7(1) shall be adopted in accordance with the following timetable:*
*(a) no later than (two years following the date of entry into force of this Directive) in the case of the spatial data sets corresponding to the themes listed in Annex I;*
*(b) no later than (five years following the date of entry into force of this Directive) in the case of the spatial data sets corresponding to the themes listed in Annex II or III.*

Article 9 is not addressed by this document, but by the INSPIRE work programme.

#### 4.1.1.12 Article 10(1)

*Member States shall ensure that any information, including data, codes and technical classifications, needed for compliance with the implementing rules provided for in Article 7(1) is made available to public authorities or third parties in accordance with conditions that do not restrict its use for that purpose.*

Article 10(1) is not addressed by this document, but by the implementing rules on data sharing.

4.1.1.13 Article 10(2)

*In order to ensure that spatial data relating to a geographical feature, the location of which spans the frontier between two or more Member States, are coherent, Member States shall, where appropriate, decide by mutual consent on the depiction and position of such common features.*

Article 10(2) is only partially addressed by this document. See the description of data interoperability component "consistency between data" described in 4.3. In addition, guidelines on edge-matching will be provided in document D2.6.

### 4.1.2 Recitals in the Directive

Of the 35 recitals of the Directive, recital (6) is partially relevant for the technical specification of implementing rules on data specifications:

*"The infrastructures for spatial information in the Member States should be designed to ensure*
- *that spatial data are stored, made available and maintained at the most appropriate level;*
- *that it is possible to combine spatial data from different sources across the Community in a consistent way and share them between several users and applications;*
- *that it is possible for spatial data collected at one level of public authority to be shared between other public authorities […]."*

It is worth highlighting that in particular the data interoperability component "object referencing" described in 4.3 is directly linked to these requirements. See also clause 13 of this document for additional details.

Also, recital (16) and (28) state that *"implementing rules should be based, where possible, on international standards […]"* and that *"in order to benefit from the state of the art and actual experience of information infrastructures, it is appropriate that the measures necessary for the implementation of this Directive should be supported by international standards and standards adopted by European standardisation bodies.*"

### 4.1.3 Additional principles for data specifications

The main goal of this document is to support the development of INSPIRE data specifications for the themes so that the individual specifications are developed in a homogeneous way. It does not specify the methodology for developing INSPIRE data specifications (this is defined in the separate document D2.6 which is nearing completion). The Generic Conceptual Model specifies common modelling rules and elements that apply to all INSPIRE data specifications.

This proposal tries to follow a “keep it simple” approach to developing rules for the wide thematic range of INSPIRE data specifications. Simplicity has been in the focus in particular for two aspects:

a) The processing and use of INSPIRE data (it is assumed that INSPIRE data will typically be accessed through download services which are assumed to provide direct access to spatial objects) should be as simple as possible for users and their software applications.

   An example of a resulting rule is the definition of a well-documented set of coordinate reference systems which may be used in INSPIRE data so that an INSPIRE-aware software application is guaranteed to be able to spatially relate two different spatial objects from different data providers.

   Another example is the recommendation to use the Simple Feature specification as specified by OGC for geometries wherever feasible, because many software components dealing with spatial data sets are able to deal with geometry data following this specification.

   As a basic rule, INSPIRE has to support the user requirements as well as is feasible and thus the Data Specifications are based on their conceptual view as well as on the various existing/emerging spatial data infrastructures and relevant existing standards processes within international communities. I.e., limitations of software components are not in the main focus of this proposal. However, it also needs to be ensured that what is specified in the INSPIRE Implementing Rules is aligned with the ICT infrastructure of the data providers and the users that will be operational in the time frame of the implementation of the Directive. All this, of course, without locking INSPIRE into specific solutions/platforms or inhibiting the future development of the ESDI in the context of the general ICT development. Naturally, this is a grey area and to an extent it will eventually be up to the development process of the Implementing Rules to identify the right balance.

As a result, the general approach taken by this proposal is to provide strict rules only where absolutely necessary. Otherwise, general restrictions are avoided at this point, but recommendations are provided where the Drafting Team considers them as a useful guideline.

The Simple Feature specification is a good example for a recommendation as it is standardised (and has gone through a consensus process) and is supported by many implementations and used in many operational systems (very likely meeting the conceptual requirements of the applications). There are, however, many applications that go way beyond what Simple Features provides/supports and in this case it is expected that the INSPIRE data specifications will do so, too. In a similar sense, while many spatial applications are based on this specification, a larger number of applications today go far beyond what Simple Feature supports.

In this context it is worth to note that Article 12(1) of the draft Directive states that combining spatial data sets should be possible “without requiring specific efforts on the part of a human operator or a machine”.

b) For data providers the publication of their existing spatial data sets as INSPIRE conformant spatial data sets should be as simple as possible.

   An example is the structure of identifiers of spatial objects that has been specified with as few rules/parts as possible and supporting the reuse of already established unique object identifiers in existing spatial data sets while at the same time addressing all the INSPIRE requirements.

As noted above, in general some of these aspects can be conflicting goals and the proposal tries to find a reasonable compromise between them in case of conflict. In many cases this document specifies recommendations rather than strict rules as of today it is difficult to foresee all thematic requirements and the constraints that can reasonably be applied throughout the individual INSPIRE data specifications.

## *4.2 A standards-based approach*

An integral part of any SDI development is an agreement on the technical standards that form the basis for interoperability between the parties in the infrastructure.

The generic conceptual model specifies the conceptual framework in which the INSPIRE data specifications will be defined. It is restricted to the conceptual level and does not provide or reference any specifications on the implementation level; this will be done by document D2.7 and the individual data specifications.

The Drafting Team has decided to follow as much as possible a standards-based approach based on the ISO 19100 series, based on the following observations:

- The recitals (16) and (28) of the Directive (see 4.1.2) highlight the role of international standards for INSPIRE.
- The ISO 19100 series has undergone a consensus process that has already involved a large number of information communities.
- The analysis of the reference material (i.e. of data specification developments across information communities) indicates that many current data specification developments follow a standards-based approach.
- The recommendations in CEN/TR 15449 and the adoption of most international standards listed as a normative reference in this document by CEN indicate that the ISO 19100 series is considered sufficiently complete and mature to be used, for example, as the framework for the development of data specifications.
- Other non-European or global SDI approaches like, for example, the GSDI cookbook and the development of the Framework Data Content Standards in the United States also recommend or

use the ISO 19100 series of International Standards at the conceptual foundation for developing data specifications.
- Since a common conceptual foundation for the development of the diverse data specifications is required in any case, a Europe-specific development would have been required to address the interoperability requirements, if no international standards would be available for adoption.

However, there are also a number of issues that need to be recognised:

- A number of aspects that are needed for INSPIRE are known to be not yet covered by the ISO 19100 series and are noted as such in this document. Measures to close these gaps are required to support all requirements.
- The ISO 19100 series is a comprehensive and complex framework that has emerged over the past decade. Therefore many SDICs and LMOs will need to build the required expertise to understand and realise the standards-based implementing rules.
- Not all Member States and organisations have adopted the ISO 19100 series. As a result these communities will be required to understand the relationship between the concepts of the ISO 19100 series and their conceptual framework and develop a mapping between both conceptual frameworks. Based on the clarification by the Consolidation Team on the last sentence of Paragraph 7(1), standards and specifications of the organisations established under the international law, if appropriate, shall be referred/integrated in the appropriate Implementing Rules. This process may both benefit from and contribute to the efforts already in place between some of the organisations under the international law and the international standardisation organisations.
- ISO standards are not free of charge.

Finally a few additional comments on the reference to international standards:

- The normative references to European and International Standards in Clause 3 are dated references. I.e., in case of a revision or amendment to an existing standard, the reference to the specific, dated version remains valid until a revision of the affected INSPIRE implementing rules has been processed.
- It is important to note that only parts of the complete ISO 19100 series are used - this document specifies which parts of the ISO 19100 series are actually relevant.

## 4.3 Data interoperability components

### 4.3.1 Principles

INSPIRE data specifications will be the result of a data interoperability process based on existing data specifications and, where available, user requirements and use cases. While the methodology for creating such harmonised data specifications is subject of another document, the work on INSPIRE data specifications is based on a framework that identifies the components relevant to the data interoperability process.

The framework is based on the following assumptions and principles that are guiding the process to an INSPIRE data specification:

- All Member States and organisations start from different positions in terms of conceptual schemas, etc. Due to different political, economic, cultural and organisational drivers, we will not achieve and should not aim at achieving total harmonisation across every nation as part of the INSPIRE process. Regional diversity will and should continue to exist.
- A mechanism that provides technical and conceptual interoperability to support needs at European and other large cross-border and cross-sector levels is required.
- The trend towards the integration of geographic information into the information and technology mainstream will accelerate.
- The main goal at least for the foreseeable future is to achieve interoperability through harmonised data product specifications on the European level rather than harmonisation of the underlying conceptual models (and restructuring the associated data sets) in the Member States. Any requirements to change the existing data should be kept to a minimum.
- Two aspects of the process to enable interoperability need to be distinguished:

  - a common process and methodology of developing data specifications in order to have a harmonised, consolidated conceptual schema for all the themes involved in INSPIRE (this is addressed by this document as well as document D2.6);
  - for every individual data specification a conceptual schema needs to be designed that is capable of representing data from the various data sources and providers that need to provide the content for the download services (this is addressed by the harmonisation approach in document D2.6).

- In this context data harmonisation requirements have to be considered on different levels:
  - the specification level (use of common data specifications independent of the specification of the source data in the Member States)
  - the metadata level (provision of metadata according to a common metadata profile as specified in the implementing rule on metadata)
  - the data level (e.g. edge matching in border areas)

The Generic Conceptual Model mainly addresses the *specification level*. Harmonisation on the data level is partly addressed by Clause 22, but will require organisational measures to address the requirements stated in Article 8(3) of the Directive.

NOTE Harmonisation on the specification level will comprises semantic aspects and rules required to support interoperability, too.

### 4.3.2 Components overview

The figure below provides an overview of the components relevant for data interoperability. The different components cover different aspects that need to be addressed in the process of enabling data interoperability. The Generic Conceptual Model needs to address these aspects as well to support the development of harmonised data specifications.

For each of the components, a separate clause specifies how this component is addressed in the Generic Conceptual Model. Component "(A) Principles" is discussed in Clause 6, "(B) Terminology" in Clause 7, and so on.

These components apply to all types of spatial objects including those with vector geometrical or topological properties as well as coverages (coverages are spatial objects, too, and include, for example, gridded raster data). However, for the different spatial representation types, the components will in general be different.

Each component may contribute in a different way to the interoperability of spatial data:

- Some components contribute to the generic conceptual model and the INSPIRE data specifications, i.e. they contain aspects that need to be modelled, agreed and published. This ranges from the basic principles, to coordinate reference systems to the application schemas and will define the ESDI in terms of achieving a level of harmonisation through interoperable services that provide data in a harmonised way. The results can then be used to test whether or not (or how much) a spatial data set conforms to the INSPIRE framework.
- Some components will be maintained as registers, managed and published in registries and support the operational ESDI. This ranges from identifier management, object classification, terminology dictionaries to multi-language definitions, etc.
- Some components may provide guidelines and best practice to support the consistent implementation of the data specifications and underlying standards to promote interoperability.

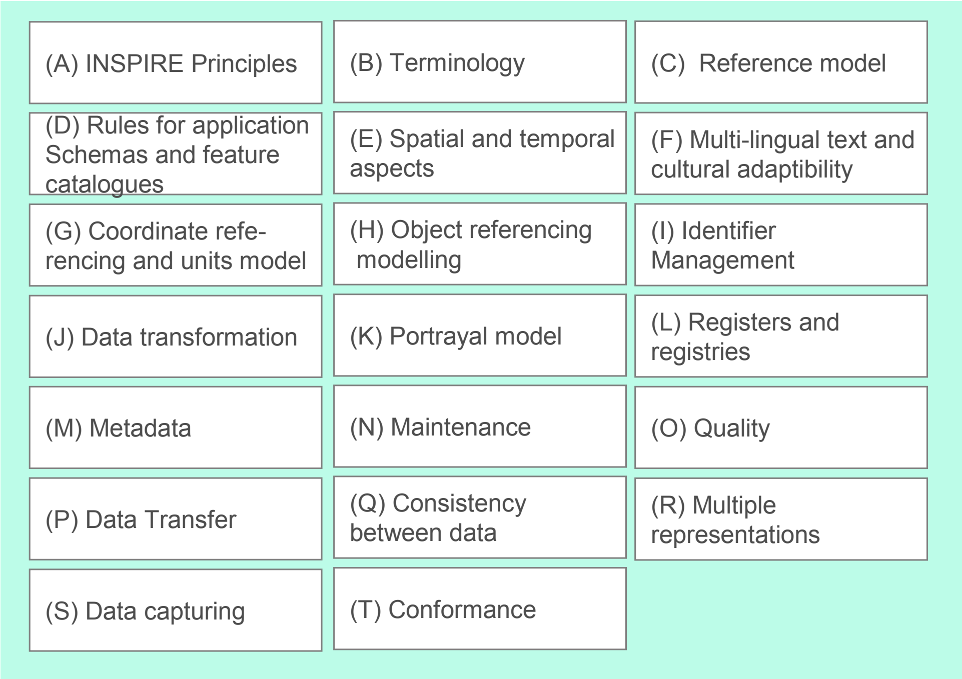



**Figure 2 - Data interoperability components – overview**

Table 1 describes the scope of each of the data interoperability components.

**Table 1 – Data interoperability components**

| **Component** | **Description** |
|---|---|
| (A) Principles | The principles cited in recital 6 of the Directive are considered to be a general basis for developing the interoperability needs for spatial data. The first three of the five principles are to be considered to help define the data interoperability process:<br>- *that spatial data are stored, made available and maintained at the most appropriate level;*<br>- *that it is possible to combine spatial data from different sources across the Community in a consistent way and share them between several users and applications;*<br>- *that it is possible for spatial data collected at one level of public authority to be shared between other public authorities.*<br><br>NOTE The first item does not imply that maintenance, storage and publication have to be done on the same level. For example, maintenance may occur on the local level, data storage on the regional level and publication on the national level. |
| (B) Terminology | This component will support the use of a consistent language when referring to terms via a glossary. This needs to be registered and managed through change control with multi-lingual support.<br><br>The glossary will not contain the definitions of feature-related concepts which are managed in the common feature concept dictionary. The common feature concept dictionary contains terms and definitions required for specifying thematic spatial object types and is regarded as a part of component (D) rather than this component.<br><br>The ESDI needs to establish a common terminology based on all of the existing terminologies and/or their translations. |

| | |
|---|---|
| (C) Reference model | This component will define the framework of the technical parts including topics like information modelling (i.e. conceptual modelling framework with rules for application schemas) and data administration (i.e. reference systems). It will provide a structure which allows the components of INSPIRE which are related to data specifications to be described in a consistent manner. |
| (D) Rules for application schemas and feature catalogues | The purpose of this component is to<br>- provide a computer-readable data description defining the data structure - enabling automated mechanisms for data management;<br>- achieve a common and correct understanding of the data, by documenting the data content of the particular theme, thereby making it possible to unambiguously retrieve information from the data.<br><br>The specification of the structure of a spatial data set is given by application schemas which are expressed in a formal conceptual schema language. An application schema specifies the types of spatial objects and their properties (attributes, association roles, operations) as well as constraints and are indispensable to turning the data into usable information.<br><br>A feature concept dictionary register is used to manage names, definitions and descriptions of all spatial object types in application schemas in INSPIRE. The feature concept dictionary facilitates the cross-theme harmonization of concepts.<br><br>A feature catalogue specifying the meaning of the spatial object types specified in an application schema as well as the properties of these spatial object types is automatically derived from an application schema (at least the English version) and published via a registry service. Feature catalogues are published in addition to the application schema and feature concept dictionary for the following purposes:<br>- styling of the application schema information into a human readable presentation<br>- access to the individual elements in the application schema though a registry service for access by software and humans<br><br>Application schemas and feature catalogues promote the dissemination, sharing, and use of geographic data through providing a better understanding of the content and meaning of the data.<br><br>Items in existing feature catalogues or feature concept dictionaries managed by external organisations may be reused or referenced in INSPIRE where feasible and in-line with the identified user and interoperability requirements.<br><br>Linguistic text in the feature catalogues and feature concept dictionaries will be maintained at least in the official European languages.<br><br>Per theme multiple application schemas (and feature catalogues) are allowed, however consistent terminology has to be used. |

| | |
|---|---|
| (E) Spatial and temporal aspects | Conceptual schema for describing the spatial and temporal characteristics of spatial objects:<br>- Spatial geometry and topology<br>- Temporal geometry and topology<br>- Coverage functions (examples of coverage functions include rasters, triangulated irregular networks, point coverages, and multi-dimensional grids)<br><br>While the component "reference model" specifies an overall framework, this component deals with the spatial and temporal aspects in more detail, for example, the types of spatial or temporal geometry that may be used to describe the spatial and temporal characteristics of a spatial object. |
| (F) Multi-lingual text and cultural adaptability | Conceptual schema for multi-lingual character strings in spatial objects and supporting information:<br>- To be used in all application schemas and as a result in data instances: all string valued properties that may be provided in a language shall use this type<br>- To be used in the dictionary model so that dictionaries may be multi-lingual, e.g. the feature catalogues, the feature concept dictionary or code lists<br><br>Since the feature catalogues and the feature concept dictionary are multilingual, the definition and names of all spatial object types, their attributes/associations and their attribute values provided by enumerations/code lists as well as all constraint descriptions are multi-lingual.<br><br>The items will originally be developed in English in conjunction with the application schema development. The application schema itself will be modelled in English only.<br><br>In principle, cultural differences have to be taken into account, e.g. not all terms may be translatable from one language to another.<br><br>Furthermore, cultural differences between communities working in the same language can be at least as much a problem as multi-lingual issues.<br><br>In the future, ontologies may help to capture multi-cultural aspects. |
| (G) Coordinate referencing and units of measurement model | This component will describe methods for spatial and temporal reference systems as well as units of measurements – including the parameters of transformations and conversions.<br><br>The focus is on reference systems that are valid across Europe (in case of projected systems split into zones this will be a collection of such systems covering the different zones).<br><br>This component will also support European geographical grids. |
| (H) Object referencing modelling | This component will describe how information is referenced to existing spatial objects, typically base topographic spatial objects, rather than directly via coordinates.<br><br>It will be specified how the spatial characteristics of a spatial object can be based on already existing spatial objects. As a result, this component |

| | |
|---|---|
| | will support the generation and maintenance of application-specific "user geographies" based on reference data.<br><br>The aim is to promote the easy and reliable exchange of data that is associated with spatial objects (e.g. river quality sample records) across several users who use a common base (thus avoiding spatial inconsistencies and massive data transfers to support regular reporting). The approach improves data integrity across distributed systems and services as well as more reliable data sharing.<br><br>Object referencing is especially relevant in referencing spatial objects of Annex III themes to those of the themes in Annex I and II. |
| (I) Identifier management | Spatial objects from Annexes I and II should have an external object identifier. This component will define the role and nature of unique object identifiers (or other mechanisms) to support unambiguous object identification.<br><br>Thematic Working Groups may decide to support unique object identifiers also in Annex III themes.<br><br>To ensure uniqueness some form of management system will be required. This does not mean that all organisations need to adopt a common form of identifier or other mechanism but the identifier management mechanisms (e.g. registers) in use at national level will need to be synchronised/mapped to ensure pan European integration.<br><br>Note that the same real-world phenomenon may be represented by different spatial objects (with their own identifiers). |
| (J) Data transformation | This component is about the transformation from a national/local application schema to an INSPIRE application schema and vice versa. Translations are required for data and for queries.<br><br>NOTE No well-defined set of translation capabilities has been standardised in the general ICT nor in the GI community at this time. It is not yet clear, if there will be a need to specify translations also between different European application schemas, e.g. for different representations or for creating specific information products, e.g. for reports or from base data etc. Also, further research will be required to identify how consistent adoption of ontologies could be exploited here. Note that while this topic has aspects related to spatial information (e.g., transformation between coordinate reference systems) this is, in principle, mainly a general ICT research topic. |
| (K) Portrayal model | This component will define a model for portrayal rules for data according to a data specification. It will clarify how standardised portrayal catalogues can be used to harmonise the portrayal of data across the different view services that will be part of INSPIRE. |
| (L) Registers and Registries | Registers will at least be required for<br>- all reference systems used in spatial data sets<br>- all units used in spatial data sets<br>- all code lists / thesauri used in the application schemas (multi-lingual, at least in all official European languages)<br>- the feature concept dictionary for elements used by application schemas (multi-lingual, at least in all official European languages)<br>- identifier namespaces<br>- all feature catalogues<br>- all application schemas |

| | |
|---|---|
| | The registers will be available through registry services.<br><br>Metadata on data set level or data set series level will be available through discovery services.<br><br>NOTE Where possible, existing registers of other competent authorities will be referenced/used instead of managing new ones. However, where no appropriate existing registers are known or available these will need to be maintained by INSPIRE. Units and coordinate reference systems are particular examples of this issue; the INSPIRE registers should be set up only to fill the "gaps" in existing registers. |
| (M) Metadata | This component will cover metadata on the following levels:<br>- Discovery<br>- Evaluation<br>- Use<br><br>Metadata associated with individual spatial objects will in general be described as part of the application schemas. |
| (N) Maintenance | This component will define best practice in ensuring that spatial data can be managed against updates of reference information without interruption of services. This will require the definition of mechanisms by different stakeholder areas to manage where this is required and it is feasible<br>- change only updates<br>- spatial object life-cycle rules<br><br>Propagation of changes across scale and between dependent spatial objects is required in general to maintain consistency of the data and metadata (automatic or manual processes). |
| (O) Data & information quality | This component will advise the need to publish quality levels of each spatial data set using the criteria defined in the ISO 19100 series of standards, including completeness, consistency, currency and accuracy.<br><br>This will include methods of best practice in publishing:<br>- Acceptable quality levels of each spatial data set<br>- Attainment against those levels for each spatial data set<br><br>Quality information associated with individual spatial objects is part of the metadata associated with the respective spatial object (see component "Metadata") and will in general be described as part of the application schemas. |
| (P) Data transfer | This component will describe methods for encoding application and reference data as well as information products.<br><br>The encoding of spatial objects will in general be model-driven, i.e. fully determined by the application schema in UML. Where appropriate, existing encodings will continue to be used. This will be discussed in document D2.7.<br><br>To support network services that are implemented as web services, spatial objects are expected to be primarily encoded in XML/GML for the transfer of spatial data. Coverage data is expected to use existing encodings for the range part. |

| | |
|---|---|
| (Q) Consistency between data | This component will describe guidelines how the consistency between the representation of the same entity in different spatial data sets as published in INSPIRE (for example along or across borders, themes, sectors or at different resolutions) shall be maintained.<br><br>The custodians of such spatial data sets will decide by mutual consent on the depiction and position of such common spatial objects or they will agree on a general method for edge-matching or other automatic means to maintain data consistency.<br><br>Note that the description above mainly relates to topographic spatial objects with a low variation over time. |
| (R) Multiple representations | This component will describe best practices how data can be aggregated<br>- across time and space<br>- across different resolutions (“generalisation” of data)<br><br>Such aggregation processes are used in particular to create the following results:<br>- Multiple representations<br>- Derived reporting (example: typically water samples at 1 km intervals are reported to the European level) |
| (S) Data capturing rules | This component will describe the data specification-specific criteria regarding which spatial objects are to be captured and which locations/points will captured to represent the given spatial object (e.g. all lakes larger than 2 ha, all roads of the Trans European Road Network, etc.).<br><br>For INSPIRE data specifications it is in general not relevant how the data is captured by the data providers. |
| (T) Conformance | This component will describe how conformance of data to a data specification is tested, i.e. it will be necessary to apply conformance tests as specified in the individual data specification. Ideally these will be automated. This aspect will be addressed in the INSPIRE data specifications.<br><br>In addition, all INSPIRE data specifications will conform to the Generic Conceptual Model as well as, since Data Specifications are specified using ISO 19131 (Data product specification), to ISO 19131. This aspect will be addressed by the Generic Conceptual Model. |

# 5 Overview

The Generic Conceptual Model serves – from a modelling perspective – as the common foundation for all theme-specific INSPIRE data specifications (see Figure 3).

| **Requirement 1** | Every INSPIRE application schema shall import the definitions of the Generic Conceptual Model. |
| --- | --- |

NOTE 1 Transitively this imports also other schemas managed by other organisations including the harmonised model of the ISO 19100 series of International Standards, maintained by ISO/TC 211.

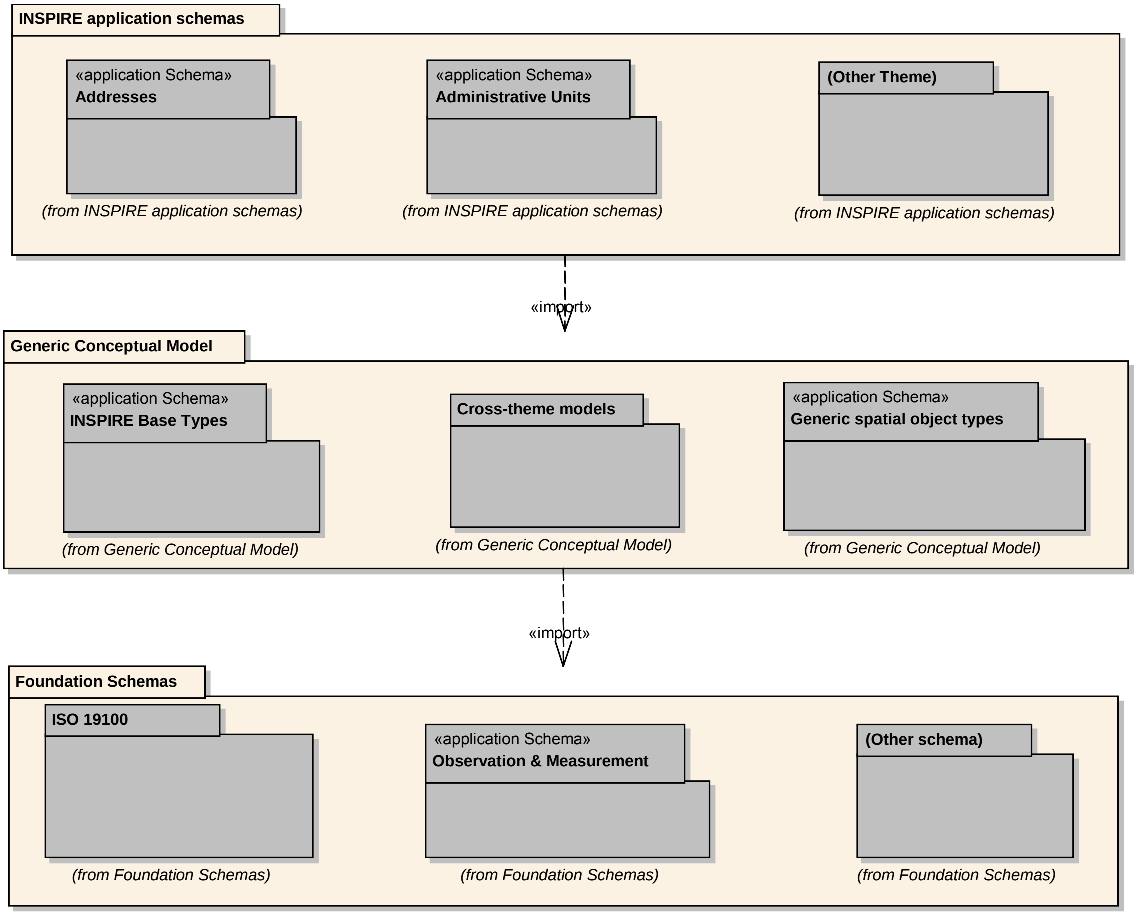



**Figure 3 – The Generic Conceptual Model as the basis for INSPIRE application schemas**

The normative rules in the Generic Conceptual Model cover, for example, geometrical, topological and temporal representations, spatial and temporal relations, unique object identifiers and reference systems.

INSPIRE application schemas may have dependencies between each other. These dependencies will be identified in process of modelling the INSPIRE application schemas (the process is described in document D2.6).

The Generic Conceptual Model in itself is abstract in the sense that no spatial data set can be created based only on the Generic Conceptual Model. It does not contain any specification for instantiable spatial object types.

| | |
|---|---|
| **Requirement 2** | No concept shall be modelled as part of an INSPIRE application schema, if it is competing with a concept already established as part of the Generic Conceptual Model. |

EXAMPLE All external object identifiers will follow the model specified in 9.8.2, it is not valid to use a different model for external object identifiers in an INSPIRE data specification.

NOTE 2 This proposal for the Generic Conceptual Model should be validated before the specification of the individual themes is adopted.

The Generic Conceptual Model will evolve over time and will become more concrete as the Data Specifications for the individual themes are being developed. The Generic Conceptual Model will be maintained by the Consolidation Team during the data specification development process. The responsibilities for different parts of the data specification deliverables are discussed in 9.4.

NOTE 3 The INSPIRE data specifications will evolve over time as well. The process for revising INSPIRE data specifications still needs to be identified.

The remaining clauses of this document specify in more technical detail generic rules for INSPIRE data specifications.

# 6 Principles

The principles identified in recital 6 of the INSPIRE Directive are considered in all individual components below. However, their impact is more visible in some components than in others. For example, the “object referencing modelling” component is strongly linked with the first of the principles (“that spatial data are stored, made available and maintained at the most appropriate level”) and the “data consistency” component is strongly linked with the second of the principles (“that it is possible to combine spatial data from different sources across the Community in a consistent way and share them between several users and applications”).

# 7 Terminology

The terms used in this document are maintained in the “INSPIRE Glossary”, and are listed in 3.1.

| | |
|---|---|
| **Requirement 3** | General terms and definitions in all INSPIRE data specifications shall be drawn from the INSPIRE Glossary. Terms that are important in the context of a theme, but which are not part of the INSPIRE Feature Concept Dictionary (see 9.3) shall be defined in the INSPIRE Glossary. |

Generally, an existing definition established by a competent organisation or international standard, will be used before an INSIRE-specific definition is created.

# 8 Reference model

## *8.1 General aspects*

| | |
|---|---|
| **Requirement 4** | The reference model specified in ISO 19101 shall be used as the reference model of the INSPIRE data specifications. |

So far, no explicit reference model for all of INSPIRE has been specified. Therefore, based on 4.2, ISO 19101 will be used as the reference model for the development of data specifications.

In addition to ISO 19101, two other views are used to structure the relevant aspects for INSPIRE data specifications, i.e. are part of the technical INSPIRE framework:

- The data interoperability components described in 4.3 provide a framework for data interoperability that is used as the basis for the structure in this document and that is used also to structure the process of developing harmonised data product specifications as described in document D2.6.
- INSPIRE data specification are harmonised data product specifications and conform to ISO 19131. An overview of ISO 19131 is provided in 8.3.

## *8.2 The ISO 19101 reference model*

From all the concepts specified in the reference model specified by ISO 19101, a few core concepts which play a particularly important role in this document are explained below for clarity.

The following figure is taken from ISO 19101 and the text in the paragraphs below is based on the related descriptions in ISO 19101:

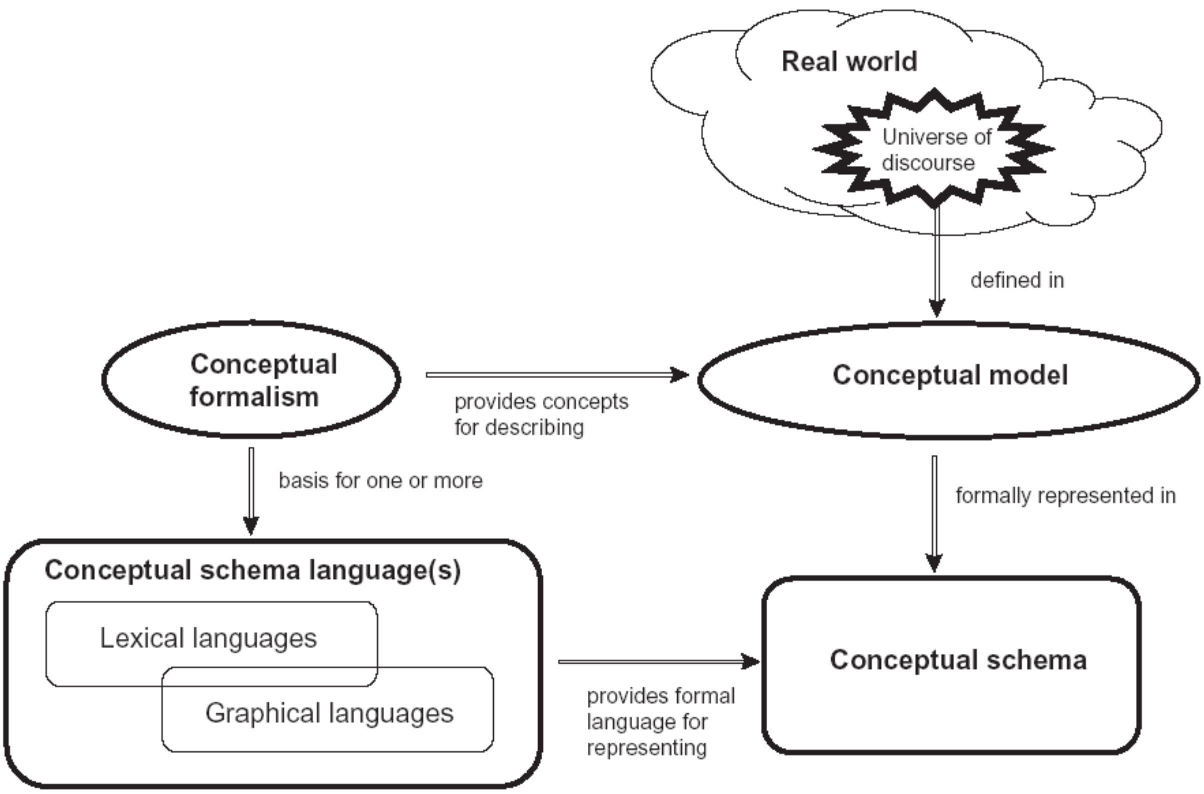



**Figure 4 – From reality to conceptual schema [ISO 19101]**

The figure provides a graphical illustration of the role of conceptual modelling in representing geographic information by describing the relationship between modelling the real world and the resulting conceptual schema.

A *universe of discourse* is a selected piece of the real world that a human being or a community wishes to describe in a model. The universe of discourse may include not only spatial objects such as watercourses, lakes, islands, property boundaries, property owners and exploitation areas, but also their attributes, their operations and the relationships that exist among such spatial objects. A universe of discourse is described in a *conceptual model*.

The *conceptual schema* is a rigorous description of a conceptual model for some universe of discourse. A *conceptual schema language* is used to describe a conceptual schema. A conceptual schema language is a formal language parsable by a computer or a human being that contains all linguistic constructs necessary to formulate a conceptual schema and to manipulate its content. A conceptual schema that defines how a universe of discourse shall be described as data and operations is called an *application schema*.

A conceptual schema language is based upon a *conceptual formalism*. The conceptual formalism provides the rules, constraints, functions, processes and other elements that make up a conceptual schema language. These elements are used to create conceptual schemas that describe a given information system or information technology standard. A conceptual formalism provides a basis for the formal definition of all knowledge considered relevant to an information technology application. More than one conceptual schema language, either lexical or graphical, can adhere to and be mapped to the same conceptual formalism. In INSPIRE, every conceptual schema will be modelled using the conceptual schema language UML (see 9.5).

The *General Feature Model* (GFM) is a meta-model for developing conceptual models of spatial object types and their properties, i.e. it is a conceptual formalism.

## *8.3 INSPIRE data specifications*

### 8.3.1 General aspects

| **Requirement 5** | Every INSPIRE data specification shall conform to ISO 19131. |
| --- | --- |

According to ISO 19131 (Data Product Specification), the scope of the standard is to describe requirements for the specification of geographic data products, based upon the concepts of other ISO 19100 standards. It also provides help in the creation of data product specifications, so that they are easily understood and fit for their intended purpose.

“Product” in the traditional sense does not really fit in the context of INSPIRE as the existing data products in the Member States do not map very well to the themes in all cases (take the topographic data products as an example). INSPIRE data product specifications aim at “virtual data products” at best, but even then we have to take into account that the contents of a single data specification may be provided by several data providers in any Member State.

It is stated in ISO 19131 that a data product specification may be created and used on different occasions, by different parties and for different reasons. It may, for example, be used for the original process of collecting data, as well as for products derived from already existing data. It may be created by producers to specify their product, or by users to state their requirements.

Some of the definitions in ISO 19131 suggest that some elements are only applicable for product specifications describing existing products. One example of this is identification information, where the definition of geographic description is stated to be “description of the geographic area within which data is available”. We consider this to be interpreted like “description of the geographic area within which data is or is intended to be available”. This is a logical conclusion since there are no notes or text in the standard stating that a mandatory element is only applicable for data product specifications describing existing data.

A data product specification contains sections covering the following aspects:

- Overview
- Specification scopes
- Data product identification
- Data content and structure
- Reference systems
- Data quality
- Data capture
- Data maintenance
- Portrayal
- Delivery

- Additional information
- Metadata

| | |
|---|---|
| **Requirement 6** | Every INSPIRE data specification shall be documented using the template given on http://www.ec-gis.org/inspire/ds/ |

# 9 Rules for INSPIRE application schemas

## *9.1 Overview*

This clause specifies the rules for INSPIRE application schemas and explains concepts that are important for such application schemas.

This first two sub-clauses (9.2 and 9.3) specify the metal-model for such application schemas (the General Feature Model as specified by ISO 19109) and the register used to manage the names and definitions of all spatial object types used in INSPIRE (INSPIRE Feature Concept Dictionary Register).

Sub-clause 9.4 specifies additional, INSPIRE specific rules for modelling application schemas in addition to those from ISO 19109.

Application schemas are expressed using a conceptual schema language and the associated requirements based on ISO/TS 19103 are specified in 9.5. The modelling environment for the application schemas is described in 9.6 (the Consolidated INSPIRE UML Model).

The topic of the life-cycle of spatial objects and modelling associated information in an INSPIRE application schema is discussed in 9.7.

Cross-theme models specified by the Generic Conceptual Model are documented in 9.8 (generic types not specified by the standards) and 9.9 (schemas that are applicable in multiple themes and which are not defined by the standards).

Finally, 9.10 describes the role of feature catalogues in INSPIRE.

## *9.2 General Feature Model*

### 9.2.1 Concepts provided by the General Feature Model – an overview

The General Feature Model, specified by ISO 19109 Clause 7, defines a meta-model (i.e. a model of concepts) for spatial objects and their properties. Whenever "General Feature Model" is used in this document it refers to the model specified in ISO 19109.

The General Feature Model is a meta-model for the specification and description of spatial object types and their properties. It defines the concept of spatial object type (note that ISO 19101 uses the term “feature type” instead) and several types of properties (attributes, association roles and operations) as well as constraints. It also serves as a meta-model for feature catalogues by providing the structure for representing the semantics of geographic information in these terms.

Attribute types are further subdivided into spatial attribute types (i.e. the value is a spatial geometry or topology), temporal attribute types (i.e. the value is a temporal geometry or topology), locational attribute type (i.e. the value is a geographic identifier referencing a gazetteer entry, see 9.9), metadata attribute types (i.e. the value is metadata about the spatial object) and thematic attribute types (i.e. all other descriptive information that does not fit into any of the other categories).

The figure below shows an extract from the General Feature Model, here expressed as UML model.

The General Feature Model defines concepts, but it does not prescribe any language or format how to document spatial object types and their concepts.

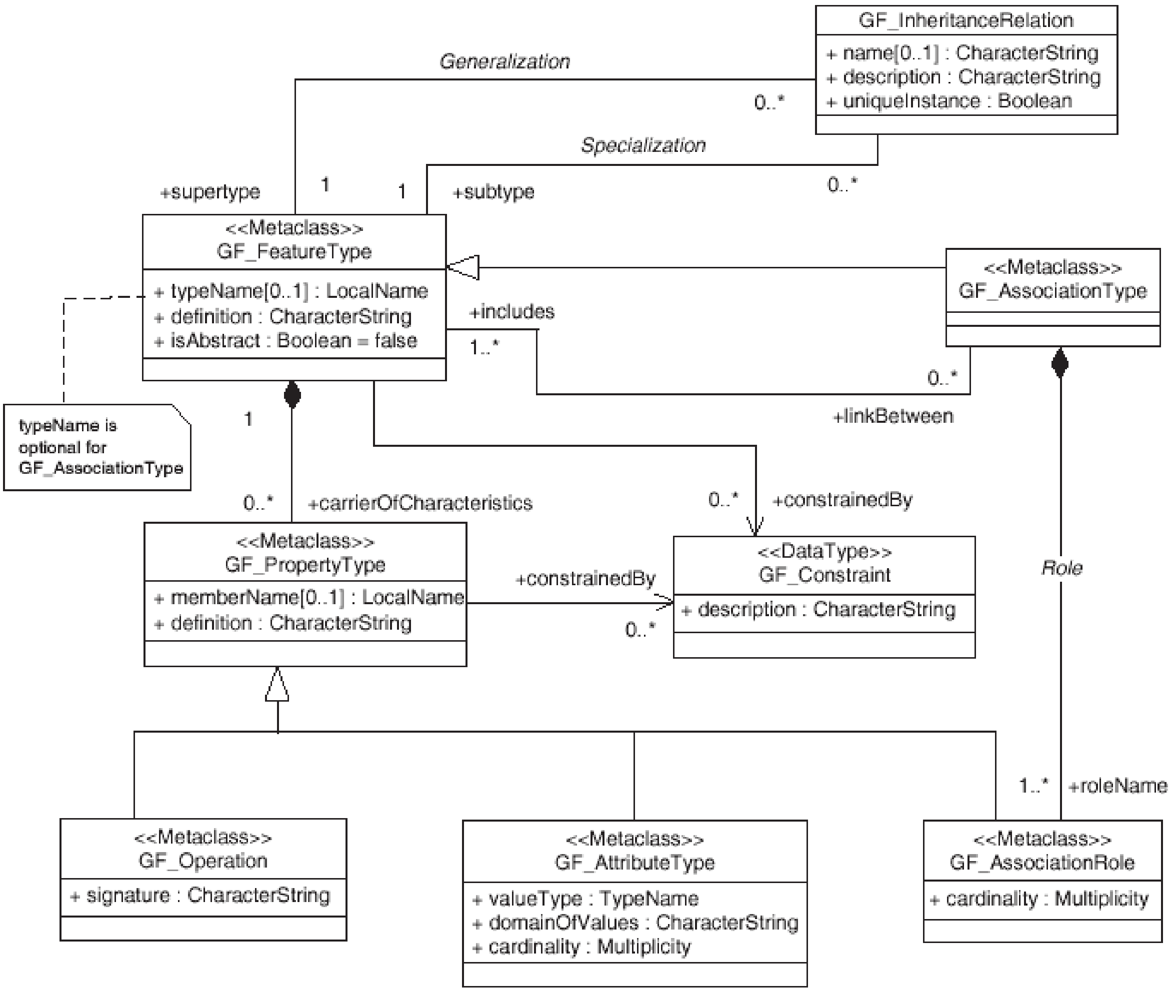



**Figure 5 – Extract from the General Feature Model [ISO 19109]**

The General Feature Model is a model of the concepts required to classify a view of the real world. The Conceptual Schema Language UML that is used to represent the conceptual schema of spatial data in INSPIRE has its own meta-model. As explained by ISO 19109, both the General Feature Model and the UML meta-model deal with classification as thus the concepts are very similar. Still, there is one important difference: the concepts in the General Feature Model establish a basis for the classification of spatial objects, whereas the UML meta-model provides a basis for classification of any kind.

### 9.2.2 Representations of models based on the General Feature Model – an overview

ISO 19101 distinguishes two representations of spatial object types and their properties:

- an application schema
- a feature catalogue

Both are used in INSPIRE data specifications for different purposes.

The specification of the structure of a spatial data set is given by an application schema which is expressed in a formal conceptual schema language. The application schema specifies the types of spatial objects and their properties (attributes, association roles, operations) as well as constraints and is indispensable to turning data into usable information.

Feature catalogues contain a large subset of the application schema information, but play a slightly different role. The English version of a feature catalogue is (in INSPIRE) automatically derived from the corresponding application schema, i.e. is mainly a different representation of the information in the application schema. The feature catalogue plays three important roles:

- It supports the styling of the application schema information into a human readable, textual presentation.
- Feature catalogues are translated at least into all official languages of the European Union (the application schema is managed in English only).
- Published via a registry service, it allows queries on and access to the individual elements in the application schema – both by human users via a portal as well as by software. For example, it allows direct access to the name and definition of an entry in an enumerated value in all supported languages.

Application schemas and feature catalogues are complemented by a so-called feature concept dictionary register that is used to manage names, definitions and descriptions of all spatial object types that are used in INSPIRE application schemas / feature catalogues. The feature concept dictionary is one of the instruments for the cross-theme harmonization of concepts in INSPIRE and is maintained in at least in the official European languages, too.

Application schemas, feature catalogues and feature concept dictionaries promote the dissemination, sharing, and use of geographic data through providing a better understanding of the content and meaning of the data.

The following figure – adapted from ISO 19109 ("from reality to geographic data") for the specific set-up in INSPIRE – illustrates the modelling process and the role of the General Feature Model. The "Universe of Discourse" of INSPIRE refers to "Community environmental policies and policies or activities which may have an impact on the environment" (see Article 1 of the INSPIRE Directive).

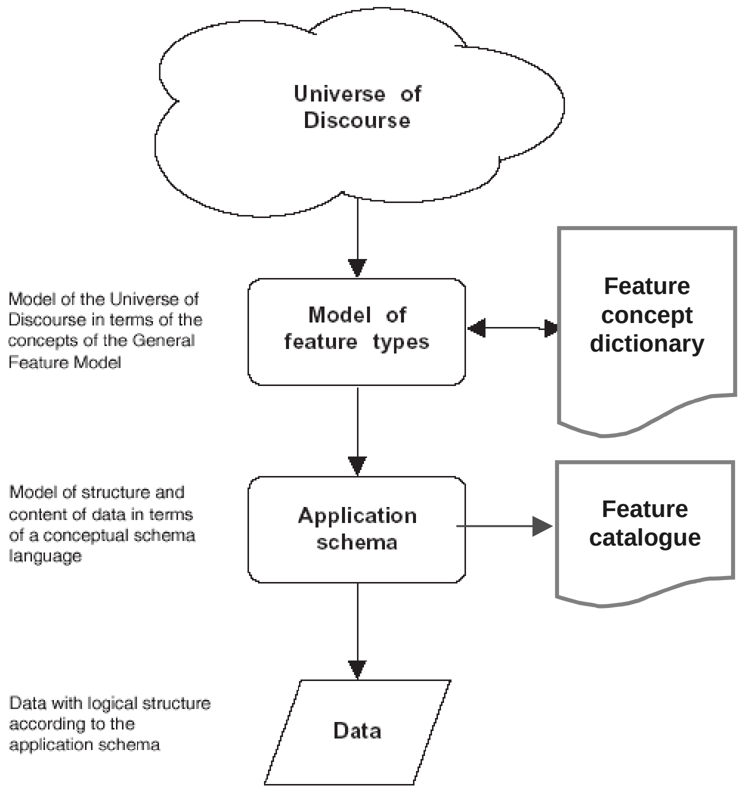



**Figure 6 – From reality to geographic data [adapted from ISO 19109 for INSPIRE]**

More details on the modelling process will be provided as part of the document D2.6 describing the methodology for developing the data specifications.

### 9.2.3 Relevant profile of the General Feature Model

INSPIRE application schemas will have to cover a wide range of requirements; therefore it is difficult to identify any generally applicable restrictions to the General Feature Model. At the same time, simple/simpler and homogeneous models will make it easier to work with and use data, for example, across themes. Therefore, the Generic Conceptual Model may in principle make recommendations to reduce the complexity of models based on past experiences with ISO 19109 based application schemas and their implementations. Currently no recommendations have been identified.

**Recommendation 1** While no restrictions to the usage of certain elements of the Generic Feature Model are specified as part of the Generic Conceptual Model, modellers of INSPIRE application schemas should be aware that some elements of the Generic Conceptual Model may not have a direct representation on the implementation platforms relevant for the application schema and, therefore, the use of these elements will lead to additional complexity on the implementation level (data encoding, more complex query expressions).

EXAMPLE 1 The use of multiple inheritance (inheriting structure and behaviour from more than one supertype): ISO/TS 19103 states that "the use of multiple inheritance should be minimized or avoided unless it is a fundamental part of the semantics of the type hierarchy."

EXAMPLE 2 Modelling operations: Operations which are modelled in an INSPIRE application schema will not be accessible to applications, because INSPIRE network services are in general not expected to support invocation of operations of spatial object types (the network services typically operate on a more coarse-grained level) and also encoding of spatial objects to transfer data is not expected to support an encoding of operations (see document D2.7). Therefore, operations will in general not be modelled as part of an INSPIRE application schema at this time unless they are required for the proper understanding and documentation of the semantics and the intended behaviour of spatial objects. However, it is expected that in the future the relationships between a spatial object type and the spatial data services that may be invoked to do something useful with one or more spatial objects of this type will be supported by architectures of spatial data infrastructures – including INSPIRE. In the conceptual models this will likely involve modelling operations on spatial object types and linking them to services.

Because the current version of ISO 19109 predates ISO 19123, it does not explicitly address coverage functions in the General Feature Model. The following extension to the General Feature Model illustrates the general approach taken by the Generic Conceptual Model on the modelling of coverage functions in INSPIRE application schemas:

- A new metaclass CoverageFunctionAttributeType is assumed to be added to the General Feature Model as a subtype of GF_ThematicAttributeType.
- CoverageFunctionAttributeType depends on CV_Coverage.

This essentially means that in an application schema a coverage function is modeled as a property of a spatial object type and the coverage itself is the value of such a property (see 10.4). Note that in some cases the coverage, which is a spatial object type, too, may be used as a “standalone” spatial object type, too.

## *9.3 INSPIRE Feature Concept Dictionary Register*

The INSPIRE Feature Concept Dictionary Register specifies concepts of spatial object types with name, definition and description. INSPIRE application schemas specify spatial object types drawing from these concepts (and using the names, definitions and descriptions from the register). It is important to note that the same spatial object type concept may be the basis for multiple spatial object types with different sets of properties in different INSPIRE application schemas.

The role of a common feature concept dictionary for all INSPIRE data specifications is in particular to support the harmonisation effort and to identify conflicts between the specifications of the spatial object type in the different themes. This is discussed in more detail in document D2.6.

The INSPIRE Feature Concept Dictionary Register is a feature concept dictionary managed as a register conforming to ISO 19126[5] (Feature concept dictionaries and registers) and maintained as an ISO 19135 conformant register.

At this stage, only the concepts of spatial object types are managed in the INSPIRE Feature Concept Dictionary Register. Other spatial object type related concepts specified in ISO 19126 (e.g., attributes, associations, coded values) are currently not managed in the register.

In addition, spatial data themes will be maintained in the INSPIRE Feature Concept Dictionary Register[6]. The conceptual schema of ISO 19126 will be extended to include these items.

| | |
|---|---|
| **Requirement 7** | Linguistic text related to concepts proposed for adoption in the INSPIRE Feature Concept Dictionary shall be translated at least to all official languages of the European Union. |

NOTE This includes the name, definition and description of a concept.

## *9.4 Modelling application schemas*

### 9.4.1 General rules

Each spatial object in a spatial data set of INSPIRE will be described in an INSPIRE application schema. The application schema defines the possible content and structure of the corresponding spatial object type on the conceptual level.

| | |
|---|---|
| **Requirement 8** | Every INSPIRE application schema shall contain a comprehensive and precise description of its spatial object types. |

NOTE 1 For the avoidance of doubt, “comprehensive” is meant as “comprehensive as required by the scope of the INSPIRE data specification”, i.e. an INSPIRE data specification for an Annex III theme will in general require less detail than an INSPIRE data specification for an Annex I/II theme.

| | |
|---|---|
| **Requirement 9** | Every INSPIRE application schema shall conform to the General Feature Model as specified in ISO 19109 7.3-7.7. |

EXAMPLE Spatial object types are realisations of GF_FeatureType and are modelled as classes with the stereotype <<featureType>>. Constraints (realisations of GF_Constraint) are modelled in invariant OCL expressions in the context of the class representing the spatial object type and are additionally described in natural language. Etc.

| | |
|---|---|
| **Requirement 10** | Every INSPIRE data specification shall include one or more INSPIRE application schemas modelled according to ISO 19109 Clause 8, with particular attention to 8.2. |

NOTE 2 ISO 19109 8.2 specifies a number of requirements necessary for the management and unambiguous interpretation of an application schema including:

- the use of a conceptual schema language;
- the modelling data structures so that data transfer of all relevant information is supported;
- the provision of a name and a version of the application schema;
- the provision of a corresponding feature catalogue;

[5] ISO 19126 is currently in Draft International Standard stage in the ISO standardisation process. It is expected that ISO 19126 will provide an XML encoding for a feature concept dictionary. In this case, this XML encoding will be used to encode the items of the feature concept dictionary register in the registry.
[6] Name and definition of the spatial data themes are given by the Directive and cannot be changed.

- the provision of sufficient documentation for all elements in the application schema;
- the provision of references from a spatial object type to the type definition in the corresponding feature catalogue (in INSPIRE: the INSPIRE Feature Concept Dictionary Register);
- the correct integration of the application schema with the standard schemas or other application schemas.

### 9.4.2 Additional rules for spatial object types

#### 9.4.2.1 Spatial object types draw definitions from the INSPIRE Feature Concept Dictionary Register

| | |
| --- | --- |
| **Requirement 11** | Every spatial object type specified in an INSPIRE application schema shall be drawn from feature type concepts in the INSPIRE Feature Concept Dictionary Register with status “valid” or proposed as a new register item when no adequate spatial object type already exists. |

| | |
| --- | --- |
| **Requirement 12** | If no related concept exists in the INSPIRE Feature Concept Dictionary Register, that can be reused or amended, a concept from another international feature concept dictionary or feature catalogue shall be reused and proposed for adoption in the INSPIRE Feature Concept Dictionary Register, if possible. |

In other words, whenever possible, a concept in an INSPIRE application schema shall be drawn from an established dictionary.

The process of defining spatial object types will be specified in the methodology for developing data specification (document D2.6) in more detail. In short, the process is as follows: A relevant concept within a theme for a spatial object type is identified. The INSPIRE Feature Concept Dictionary Register is analysed to identify if the concept or a similar concept already exists. The further steps depend on the outcome of this analysis:

a) If it does not exist, the spatial object type is added to the INSPIRE Feature Concept Dictionary Register and used in the application schema. If possible, the new concept is imported from another international feature concept dictionary or feature catalogue.

   Importing and referencing existing definitions from an externally managed dictionary once (during the creation of an application schema) obviously would not assure that consistency between the different dictionaries is maintained over time and will require additional organisational measures by the European Commission.

b) If the same concept already exists, the other INSPIRE application schemas are analysed to identify, where the relevant spatial object type is already used. Depending on the result of the analysis

   - a new spatial object type may be created in the application schema using the concept from the common feature concept dictionary,
   - a spatial object type specified in another application schema may be amended to meet the current requirements and used in the current application schema, or
   - a new spatial object type may be specified as a specialisation or generalisation of a spatial object type specified in another application schema.

If a similar concept exists it needs to be decided, if the concepts should be merged – amendments to other application schemas will in general be required – or if they should be treated as separate concepts. Depending on the outcome either a) or b) applies from then on.

#### 9.4.2.2 Spatial object types conform to ISO 19109

| | |
|---|---|
| **Requirement 13** | Spatial object types shall be modelled according to ISO 19109 7.1-7.2, 8.1, 8.5-8.9 and according to the additional rules in Clauses 9-12, 18, and 22 of this document. |

NOTE ISO 19109 7.1 and 7.2 describe principles for defining spatial objects and their relationship with application schemas. ISO 19109 8.1 specifies core aspects of the process of modelling application schemas. ISO 19109 8.5 to 8.9 specify the rules for the use of metadata, temporal and spatial characteristics, geographic identifiers as well as the relationship to feature catalogues.

Details on the process of modelling spatial object types in INSPIRE application schemas are provided in document D2.6.

#### 9.4.2.3 Multiple spatial objects may represent the same real-world phenomena

The same real-world phenomenon may be represented by multiple spatial objects (with different unique object identifiers, see below). In general, references between these spatial objects will only exist, if they are explicitly modelled as part of the thematic INSPIRE application schemas.

| | |
|---|---|
| **Recommendation 2** | To allow that multiple spatial objects representing the same real-world phenomenon but in data sets of different Member States can be explicitly associated, an association to other spatial objects of the same type in an adjacent spatial data set should be modelled in the INSPIRE application schema. |

NOTE In general, such links will not be available today in most data sets. However, in the process of harmonising the geography of spatial objects representing the same real-world phenomenon that spans the frontier between two or more Member States - see Article 10(2) of the Directive, such mutual references may be added to the source data sets in the Member States.

EXAMPLE The river Danube runs through several Member States. If requirements to aggregate spatial objects of phenomena that span frontiers exist, the association could be modelled as shown in Figure 7 with an association (here called “neighbour”) to other River instances in other data sets. Note that although the association is symmetric (if A is a neighbour to B, then B is also a neighbour to A) it is modelled as an unidirectional association so that the property is called “neighbour” in all River instances.

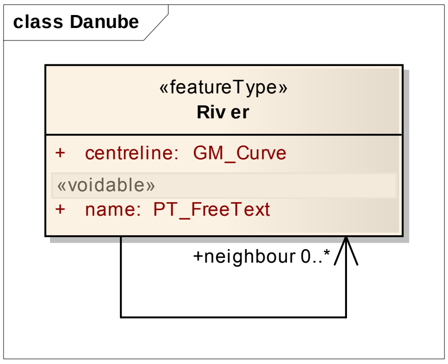



**Figure 7 – Associating multiple spatial objects representing the same river**

Requirements to aggregate spatial objects of phenomena that span frontiers exist in environmental community policies. For example, specific reporting requirements or actions may depend on the size of a lake and while no part of a lake that spans multiple Member States may be above the threshold in a single Member State, the size of the lake itself may be above the threshold.

### 9.4.3 Profiles of the ISO 19100 series

| **Requirement 14** | The profile of the conceptual schema defined in the ISO 19100 series that is used in the application schema shall conform with ISO 19109 8.4. |
|---|---|

NOTE 1 ISO 19109 8.4 specifies how adjustments can be made to the standard schemas to add information to the types defined in the standard schemas, for example to specify a new curve segment type not foreseen in ISO 19107 (spatial schema), or to restrict elements of a standard schema as permitted by the conformance clause of the standard that specifies that schema.

To support the variety of spatial information that is part of the themes listed in Annexes I, II and III of the Directive, the specification of a stable profile of the conceptual schema of the data content standards of the ISO 19100 series is not possible at this time and is considered to be unnecessarily restrictive. As a result the profile used by the INSPIRE application schemas will eventually be documented based on the actual use of ISO 19100 types used in the application schemas.

| **Requirement 15** | Every INSPIRE application schema shall document the profile to be used for the different properties of spatial object types. |
|---|---|

EXAMPLE If a spatial property has the type GM_Curve then it should be specified in the application schema which curve segment types are allowed. For example, the allowed curve segment types for road centrelines could be restricted to GM_LineString, GM_Arc and GM_Clothoid as shown in the figure below. Note that constraints in the model may be shown as part of a class diagram (as in the figure) or they may not be shown in class diagrams but documented in a different way.

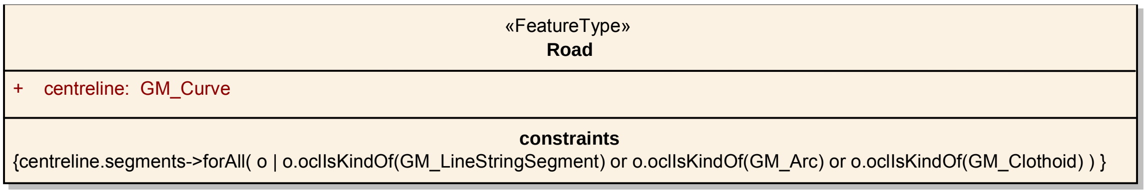



**Figure 8 – Specifying constraints on the use of types from the ISO 19100 series**

| **Recommendation 3** | It is recommended that the simplest profile that addresses the requirements will be used to keep the requirements on software that will process INSPIRE data as low as possible. |
|---|---|

NOTE 2 Obviously "simplest profile" is not an absolute term and different stakeholders will have different views on what the simplest profile is. The common understanding what the simplest profile meeting the minimal functional requirements will therefore be determined by the implementing rule drafting process involving the registered SDICs and LMOs.

### 9.4.4 Additional rules for basic types and coded values

| **Requirement 16** | Basic types as specified in ISO/TS 19103 6.5 shall be used in an INSPIRE application schema, whenever applicable. |
|---|---|

EXAMPLE 1 Examples of basic types specified in ISO/TS 19103 6.5 are Integer, Real, CharacterString, Boolean, Measure.

| | |
| --- | --- |
| **Recommendation 4** | In the case of an attribute type with coded values (enumerations and code lists), an enumeration should be used only, if the set of allowed values is fixed. If the set of allowed values is extensible, a code list should be used. For code lists, the use of a code list managed in the INSPIRE code list register should be mandated. |

There are at least two cases where code lists may be more suitable:

- the list of possible values of an attribute are difficult to harmonise and some data providers may have to use sub-sets or extensions of the harmonised list
- the list of possible values is likely to evolve, some other values may have to be added later, either because of new user requirements or because of upgrading of existing data.

EXAMPLE 2 For a dam feature, Eurospec allows the following values for the condition of the dam:

- fully functional
- disused
- under construction

As this list of possible values may be considered as exhaustive, it is not likely to change; so, it is better to specify it by means of an enumeration directly in the application schema.

EXAMPLE 3 For a foreshore feature, Eurospec allows the following values for the primary structural material:

- boulders
- sand
- stone

As this list of possible values is not exhaustive, the user requirements may evolve and this list may have to be enriched; so, it is better to specify it in a code list with the above values as initial values of the code list. The code list will be managed in INSPIRE Code List Register.

### 9.4.5 Additional rules for the properties with “no data”

There is a need to distinguish two types of properties with “no data” to allow for a correct interpretation of the data:

- The characteristic is not present or not applicable in the real world.
- The characteristic is not present in the spatial object, but may be present or applicable in the real world.

| | |
| --- | --- |
| **Requirement 17** | If a characteristic of a spatial object may be not present or not applicable in the real world, the property shall be modelled with a minimum cardinality of “0” and a missing property shall imply that the characteristic is not present or not applicable in the real world. |

EXAMPLE 1 If a spatial object type Road would carry an attribute “streetName” and it is determined that not all roads in Europe have a street name, the property would receive a minimum cardinality of “0”.

| | |
|---|---|
| **Requirement 18** | If a characteristic of a spatial object is not present in the spatial data set, but may be present or applicable in the real world, the property shall receive the stereotype <<voidable>>. If and only if a property receives the stereotype <<voidable>>, the value of void[7] may be used as a value of the property which shall imply that the characteristic is not present in the spatial data set, but may be present or applicable in the real world. It shall be possible to qualify a value of void in the data with a reason using the VoidValueReason type (see 9.8.4). |

EXAMPLE 2 Using the spatial object type Road from example 1, if a data set has not captured street names for roads, it would report the streetName property values as void with a void value reason of "Unpopulated".

| | |
|---|---|
| **Recommendation 5** | All properties of spatial object types except those without which a spatial object is not meaningful should be voidable. |

EXAMPLE 3 A spatial object type GeographicalName without a name property would not be meaningful and thus it would not be voidable.

EXAMPLE 4 Figure 9 illustrates the spatial object type "Road" used in the examples above. The centre line geometry is considered mandatory in this definition, i.e. the spatial object would be useless for the particular application without it. The street name, however is both optional (see Example 1) and voidable (see Example 2).

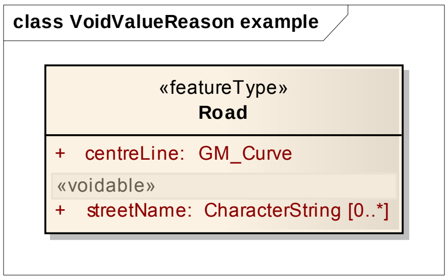



**Figure 9 – Example of a model with no data**

## *9.5 Conceptual schema language*

| | |
|---|---|
| **Requirement 19** | Every INSPIRE application schema shall be specified in UML, version 2.1. |

The use of a common conceptual schema language (i.e. UML) allows for an automated processing of application schemas and the encoding, querying and updating of data based on the application schema – across different themes and different levels of detail.

| | |
|---|---|
| **Requirement 20** | Every spatial object type and its properties shall be shown in class diagrams in the UML package describing the application schema (or packages contained by that package). |

| | |
|---|---|
| **Requirement 21** | The use of UML shall conform to ISO 19109 8.3 and ISO/TS 19103 with the exception that UML 2.1 instead of ISO/IEC 19501 shall be used. |

[7] Void is "an object whose presence is syntactically or semantically required, but carries no information in a given instance" [ISO/IEC 11404].

**Recommendation 6** It is recommended that the use of UML conforms with ISO 19136 E.2.1.1.1-E.2.1.1.4.

NOTE ISO/TS 19103 and ISO 19109 specify a profile of UML to be used in conjunction with the ISO 19100 series. This includes in particular a list of stereotypes and basic types to be used in application schemas. ISO 19136 specifies a more restricted UML profile that allows for a direct encoding in XML Schema for data transfer purposes.

**Requirement 22** All spatial object types specified in INSPIRE application schemas shall carry the stereotype <<featureType>>.

If an association with all spatial object types needs to be modelled, the class AbstractFeature from ISO 19136 (part of the ISO 19100 harmonised model) may be used as the target type of the association.

**Requirement 23** To model constraints on the spatial object types and their properties, in particular to express data/data set consistency rules, OCL shall be used as described in ISO/TS 19103. In addition, all constraints shall be described in the application schema in English, too.

EXAMPLE The following class diagram shows the specification of a (hypothetical) spatial object type "Building" in UML. The stereotype <<featureType>> identifies the class as a spatial object type. The spatial object type has five properties:

- an optional external object identifier;
- a voidable date (which might just be a year) when the building was constructed;
- a voidable height which – if present – has to be provided in metres;
- a mandatory geometry describing the shape of the building at its base;
- zero or more postal addresses that can be associated with the building; PostalAddress is a spatial object type that is defined in another application schema.

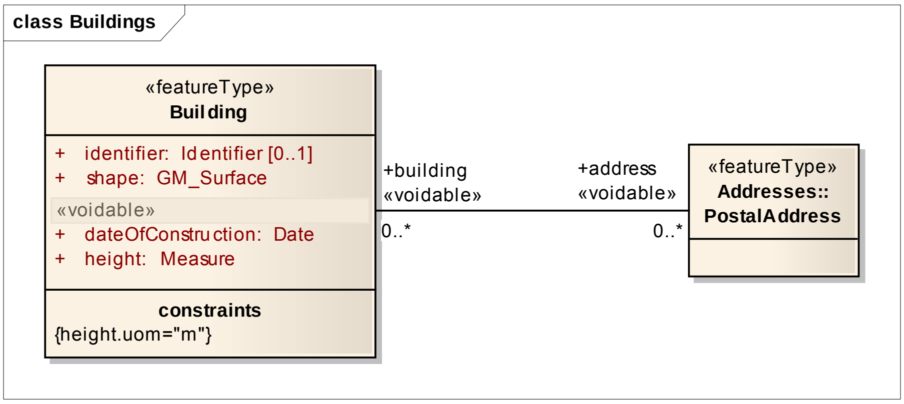



**Figure 10 – Example of a UML class diagram**

**Recommendation 7** The names of spatial object types, properties or coded values should be as explicit and self-describing as possible. See also ISO/TS 19103 6.10.

## 9.6 The Consolidated INSPIRE UML Model

### 9.6.1 Layers

A UML model will be maintained containing the complete and consolidated UML model of the conceptual schema of data specification in INSPIRE.

The content of the consolidated model is separated into three different layers, based on different responsible parties (see Figure 3):

- Foundation schemas that are developed and maintained by an external organisation and which are imported "as-is" by the Generic Conceptual Model. These schemas are – at the moment – to a large extent simply the schemas specified in the ISO 19100 series, maintained by ISO/TC 211 as the so-called ISO/TC 211 Harmonised Model. It is expected that other schemas will be added based on thematic requirements during the development phase, for example, the Observation & Measurements schema, an OGC standard.
- Generic, cross-domain application schemas as identified by this document, developed and maintained during the data specification development phase by the Consolidation Team with support from the Drafting Team "Data Specifications". This layer contains three packages:
    - "INSPIRE Base": The INSPIRE base application schema contains generic types not defined in foundation schemas, but which are required by INSPIRE application schemas. The types specified in this package a documented in 9.8.
    - "Cross-theme models": This package contains sub-packages with general modelling patterns that are used by INSPIRE application schemas, but are not defined by foundation schemas. Currently, only one such models is specified, a model for Gazetteers as specified in 9.9.

      The process for identifying and adding new cross-theme modelling patterns to the Generic Conceptual Model is discussed in document D2.6.
    - "Generic spatial object types": This package will contain abstract spatial object types, but currently is empty. If, for example, spatial object types "Building" are proposed or specified in multiple INSPIRE application schemas with some common or similar properties, then an abstract spatial object type "Building" with the common properties will be added to the Generic Conceptual Model layer to improve cross-application-schema harmonisation.
- Application schemas for the different spatial data themes as defined in the Annexes I, II and III of the Directive. These will be developed by the Thematic Working Groups, or are part of a candidate specification submitted by an SDIC or LMO. These application schemas are maintained during the data specification development phase by the Consolidation Team with support from the Thematic Working Group and the Drafting Team "Data Specifications".
    - For each spatial data theme there is one package with the name of the theme. The package contains the INSPIRE application schemas for the theme.
    - The first two themes from Annex I of the Directive (coordinate reference system and geographical grid systems) are special in that they are not represented by spatial objects, but provide basic concepts so that spatial objects in the other themes can be referenced spatially. As a result, core aspects of these two themes are already specified as part of this document (see Clause 12).

| | |
| --- | --- |
| **Recommendation 8** | All concepts which are of general utility and not limited to a theme should not be modelled in an INSPIRE application schema, but be modelled as part of the Generic Conceptual Model. |

### 9.6.2 Maintenance

The Consolidated INSPIRE UML Model is maintained by the European Commission.

The UML tool Enterprise Architect from Sparx Systems is used to model all packages of the Consolidated UML Model. The packages of the model is stored as XMI 2.1 documents using the version control system Subversion.

In the model, the status of all items in the model shall be set correctly using the following status values:

- Draft: item under development
- Proposed: candidate item submitted for approval
- Approved: item checked and approved by maintainers of the model
- Adopted: item adopted in implementing rule

NOTE 1 These status values may need some further refinements in the future to express the different stages of a model item before adoption.

Thematic Working Groups will create new items with status "Draft" or tag items with this status if they are updating this item in the model. In this phase, the Thematic Working Group has full control and responsibility over these items in their application schema(s).

Once their schema is ready for submission for SDIC/LMO consultation, the status of all items in the schema are updated to "Proposed" which transfers control over the items to the maintainer of the Consolidated INSPIRE UML Model. He will check the proposed items for conformance with the Generic Conceptual Model. If required, inconsistencies will be resolved in collaboration with the Thematic Working Group. Another action that may typically occur during this stage is that model items that are not specific to a theme but which are modelled as part of a theme are transferred to the middle layer of generic, cross-domain application schemas.

After the checks were completed successfully, the status of the items will be set to "Approved".

NOTE 2 This status may need some further refinements in the future to express the different stages of a model item before adoption.

Once an application schema is adopted as part of an Implementing Rule, the status of all items in the application schema is set to "Adopted".

If further changes to the model are required at any time for any reason including but not limited to

- comments received from the European Commission, Drafting Team Data Specifications or subject matter experts,
- comments received from SDICs and LMOs during the consultation,
- change requests received from other Thematic Working Groups, or
- errors that have been identified

the control is transferred back to a party responsible for updating the application schema and the status is set to "Draft" again.

### 9.6.3 UML profile

This sub-clause specifies the stereotypes and associated tagged values used in the Consolidated INSPIRE UML Model, based on the requirements stated in this document and in document D2.7, the guidelines for the encoding of data.

**Table 2 – Stereotypes and tagged values**

| Stereotype | Model element | Description | Tagged Value | Description |
|---|---|---|---|---|
| applicationSchema | Package | An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model. [ISO 19109] | targetNamespace | Target XML namespace of the application schema [ISO 19136] |
| | | | xmlns | Namespace prefix to be used as short form of the target namespace [ISO 19136] |
| | | | version | Current version of the application schema [ISO 19136] |
| | | | gmlProfileSchema | URL of the schema location of a GML profile (optional) [ISO 19136] |
| | | | xsdDocument | Name of an XML Schema document to create representing the content of this package [ISO 19136] |
| | | | xsdEncodingRule | XML Schema encoding rule to apply (iso19136_2007 or iso19139_2007) [D2.7] |
| leaf | Package | A package that is not an application schema and contains no packages. [ISO/TS 19103] | n/a | n/a |
| featureType | Class | A spatial object type. [ISO 19136] | inspireConcept | URN reference to the feature concept in the INSPIRE Feature Concept Dictionary Register [GCM] |
| | | | noPropertyType | Surpress creation of a standard property type that supports inline or by-reference encoding (applies to ISO 19136:2007 encoding rule). Always set to false in INSPIRE. [ISO 19136] |
| | | | byValuePropertyType | Create a property type that requires that the instance is encoded inline (applies to ISO 19136:2007 encoding rule). Always set to false in INSPIRE. [ISO 19136] |
| | | | isCollection | Identifies the feature type as a feature collection. [ISO 19136] |
| type | Class | A conceptual, abstract type that is not a spatial object type. [ISO/TS 19103] | xsdEncodingRule | XML Schema encoding rule to apply (iso19136_2007 or iso19139_2007) [D2.7] |
| | | | noPropertyType | Surpress creation of a standard property type that supports inline or by-reference encoding (applies to ISO 19136:2007 encoding rule). Always set to false in INSPIRE. [ISO 19136] |
| | | | byValuePropertyType | Create a property type that requires that the instance is encoded inline (applies to ISO 19136:2007 encoding rule). Always set to false in INSPIRE. [ISO 19136] |
| | | | isCollection | Identifies the feature type as a spatial object collection. [ISO 19136] |

| | | | | |
|---|---|---|---|---|
| | | | xmlSchemaType | If the type has a canonical XML Schema encoding the XML Schema typename corresponding to the data type shall be given as the value (applies to ISO 19136:2007 encoding rule) [ISO 19136] |
| dataType | Class | A structured data type without identity. [ISO/TS 19103] | xsdEncodingRule | XML Schema encoding rule to apply (iso19136_2007 or iso19139_2007) [D2.7] |
| | | | noPropertyType | Surpress creation of a standard property type that supports inline or by-reference encoding (applies to ISO 19136:2007 encoding rule). Always set to false in INSPIRE. [ISO 19136] |
| | | | isCollection | Identifies the feature type as a spatial object collection. [ISO 19136] |
| union | Class | A structured data type without identity where exactly one of the properties of the type is present in any instance. [ISO/TS 19103] | xsdEncodingRule | XML Schema encoding rule to apply (iso19136_2007 or iso19139_2007) [D2.7] |
| | | | noPropertyType | Surpress creation of a standard property type that supports inline or by-reference encoding (applies to ISO 19136:2007 encoding rule). Always set to false in INSPIRE. [ISO 19136] |
| enumeration | Class | An enumeration. | xsdEncodingRule | XML Schema encoding rule to apply (iso19136_2007 or iso19139_2007) [D2.7] |
| codeList | Class | A code list. | xsdEncodingRule | XML Schema encoding rule to apply (iso19136_2007 or iso19139_2007) [D2.7] |
| | | | asDictionary | Encode code list as externally managed dictionary (applies to ISO 19136:2007 encoding rule). Always true in INSPIRE. [ISO 19136] |
| import | Dependency | The model elements of the supplier package are imported. | n/a | n/a |
| voidable | Attribute, association role | If a characteristic of a spatial object is not present in the spatial data set, but may be present or applicable in the real world, the property shall receive this stereotype. If and only if a property receives this stereotype, the value of void may be used as a value of the property which shall imply that the characteristic is not present in the spatial data set, but may be present or applicable in the real world. It is possible to qualify a value of void in the data with a reason using the VoidValueReason type. | n/a | n/a |
| lifeCycleInfo | Attribute, association role | If in an application schema a property is considered to be part of the life-cycle information of a spatial object, the property shall receive this stereotype. | n/a | n/a |

| | | | | |
|---|---|---|---|---|
| version | association role | "If in an application schema an association role ends at a spatial object type, this stereotype denotes that the value of the property is meant to be a specific version of the spatial object, not the spatial object in general. | n/a | n/a |

## 9.7 *Spatial object life-cycle*

### 9.7.1 General rules

| | |
|---|---|
| **Requirement 24** | In the case where a spatial object may change in a way where it is still considered to be the same spatial object and user requirements for the provision of life-cycle information for a spatial object are identified, the life-cycle information shall be part of the model of the spatial object type as specified in this sub-clause. |

In different themes there are different requirements for life-cycle information of spatial objects. Therefore, the rules stated in this document are constructed to allow adaptations to specific requirements.

| | |
|---|---|
| **Requirement 25** | Life-cycle information of a spatial object shall be modelled in a way that allows data providers who do not maintain or track versions of spatial objects to still conform to the data specification. This requirement does not apply in cases where applications with a strong requirement for life-cycle information are known; these string requirements shall be documented in the data product specification that references the application schema. |

NOTE 1 These requirements acknowledge that spatial data sets with support for life-cycle information about the individual spatial objects are currently not available across Europe for many of the spatial data themes. Unless strong requirements are known, the requirements above were worded in a way to not impose any requirements on the data providers to add such information. Still, life-cycle information is useful for many applications and it is expected that in the future more spatial data sets will provide access to older versions of a spatial object.

NOTE 2 The previous note applies in particular to spatial objects that represent discrete and relatively static phenomena. It has to be understood that for spatial objects that are mainly coverage functions or data sets, life-cycle information will often be available, e.g. date and time of capture or last update, and it is expected that strong requirements will more often exist that such information will also be provided for these spatial objects in INSPIRE.

| | |
|---|---|
| **Requirement 26** | Every INSPIRE application schema that distinguishes multiple versions of a spatial object shall require that different versions of the same spatial object shall always be instances of the same spatial object type. |

| | |
|---|---|
| **Requirement 27** | Every INSPIRE application schema that distinguishes multiple versions of a spatial object shall require that different versions of the same spatial object shall not have different external object identifiers (see Clause 14). |

### 9.7.2 Modelling patterns for life-cycle information

Sub-clause 10.1 discusses the temporal characteristics of data and how a spatial object may be "temporally referenced". This sub-clause, on the other hand, discusses how different versions of a spatial object that changes over time can be modelled. Both aspects are different.

This sub-clause provides patterns that may be used to capture life-cycle information in case of discrete changes of properties, i.e. no examples are provided for modelling continuous changes of property values.

Depending on the situation, various approaches may be taken as illustrated by the recommendations and examples below and in Annex E.

**Requirement 28** A property that is considered to be part of the life-cycle information of a spatial object shall receive the stereotype <<lifeCycleInfo>>.

NOTE 1 This stereotype is introduced to distinguish thematic and temporal properties of a spatial object from properties describing life-cycle information of that spatial object. However, this introduces additional requirements that go beyond standard ISO 19100 modelling and may complicate the adoption of existing schemas in INSPIRE. If the use of stereotypes on the property level turns out to be a problem, the requirements regarding this stereotype and other property-related stereotypes may be revised or removed altogether.

**Requirement 29** An association role that ends at a spatial object type shall imply that the value of the property is the spatial object unless the role has the stereotype <<version>> which shall imply that the value of the property is a specific version of the target spatial object.

EXAMPLE 1 The association role "member" from SpatialDataSet to AbstractFeature in 9.8.3 is an example for a property where the target is a specific version of a spatial object.

NOTE 2 The encoding of an association role property will be often be based on an external object identifier, but a mechanism will be provided for cases where specific versions need to be identified. This will be addressed in document D2.7.

NOTE 3 As specified in 14.6, the version information is not part of the external object identifier.

**Recommendation 9** If the spatial objects in a data set are updated individually, then application-specific version information is typically attached to the individual spatial object – in addition to the generic version identifier string specified in 14.6.

This can be done in different ways:
- as attributes of the spatial object; this is often done using "start" and "end" date/time stamps and/or with a version count
- as temporal extent metadata attached to the spatial object

The use of timestamps is recommended in INSPIRE (compared, for example, with version counts).

It is important to note that different temporal information may be relevant depending on the requirements of the applications using the data (and the availability of the required information), for example:

- transaction time (time when the object version was inserted in data base)
- valid time (time when the object version became valid in the real-world)
- publication time (time when the object version was published)
- verification time (time when the object version was or (for forecasts) will be verified to be correct)
- etc.

Annex E contains several examples of models that include life-cycle information using this approach.

**Recommendation 10** If a data set is updated as a whole, then it may be more appropriate to provide the temporal information as part of the metadata associated with the spatial data set instead of associating the information with the individual spatial objects.

The patterns and examples described above support life-cycle information on the object or data set level. In some cases, an even more fine-grained approach could in principle be useful, i.e. on the property level. Specific support for life-cycle rules of individual properties is currently not seen in any data products, but is a likely addition in the future, at least in some countries.

EXAMPLE 2 The following class diagram shows a spatial object type "AdministrativeUnit" where every instance represents a version of the spatial object with

- the external object identifier of the spatial object;
- the version identifier of the particular version (unique within the spatial object); the versionId property has been made mandatory through a constraint;
- properties to specify the begin (and, for a superseded or retired version, also the end) time of the lifespan of the version;
- derived properties to specify the begin (and, for retired spatial objects, also the end) time of the lifespan of the spatial object;
- additional thematic and spatial properties.

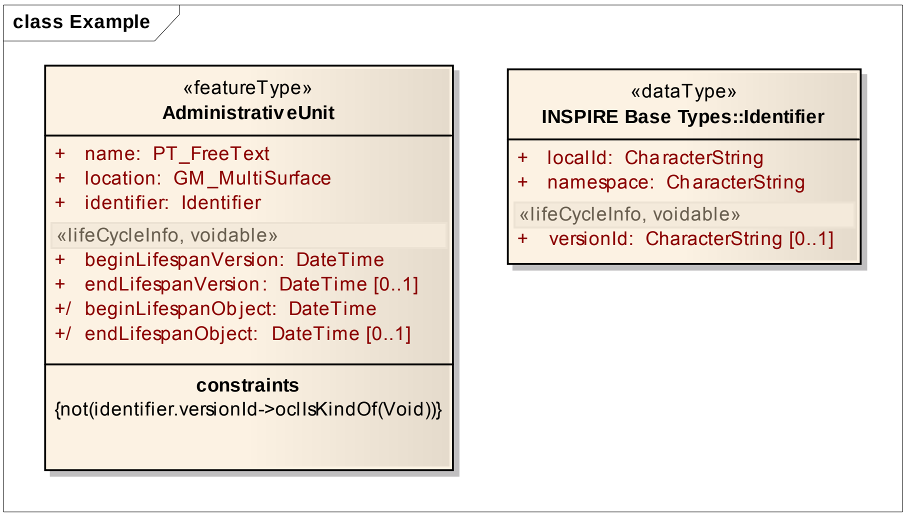



**Figure 11 – Example: A spatial object type**

## *9.8 Base application schema*

### 9.8.1 Overview

The INSPIRE base application schema contains types not defined in the foundation schemas, but which are required in INSPIRE.

NOTE The requirements stated in the other sub-clauses of 9.8 are not requirements for INSPIRE data specifications per se, but requirements associated with the base schema defined in this document. As a result they are not shown in a special layout. However, INSPIRE application schemas using one or more types specified in the other sub-clauses of 9.8 will "inherit" all requirements specified for the imported type(s).

### 9.8.2 Identifier

#### 9.8.2.1 General

The Identifier data type implements the concepts specified in Clause 14.

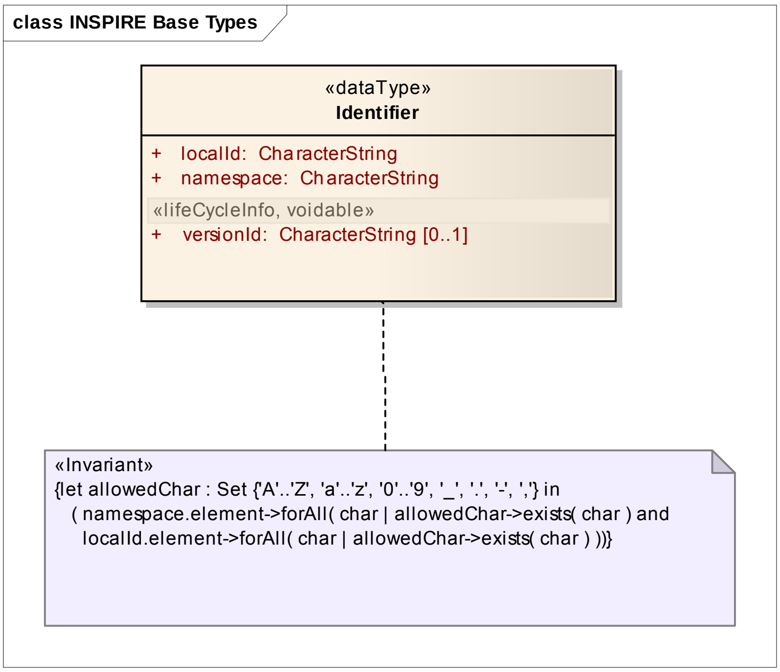



**Figure 12 – Identifier**

Unique identifiers of spatial objects consists of two parts:
- a namespace (specified in 9.8.2.2)
- a local identifier (specified in 9.8.2.3)

NOTE External object identifiers are distinct from thematic object identifiers, see Clause 14.

The third property, an optional version identifier (specified in 9.8.2.4) is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object.

The unique identifier shall not be changed during the life-time of a spatial object.

The properties of the Identifier type are discussed in the next sub-clauses. More details are specified in Clause 14.

#### 9.8.2.2 namespace

The value of the “namespace” property identifies the data source of the spatial object.

The namespace value shall be owned by the data provider of the spatial object and shall be registered in the INSPIRE External Object Identifier Namespaces Register, see Clause 17.

For a data provider associated with a member state the namespace shall, in general, start with the two letter ISO 3166 code of the member state. For other data providers, e.g. multinational data providers, the namespace shall start with an underscore ("_") to avoid conflicts with ISO 3166.

EXAMPLE FR for France, DE for Germany, NL for the Netherlands, etc.

NOTE An exception may have to be made for the United Kingdom: In ISO 3166, the code is GB (Great Britain) which excludes Northern Ireland, whereas Northern Ireland is part of the country United Kingdom. I.e., in this case, UK seems the more appropriate code.

All remaining characters of the namespace shall uniquely identify the data source within the member state (or multinational organisation).

The namespace shall only use the following set of characters: {"A" …"Z", "a"…"z,""0"…"9", "_", ".", "-", ","}, i.e. only letters from the Latin alphabet, digits, underscore, point, comma, and dash are allowed.

#### 9.8.2.3 localId

A local identifier, assigned by the data provider. The local identifier shall be unique within the namespace, i.e. no other spatial object shall carry the same unique identifier.

It is the responsibility of the data provider to guarantee uniqueness of the local identifier within the namespace.

The local identifier shall only use the following set of characters: {"A" …"Z", "a"…"z,""0"…"9", "_", ".", "-", ","}, i.e. only letters from the Latin alphabet, digits, underscore, point, comma, and dash are allowed.

#### 9.8.2.4 versionId

The identifier of the particular version of the spatial object. If the specification of a spatial object type with an external object identifier includes life-cycle information, the version identifier shall be used to distinguish between the different versions of a spatial object. Within the set of all versions of a spatial object, the version identifier shall be unique.

The property shall be void, if the spatial data set does not distinguish between different versions of the spatial object. It shall be missing, if the spatial object type does not support any life-cycle information.

The version identifier shall be a character string with a maximum length of 25 characters.

NOTE The maximum length has been selected to allow for time stamps based on ISO 8601, for example, "2007-02-12T12:12:12+05:30" as the version identifier.

### 9.8.3 SpatialDataSet

The type SpatialDataSet is offered as a pre-defined type for spatial data sets. INSPIRE application schemas may specify their own spatial data set types. It specifies three properties: an external object identifier, a container for metadata (may be void), and an association to zero or more spatial objects.

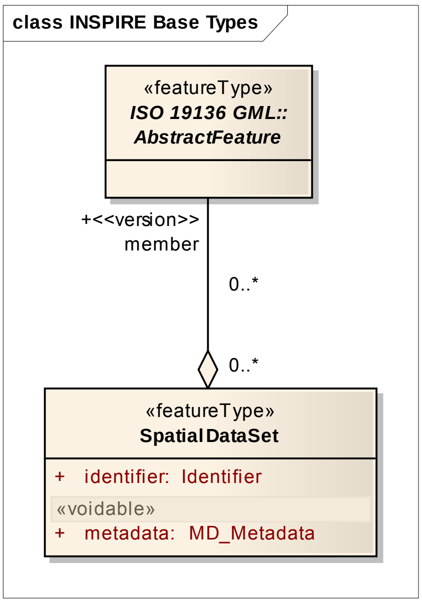



**Figure 13 – SpatialDataSet**

### 9.8.4 Void

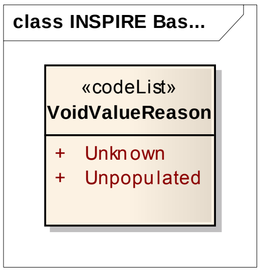



**Figure 14 – Void value reasons**

The following values are pre-defined reasons for void values (see 9.4.5). INSPIRE application schemas may propose extensions to this code list, if required.

- Unknown

  The correct value for the specific spatial object is not known to, and not computable by, the data provider. However, a correct value may exist. For example when the “elevation of the water body above the sea level” of a certain lake has not been measured, then the reason for a void value of this property would be ‘Unknown’.

  ‘Unknown’ is applied on an object-by-object basis in a spatial data set.

- Unpopulated

  Same as ‘Unknown’ with the difference that the property is unknown for all spatial objects of that spatial object type within the spatial data set.

NOTE It is expected that additional reasons will be identified in the future, in particular to support reasons / special values in coverage ranges.

## *9.9 Cross-theme models*

### 9.9.1 Overview

The package “Cross-theme models” contains sub-packages with general modelling patterns that are used by INSPIRE application schemas, but which are not defined by the foundation schemas. Currently, only a model for gazetteers is specified.

### 9.9.2 Gazetteers

The use of gazetteers and spatial reference systems using geographic identifiers in INSPIRE follows ISO 19112. However, the schema from ISO 19112 is not used as-is to correct errors in that schema and allow for a better integration in INSPIRE as a spatial data infrastructure.

Gazetteers are first of all needed for indirect spatial referencing, see object referencing in Clause 13. I.e., it is crucial that all geographic identifiers are unique.

NOTE 1 It is expected that the spatial data themes “geographical names” and “addresses” will require separate application schemas for geographical names and addresses. Gazetteers are a means to publish spatial data from the themes in a way that allows others to use them in indirect spatial referencing.

**Requirement 30** The application schema for gazetteers specified in this sub-clause shall be used in INSPIRE data specifications as the basis for all gazetteers and spatial reference systems using geographic identifiers.

**Requirement 31** If an INSPIRE data specification requires that a gazetteer is published via a gazetteer service, it shall include a requirement that all location instances are also published as "LocationInstance" objects, i.e. any instance of an application-specific subtype of "LocationInstance" is casted to a "LocationInstance" object.

NOTE 2 It perfectly valid, if an INSPIRE application schema specifies subtypes of LocationInstance or any of the other types in the gazetteer application schema. For example, for several use cases involving geographical names, the model of LocationInstance is not sufficient, i.e. in order to support all requirements of geographical names, it may be decided to extend the 'LocationInstance' type. However, for location instances used in indirect spatial referencing (see Clause 13), the LocationInstance already provides all required information. To improve interoperability and simplify the development of gazetteer client software, such location instances have to be published *in addition* as "simple" LocationInstance objects through gazetteer services.

All spatial object types may be used to define a location type of a gazetteer.

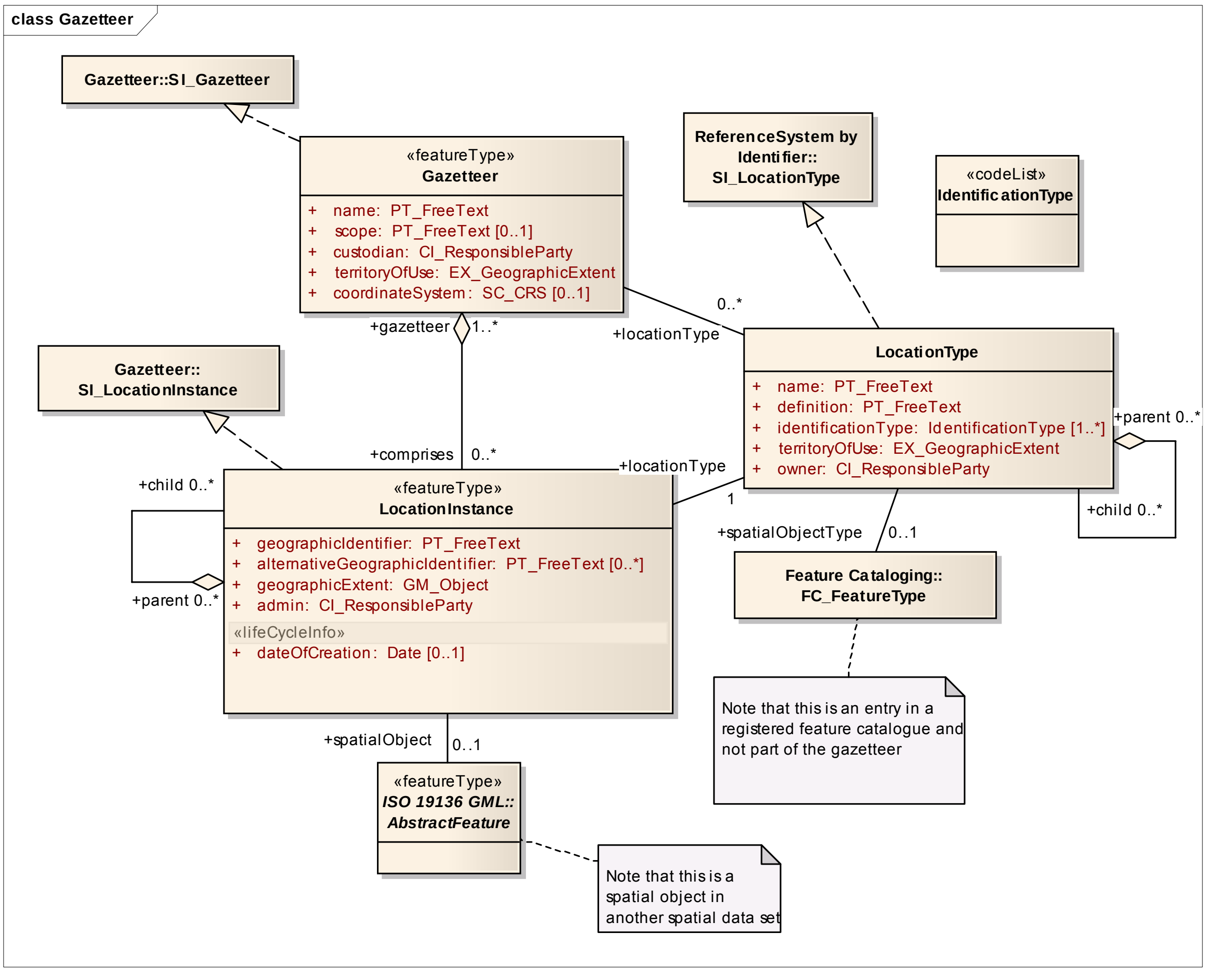



**Figure 15 – Gazetteer application schema**

The schema contains the following changes to the ISO 19112 model based on requirements of INSPIRE and implementation experiences:

- PT_FreeText has been used as a data type instead of CharacterString. While PT_FreeText is a subtype of CharacterString and can replace that type through the usual polymorphism mechanisms, the type has been used explicitly as all gazetteers in INSPIRE are assumed to be multilingual.

  In localised character strings, the locale could reference well-known locales managed in a register.

- SI_LocationType is realised by LocationType with the following non-trivial changes:
  - “theme” is implemented by a reference to a definition in a registered feature catalogue;
  - “identification” is implemented by a code list, the values of the code list will be identified during the process of modelling the INSPIRE application schemas.

- Multiple alternative geographic identifiers are supported (there is an inconsistency in ISO 19112: according to the UML, only one alternative geographic identifier is allowed, however, the textual description states that multiple alternative geographic identifiers can be provided).

- Since the temporal extent is specified in ISO 19112 as “the date of creation of this version of the location instance”, a more appropriate data type and attribute name are used. Also, this property has been tagged as life-cycle information.

- ISO 19112 specifies that the geographic extent shall be defined in one of the following ways: either as a collection of smaller spatial objects (for example the European Union, defined by its constituent countries) or by a bounding polygon. However, the data type EX_GeographicExtent is not appropriate for this as it does not support the first method while it supports additional methods that are not allowed (a rough bounding box or a geographic identifier).

  At the same time the position attribute is restricted to a point.

  However, in INSPIRE it is expected that the positions/extents of locations are described by either points, curves, surfaces or even solids (or aggregates of these). Therefore, the attribute “geographicExtent” is of type GM_Object and “position” has been dropped.

- The information about the location is one piece of information to be derived from a gazetteer. Another piece of information that is considered important in INSPIRE is the reference to a spatial object that is associated with the location. An association has been added to allow representing such information in an INSPIRE gazetteer.

  NOTE 3 This also allows, in principle, that the “geographicExtent” attribute can be derived on demand (see the clause on object referencing, Clause 13). For example, the EuroGeoNames project will head in the same direction: coordinates are no longer stored (duplicated) in the gazetteer, but are referenced to and maintained in the national reference data set(s), at various scales.

- The attributes of Gazetteer (i.e. name, custodian, scope) could be represented by references to registry entries.

In location types where geographic identifiers are based on a linguistic name (vs. a structured identifier), the topic of “equally treated names” requires additional clarification and guidance. In principle, such a clarification should be part of ISO 19112, but since this is not the case, it is expected that the current OGC Standards Working Group may provide guidance about this subject. For example, the project EuroGeoNames has to deal with many cases of the complex issue of equally treated names in Europe. One German example for two official geographical names for one location is: ‘Bautzen’ (German) and ‘Budyšin’ (Sorbian). Both are official and equally treated names regarding their status. Using one as the geographic identifier and the other as an alternative geographic identifier is not an appropriate or acceptable solution. It also does not reflect that different names may have different characteristics, e.g. different dates of creation. Currently, different gazetteers may choose different approaches.

EXAMPLE The approach within the EuroGeoNames project for the ‘Bautzen’/‘Budyšin’ example is to create two different geographic identifiers and thus also two location instances. Both location instances refer to the same spatial object and both represent the other geographic identifier as an alternative geographic identifier.

NOTE 4 It is likely that the standardisation of a gazetteer application schema in the current OGC Standards Working Group may lead to changes of the schema discussed above.

## *9.10 Feature catalogues*

| | |
|---|---|
| **Requirement 32** | The spatial object types of an INSPIRE application schema shall be represented in a corresponding feature catalogue. |

| | |
|---|---|
| **Requirement 33** | Every feature catalogue shall contain the information specified in the corresponding application schema in accordance with ISO 19110[8]. |

An ISO 19135 conformant register for the INSPIRE feature catalogues will be established. The register content will be published via a registry service.

The English version of each feature catalogue will be derived automatically from the corresponding application schema. Other language versions of the feature catalogue will be translated manually with support in particular by the INSPIRE Glossary and the INSPIRE Feature Concept Dictionary Register.

NOTE This is a narrower – but conformant – view of a feature catalogue than it is taken by ISO 19110. ISO 19110 supports that standardised feature catalogues are developed and multiple application schemas draw their spatial object type definitions from these standardised feature catalogues. This approach has not been adopted in INSPIRE for the following reasons:
- One aspect of that approach is the use of common definitions for spatial object types, etc. This role is covered in INSPIRE by the registers, in particular the INSPIRE Feature Concept Dictionary Register.
- The second aspect of that approach are reusable bindings of properties to spatial object types. This requirement is addressed in INSPIRE by the consolidation of all application schemas and base schemas in a single UML model. If the same spatial object type concept is used multiple times with a similar property pattern, it is foreseen to create a supertype implementing the common property pattern.

The main role of the feature catalogue in INSPIRE is to provide a well-defined machine-readable, online-accessible and discoverable representation of the spatial object types in the INSPIRE application schemas. Of particular importance is that the representation can easily be styled into a human-readable form.

# 10 Spatial and temporal aspects

## *10.1 Spatial and temporal characteristics of a spatial object*

A core characteristic of a spatial object is that it is associated not only with spatial but often also with temporal characteristics.

All spatial and temporal characteristics are directly or indirectly associated with a reference system describing the interpretation of, for example, coordinate values. This is essential to enabling services (e.g., a download service supporting spatial queries with access to coordinate transformation services) or other software applications to relating different spatial objects to each other – spatially and temporally.

[8] An amendment of ISO 19110 is currently in Committee Draft stage in the ISO standardisation process. The amendment of ISO 19110 is expected to provide an XML encoding for feature catalogues. In this case, this XML encoding will be used to encode the items of the feature catalogue register in the registry.

**Requirement 34** Spatial characteristics of a spatial object shall be expressed in an application schema in one of the following ways depending on the requirements:

- by specifying properties of the spatial object type with a value that is a spatial geometry or a topology (see ISO 19109 8.7)
- by specifying properties of the spatial object type with a value that is a geographic identifier in a gazetteer (see 9.9 and ISO 19109 8.9)
- by specifying properties of the spatial object type with a value that is a coverage function (see 10.4)
- by specifying references to other spatial objects (see Clause 13)

NOTE ISO 19107 allows the use of topology without a geometric realisation. It is not expected that topology without a geometric realisation will be used in an INSPIRE application schema.

**Requirement 35** Temporal characteristics of a spatial object shall be expressed in an application schema in one of the following ways depending on the requirements:

- by specifying properties of the spatial object type with a value that is a temporal geometry or a temporal topology (see ISO 19109 8.6; note that time is a dimension analogous to any of the spatial dimensions and that time, like space, has geometry and topology);
- by specifying properties of the spatial object type with a value that is one of the basic types Date, DateTime and Time. However, this makes the attribute a “thematic attribute” instead of a “temporal attribute” in terms of the General Feature Model, as there is no temporal reference system connected to it (see note in ISO 19109 8.6.1), i.e. this method should be applied with care. The Gregorian calendar shall be the default calendar, UTC the default time zone.

NOTE Time is a dimension analogous to any of the spatial dimensions. Like space, time has geometry and topology. A point in time occupies a position that can be identified in relation to a temporal reference system. Unlike space, however, time has a single dimension. See ISO 19108 5.2 for details.

EXAMPLE 1 A time period is the 1-dimensional primitive of temporal geometry.

When modelling temporal characteristics, it is important to take the diversity of temporal aspects into account that may be relevant to an individual spatial object. Temporal characteristics that are relevant to distinguish different versions of the same spatial object are a special case, see 9.6.3.

EXAMPLE 2 In meteorological simulations there are a number of temporal aspects that need to be considered:

- In numerical meteorological/ocean/climate simulation models, the time axis is not always based on a Gregorian calendar - e.g. a 360-day calendar of 30-day months is often used in climate models. A projection onto a Gregorian calendar may be possible, though not always straightforward.
- Other times associated with a numerical simulation, e.g. weather forecast (note all these times are with respect to the real Gregorian calendar and not the simulation calendar):
    - datumTime: the initial (origin) time of the simulation
    - creationTime: time at which the simulation was executed
    - issueTime: time at which the results were published/issued
    - verificationTime: time at which the simulation should be verified, sometimes called the validTime (e.g. a forecast may be for 'tomorrow midday')
    - validUsagePeriod: a period of time within which the simulation results should be used; encompasses the verificationTime
- A forecast is a simulation where the verificationTime is in the future while a hindcast is a simulation where the verificationTime is in the past.

The crucial times in this example are the datumTime and the verificationTime. So there is the familiar situation of having successive forecasts for a specific time, say 06:00 (GMT), Thursday August 10

2006. (These might be regarded as different versions of a forecast data set.) Normally, a weather forecast will extend out to between five and ten days ahead, and will be reissued each twelve hours.

A different approach instead of treating spatial and temporal characteristics as separate would have been to specify a model for spatio-temporal characteristics. The ISO 19100 series, however, currently do not provide support for such models. However, in practice, assigning temporal characteristics to a spatial object or a spatial property is typically insufficient for atmospheric/oceanic models, and spatio-temporal characteristics need to be modelled as such. Other application examples for spatio-temporal characteristics are topography changes over time or town-planning analysis of urban growth.

## 10.2 Profile of the spatial schema

Geometry and topology types as specified in ISO 19107 may be used in an INSPIRE application schema without restrictions.

| | |
| --- | --- |
| **Recommendation 11** | The value domain of spatial properties should be restricted to the Simple Feature spatial schema as defined by OGC document 06-103r3 (Implementation Specification for Geographic Information - Simple feature access - Part 1: Common Architecture v1.2.0) whenever feasible. The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear. |

NOTE The topological relations of two spatial objects based on their specific geometry and topology properties can in principle be investigated by invoking the operations of the types defined in ISO 19107 (or the methods specified in OGC 06-103r3).

## 10.3 Profile of the temporal schema

Temporal geometry and topology types as specified in ISO 19108 may be used in an INSPIRE application schema without restrictions.

NOTE The temporal relationship of two temporal spatial objects based on specific geometry and topology properties of the objects can in principle be investigated by invoking the operations of the types defined in ISO 19108. However, ISO 19108 does not allow for a computation of relationships between two temporal objects where one of the objects is indeterminate such as “now”, whereas a real time data sets containing data for the last 3 days until "now" has a practical application and a length/duration.

## 10.4 Rules for use of coverage functions

Coverage functions are used to describe characteristics of real-world phenomena that vary over space and/or time. Typical examples are temperature, elevation, precipitation, imagery. A coverage contains a set of such values, each associated with one of the elements in a spatial, temporal or spatio-temporal domain. Typical spatial domains are point sets (e.g. sensor locations), curve sets (e.g. contour lines), grids (e.g. orthoimages, elevation models), etc. A continuous coverage is associated with a method for interpolating values at spatial positions between the elements of a domain, e.g. between two points or contour lines.

Rules on coverage functions are not part of the current version of ISO 19109 since that standard predates ISO 19123. Therefore, the following rules are added in the Generic Conceptual Model, based on the extension to General Feature Model specified in 9.2.3.

| | |
| --- | --- |
| **Requirement 36** | Any specification of a coverage function in an INSPIRE application schema shall be in accordance with ISO 19123 and 9.2.3. |

| | |
| --- | --- |
| **Requirement 37** | An application schema package that uses coverage functions shall follow the rules of ISO 19109 8.2.5 for referencing standardized schemas, i.e. import the coverage schema specified by ISO 19123. |

| | |
| --- | --- |
| **Requirement 38** | A coverage function shall be defined as a property of a spatial object type where the type of the property value is a realisation of one of the types given in Table 3. |

NOTE 1 This approach creates a implementation profile of the relevant ISO 19123 types in the INSPIRE application schema (or the Generic Conceptual Model).

**Table 3 - List of valid coverage types in an application schema**

| Abstract coverage types | Discrete coverages | Continuous coverages |
| --- | --- | --- |
| CV_Coverage<br>CV_DiscreteCoverage<br>CV_ContinuousCoverage | CV_DiscretePointCoverage<br>CV_DiscreteGridPointCoverage<br>CV_DiscreteCurveCoverage<br>CV_DiscreteSurfaceCoverage<br>CV_DiscreteSolidCoverage | CV_ThiessenPolygonCoverage<br>CV_ContinousQuadrilateralGridCoverage<br>CV_HexagonalGridCoverage<br>CV_TINCoverage<br>CV_SegmentedCurveCoverage |

NOTE 2 The implementation of ISO 19123 within ISO 19136 and the OGC Web Coverage Service is incomplete from the point of view of some of the themes. For example, spatio-temporal coverage domains, the continuous coverage types, and the irregular nature of some atmospheric and oceanic model coverages (e.g. using CV_ReferenceableGrid) are insufficiently specified.

EXAMPLE The model of the elevation of a land surface shown in Figure 16 illustrates the modeling approach. The LandSurface spatial object type represents a land surface (see theme “elevation”) where the terrestial elevation may be describe by one or more coverage functions. The example supports elevation values provided at various points on the land surface (point coverage), isolines at various elevations (curve coverage) and an elevation grid (grid coverage). The only coverage that is modeled in the example is the elevation grid, which realizes a continuous quadrilateral grid coverage with a bilinear default interpolation of the elevation between grid points in a rectified grid. The unit of all elevation values is fixed to metres.

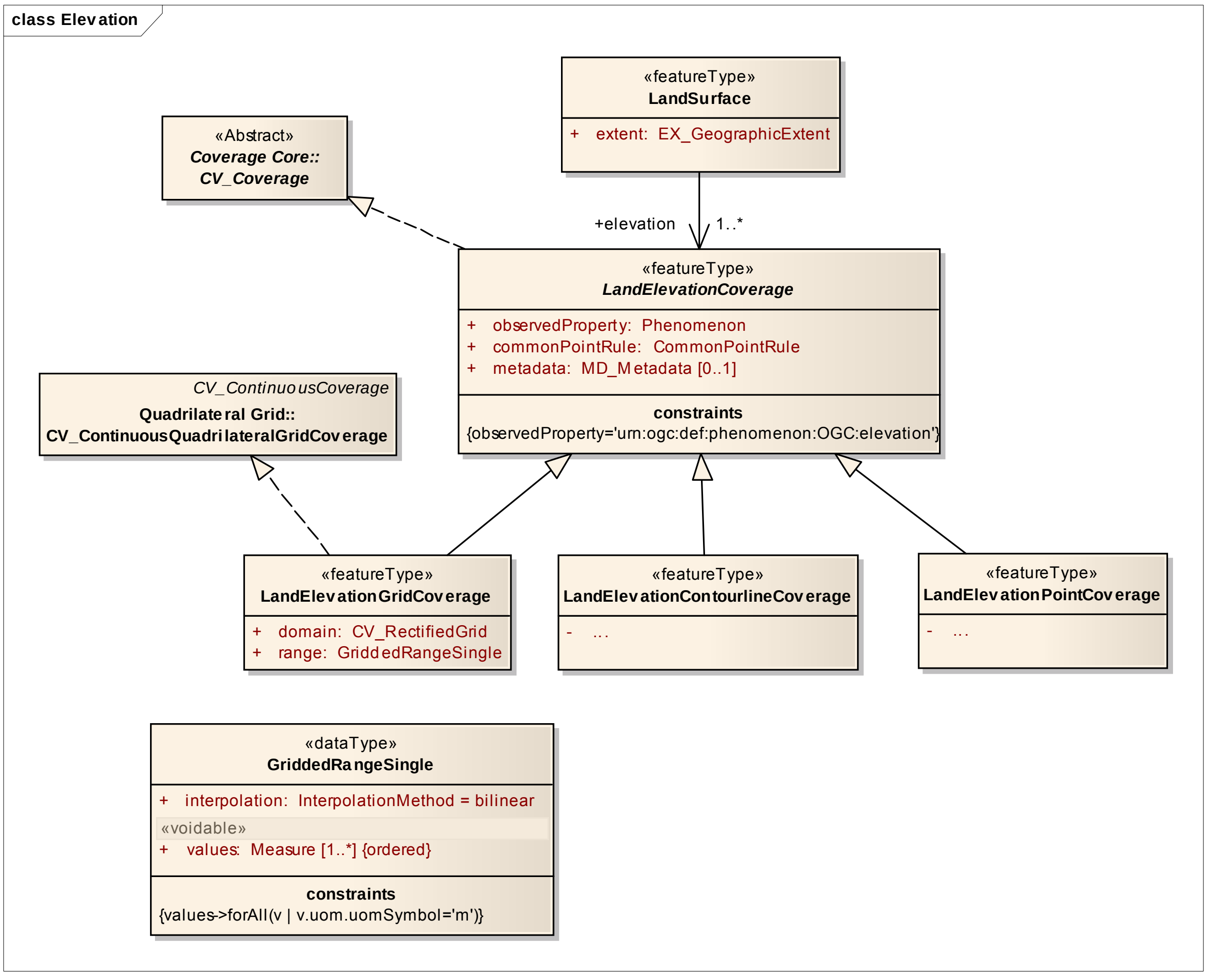



**Figure 16 – Coverage example (elevation of land surface)**

## *10.5 Profile of the coverage schema*

Coverage types as specified in ISO 19123 and in 10.4 may be used in an INSPIRE application schema without restrictions.

## *10.6 Geographic identifiers*

Geographic identifiers may be used in an INSPIRE application schema to reference LocationInstance objects in a gazetteer (see 9.9).

The initial list of spatial object types for which gazetteers are required within INSPIRE, will be identified in INSPIRE data specification development process.

# 11 Multi-lingual text and cultural adaptability

## *11.1 Multilingual and multicultural requirements*

| | |
|---|---|
| **Requirement 39** | For all geographical names and exonyms the support for multilingual text in the INSPIRE application schemas shall be considered. |

| | |
| --- | --- |
| **Requirement 40** | Translation of geographical names shall not be required in INSPIRE application schemas, only exonyms may be used. |

EXAMPLE 1 The name of the German city "Neu-Ulm" in French will still be "Neu-Ulm" and not "Nouveau-Ulm" (translation). However, "London" will become "Londres" in French (exonym).

| | |
| --- | --- |
| **Requirement 41** | There shall not be a limitation to the number of names in different languages for one spatial object. |

EXAMPLE 2 Names of cities (e.g. "Bruxelles", "Brussel", "Brussels", "Brüssel", etc.) or other spatial object names in a multilingual area ("Brussel-Zuid", "Bruxelles-Midi").

| | |
| --- | --- |
| **Requirement 42** | The types specified in 11.2 shall be used in application schemas whenever the value of a property is linguistic text. |

NOTE 1 Requirement 39 to Requirement 42 address the modellers of the Thematic Working Groups in the first place. The application schemas will support multilingual names, and the association of names with language. The Generic Conceptual Model does not require the Members States to provide that linguistic information per se. Such requirements may or may not be spelt out in the data specifications for 'Geographical names' and the other Annex themes.

| | |
| --- | --- |
| **Requirement 43** | Where applicable, every INSPIRE application schema shall require that mixing different languages in a single character string is not allowed, with the exception of multilingual official names. |

EXAMPLE 3 In Spain the official name of the capital city of the province of Guipuzcoa is Donostia-San Sebastián, where Donostia is in Basque and San Sebastián is in Spanish.

| | |
| --- | --- |
| **Recommendation 12** | Free text attributes in application schemas should be avoided; the use of code lists and enumerations is recommended whenever possible. |

NOTE 2 It will not be possible to avoid free texts completely (e.g. in addresses).

| | |
| --- | --- |
| **Requirement 44** | For properties containing linguistic text it shall be analysed as part of the modelling process, if the property needs to support a text value in a single language only, or if the property shall be able to represent the value in multiple languages. The application schema shall reflect the result of the analysis, see Requirement 47. |

NOTE 3 As prCEN/TR 15449 points out, "the solution to multi-lingual issues is not the translation of everything into a common language (e.g., English). Often, it is sufficient to obtain resources in their original production language, rather than in its translated version." An example may be textual descriptions of a feature. However, in order to find spatial objects, certain service interfaces, portals or client applications should support translation capabilities.

| | |
| --- | --- |
| **Requirement 45** | Code lists specified in or referenced from an INSPIRE application schema shall be multi-lingual and use a language-independent code for every entry in the code list. |

EXAMPLE 4 A building feature may have a property specifying the usage of the building. The codelist values are maintained in a multilingual dictionary, so that the correct text value can be selected from the dictionary based on the code list value ("Rathaus", "hôtel de ville", "Stadhuis", etc.)

EXAMPLE 5 To denote a security classification with the meaning "kept or meant to be kept private, unknown, or hidden from all but a select group of people", ISO 19115 specifies a short name ("secret") and a numeric code ("005").

Not all terms may be translatable from one language to another, and even in the same language different disciplinary communities may interpret the same word very differently. For example, computer scientists and psychologists would attach very different meanings to the word "schema". Ontologies may in principle be used to help capturing multi-cultural aspects, but they must be rich enough to include the contextual information necessary for different communities to reach a shared understanding. The development of such ontologies is not within the scope of INSPIRE in its first version. Therefore, no formal requirements how cultural differences are to be taken into account when modelling an INSPIRE application schema will be specified.

| | |
| --- | --- |
| **Requirement 46** | In every INSPIRE application schema, English shall be used for package, class, attribute and association role names. |

NOTE 4 This does not impact the existing application schemas or spatial data sets in the Member States.

## *11.2 Multilingual extensions*

### 11.2.1 Multilingual text

In the context of application schema, multilingual aspects are crucial with geographical names and spatial object and attribute classifications (feature catalogues, feature concept dictionaries, codelist values).

| | |
| --- | --- |
| **Requirement 47** | PT_FreeText from the conceptual model specified in ISO/TS 19139 shall be used as the data type for multilingual text and LocalisedCharacterString for linguistic text. LocalisedCharacterString is a character string with a locale. A locale is a combination of language, potentially a country, and a character encoding (i.e., character set) in which localised character strings are expressed. |

NOTE While these types have been developed in the context of metadata, in principle they should be basic data types (and belong in ISO/TS 19103 instead of ISO/TS 19139).

### 11.2.2 Multilingual feature concept dictionaries

Feature concept dictionaries that conform to ISO 19126 are multilingual, i.e. there are no additional requirements.

### 11.2.3 Multilingual feature catalogues

Feature catalogues modelled that conform to ISO 19110 Amd1 are multilingual, i.e. there are no additional requirements.

### 11.2.4 Other multilingual dictionaries

| | |
| --- | --- |
| **Requirement 48** | For multilingual dictionaries for coordinate reference systems, units of measurement, and code lists the conceptual model for such dictionaries specified in ISO/TS 19139 shall be used. |

# 12 Coordinate referencing and units of measurement model

## 12.1 Overview

This clause specifies the application schema of the first two themes in Annex I of the INSPIRE Directive:

1. Coordinate reference systems: Systems for uniquely referencing spatial information in space as a set of coordinates (x,y,z) and/or latitude and longitude and height, based on a geodetic horizontal and vertical datum.

   See 12.2.

2. Geographical grid system: Harmonised multi-resolution grid with a common point of origin and standardised location and size of grid cells.

   See 12.5.

In addition, the conceptual schemas for temporal reference systems and units of measurements, which are also required, are specified in 12.3 and 12.4.

## 12.2 Spatial coordinate reference systems and coordinate operations

| | |
|---|---|
| **Requirement 49** | Spatial and spatio-temporal coordinate reference systems shall be described in accordance with ISO 19111 and ISO 19111-2[9] whenever the spatial reference system is within the scope of these standards. |

It is known that ISO 19111 is not sufficient for some spatial reference systems that are frequently used:

- Similarly, linear reference systems are used, for example, in the transportation domain. A work item for such extensions has recently been added to the work programme of ISO/TC 211.

NOTE Spatial references systems using geographic identifiers are specified by ISO 19112, see 9.9.2 and 10.6.

To support the ESDI, an ISO/TS 19127 and ISO 19135 conformant register and registry for spatial reference systems and transformations between the systems will be established as part of INSPIRE.

| | |
|---|---|
| **Requirement 50** | Every INSPIRE data specification shall specify the list of coordinate reference systems that may be used in the encoding of spatial objects defined by that data product specification. |

| | |
|---|---|
| **Requirement 51** | Every INSPIRE data specification shall specify a minimum list of reference systems that may be used to query spatial objects defined by that data specification in a request to a download service. |

[9] ISO 19111-2 is expected to enter Draft International Standard stage in the ISO standardisation process in June 2008.

## 12.3 Temporal reference systems

| | |
| --- | --- |
| **Requirement 52** | Temporal reference systems shall be described using the model specified in ISO 19108 5.3 (TM_ReferenceSystem). |

NOTE The relationship of temporal and spatial reference systems was discussed in the Editing Committee of the current revision of ISO 19111. There, it was agreed that the scope of ISO 19111 should be limited to spatial referencing by coordinates, except that a compound coordinate reference system may include a temporal coordinate reference system. It was assumed that ISO 19108 will be amended to change TM_TemporalCoordinateSystem as currently specified in ISO 19108 to TM_TemporalCoordinateReferenceSystem. Since ISO 19108 has not yet been amended, this type is currently specified in ISO 19136 D.3.10 to provide a temporary home.

To support the ESDI, an ISO 19135 conformant register and registry for temporal reference systems and conversions between the systems will be established as part of INSPIRE. Temporal reference systems that are used in INSPIRE spatial data sets as well as conversions between the systems will be registered, where appropriate.

NOTE 1 In meteorological data, each forecast has a generic reference system (T+0, T+24, etc..), but also an individual specific reference system with a datum which changes every 6 hours with every forecast. These individual temporal coordinate reference systems are examples of reference systems that will not be registered, but only provided directly with data.

NOTE 2 Not all temporal reference systems can or should have conversions; ordinal reference systems, for example do not.

| | |
| --- | --- |
| **Requirement 53** | Every INSPIRE data specification shall specify the list of temporal reference systems that may be used in the encoding of spatial objects defined by that data specification. |

| | |
| --- | --- |
| **Recommendation 13** | Whenever possible and appropriate, the Gregorian calendar should be used as the temporal reference system. |

## 12.4 Units of measurement

| | |
| --- | --- |
| **Requirement 54** | Units of measurements shall be described using the model contained in ISO 19136 D.3.13. |

NOTE This model follows SI and ISO 1000 in supporting both base units and derived units.

| | |
| --- | --- |
| **Recommendation 14** | Where feasible, property values of a spatial object type that are measures should require the use of the same unit (e.g. metres) for all instances to simplify processing of data. |

| | |
| --- | --- |
| **Recommendation 15** | Units based on SI units should be used. |

Where this is not feasible due to different practice in the member states, the unit associated with a specific property type may be kept open (e.g. metres, feet, centimetres, etc. would all be allowed) and user applications will have to convert these values, if different units are used. This burden for the client applications should be avoided, if possible.

To support the ESDI, an ISO 19135 conformant register and registry for units and conversions for commonly used units will be established as part of INSPIRE. Units that may are used in spatial data sets will be registered, where appropriate.

NOTE Conversions between coordinate reference systems with different units are handled by a coordinate operation as specified by ISO 19111 and registered in the CRS register.

## *12.5 Geographical grid systems*

The 2003 JRC Workshop on European Reference Grids adopted the following definition for geographical grids*: "A grid for representing thematic information is a system of regular and geo-referenced cells, with a specified shape and size, and an associated property."* Therefore:

| | |
| --- | --- |
| **Requirement 55** | A geographical grid shall be a coverage in accordance with ISO 19123, where the domain is restricted to a CV_RectifiedGrid. |

NOTE For the avoidance of doubt, application schemas may also use other types of gridded coverages, for example coverages based on a referencable grid (CV_ReferencableGrid in ISO 19123) and/or a different domain than the horizontal surface of the earth.

| | |
| --- | --- |
| **Requirement 56** | Every INSPIRE data specification that specifies gridded coverages shall specify the grid systems and associated coordinate reference systems that may be used in the encoding of spatial objects defined by that data specification. |

A cell in a grid can be referenced by a sequence of integer values (one for each axis), see CV_GridCoordinates in ISO 19123.

# 13 Modelling object references

## *13.1 Overview*

Object referencing addresses how information is spatially or temporally referenced to existing spatial objects, typically topographic objects, rather than directly via coordinates. In turn it is also possible to “reuse” the referenced spatial object by a third party. For example a road centreline might reference base topographic objects maintained by a different organisation. In turn a third party might then reference their own application view, e.g., highways maintenance programme to the centreline network and so on. This then provides an unambiguous linkage to the same spatial object representing real world phenomena and also promotes reuse of information. As a result, object referencing significantly enables improvements in data integrity and reliability.

The motivation for and of benefits of object referencing in a spatial data infrastructure as well as the current state of play are discussed in more detail in Annex D.

This data interoperability component aims to encourage and promote the use of object referencing. However, based on the current state of play in the Member States, the Generic Conceptual Model does not contain any requirements on this subject at this time and only provides recommendations.

All examples in this clause use object referencing in a spatial context. However, the same guidelines apply as well to object referencing in a temporal context.

## *13.2 Object referencing in application schemas*

| | |
| --- | --- |
| **Recommendation 16** | Recognising that object referencing to a common base (see Annex D) supports the principles in recital (6) of the INSPIRE Directive best, it is recommended to install structured object referencing by means of reference data where possible. |

However, the situation in member states may be that

- the relevant spatial reference data sets are not yet available,
- an agreement for such reference data sets might not be found e.g. for commercial or political reasons, and/or
- implementation of the reference sets usually implies costly and time-consuming data re-engineering.

Therefore, the INSPIRE implementation rules have to cater for object referencing and feature relationships such as aggregations from a modelling perspective, but not mandate approach C, allowing for other models as well.

The issue of how to publish the data is another topic where no one-size-fits-all solution is available. On the one hand, most users may prefer to have directly the spatial object with its own (redundant, derived) geometry rather than a spatial object that simply references other spatial objects. Yet, to publish the spatial object with its own geometry and without the link to the reference spatial objects may imply a risk of losing data consistency.

**Recommendation 17** To address the different requirements, the following modelling pattern should be used, if an application schema intends to allow that the spatial or temporal location of a spatial object may be provided directly, by a reference to a base spatial object or by providing a geographic identifier. Depending on the specific semantics and operational context of a spatial object type, this pattern may be adapted.

EXAMPLE Assume that the geography of a spatial object type “Road” may be expressed in one of three ways:

- an object reference to road segments which carry a spatial geometry (variant “indirect”, i.e. using external object identifiers to reference the road segment objects)
- a redundant geometric aggregate (variant “direct”)
- a collection of geographic identifiers (variant “roadSegmentName”, i.e. a reference using geographic identifiers).

In the application schema, this could be expressed as shown in the figure below. The property “centreline” can be exactly one of the following as indicated by the <<union>> stereotype (specified in ISO/TS 19103) of the data type DirectOrIndirectCurve.

Whatever variant is used to provide the “defining” spatial information, an additional, derived spatial property (“derivedPosition”) is included in Road. This allows the use of spatial predicates in queries like with any “regular” spatial object. A disadvantage is that if both Road and RoadSegment objects are requested from a download service, the redundant geometry would increase the amount of data to be transferred.

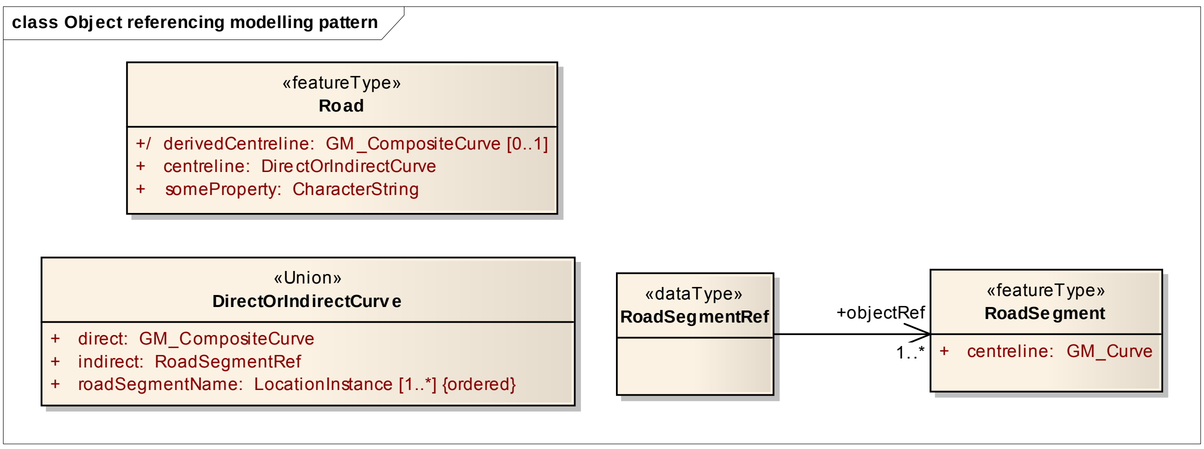



**Figure 17 – Object referencing modelling pattern**

Note that the above is a modelling pattern. It will be the decision in the modelling of the individual themes to decide if and how the object referencing capabilities are used in the specifications of the individual spatial object types.

The practical differences between the three possibilities are:

- The first option is an association role, an object reference, to another spatial object. To access the geometry the reference has to be resolved and the geometry has to be accessed from the referenced spatial object (which in theory could again require resolving a reference).
- The second option is a geometry that would be typically be a copy of a geometry in some reference data set, or a geometry that would captured in some other way, e.g. digitising from a map or from an orthoimage. A common characteristic is that the consistency with the geography of a related spatial object is not maintained as their geometries are not "aware" of each other.
- The third option is a geographic identifier which may be translated into a location using a gazetteer as described in the gazetteer schema in 9.9. This option requires that geographic identifiers for segments of the road network exist and are published in a Gazetteer.

## *13.3 Discussion of object referencing cases*

### 13.3.1 Overview

This overview provides a general approach for object referencing. The specific relationships will be part of the models of the individual themes.

To support interoperability and harmonisation of spatial data, a limited list of methods to express object referencing relationships may be used in INSPIRE application schemas would be beneficial. However, at the moment, it is not feasible to specify a complete and closed list of such relationship types. The referencing methods that are considered to be the most important are described in 13.2.

From examples given in reference material, one may distinguish three broad cases relevant to point, curve and surface spatial objects. Generally the spatial relationships between an existing reference object and a third party object of the same kind are shown in Table 4.

**Table 4 – Spatial relationships between spatial objects**

| Physical relationship between spatial objects: | No relationship[10] | Common extents | Partially related[11] |
|---|---|---|---|
| **Point** | *Non-coincident* | *Wholly Coincident* | *Partially Coincident* |
| **Curve** | *Non-collinear* | *Wholly Collinear* | *Partially Collinear* |
| **Surface** | *Non-coterminous* | *Wholly Coterminous* | *Partially Coterminous* |

In addition some kinds of multidimensional information may not be applicable to object referencing – e.g. certain aspects of meteorological datasets/models.

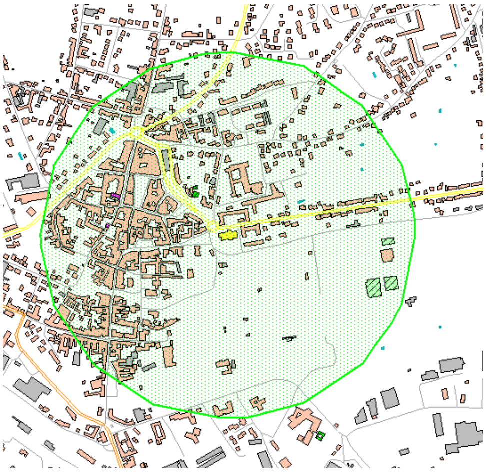
Several of the above relationships are illustrated in the following sub-clauses.

### 13.3.2 Case A: non-aligned spatial objects

The implementation in this case is similar to a simple overlay method. There is no coterminosity of the spatial object and the reference objects. In such cases the positional accuracy of the referenced object is very important since on-line queries such as “is my property affected by protected site x?” may be solely dependent on coordinate based relationships.

[10] while not being wholly aligned with existing spatial objects, these may of course intersect the referenced objects
[11] while not being wholly aligned with existing spatial objects, these may of course intersect the referenced objects

EXAMPLE 1 Non-coterminous surface spatial objects:



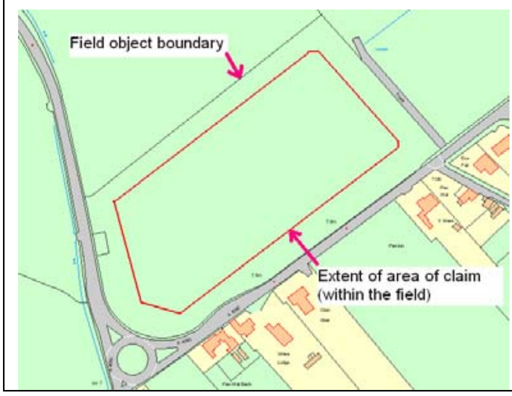
The boundaries of some spatial objects do not hold any relationship with any other geographic object. In the example a protected site is centred on the church tower with a radius of 500m.

The protected site may reference the church spatial object. In addition, the boundary would be created as a free-standing geometry, i.e. no part of the boundary of the spatial object is coterminous with any other spatial object.

Note that it is possible that a third party may in turn reuse this geometry to create a spatial object of their own.

Generally this case adopts:
- a method similar to the traditional overlay approach along the boundary since there is no existing geometry to be reused,
- the boundary can be said to be formed entirely of ancillary geometry,
- such a spatial object may reference existing reference objects to indicate a relationship.

EXAMPLE 2: Non coterminous surface spatial objects:




When claiming subsidies a farmer may not use the full extent of the field parcel. In the example the area being claimed is shown in red within the field. This is an application spatial object.

The geometry of this (application) spatial object is therefore non-coterminous with any other spatial object, i.e. the field.

As above this is also similar to conventional overlay methods and is formed entirely from third party geometry.

The application object is however a spatial object and could be referenced to the field parcel spatial object via its identifier (in a web service the application object may then locate the reference object which might be served on another network resource).

There are also instances of non-collinear line and non-coincident point spatial objects.

**Recommendation 18** In INSPIRE application schemas, non-coincident/non-collinear/non-coterminous spatial objects should be modelled without object referencing, i.e. typically contain spatial properties that have a geometry as its value. However, establishing associations between related objects will assist data linking.

### 13.3.3 Case B: wholly aligned spatial objects

In this case, the object referencing will use a unique identifier from the spatial object in the reference data. This will in general be the external identifier, it may be also a geographic identifier that can be resolved using a gazetteer service.

If a spatial object references multiple spatial objects in the reference data, it constitutes an aggregation. An example is a road made up from individual road segments.

Often, linear referencing may be used to reference spatial objects to positions along curve geometries from reference data. This may be used for point objects (e.g. a Point Of Interest or the location of an accident or an address along a road, or a water sampling measurement point or a discharge point from a sewage works along a river) or for linear objects (e.g. speed limit jurisdiction, a tunnel or a sustaining wall along a railway or a road).

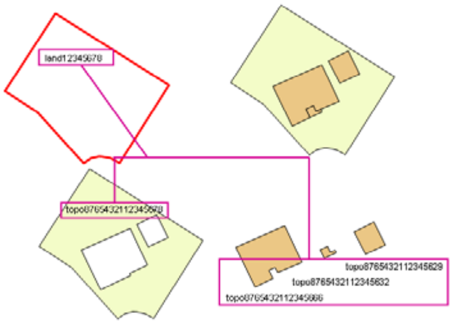
Explicit cross references allow for unambiguous responses across two data sets that are referenced in this way. For example a query again such as "is my property affected by protected site x?" could be answered immediately from the cross referenced identifiers.

EXAMPLE 1 Coterminous (surface) objects:


In the example (left) a property parcel or cadastral parcel is related to the spatial objects in the real world represented in a topographic database. Not all such boundaries may be coterminous with common reference objects (see Case C example 1 below) but this example given here is such a coterminous case .

In an overlay method gaps and overlaps often impair data integrity and undermine automated processes.

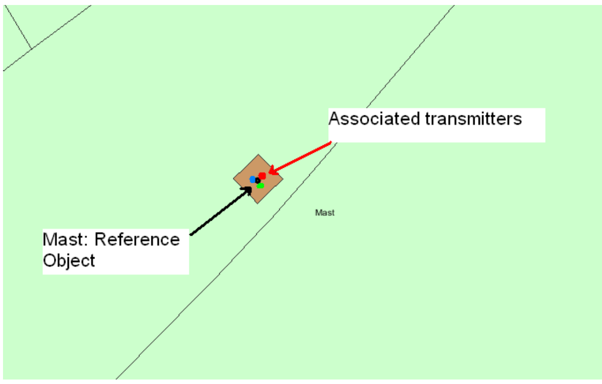
Generally thematic data will be assigned to the property parcel (ownership details, mortgage records, property rights etc).




Object referencing in this case does not require the digitising of any geometry by the user. Instead the spatial objects that make up the application object are referenced by the property parcel. In the example the property parcel references four topographic objects.

The data integrity of the property parcel is preserved and can support automated processes reliably. Any changes to the underlying spatial objects can also automatically trigger a process for the provider of the property parcel information to automatically realign their own data as well.

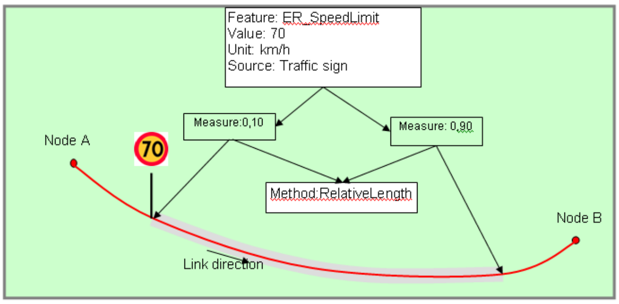
EXAMPLE 2 Coincident (point) objects:




The simplest case is that of a point - where other objects might be attached to that object.

The case shown (left) is a telecommunications mast on a hill. It is fenced in a small compound and represented by a (black) point. Today telecoms companies are encouraged to share the same mast – therefore several providers will have transmitters attached to a common mast (shown here in red, green and blue). In turn each transmitter will have all kinds of data and associated business information to support an application. In the case shown each transmitter object will be cross referenced to the common telecoms mast object
Similar applications can apply to street furniture, bus stops and other objects that are often too small to be represented fully in databases covering large areas.

EXAMPLE 3 Collinear (curve) objects & linear referencing:




To date, road, railway and to a certain extent rivers are the most common form of object referencing examples.

In the example (left) the road object is being used to reference speed limit data (in this case by linear referencing from the start node). The speed zone is therefore collinear with the highway object.

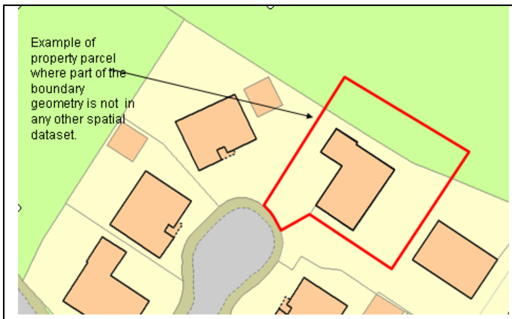
Equally a highway asset management referencing system, or traffic accident recording system might also reference the common reference objects because they both reference the same physical geographic features.

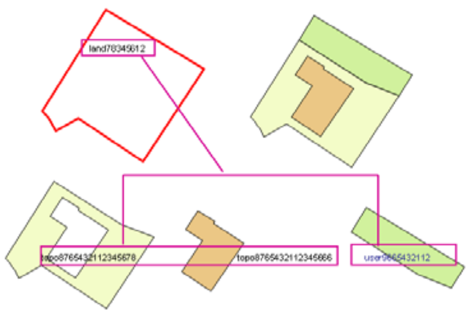
**Recommendation 19** In INSPIRE application schemas, wholly coincident/collinear/coterminous objects should be modelled using the object referencing pattern specified in 13.2. Note that still the option to specify a spatial property (first option in 13.2) should be included to support data sets and data providers that currently do not support an object referencing framework.

### 13.3.4 Case C: partially aligned spatial objects

This case is more complex since partially aligned requires a hybrid of cases A and B. The techniques and services to support this are relatively immature and still evolving.

EXAMPLE 1 Partially coterminous (surface) spatial objects:



This case is similar to the case B above except that the property extent includes part of the land shown in green in the diagram.

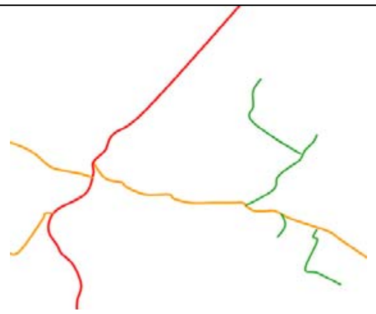
Therefore only part of the geometry is coterminous with the property land parcel.

As the additional geometry (known as ancillary geometry) is not held by any other organisation the user creates it and uses it in the same way as the topographic objects.

The Ancillary Geometry will normally be created to a specification commensurate with the topographic objects (so that others might in turn reuse it).

As in case B the property parcel then references (in this case) two topographic objects entirely as well as the ancillary geometry object.

EXAMPLE 2 Partial collinear & extending (linear) objects:

| | |
|---|---|
|  | Likewise existing linear networks can be reused and extended by adding ancillary geometry - this may be added by a third party.<br><br>In the example the only the red and orange road centrelines are managed as part of a national specification.<br><br>The green centrelines are local tracks to farms and remote rural buildings. These are added by the third party as part of an application and maintained to a specification commensurate with the national data set. |

**Recommendation 20** In INSPIRE application schemas, partially coincident/collinear/coterminous/ objects should for the time being be modelled as non-coincident/non-collinear/non-coterminous/ objects.

# 14 Identifier management

## *14.1 General requirements*

This document specifies the "common framework for the unique identification of spatial objects" referred to in Article 8(2)(a) of the Directive.

Unique identification of spatial objects is provided by external object identifiers, i.e. identifiers published by the responsible data provider with the intention that they may be used by third parties to reference the spatial object within INSPIRE.

NOTE 1 Internal object identifiers are not relevant in INSPIRE.

NOTE 2 Thematic object identifiers (e.g., ICAO location identifiers for airports or NUTS codes for administrative areas) are relevant but will be modelled as properties of the thematic spatial object types with theme-specific types.

**Requirement 57** Every spatial object type of Annexes I and II of the INSPIRE Directive shall receive a property of type "Identifier" (see 9.8.2), with cardinality "0..1" or "1", unless it is known that no requirement exists to identify or reference spatial objects of that type.

No unique object identifier will typically be required for spatial object types for which the underlying data sets do not maintain such identifiers and where no requirement is known to add such identifiers

EXAMPLE 1 It is possible that spatial object types in the theme "Geology" do not require unique identifiers.

**Recommendation 21** It is strongly recommended that unique identifiers should be provided for spatial object types where references from other spatial objects are expected to be applicable.

As the generic Conceptual Model includes the possibility of modelling object references (Clause 13), it is necessary that spatial objects which may be used as reference data carry a unique identifier.

Spatial objects in Annex III of the INSPIRE Directive may carry a unique identifier property, which should, where possible, conform to the general requirements of 14.1.

**Recommendation 22**
Annex III contains themes with spatial objects for which identifiers may be important. Where this is the case, identifier properties should be modelled in the application schema.

EXAMPLE 2 Buildings, though in Annex III, may be used as reference data, so they may have to carry a unique identifier property.

NOTE 3 Coverages and spatial data sets are spatial objects, too.

The four requirements for unique object identifiers are: uniqueness, persistence, traceability, and feasibility.

Uniqueness: No two spatial objects of spatial object types specified in INSPIRE application schemas may have the same external object identifier, i.e. the identifier has to be unique within all the spatial objects published in INSPIRE.

NOTE 4 Different versions or copies of the same spatial object will still have the same identifier.

NOTE 5 This implies that identifiers are not reused.

Persistence: The identifier has to remain unchanged during the life-time of a spatial object.

**Requirement 58** The specification of every spatial object type in an INSPIRE application schema shall state which modifications (e.g. attribute changes, merging with another spatial object) may change the identity of a spatial object, i.e. when the existing spatial object is "retired" and a new spatial object with a new identifier is created. Where applicable, every INSPIRE data specification shall require that the life-cycle rules for spatial object types in a spatial data set are documented in the metadata of the data set.

The life-cycle rules vary from data provider to data provider and as a consequence no fixed rules will be possible in general in INSPIRE data specifications.

NOTE 6 It will not be required that the life-cycle rules are copied to the metadata, a reference to a source that provides the information is sufficient – if the source is available in the required language(s).

Traceability: Since INSPIRE assumes a distributed, service-based SDI, a mechanism is required to find a spatial object based on its identifier. I.e. the identifier has to provide sufficient information about the source of the spatial object so that arrangements can be made that allow to determine the download service(s) that provide access to data from that source.

Feasibility: The system has to be designed to allow that identifiers under existing national identifier systems can be mapped.

**Recommendation 23** Whenever possible, the use of unique identifiers should be limited to spatial objects. Unique identifiers for other objects, e.g. for geometrical or topological primitives should only be considered where multiple spatial objects use the same geometry or topology primitive and this information needs to be communicated to users.

EXAMPLE 2 Sometimes, topology constraints should be used within a spatial data set internally (for example, to increase performance or data consistency), but it may not be required to expose this information explicitly to the user.

NOTE 7 Objects which do not have any spatial or temporal characteristics are outside the scope of INSPIRE. If such object types need to be modelled in an INSPIRE application schema, this document does not provide any guidance how such object types should be modelled.

## 14.2 Structure of unique identifiers

To address the requirements discussed in 14.1, unique identifiers of spatial objects consist of two parts:

- A namespace to identify the data source. The namespace is owned by the data provider and registered in the INSPIRE External Object Identifier Namespaces Register, see Clause 17.
- A local identifier, assigned by the data provider. The local identifier is unique within the namespace, i.e. no other spatial object carries the same unique identifier.

This is reflected in the type “Identifier” specified in 9.8.2.

To allow for the organisation of namespaces in INSPIRE, a hierarchical structure is encoded in the namespace.

On the first level, the Member State or multinational organisation is identified using unique codes (see 9.8.2.2).

The remaining characters of the namespace uniquely identify the data source within the Member State / multinational organisation. Often this will consist of two parts: The first part will identify the data provider within the member state and the second part will be used to distinguish between different data sources maintained and provided by the data provider. For example, if a data provider assigns unique object identifiers in the context of a product, then the namespaces registered by the data provider may include information about the data provider and the product.

EXAMPLE 1 “FR.IGNF.BDCARTO” may be the namespace used by IGN France for spatial object in their BD CARTO product. “NL.TOP10NL” may be the namespace for spatial objects in the TOP10 NL product in the Netherlands. “_EGGR.ERM” may be the namespace for spatial objects in the EuroRegionalMap product of from EuroGeographics (assuming that “_EGGR” would be the registered abbreviation of EuroGeographics).

NOTE 1 The use of a product code/name in the namespace may create problems if the data provider changes the organisation of its data products - as it would be forced to maintain the product-specific identifiers with the spatial objects also after the product itself has been retired.

This rule can accommodate the different current identifier assignment rules of data providers. If, for example, a data provider assigns local identifiers not per data product but per spatial object type, then the namespace will include the name of the spatial object type, i.e. the data provider will register a number of namespaces.

EXAMPLE 2 Data providers in a Member State may choose to use UUID as local identifier. If there is only one centralised download service, the namespace may just contain the country code. If there are several download services (e.g. depending on the products or data providers), the MAC address of the UUID would have to be considered as part of the namespace and a correspondence will have to be established between these namespaces and the download services which provide access to the data.

NOTE 2 Because of the use of the prefix this could in principle be organised without a central register but with hierarchical registers maintained by the member states and the multinational organisations. On the European level only the list of the registries on the next hierarchy level would be required.

## 14.3 Lexical rules

Recognising the key role of identifiers and the need to allow for an easy processing of identifiers in software applications, the lexical space of identifiers is restricted (see 9.8.2.2 and 9.8.2.3). The technical rationale for a restriction of the lexical space (maximum length and/or allowed characters) of unique identifiers is that in implementations identifiers play an important role in referencing or retrieving items labelled with an identifier and, therefore, identifiers are used in indexing mechanisms in information systems of both the data provider and the user. Since implementation platforms sometimes place restrictions on the lexical space for such keys, this has an impact on the implementation of INSPIRE. An example is the Web Feature Service (a candidate for the download service) that uses XML IDs to encode identifiers. As a consequence, identifiers are not constrained in length, but in the characters they can use. For example, they may not start with a digit and contain only a restricted set of allowed characters. Another related reason for considering lexical constraints is a potential performance impact on the indexing mechanism, if no constraints are specified.

## 14.4 Spatial data sets

| | |
| --- | --- |
| **Requirement 59** | The rules for unique identifiers of spatial objects shall apply for spatial data sets, too. |

Spatial data sets are spatial objects themselves, see also 9.8.3.

## 14.5 Coverages

| | |
| --- | --- |
| **Requirement 60** | The rules for unique identifiers of spatial objects shall apply for coverages, too. |

This sub-clause adds a few considerations about identifiers of coverages.

As a coverage is today typically represented by a file, current identifier conventions generally apply at file-level. Typically, identifiers are not opaque, but they incorporate 'metadata' (e.g. data product types, timestamps, data origin, sensor information, processing information). However, there is no uniform approach across agencies and data providers.

In terms of the structure specified in 14.2 the file name is the local identifier.

EXAMPLE 1 The BDORTHO product of IGN France is an orthophoto in colour at resolution 50 cm; it is produced by “department” (an administrative unit). It is provided in TIFF format, by tiles whose size is 1 km x 1 km.

The namespace could be, for example, FR.IGN.BDORTHO and the local identifier the tile name. The tile is named:

*DD-AAAA-XXXX-YYYY-PPP*.tif

where :
- *DD* is the number of the “department”
- *AAAA* is the year when the photos were taken
- *XXXX* is the X co-ordinate of the left upper side of the tile in km
- *YYYY* is the Y co-ordinate of the left upper side of the tile in km
- *PPP* is the projection acronym.

For example, 56.2002.0256.2463.IA1 is the name of a tile from department 56, from photos taken in 2002, the area is a square km whose left upper corner coordinates are 256 km and 2463 km in Lambert 1.

The BD ORTHO may be provided with other options (and with larger tiles) :

- resampling: a suffix is added to explain the resampling nature, e.g. “5m” (size of the pixel) or “NB” (for black and white)
- in compressed format: a suffix is added to give the compression factor and the extension will be “.ecw”.

EXAMPLE 2 As an example of an operational archiving centre, the UK NERC Earth Observation Data Centre is developing a convention for unique identifiers across its holdings. The current proposal is to use the following naming convention for its data sets:

*NEODC_<PLATFORM/PROJECT>[_<INSTRUMENT/PROJECT>][_<PROCESSING LEVEL/NAME>]*

The last two parts are optional and are included only where appropriate. A small selection of examples is shown in the following table.

**Table 5 – Examples of the use of unique identifiers in the UK NERC Earth Observation Data Centre**

| Data set | Data set title | Unique identifier |
|---|---|---|
| ARSF Photography | NEODC data collection: Aerial Photography | NEODC_ARSF_PHOTOGRAPHY_HARDCOPY |
| | | NEODC_ARSF_PHOTOGRAPHY_SCANNED |
| | | NEODC_ARSF_PHOTOGRAPHY_DIGITAL |
| Landsat7 ETM+ | NEODC data collection: Landsat-7 ETM+ scenes | NEODC_LANDSAT_ETMPLUS |
| Landsat 4/5 TM | NEODC data collection: Landsat TM scenes (Landsat-4/5) | NEODC_LANDSAT_TM |
| Landsat MSS | NEODC data collection: Landsat MSS scenes (Landsat-1/2/3/4/5) | NEODC_LANDSAT_MSS |
| SPOT | NEODC data collection: SPOT scenes | NEODC_SPOT |
| … | | |

NOTE 1 These examples of identifiers are just examples of structure based on metadata, but have nothing to do with metadata.

## *14.6 Versions of spatial objects*

Whenever the application schema contains life-cycle information for a spatial object type with an external object identifier, the version identifier property specified in 9.8.2.4 allows to distinguish between the different versions of a spatial object.

The version identifier is not part of the unique identifier of a spatial object.

# 15 Data transformation

The current assumption is that this component is not part of the INSPIRE data specifications, but that the transformation of data between the data specification of the Member State and the corresponding INSPIRE data specification will be taken care of by each data provider as part of providing the spatial data through their download service. The purpose of this document is solely for the intent of creating INSPIRE data specifications; there will be no expectations that the same requirements will be implemented at the national level (although it would make the mapping easier). The mapping from the existing data at the national level to the harmonised data product specifications of INSPIRE will be done by translation in the context of a download service, for example, a Web Feature Service. And it will be the responsibility of each Member State to enable this data transformation, which will be different from Member State to Member State.

NOTE 1 This is in-line with the preliminary recommendations of the Workshop on INSPIRE Download Services.

NOTE 2 In addition, the Drafting Team "Data Specifications" has proposed a study on this topic to the Consolidation Team, with the intent of establishing a better understanding about the type of transformations that are feasible for data providers. The results are intended to support the development of the INSPIRE data specifications.

# 16 Portrayal model

The conceptual model for portrayal as specified by the draft implementing rule of the view service is not explicitly specified, but implicitly specified by the OGC Symbology Encoding standard, which is adopted by the draft implementing rule.

# 17 Registers and registries

In addition to the actual spatial data sets a number of resources describing the data need to be maintained properly and will be made available online in order to allow for a correct processing and interpretation of the data. These resources will be maintained in ISO 19135 conformant registers, which will have a clear and well-defined governance model. The European Commission will provide the register managers.

The register contents will be made available by the European Commission via a registry service.

The registers keep track of changes so that data created in the past can still be interpreted completely and correctly; i.e. superseded or retired register items will remain in the register.

A key characteristic of a register is that every item in the register is associated with a unique, unambiguous and permanent identifier.

At least the following resources will be maintained in registers.

NOTE All registers have to be created as part of INSPIRE. The examples about existing registers are provided only to illustrate the concept. However, it may be decided that some register imports items from other registers.

- INSPIRE Feature Concept Dictionary Register: Feature concept dictionary maintained as a register establishing a set of feature-related concepts that may be used to describe geographic information. A common feature concept dictionary will be maintained for all INSPIRE application schemas. In addition, the register will be used to manage spatial data themes, too. See 9.3.

  EXAMPLE 1 A well-known example of a feature concept dictionary is FACC, developed and maintained by DGIWG (http://www.dgiwg.org/). FACC has been deprecated and replaced by the DFDD which conforms to ISO 19126.

- INSPIRE Feature Catalogue Register: Register of ISO 19110 feature catalogues containing definitions and descriptions of the spatial object types, their properties and associated components occurring in one or more data sets, together with any operations that may be applied. See 9.10.

  EXAMPLE 2 Examples of ISO 19110 conformant feature catalogues are the GeoInfoDok feature catalogues in Germany or the SOSI feature catalogue in Norway.

- Consolidated INSPIRE UML Model: UML model consisting of the INSPIRE application schemas and all imported schemas. See Clause 9.

EXAMPLE 3 Examples of ISO 19109 conformant application schemas are NEN 3610 (The Netherlands), AFIS-ALKIS-ATKIS (Germany), SOSI (Norway), INTERLIS-based models (Switzerland), GeoSciML (Geological Surveys), EuroRoadS (EuroRoads Forum), CityGML (OGC candidate standard).

- INSPIRE Code List Register: Dictionary managed as a register describing the value domains for selected properties in an application schema, but which is managed separately from the application schema in its own dictionary. I.e. this establishes an extendable controlled vocabulary outside of the INSPIRE data specifications.

  EXAMPLE 4 Examples of code list dictionaries are provided with the ISO/TS 19139 schema documents (http://www.iso.org/ittf/ISO_19139_Schemas/resources/CodeList/).

- INSPIRE Coordinate Reference System Register: Register of coordinate reference systems, datums, coordinate systems and coordinate operations which are used in data sets. See Clause 12.

  EXAMPLE 5 Examples of coordinate reference system dictionaries are the "EPSG Geodetic Parameter Dataset" (http://www.epsg.org/), the "Information and Service System for European Coordinate Reference Systems" (http://crs.bkg.bund.de/crs-eu/), a coordinate reference system catalogue prototype (http://crs.opengis.org/crsportal/), and examples provided with the ISO/TS 19139 schema documents (http://www.iso.org/ittf/ISO_19139_Schemas/resources/crs/).

- INSPIRE Units of Measurements Register: Register of units of measurements which may be used in spatial data sets. See Clause 12.

  EXAMPLE 6 Units dictionaries are part of all coordinate reference system dictionaries referenced above.

- INSPIRE External Object Identifier Namespaces Register: Register to manage uniqueness of namespaces used within INSPIRE. I.e., it is a mechanism to guarantee uniqueness of external object identifiers across various content providers. See 14.2. The register will provide sufficient information about the data provider and about the download service(s) that provide access to his spatial objects.

- INSPIRE Glossary: Register of general terms and definitions used in INSPIRE data specifications. See Clause 7.

NOTE 1 As these registers and their use through registry services will form a key component of the operational infrastructure, it is considered important that the approach to registers and registry services for the various registers discussed in this document is tested as early as possible in a pilot.

NOTE 2 A gazetteer contains location instances of a spatial reference system and act as a geographical index. Thus, gazetteers may also be maintained in a registry in INSPIRE. The international standardisation is following a different approach and the gazetteer service will not be specified based on a registry service, but based on a feature access service, i.e. be specified as a WFS profile. It is expected that INSPIRE will adopt the result of the international standardisation.

# 18 Metadata

Metadata for discovery and for first level evaluation of a spatial data set or spatial data series as required by the Directive, including issues of quality, validity, and conformity are mandated by the Implementing Rule on Metadata[12].

[12] The text of the Metadata Implementing Rule as adopted by the INSPIRE Committee can be viewed on http://ec.europa.eu/transparency/regcomitology/searchform/CFC/Doc.cfc?Method=GetDoc&CL=en&DocID=241&AttLang=en&Version=2

Additional, theme-specific metadata elements may be specified as part of the INSPIRE data specifications as mandatory, conditional or optional metadata elements.

| | |
| --- | --- |
| **Requirement 61** | Where applicable, additional theme-specific metadata requirements and/or recommendations shall be specified in INSPIRE data specifications in conformance with ISO 19131 and the Implementing Rule on Metadata. |

ISO 19109 8.5.2 provides rules for metadata for features, feature attributes, and feature associations in application schemas and is referenced from Requirement 13. The rules do not place restrictions on the use of types from ISO 19115 in application schemas.

| | |
| --- | --- |
| **Requirement 62** | For metadata, the data specification shall refer to the metadata elements from ISO 19115. If the types from ISO 19115 need to be extended in an INSPIRE application schema, the extensions shall conform to ISO 19109 and ISO 19115. |

# 19 Maintenance

This component is about the documentation of maintenance procedures and life-cycle rules, where known. It does not require any re-engineering of existing data specifications in the Member States.

| | |
| --- | --- |
| **Requirement 63** | Maintenance procedures shall be specified as part of every INSPIRE data specification as required by ISO 19131, where applicable. |

| | |
| --- | --- |
| **Recommendation 24** | INSPIRE data specifications should require that data providers document the life-cycle rules for spatial object types as part of the data set metadata, if available. |

It is expected that the interface of a download service will be capable of providing information about changed spatial objects since a given point in time. Depending on the final capabilities of the download service, this paragraph will be revised.

NOTE 1 Of course, this capability of a download service can only be used, if the underlying spatial data maintains that allows to derive date/time of the last change.

NOTE 2 In general, information about the reasons for changes in property values have a lot of utility for the user as he can then better determine the impact of the change for his application. However, often such information is not available, but where available its publication as metadata is encouraged.

# 20 Data & Information quality

| | |
| --- | --- |
| **Requirement 64** | An INSPIRE data specification shall specify all data quality elements and sub-elements that have to be provided with the data set metadata in accordance with ISO 19113 and the implementing rule on Metadata. This shall include a statement on applicable data quality measures as defined in ISO/TS 19138. |

NOTE 1 This excludes the description of test methods and test procedures.

NOTE 2 Article 5(2) of the INSPIRE Directive spells out the requirement that the conformity of spatial data sets with the INSPIRE data specifications shall be reported with the metadata of the data set as part of the logical consistency quality information. The Implementing Rules on Metadata define a metadata element 'Conformity' which is mandatory for data sets and data set series (see draft IR on Metadata 5.2.18, A.3.3 and Annex F). The conformity of data sets to the INSPIRE Data Specifications is represented by a code list (see draft IR on Metadata A.3.3). The code list will be filled as INSPIRE Data Specification Implementing Rules become available and includes one entry per conformance class of an INSPIRE Data Specification.

# 21 Data transfer

This data interoperability component is specified in detail in document D2.7, guidelines for the encoding of data.

| | |
| --- | --- |
| **Requirement 65** | In an INSPIRE data specification, aspects related to data transfer shall be specified in the section about delivery. |

| | |
| --- | --- |
| **Requirement 66** | The delivery medium shall be specified in conformance with the implementing rules on network services[13]. |

| | |
| --- | --- |
| **Requirement 67** | The delivery format shall be specified in conformance with the guidelines on data encoding (document D2.7)[14]. |

# 22 Consistency between data

This clause lists the relevant requirements on regarding consistency between data from the INSPIRE Directive and provides recommendations, in order to minimise inconsistencies or to correct them.

Consistency between data is a very complex subject to deal with. Even if data are harmonised according to very well defined rules, they rarely fit exactly for various reasons. Annex B provides a brief overview of the topic in general describing the general meaning of consistency (B.2) as well as of Level of Detail (B.3). The annex also provides examples that illustrate inconsistency in the context of INSPIRE (B.4).

NOTE 1 Certain 'inconsistencies' between data sets may be related to the temporal differences between datasets, e.g. update frequencies. In this clause it is further assumed that the data sets are related to the same moment in time. 'Inconsistencies' related to temporal differences are strictly speaking not inconsistencies. However, in practise this may cause difficulties in the production of harmonised datasets.

Methods for ensuring data consistency often concern topographic data. In the context of INSPIRE, the complexity comes from the diversity of themes. A priori data coming from different data providers are never perfectly consistent one to another.

Consistency between data as required by Articles 8(3) and 10(2) of the Directive concerns data described in all annexes of the Directive.

Some themes of annex III like atmospheric conditions, meteorological geographical features, oceanographic geographical features or sea regions are not or not much concerned by this component, because of their cross-border, transitory or fuzzy nature. More generally, consistency should not be ensured between all themes together.

An in-depth analysis of the themes based on the work already done in document D2.3 would be required to provide a more detailed understanding of the cross-theme relationships.

---
[13] to be published
[14] to be published

The following recommendations for processes introducing and maintaining consistency between data, for further research studies as well as the development of INSPIRE data specifications are a summary of the discussion in Annex B which provides additional background information.

The first consistency to check is the conformance to data specifications including the data capturing rules, i.e. with respect to the selection criteria such as minimum size and not with respect to data capture methods (photogrammetry, laser scanning, etc.). Before checking the consistency between different data sets, each data set shall be verified to conform to the corresponding INSPIRE application schema, in particular complying to the same set of constraints.

Consistency should not be ensured between all themes together. An accurate study of related themes should be carried out, based on the work already done in document D2.3.

**Recommendation 25** Consistency between different themes should be required only within same or close levels of detail.

Once the levels of detail for each theme in Annex I, II and III are known, it should be decided which pairs (theme, LoD) should be consistent one to another.

**Recommendation 26** In cases where multiple levels of detail are specified for a theme (see Recommendation 27), the representations should in general be required to be consistent one to another. Multiple representations can be used to link the representation of different levels one to another but this will not be sufficient. Specific relationships, such as aggregation (partonomic relation or others), generalisation, selection or geometric simplification, should be described as accurately as possible to allow the automation of the consistency checking.

**Requirement 68** Every INSPIRE application schema shall address the requirements on consistency between spatial data as stated in Article 8(3) of the Directive, if applicable. The rules governing consistency shall be modelled as far as possible as constraints.

**Requirement 69** Every INSPIRE data specification shall address the requirements on consistency between spatial data as defined in Article 10(2) of the Directive, if applicable.

The harmonisation of data specifications is the best way to promote consistency. Specific studies related to the use of ontologies in data specifications should be encouraged and if possible funded.

In cases where the harmonisation of application schemas is rather simple, the harmonisation of data capturing rules between data producers would be very useful (in case the application schemas can not be easily harmonized, then the data capture rule related to these are too different anyhow). Recommended data capture rules should be specified in sufficient detail to indicate the data requirements for a dataset and minimise harmonisation inconsistencies over a longer timeframe. Since existing data will be the basis of INSPIRE, feasibility and cost/benefit will not always allow for a harmonisation of capturing rules (unless for example they can be covered by transformation services).

The harmonisation of data capturing rules is complex for the following reasons:

- the rules often refer to underdefined concepts (the hidden ontology),
- the rules are often not fully described,
- the rules are not formally described,
- the cost of transforming the data according to new data capturing rules is far more expensive than the cost of transforming the data to a new application schema.

A formal language to describe the acquisition rules would greatly simplify the harmonisation of acquisition rules and the detection of inconsistency. Some research studies for defining formal language are promising and should be mature for the effective beginning of INSPIRE data availability.

Differences between data sets are a natural result of the exact scope, the acquisition process, the levels of detail and also from the nature of the entities. Some entities have well-defined boundaries (a building, a road) while others have a boundary that partially depends on human cognition (a city, a district, the North Sea, corridor for air traffic control, a mountain, a bay, etc.) (Smith and Varzi, 2000). However, it is also a result of the fact that some data specifications are not completely defined such as the selection rules that hide complex criteria (see Gesbert 2005).

To improve the consistency between data coming from two different providers, one or both data sets will be slightly changed. These data transformations will require mutual approval from data providers and also a technical organisation (eventually by means of a service) to match the data together either before sending them to the user (an on-demand matching service) or once, before integrating them into INSPIRE. Whatever the case, the spatial data in INSPIRE will be slightly different from the original data of the provider. This situation has to be well understood and accepted by data providers, or other solutions would have to be elaborated. The original geometries are never changed but may be added as an additional spatial attribute to the relevant spatial objects. It must be transparent to a data user which parts of the data are the source and which ones are derived.

For the specific case of cross-border consistency, if data does not exist at the same level of detail on both sides, forcing data matching could be a very bad solution. Multiple representations associated with a mechanism based on corresponding points or edges might be far more efficient. Higher priority (that is, less changes) should be given to data sets known to be of higher quality in determining which geometries should be moved or fixed (also see the informative Annex B.3.1 ‘Geometry edge-matching’ of document D2.6).

In order to automatically create new edge-matched representations of small geometrical inconsistencies between two themes, either redundant spatial objects or anchor points (so-called homologous points) are necessary. Redundant information represents a same theme (such as river network) that would be present in both data sets. When either redundant spatial objects or anchor points exist, existing matching and stretching algorithms (such as rubber sheeting) can be used to match the data together.

Specific studies on automated matching should be executed as soon as possible to have robust solution before the availability of INSPIRE data.

Ensuring data consistency between themes and between levels of detail raises the problem of geometrical deformations: forcing data consistency can result in geometrical changes. As a consequence the INSPIRE data (globally coherent one to another) cannot be a strict copy of the data of data producers: for consistency, the geometry and perhaps some attribution of spatial objects will be slightly different e.g computed area. Note that this can also happen within a country (e.g. different municipalities/provinces collecting data). This situation should not be a technical problem, if unique object identifiers are managed well, for instance, by keeping the same identifier or by establishing links between the two identifiers.

NOTE The required changes to data raise additional questions that may need to be addressed: How does this impact intellectual property rights? What is the “correct” version of a data set? Which one should be used in which case (“original” vs. “consistent” data)? Can general rules for responsibilities be specified?

# 23 Multiple representations

Based on reference material and the findings and recommendations of a workshop on data consistency and multiple representations that was organised by JRC in November 2006, automatic generalisation methods are not mature enough to be considered as a service in INSPIRE. Therefore:

| | |
|---|---|
| **Requirement 70** | Multiple representations of the same real-world phenomenon shall be modelled explicitly in the application schemas. |

For consistency between the representations, the rules specified in Clause 22 apply.

**Recommendation 27** In principle, as few levels of detail as possible but as much as necessary should be defined per theme.

**Requirement 71** In cases where multiple levels of detail are required, the requirement for the different levels shall be justified and documented as part of the data specification.

# 24 Data capturing rules

**Requirement 72** Capturing rules and associated criteria shall be specified for every spatial object type as part of every INSPIRE data specification in conformance with ISO 19131.

NOTE 1 Data capturing rules are the main element to define the targeted level of detail. For instance, there may be a need for transport networks on two levels of detail (at the European level, scale about 1:1000000 and at the local level, scale about 1:10000) with very similar feature catalogues. However, the data will be very different. This difference is a result of different capturing rules / selection criteria for both levels of detail.

EXAMPLE Typical selection criteria are minimum area or length or functional characteristics like the class of a road.

NOTE 2 The data capturing processes used by a data provider, i.e. the "how", are not relevant for this component.

Guidelines on this topic based on experience in SDICs and LMOs are provided in document D2.6.

# 25 Conformance

## 25.1 Conformance to an INSPIRE data specification

**Requirement 73** Every INSPIRE data specification shall specify a single conformance class per specification scope, i.e. in general one conformance class per INSPIRE data specification. Each conformance class shall reference an abstract test suite that tests all requirements specified in the data specification that are applicable to the specification scope of the conformance class.

## 25.2 Conformance of INSPIRE data specifications

Clauses 5 to 25 of this document specify requirements (mandatory or conditional) and recommendations (optional) for INSPIRE data specifications.

**Requirement 74** Every INSPIRE data specification shall pass all test cases of the Abstract Test Suite in A.1.

**Requirement 75** Every INSPIRE data specification for a spatial data theme in Annex I or Annex II of the Directive shall pass all test cases of the Abstract Test Suite in A.2.

**Recommendation 28** The requirements referred to by the test cases in A.2 are not requirements for INSPIRE data specifications of spatial data themes in Annex III of the Directive. However, the requirements should be understood as optional recommendations for such specifications.

As a result, two conformance classes for INSPIRE data specifications are distinguished. Table 6 lists the classes and the corresponding sub-clause of the Abstract Test Suite.

**Table 6 - Conformance classes for INSPIRE data specifications**

| Conformance class | Subclause of the Abstract Test Suite |
| --- | --- |
| Basic conformance to the Generic Conceptual Model (Annex III) | A.1 |
| Extended conformance to the Generic Conceptual Model (Annex I/II) | A.2 |

# Annex A
(normative)

# Abstract Test Suite

## A.1 Test cases for all INSPIRE data specifications

### A.1.1 Conformance to requirements related to Article 7

a) Test Purpose: Verify that the INSPIRE data specification fulfils all requirements of the Generic Conceptual Model related to paragraphs 7(1) and 7(4) of the INSPIRE Directive.

b) Test Method: Inspect the INSPIRE data specification and check that it satisfies the following requirements: 1-16, 19-22, 32-34, 36-38, 46, 48-51, 54-56, 61-62, 64-67, 73

c) Reference: Clauses 5-12, 18, 20-21, 25; Requirement 74

d) Test Type: Basic Test

### A.1.2 Conformance to requirements related to Article 10

a) Test Purpose: Verify that the INSPIRE data specification fulfils all requirements of the Generic Conceptual Model related to paragraph 10(2) of the INSPIRE Directive.

b) Test Method: Inspect the INSPIRE data specification and check that it satisfies the following requirement: 69

c) Reference: Clause 22; Requirement 74

d) Test Type: Basic Test

## A.2 Test cases for Annex I/II INSPIRE data specifications

### A.2.1 Core

a) Test Purpose: Verify that the INSPIRE data specification conforms to all core requirements.

b) Test Method: Inspect conformance of the INSPIRE data specification against the test cases in A.1.

c) Reference: Requirement 74, Requirement 75

d) Test Type: Basic Test

### A.2.2 Conformance to requirements related to Article 8

a) Test Purpose: Verify that the INSPIRE data specification fulfils all requirements of the Generic Conceptual Model related to paragraphs 8(1) to 8(4) of the INSPIRE Directive.

b) Test Method: Inspect the INSPIRE data specification and check that it satisfies the following requirements: 17-18, 23-31, 35, 39-45, 47, 52-53, 57-60, 63, 68, 70-72

c) Reference: Clauses 9-12, 14, 19, 22-24; Requirement 75

d) Test Type: Basic Test

# Annex B
(informative)

# Consistency between data

## B.1 Assumptions

This annex assumes that all spatial objects use the same coordinate reference system (all spatial data sets use a CRS expressed in ETRS89) and the consolidated INSPIRE application schemas.

'Inconsistencies' coming from different actualities (that is, related to moment in the past) of spatial data sets are not considered as these are strictly speaking not inconsistencies. However, in practise this may cause difficulties in the production of harmonised datasets. The 'inconsistencies' of forecasts is another important topic: different simulation models may produce different results, but should when put into the context of a forecast not be considered as inconsistencies.

## B.2 Correctness and consistency

In a very simple way data is correct (in the broad sense), if it depicts the real world well according to the data specifications. Specifications encompass the rules of selection and the rules of representation (i.e. how to represent what is selected from the real world). As a consequence, a way to check data correctness would be to control the respect of the specifications rules. Recent work (Gesbert 2004, 2005) proposes a formal model to describe these rules based on the idea of ontology. Unfortunately

- data specifications are not completely formalised;
- no general mechanism exists yet to combine *a posteriori* different specifications, even if some approaches to semantic mapping, such as the one followed in INTERLIS, do exist.

The best solution to minimise inconsistency is to harmonise as far as possible the data specification (the selection rules and the application schema), and then to update each existing data according to this new and harmonised data base specification. This harmonisation can be built following a bottom-up approach starting from existing data sets and specifications, comparing them and building common and reasonable specification for each theme of each level of detail.

Alternatively answering the question "does geographic data depict the reality well" can be decomposed into a set of questions:

- For each spatial object, does it represent the corresponding entities well? (positional and attribute accuracy, shape and size accuracy, attribute actuality, correctness and completeness)
- For each spatial object type or theme does the collection of spatial objects of that type or theme (e.g. all hydrographic objects) represent the set of entities well (e.g. the hydrographic network)? (appropriate selection, appropriate distribution, actuality, completeness)
- Altogether, do the spatial objects have relationships that are coherent with the relationships of the entities they represent? (topology, superposition in case of 2.5D or 3D data, etc.)

If the two first points are supposed to be ensured by each data producer, the last point is particularly important in the context of INSPIRE as relationships between spatial objects of different themes, coming from different data providers, are a priori not formalised and not checked at all.

In classical GIS terminology, whereas *correctness* refers to the reality, *consistency*, focuses only on the representation. Egenhofer et al. (1994) distinguishes logical consistency (coherence of data with the model) and the inter-representation consistency (absence of contradictions between the different representations): "*Consistency* refers to the lack of any logical contradiction within a model of reality. This must not be confused with *correctness*, which excludes any contradiction with reality. […] In itself, each individual level may be consistent, however, when integrating and comparing the different levels, inconsistencies may be detected if the representations contradict." From this definition we will retain the necessity of coherence between spatial objects of the same theme at different levels of detail. Within the context of INSPIRE the consolidated model will include all INSPIRE data themes.

To sum up, consistency encompasses

a) harmonisation of data specifications,
b) conformance to this specification (including selection rules and application schema),
c) coherence between spatial objects of the same theme at different levels of detail and at least
d) coherence between different spatial objects within a same area and
e) consistency along state boundaries.

## B.3 Level of detail

The level of detail (LoD) simply represents the quantity of information that portrays the real world. Previously described by scale for maps, the notion has been extended and adapted for geographic data base (Ruas and Bianchin 2002). As well as for maps different scales are necessary, different levels of detail are necessary for digital data, as our perception of entities depends on these levels of detail. “Geographers know for ages that what is true at a scale is not at another one and while changing the scale we change the nature of observation, the problem, the explanation, the analytical tool and the representation” (translated from Racine 1981).

Although the LoD is often described by a metric number (e.g. “a metric DB”), the Level of Detail of a spatial data set is defined by:

- the type of information (the spatial object type and its properties)
- the selection rules (explaining which entities of the real world are represented in the data set)
- the accuracy of the attributes
- the semantic granularity (e.g. the LoD’s in candidate OGC standard CityGML)
- the type of geometries (3D, 2.5D, or 2D; volume, surface, curve or point)
- the accuracy of the geometries

The number that defines the LoD (e.g. 1 meter) sums up all these information, while the LoD is accurately defined by the data specification.

The bigger the resolution (10m, 100m, 1km) the more the information is either generalized (aggregated, simplified, abstracted) or deduced by computation from sample data (like geological or meteorological data). Of course these complex processes of generalisation and computation make hard the consistency between data having different resolutions.

NOTE Some examples and guidelines about how to define the LoD in INSPIRE are given in document D2.6.

## B.4 Consistency, in the context of INSPIRE

In the context of INSPIRE, spatial data is categorised by themes (see document D2.3) which will be described by data specifications specifying the different spatial object types. The spatial data will be provided by different producers, from different Member States, with different levels of detail. The value of INSPIRE is not only to define an architecture and services to provide spatial data sets, but it is also to ensure the coherence between these data sets.

Apart from the existence and the respect of harmonised data specification, we distinguish four types of consistencies to check:

- Consistency within a data set
- Consistency between spatial objects of different themes at the same level of detail
- Consistency of spatial objects of a theme at two different levels of detail
- Consistency of spatial objects along a boundary

### B.4.1 Consistency within a data set

Before checking the consistency between different themes, each data set of a theme has to conform to the INSPIRE application schema of the theme, in particular complying to the same set of constraints.

EXAMPLE 1 Attribute values have to be inside predefined intervals

EXAMPLE 2 The spatial object types of some themes may be structured as a graph (e.g. a road network) or a complete planar graph (e.g. a partition of polygons). The topology is often computed to connect spatial objects one to another and to remove dangling arcs and sliver polygons (see figure below). Normally these inconsistencies are detected and corrected by the data producer theme by theme.

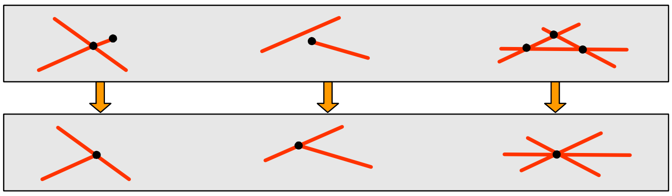


**Figure 18 - Typical operations to connect spatial data**

### B.4.2 Consistency at the same level of detail between themes

Above all, analysing inter-theme data consistency requires that the data sets representing spatial objects of different themes share a common level of detail. Checking consistency between different thematic data sets that are decimetric and decametric data would nearly be nonsense. In the same way, some themes do not share any constraint of coherence one to another. As an example, if one can study the interactions between roads and risk or population areas, there is a priori no constraint between theses themes.

When spatial objects are supposed to share a common space, due to data accuracy and acquisition process, objects almost never fit perfectly well together. The geometrical incoherencies are often not important (they are within the level of accuracy of the data), but the relative position of spatial objects one to another may be wrong. In the following figure, topographic data from IGN-France BDTopo and data coming from the Inventaire Forestier National (the forest in green) before a process of data integration is shown.

- Simple inconsistencies exist when spatial objects are supposed to have the same geometry (in the purple ellipsoids in the figure). These inconsistencies can be detected and corrected by appropriate data matching algorithms.
- More complex errors concern the relationships that look coherent without external information. For example there could be a building that is represented inside a forest whereas in reality it is outside the forest. In such a case, the representation looks coherent but the information is incorrect. External information is needed to detect such errors. If we refer to Egenhofer definition (see above) this error is not an inconsistency but incorrectness. However we could also argue that this kind of error should be avoided, if possible, because for many decision makers, relative position of objects is the most valuable information. An important point is that this kind of problems may often be solved automatically if in the initial data base (before the INSPIRE integration) some redundant themes exist (e.g. rivers in both data bases). This *redundancy* of information can be used to automatically relocate both data sets one to another.

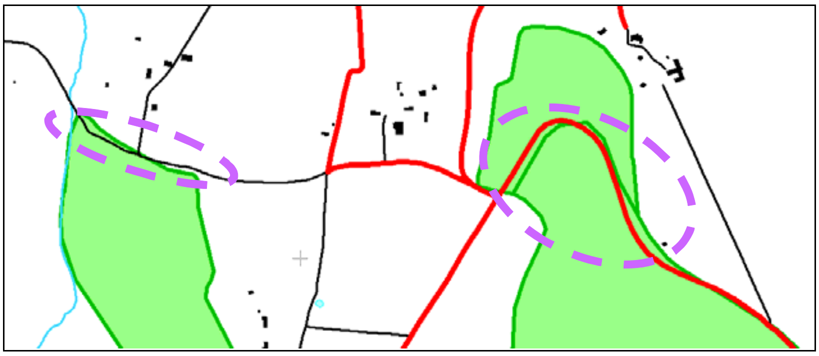


**Figure 19 - Example of inconsistencies on a simple overlay between Topographic and Forestry data**

Data matching algorithms can be used to recognize close geometries and to solve conflation problems (see bibliography). Matching is often based on distance and topology for networks (e.g. Mustière 2006), and on area overlapping for surfaces. Sophisticated methods might include shape analysis.

It is also necessary to check for each couple of themes if the spatial objects share specific constraints. Topographic data, i.e. data describing the landscape, is certainly the most constrained. As an example *relief* and *rivers* should be coherent one to another. In the same way road should lie on a digital terrain model (see figure below).

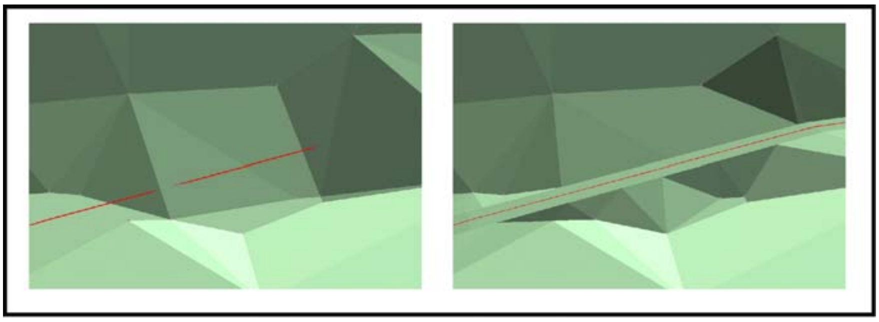


**Figure 20 - Improving consistency between roads and digital terrain models (from Rousseaux and Bonin 2003)**

In the case of underground data, some consistency rules might be checked when a geological layer touches the ground. For example when a geological layer touches the ground, sometimes it creates a remarkable mark such as a slope or a fault. In such a case the representation coming from the geological data and from topographical data should fit together.

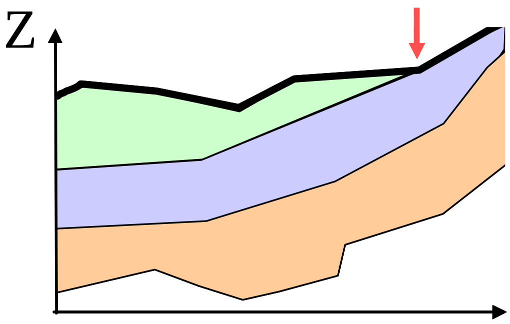



**Figure 21 - Consistency between geological layer and topographic data**

To improve the consistency between data coming from two different providers, one or both data sets will be slightly changed. These data transformations will require mutual approval from data providers and also a technical organisation (eventually by means of a service) to match the data together either before sending them to the user (an on demand matching service) or before integrating them into INSPIRE. In such a case, the INSPIRE data will be slightly different from the data of the providers. This situation should be well understood and accepted by data providers, or other solutions should be elaborated.

### B.4.3 Consistency between Levels of Detail

While comparing data at two levels of detail (LoD1 and LoD2), Sheeren (2005) distinguishes between differences and inconsistencies. Differences are due to the data base specifications (level of detail) while inconsistencies are differences that are not explained by the specifications.

In the following figure we can see examples of different levels of detail for three topographic themes: Rivers, Build-up area and Road network. Neither the quantity of information nor the types of geometry are the same but the representations are consistent one to another:

- Rivers: the river flow is the same even if the geometry is simplified from polygons to lines
- Buildings: the build-up area is coherent with the distribution of buildings, even if small building extensions are not included in these areas
- Roads: even very simplified, the logic of car navigation is respected (some topological intersections do not correspond to road connection).

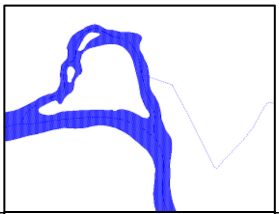
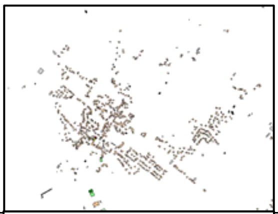
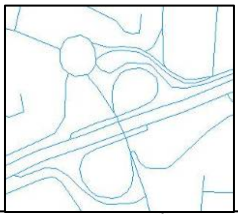
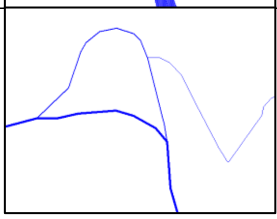
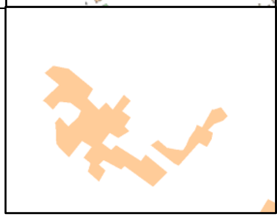
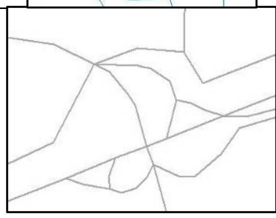
| | Rivers | Buildings | Roads |
|---|---|---|---|
| **LoD1**<br>© BDTopo |  |  |  |
| **LoD2**<br>© BDCarto |  |  |  |

**Figure 22 - Different but consistent levels of detail from BDTopo and BDCarto (from Sheeren 2005)**

Checking the consistency between levels of detail lie on the analysis of relationships between spatial objects at different levels of detail. These relationships can be characterised by means of:

- aggregation: a spatial object at LoD2 is an aggregate of spatial objects at LoD1 (e.g. the build-up area at LoD2 *is composed of* buildings at LoD1)
- generalisation/type hierarchies: a spatial object at LoD2 is represented in LoD1 by several spatially connected objects from more specific spatial object types (e.g. a forest in LoD2 and conifers and leafy trees areas in LoD1). These inheritance relationships are sometimes called “classification hierarchy”, too.
- object selection: a set of spatial objects of a class in LoD2 represents a selection of the main spatial objects of a larger set at LoD1 (e.g. the road or river network).
- Simplification/reduction of geometric dimension: A spatial object represented by a surface at LoD1 is represented by a curve or point at LoD2 (e.g. a river from surface to curve or a building from surface to point).

Chaudhry and Mackaness (2006a) use the notion of *partonomic* relationships to describe specific aggregation relations between levels of detail. These aggregations combine phenomena from different themes when they share a common space and when they participate to a common function. As an example, a city is a combination of heterogeneous but related spatial objects such as streets, buildings and various facilities.

Checking the coherence between levels of detail requires first to identify type by type the relationships between spatial object types of both LoD (aggregation, generalisation, selection, simplification). Then, it requires checking, if the main properties at a level of detail are well maintained at the other level of detail (e.g. the build-up area and the buildings).

Gesbert, Sheeren and Mustière (Gesbert, 2004, 2005; Sheeren at al., 2004, Sheeren, 2005) argue that the analysis of consistency between levels of detail requires an accurate description of data specifications by means of a formal model of description. Aggregation (particularly partonomic relationships) and selection are frequent between LoDs and are often underdefined. The accurate formalisation of these relationships might require specific studies.

When the formalisation of theoretical relationships between different LoDs of each theme will be identified and formalised, the process of detection and correction of inconsistencies will be possible.

NOTE In topographic mapping a general understanding of generalisation rules have been developed based on significant experience in the past. For other thematic areas it is often not clear, how far away such a well defined understanding is. It is also an open question what level of consistency is possible for thematic areas and what kind of "inconsistent information" is acceptable.

### B.4.4 Consistency along state boundaries

In the context of a European project (Walk on Web), Lamine and Mustiere (2005) studied the integration of data along boundaries.

The study begins with an identification of inconsistencies along the boundaries that we sum-up in the following figure.

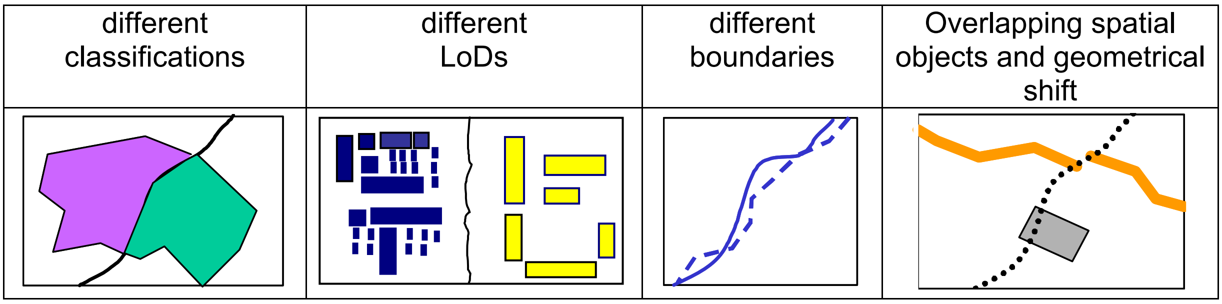



**Figure 23 - Inconsistencies along boundary**

Assuming that the different data providers are using the same data schema, the classification of **spatial** objects might be different (because of different interpretations), as well as the level of detail. Geometric inconsistencies – such as the ones illustrated above – will be systematic.

NOTE Rules and guidelines about edge-matching are given in document D2.6, Annex B

Of course, consistency along the state boundaries should be based on mutual consent of both countries. This requirement is specified in INSPIRE directive: "*Member States shall, where appropriate, decide by mutual consent on the depiction and position of such common features*" (article 10(2)). The project EuroBoundaries from EuroGeographics, whose aim is to provide accurate and legally agreed international boundaries, is a good example to illustrate the process of mutual consent between data providers. As well as for the necessary harmonisation between data providers within a state (see above), in order to ensure consistency one or both data sets will be slightly changed. These data transformations will require mutual approval from data providers and also a technical organisation (eventually by means of a service) to match the data together either before sending them to the user (an on demand matching service) or once, before integrating them into INSPIRE. In such a case, the INSPIRE data will be slightly different from the providers data. This situation should be well understood and accepted by data providers, or other solutions should be elaborated.

If the parts of a border-crossing feature are supplied by several data providers, each part should be marked, that there are further parts belonging to it. This can be done (e.g.) by referencing the other spatial objects.

# Annex C
(informative)

# Class name prefixes in the ISO 19100 series

Table 6 provides a mapping between high level packages of the ISO 19100 series of International Standards and the class prefixes associated with the package.

**Table 7 – Overview of the relevant packages of the ISO 19100 series of International Standards**

| UML package | UML Class Prefix |
|---|---|
| ISO/TS 19103 | - |
| ISO 19107: Geometry | GM |
| ISO 19107: Topology | TP |
| ISO 19108 | TM |
| ISO 19109:General Feature Model | GF |
| ISO 19111: SC_CoordinateReferenceSystem | SC |
| ISO 19111: SC_CoordinateSystem | CS |
| ISO 19111: SC_Datum | CD |
| ISO 19111: SC_CoordinateOperation | CC |
| ISO 19112 | SI |
| ISO 19115:Metadata entity set information<br>ISO 19115:Identification information<br>ISO 19115:Constraint information<br>ISO 19115:Maintenance information<br>ISO 19115:Spatial representation information<br>ISO 19115:Reference system information<br>ISO 19115:Content information<br>ISO 19115:Portrayal catalogue information<br>ISO 19115:Distribution information<br>ISO 19115:Application schema information | MD |
| ISO 19115:Extent information | EX |
| ISO 19115:Citation and responsible party information | CI |
| ISO 19115:Data quality information | DQ |
| ISO 19123 | CV |
| ISO/DIS 19126 | CD |
| ISO 19131 | DPS |
| ISO 19135 | RE |
| ISO/TS 19139 | CT<br>PT |

# Annex D
(informative)

# Object referencing – motivation and benefits

## D.1 Motivation and requirements

### D.1.1 General aspects

The aim of object referencing is to promote the easy and reliable exchange of application level data (e.g. river quality sample records) across several users who use an agreed common base data set of spatial objects, thus avoiding spatial inconsistencies, data duplication and frequent high volume data transfers to support regular reporting commitments. Object referencing significantly enables improvements in data integrity and reliability.

However, object referencing has proven to be a complex subject, in particular because the use of object referencing is not widespread today. Most spatial data sets today are data sets that are self-contained; even in cases where geometries are reused from other spatial objects in other data sets; these geometries are often copied instead of referenced usually. The reasons have not been analysed in detail, but the following issues are understood to contribute to this:

- GIS tools provide better support for self-contained data sets and spatial objects,
- limited availability of reference objects via reliable network services,
- lack of reliable and stable identifiers,
- more complex life-cycle management, and
- performance concerns.

To some extent, this is similar to the changes from self-contained documents to a document web connected by hyperlinks.

The INSPIRE Directive does not refer to this topic directly. However, there are requirements in INSPIRE where object referencing is an essential or at least useful methodology, namely:

Article 7(4): *"Implementing rules […] shall cover […] the way in which […] spatial data are geo-referenced."*

Article 8(3): *"The implementing rules shall be designed to ensure consistency between items of information which refer to the same location […]."*

The principles in recital (6):

- *"[…] that spatial data are stored, made available and maintained at the most appropriate level;*
- *that it is possible to combine spatial data from different sources across the Community in a consistent way and share them between several users and applications;*
- *that it is possible for spatial data collected at one level of public authority to be shared between other public authorities […]."*

EXAMPLE In the UK, the Dudley Metropolitan Borough Council needed to share and integrate data held in disparate application databases while maintaining a corporate data system. As a result, data in spatial applications was associated to a single geometry database source, converting their existing polygon data sets to associate with spatial objects in the OS MasterMap data set that is provided by the Ordnance Survey. Incomplete conversions were addressed separately to complete the data association. As a by-product, the process, which was a massive undertaking by the local custodian, eliminated most of the effects of a follow up positional accuracy improvement programme in the reference base. This is because boundaries in the spatial objects of an application now refer to the unique object identifiers used in the OS MasterMap for its geography, if the base object is moved, the (coterminous) boundary can move as well.

From the guidance documents of INSPIRE and the available reference material the following requirements have been identified related to this topic:

- referencing spatial objects in a way that allows to find and retrieve them in the ESDI;
- building spatial objects based on reference data;
- enabling harmonised gazetteer services, e.g., to make search of data easier.

The different requirements are discussed in the following sub-clauses.

### D.1.2 Referencing a spatial object in the ESDI

The typical way to reference another spatial object is to reference it by means of the external identifier of the referenced spatial object.

EXAMPLE 1 In Germany, spatial objects in data sets of the mapping agencies are in general referenced by means of its external object identifier. URNs are used to create a globally unique identifier from the local identifier. In the GML encoding, this is expressed as follows:

```
<Building gml:id="DEXX123412345678">
   <!-- some properties -->
   <owner xlink:href="urn:adv:oid:DEXX12341234abcd"/>
   <!-- more properties -->
</Building>
<Person gml:id="DEXX12341234abcd">
   <!-- some properties -->
</Person>
```

It is expected that in D2.7 URNs will be used to encode unique identifiers including the namespace and the local identifier part. Using the proposed INSPIRE register for identifier namespaces which includes information about the download service providing access to the spatial objects in a particular namespace, the spatial object can be accessed directly by means of INSPIRE network services.

There are cases where references to certain spatial objects are made not using an external identifier, but by providing a well-known, often structured name of a spatial object (thematic identifier).

EXAMPLE 2 NUTS (Nomenclature of Territorial Units for Statistics) codes as defined by Eurostat. The code "DE7" for example denotes the state Hesse (7) in Germany (DE).

The version identifier for a specific version has to be included where the reference targets a specific spatial object version during the lifetime of the spatial object instead of the spatial object itself. It is expected that in D2.7 the URN scheme mentioned above will provide a mechanism to reference a specific version based on the version identifier.

EXAMPLE 3 Extending the EXAMPLE 1 above, in incremental update operations it is required to reference the specific version that is to be modified. The XML fragment below shows a Web Feature Service transaction (wfs:Transaction) where a spatial object is to be “retired”, i.e. its lifespan ends. In this case, the identifier of the version is used explicitly:

```
<wfs:Transaction>
   <wfs:Delete typeName="Building">
      <ogc:Filter>
         <ogc:FeatureId rid=" DEXX123412345678” version=”2001-01-01T00:00:00Z"/>
      </ogc:Filter>
   </wfs:Delete>
</wfs:Transaction>
```

### D.1.3 Building spatial objects based on reference data

Each user will take a different view of the world – this is largely driven by their application. Increasingly these users need to exchange and share information about the same real world entity. This can be achieved – at least for spatial objects where the spatial characteristics are related to topographic objects – by one of three general approaches:

A. Simple overlay

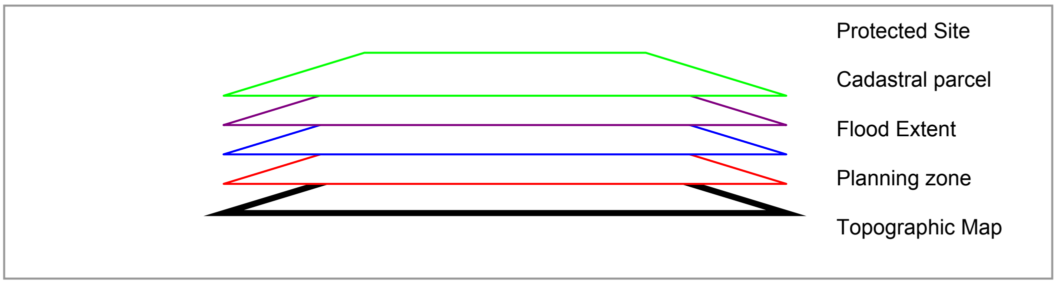



**Figure 24 – Simple overlay**

NOTE 1 In the overlay model, there are no constraints that a spatial object that is coincident, collinear or coterminous with another spatial object present – will actually be so. For example a planning zone that should follow the boundary of several properties or a river centreline with a topographic river spatial objects. Duplications of several spatial object types e.g. road centrelines can be present. The use of a GIS is required and human operator – imperfections can be visually located and considered by the operator in the form of output offered.

In the overlay method each user-defined geography may be based on a different base map. Even where it has been digitised from the same topographic map, co-ordinate differences may be difficult to avoid and therefore gaps and overlaps may often exist (these are not present in the real world features).

B. Many to many linking

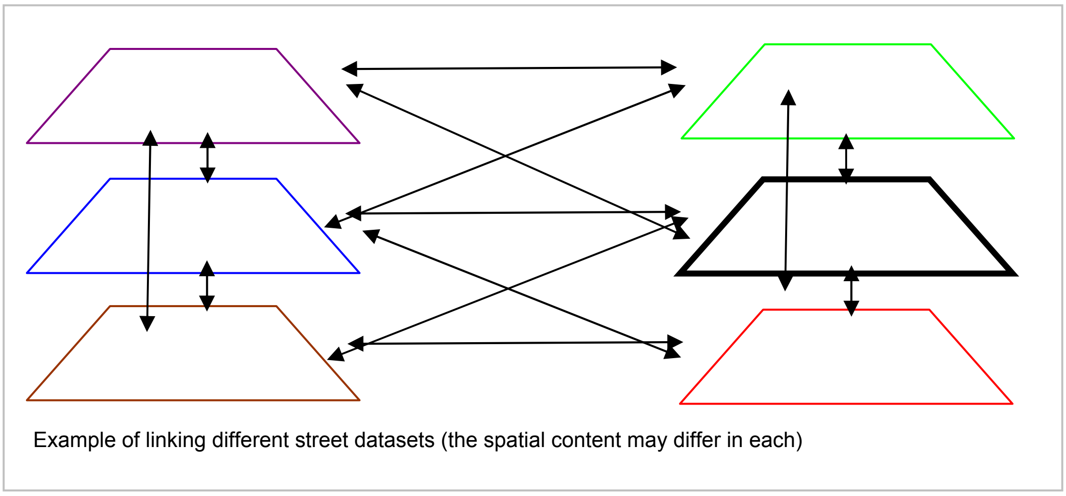



**Figure 25 – Many-to-many linking**

NOTE 2 In the many to many model linking approach - the geographic components are no different from those used in the simple overlay approach in Figure 24. They could represent different organisational views or just those within an organisation. However it is recognised that these spatial objects are related and can be cross referenced. However - no attempt is made to declare any one of them as a reference object. Therefore as time goes on cross references are made from one spatial object to another in an ad-hoc way – this allows data about the objects to be shared by the participating players. However over time the lack of a common structure coupled with a complex maintenance overhead is likely to lead to a situation where the costs outweigh the advantages.

Many to many linking using external identifiers (e.g. of various views of a highway maintained by different organisations) establishes an explicit relationship. Nevertheless the disadvantages of the overlay method remain and this is compounded by the need to maintain as many cross references as there are geographic relationships. These spatial objects are rarely coterminous, maintenance is disjoint and hence data sharing is very often very inefficient and ineffective.

In general, associations between spatial objects described by different data specifications shall be kept to a minimum as a large number of associations will make it more difficult to maintain consistent data and to reduce the effects of updates on other data sets, etc.

C. Referencing a common base

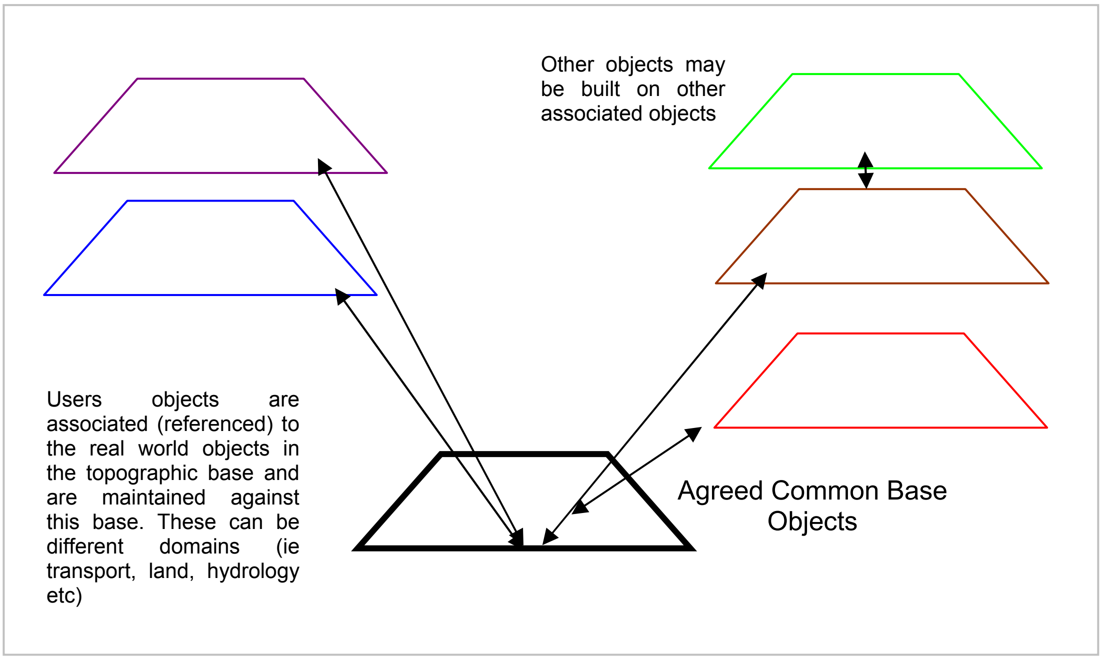



**Figure 26 – Object referencing to a common base**

NOTE 3 In this case it is agreed within a information community that a set of spatial objects are used as a common base and these represent the real world equivalents. Third parties then use these as building blocks to build their own spatial objects, which in turn maybe used as reference objects by other third parties. Compared with Figure 18 the integrity of the geometry of the associated objects can be significantly improved and this then makes the data more reliable and more readily available for use in automated applications.

In object referencing it is assumed that there is a commonly agreed and well defined base of spatial objects that others can associate their own information with that base Users who build on these spatial objects will inherit the links, continuity and integrity provided by the common base. The approach supports the key INSPIRE principles of data sharing and information reuse across distributed spatial data sets.

The different steps for achieving data integrity by object referencing are the following :

- at national level, find an agreement on which data forms part of the national reference data
- each public organisation will build their data on the reference data, using the object referencing methods described below
- each public organisation will publish their data according to the user's requirements

Object level reference databases are becoming well established across Europe through TOP10DK in Denmark, the AAA model in Germany, OS MasterMap Topo in Great Britain, RGE in France and more recently TOP10NL in the Netherlands. Likewise the International Hydrographic Organization/Bureau maintains the S-57 and future S-100 standards, both of these support object models and the linking of one spatial object to another.

### D.1.4 Enabling harmonised gazetteer services

Gazetteers do associate locations with a geographic identifier and their role is to reference the spatial object representing the location. Gazetteer services provide access to information in gazetteers. See 9.9 for details. As a result, they provide a quick method for locating and retrieving spatial objects by name and allow for an identification of spatial objects, e.g. addresses or settlements, that lie within different areas, e.g. administrative areas or postal codes.

For example, a user may launch a request with a geographic identifier (e.g. a geographical name such as “Milano, Italia”, a postal address or an administrative code). The search engine will then choose a relevant gazetteer to find this geographic identifier and the spatial object associated with it. This gazetteer will provide a location, for instance the geometry or the coordinates of a representative point of the spatial object.

## D.2 Benefits

The high level advantages and disadvantages of using object referencing are summarised in Table 7 below.

**Table 8 – Summary of benefits of Object Referencing**

| Role | Benefits of adoption | Consequences of adoption |
|---|---|---|
| **National level** | • Knowledge can be derived from shared information about an unambiguous common location<br>• Cost savings based on less duplication – more reuse<br>• Data management security - location information in-line with similar standards in other IS domains | • Requires a sound reference base (or set of inter-related reference bases) and these must be adequately maintained. |
| **Service provider** | • Faster concept to implementation times based on ready to use information<br>• Greater potential for automation without manual intervention – cross references provide the links<br>• Cross references provide hooks to support reliable services in a distributed environment | • Dependency on all providers to keep data maintained in line with the reference base. |
| **Data user** | • Cost savings based on reuse of existing information<br>• Focus on primary business task and less on cleaning up third party data before using<br>• Data integrity improvements = greater reliability | • Less direct control of data used in their business and more dependency on third parties. |
| **Data manager** | • Adoption of mainstream ICT data management processes for all corporate data | • Change of data processes and adoption of new approaches |
| **Data Provider** | • Information is more reliable and potentially more attractive & useful to third parties<br>• Ability to configure different outputs from a common base which are all linked up<br>Investments in data are more secure based on the capture once and use many times model – ie reference the same basic spatial objects | • Greater dependency on third parties and need for x-organisational collaboration.<br>• Potential need to manage time and temporal views of the database. |

# Annex E
(informative)

# Examples of life-cycle information

## E.1 OS MasterMap Topo Layer (UK)

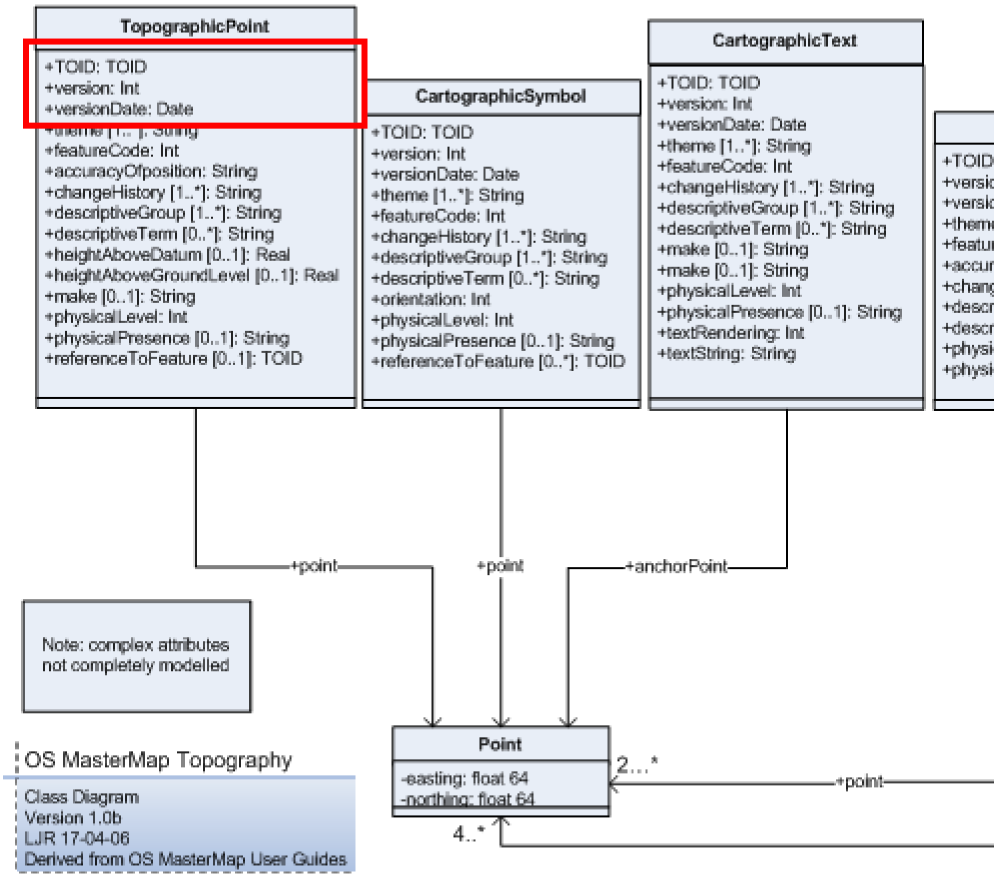



**Figure 27 – Example: life-cycle information in the OS MasterMap schema**

Each spatial object instance (identified by its unique object identifier TOID) is supported by a property “version” (an Integer that is incremented with every version) and a property “versionDate” (a Date). The main purpose of the “version” property is to allow for correct sequencing where several updates might be applied in the same day.

The TOID is a local identifier in the terminology of Clause 14 and would have to have a namespace prefix to raise it to full “unique object identifier” status.

## E.2 NEN3610 model (the Netherlands)

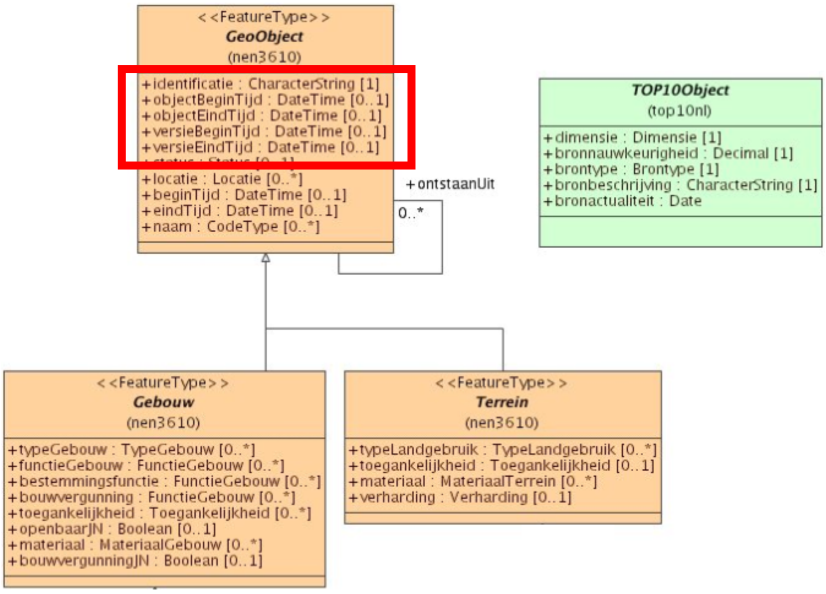



**Figure 28 – Example: life-cycle information in NEN 3610**

Each version of a spatial object instance is supported by additional properties identifying the time where the transaction committed that added this version to the data set (AAA: lebenszeitinterval.beginnt; NEN 3610: versieBeginTijd). The granularity is a second. Similarly the end time marks the end of the validity of a version - and if the spatial object still exists after that time, the beginning of the successor version (AAA: lebenszeitinterval.endet; NEN 3610: versieEindTijd). In NEN 3610 also the derived start (and for terminated spatial objects also the end) times are represented (objektBeginTijd and objektEindTijd).

The rules governing the versions are:

- At any given time during the lifetime of a spatial object there must be exactly one valid version of that spatial object.
- Every version is part of exactly one spatial object.
- The validity interval of a version is always less than or equal to that of the spatial object.
- In NEN 3610: For the first version of a spatial object, versieBeginTijd = objektBeginTijd; for the final version, versieEindTijd = objektEindTijd.
- As a corollary: There is no temporal overlap or gap between the different versions of any spatial object.

Also:

- An association role property of a spatial object in the UML application schema is by convention always understood as references to a spatial object and not to a specific version of the target spatial object.
- The temporal version attributes are in system time, which is the time at which the spatial object was entered or updated in the data set.

The tables below give an example of the version concept. At time $t_1$ a building is entered with a building function and an address.

| Identification | Version startTime | Version endTime | Feature startTime | Feature endTime | buildingFunction | address |
|---|---|---|---|---|---|---|
| 00111 | $t_1$ | | $t_1$ | | office function | Dahliastraat etc. |

At time $t_2$ the building is altered and acquires a residential function:

| Identification | Version startTime | Version endTime | Feature startTime | Feature endTime | buildingFunction | address |
|---|---|---|---|---|---|---|
| 00111 | $t_1$ | $t_2$ | $t_1$ | | office function | Dahliastraat etc. |
| 00111 | $t_2$ | | $t_1$ | | residential function | Dahliastraat etc. |

At time $t_3$ the building is demolished and the spatial object is left with only a historical function.

| identification | Version startTime | Version endTime | Feature startTime | Feature endTime | buildingFunction | address |
|---|---|---|---|---|---|---|
| 00111 | $t_1$ | $t_2$ | $t_1$ | | office function | Dahliastraat etc. |
| 00111 | $t_2$ | $t_3$ | $t_1$ | $t_3$ | residential function | Dahliastraat etc. |

NOTE 5 In addition to the information required to differentiate two versions, additional metadata may be stored with the version.

## E.3 AAA model (Germany)

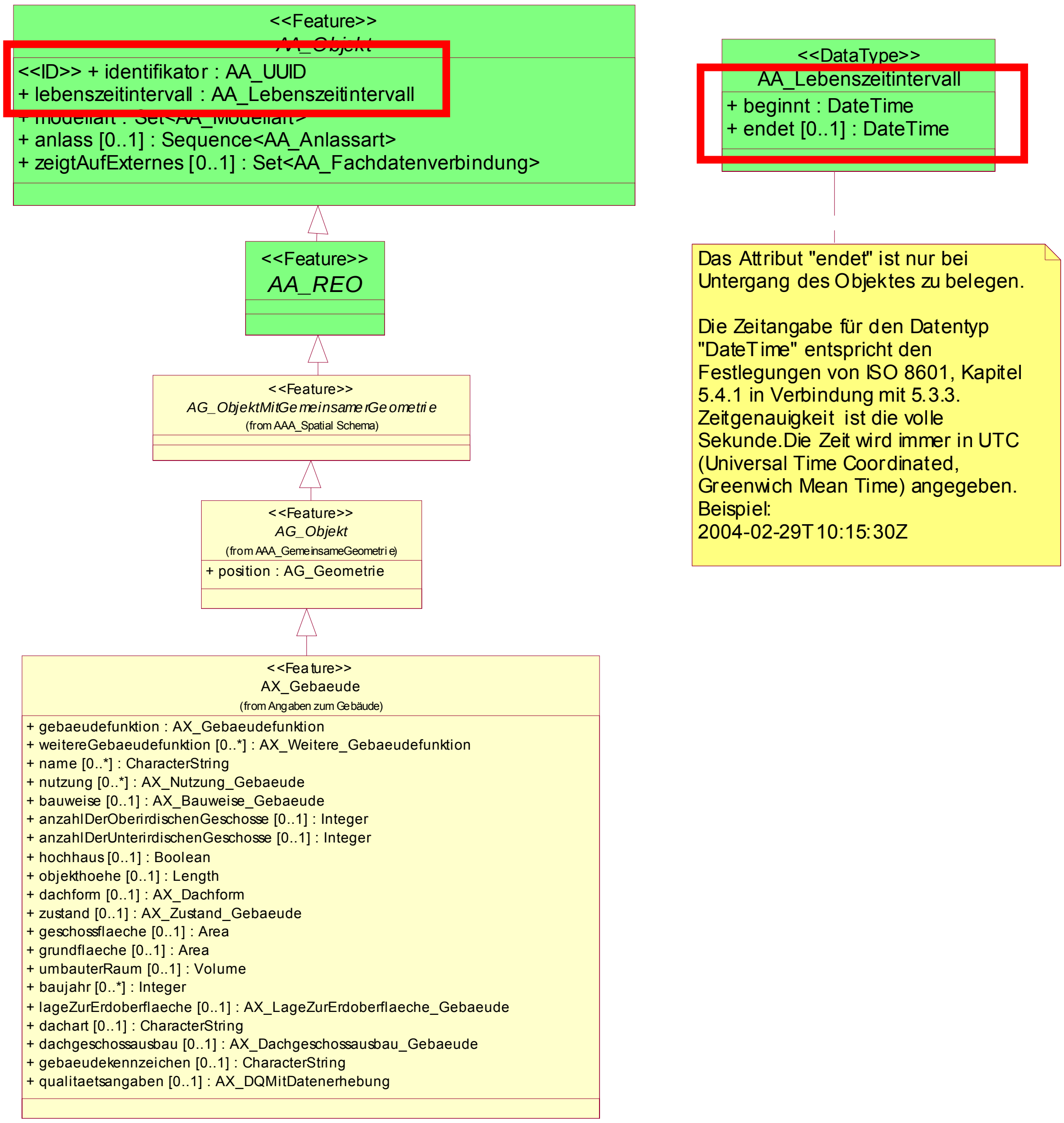



**Figure 29 – Example: life-cycle information in the AAA model**

The rules are similar to the rules for NEN 3610. The equivalent properties to versieBeginTijd and versieEndTijd in NEN3610 is lebenszeitinterval.beginnt and lebenszeitinterval.endet in AAA.

## E.4 Data set level life-cycle information - ATKIS (Germany)

EXAMPLE 4 Unlike the previous examples which illustrated life-cycle information on the *object level*, this examples illustrates life-cycle information on the *data set level*. Currently, the typical way how information about the temporal validity and up-to-dateness of the objects in a spatial data set is provided is as part of the metadata (see D1.3, draft Implementing Rule on metadata). This information is in general provided for the whole data set, by a spatial object type or by sub-region. An example is the metadata for the topographic ATKIS data in Germany where the up-to-dateness can also be viewed in a overview map (see Figure 30, where for different areas of Germany the up-to-dateness is indicated by year, see legend with different colours for each year on the left side).

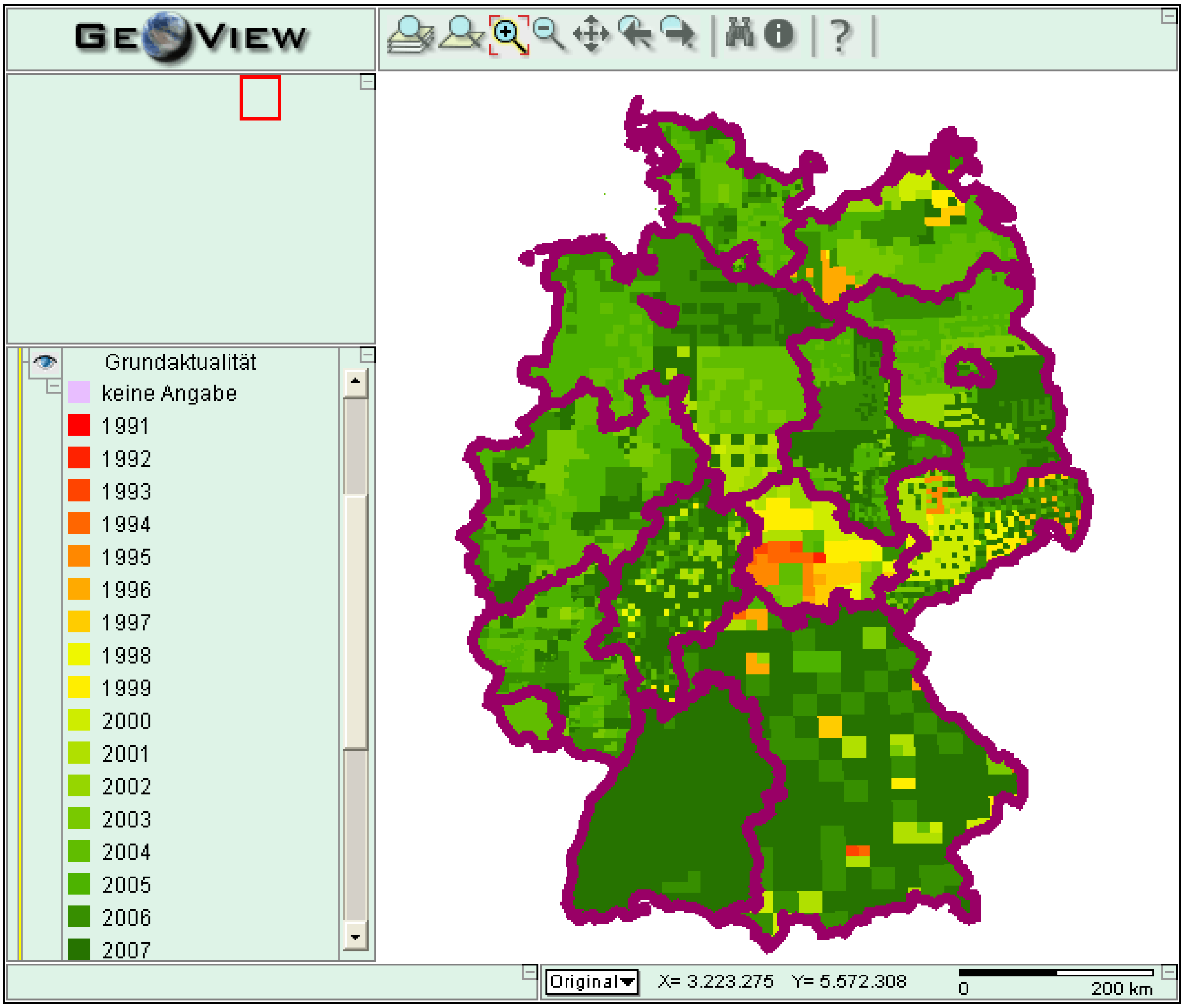



**Figure 30 – Example: life-cycle information in data set metadata**

# Bibliography

This clause lists documents that were used in the drafting of this document, but which are not normative.

NOTE Not all reference material is publicly available and some of the documents are still in a draft stage. In addition, full referencing information of the reference material is not available from the reference material database.

The following reference material submitted by SDICs and LMOs was in particular used in the development of this document (the title of the reference material and the submitting SDIC/LMO):


[1] Analyse du Guide de rédaction des spécifications normalisées des produits IGN (Institut Géographique National)

[2] Argumentation on unique identifier (Institut Géographique National)

[3] ATKIS Feature catalogue – chapter D3 : DLM250 (Bundesamt für Kartographie und Geodäsie (BKG))

[4] ATKIS Feature catalogue – chapter D4 : DLM1000 (Bundesamt für Kartographie und Geodäsie (BKG))

[5] BD Adresse descriptif technique (Institut Géographique National)

[6] BD Alti Descriptif technique (Institut Géographique National)

[7] BD Carthage version 3.0 descriptif de contenu (Institut Géographique National)

[8] BD Carto Descriptif technique (Institut Géographique National)

[9] BD Nyme descriptif technique (Institut Géographique National)

[10] BD Ortho version 2 descriptif de contenu (Institut Géographique National)

[11] BD Parcellaire version 1.1 descriptif technique (Institut Géographique National)

[12] BD Topo version 3.1 descriptif technique (Institut Géographique National)

[13] Climate Science Modelling Language: Standards-Based Markup For Metocean Data (ATMOS-DMC)

[14] Departmental Geographical Information Strategies (Ordnance Survey)

[15] Descriptif technique de BD TOPO Pays (Institut Géographique National)

[16] Digital National Framework - White Paper (Ordnance Survey)

[17] Documentation on the Modelling of Geoinformation of Official Surveying and Mapping GeoInfoDok (Lenkungsgremium GDI-DE (Steering Committee GDI-DE), BKG)

[18] EDC-11031 EuroRegionalMap: Incremental Development of a Pan-European Database at Medium Scale (Institut Géographique National)

[19] Etude de la formalisation des spécifications de base de données géographiques en vue de leur intégration (Institut Géographique National)

[20] EUREF Publication No.13 (EUREF)

[21] EuroBoundaryMap, User Guide and Data Specification (EuroGeographics, BKG)

[22] EuroGlobalMap data specification (EuroGeographics, National Land Survey of Finland)

[23] EuroRegionalMap Specification and Data Catalogue (EuroGeographics, NGI Nationaal Geografisch Insituut / IGN Institut Géographique National)

[24] EuroRoadS (EuroGeographics)

[25] Geographic Information: An analysis of interoperability and information sharing in the United Kingdom (Ordnance Survey)

[26] GeoUML: a geographic conceptual model defined through specialisation of ISO TC 211 standards (SpatialDBlab)

[27] GeoUML: an ISO TC 211 compatible data model for the conceptual design of geographical databases (SpatialDBlab)

[28] GiMoDig, Architecture Specification (Finnish Geodetic Institute)

[29] GiMoDig, Final report, public (Finnish Geodetic Institute)

[30] GiMoDig, Global Schema specification (Finnish Geodetic Institute, BKG)

[31] GiMoDig, Report of Data Service Prototype (Finnish Geodetic Institute)

[32] INTERLIS (Federal Office of Topography Switzerland - swisstopo )

[33] Intesa GIS 1n 1007_1 - “Specifiche per la realizzazione dei Data Base Topografici di interesse generale, Specifiche di contenuto: Gli Strati, I Temi, Le Classi” alias “Specifications for producing Topographic Data Bases of general concern, content Specifications: Layers, Themes, Classes” (SITAD SP)

[34] Intesa GIS 1n 1007_2 - “Specifiche per la realizzazione dei Data Base Topografici di interesse generale, Specifiche di contenuto: Documento di riferimento” alias “Specifications for producing Topographic Data Bases of general concern, content Specifications: technical reference Document” (SITAD SP)

[35] Intesa GIS 1n 1007_4 - “Specifiche per la realizzazione dei Data Base Topografici di interesse generale, Specifiche di contenuto: Lo Schema concettuale delle Specifiche di contenuto in UML”

[36] Intesa GIS 1n1010 _1 – “Specifiche per la realizzazione dei Data Base Topografici di interesse generale, Il modello concettuale GeoUML – Specifica Formale in UML”

[37] Intesa GIS 1n1010 _2 – “Specifiche per la realizzazione dei Data Base Topografici di interesse generale, Il modello concettuale GeoUML – inquadramento generale ed introduzione all’uso”

[38] Intesa GIS 1n1012 – “Specifiche per la realizzazione dei Data Base Topografici di interesse generale – Inquadramento generale e guida ai documenti” alias “Specifications for producing Topographic Data Bases of general concern - Overview and guidebook” (SITAD SP)

[39] Link list to documents relating to: Framework for the WMO Information System (GRDC)

[40] NEN 3610 - Basic scheme for geo-information - Terms, definitions, relations and general rules for the interchange of information of spatial objects related to the earth's surface (Ravi/NCGI)

[41] Report on Reference Data Sets and Feature types in Europe (EuroGeographics)

[42] Route 120 descriptif de contenu (Institut Géographique National)

[43] Route 500 descriptif technique (Institut Géographique National)

[44] Site de l'ACI (Institut Géographique National)

[45] Spécification de la composante orthophotographique du RGE (Institut Géographique National)

[46] Specification of Georoute (Institut Géographique National)

[47] Spécifications BD Uni v0.1 (Institut Géographique National)

[48] Using XML Technology for Marine Data Exchange: A Position Paper of the MarineXML Initiative (ATMOS-DMC)

[49] alias "Specifications for producing Topographic Data Bases of general concern, content Specifications: UML Conceptual schema" (SpatialDBlab, SITAD SP)

[50] alias "Specifications for producing Topographic Data Bases of general concern, GeoUML conceptual model – Overview and guideline" (SpatialDBlab, SITAD SP)

[51] alias "Specifications for producing Topographic Data Bases of general concern, GeoUML conceptual model – UML formal Specifications" (SpatialDBlab, SITAD SP)

Other documents that were used in the compilation of this document:

[52] Chaudhry O., and W. Mackaness, 2006a, Modelling Geographic Phenomena at Different Levels of Detail, In Proceedings of Autocarto 2006, USA.

[53] Claudia Hess and Marian de Vries, From Models to Data: A Prototype Query Translator for the Cadastral Domain Workshop Standardization in the Cadastral Domain, held by 'COST Action G9' and 'FIG Commission 7', Bamberg, December 9-10 2004, 14 p.

[54] DNF Expert Group, Results of DNF Unique Identifier Consultation

[55] DNF Expert Group, Technical Guide on Unique Object Identifiers

[56] DNF Expert Group, Unique Object Identifiers within the Digital National Framework (DNF)

[57] Douglas D. Nebert (editor), The SDI Cookbook, January 2004, GSDI

[58] Dudley MBC, Building a single-geometry land and property database at Dudley Metropolitan Council using the Digital National Framework

[59] Egenhofer M.J., Clementini E. and Di Felice P. 1994. Evaluating inconsistencies among multiple representations, In Proceedings of the 6th International Symposium on Spatial Data Handling (SDH'94), pp. 901-920.

[60] EPSG Geodetic Parameter Dataset online at http://www.epsg.org/Geodetic.html

[61] EUREF - Information and Service system for European Coordinate Reference Systems, Bundesamt für Kartographie und Geodäsie, EuroGeographics http://crs.bkg.bund.de/crs-eu

[62] EuroGeoNames Consortium: Survey/Inventory on European Geographical Names data http://www.eurogeographics.org/eng/documents/051115_SI-EGN_final_report.pdf

[63] European Reference Grids (EUR 2194 EN), European Commission, Joint Research Centre http://gi-gis.jrc.it/publist/annoni2005eugrids.pdf

[64] Gazetteer Service (WFS-G), OGC Best practice document

[65] Geoscience Markup Language (GeoSciML) https://www.seegrid.csiro.au/twiki/bin/view/CGIModel/GeoSciML

[66] Gesbert N., 2004, Formalisation of Geographical Database Specifications, in proceeding of the Conference on Advances in Databases and Information Systems (ADBIS), September 2004, Budapest, pp. 202-211

[67] Gesbert N., 2005, « Etude de la formalisation des spécifications de bases de données géographiques en vue de leur intégration ». PhD Thesis Université de Marne-La-Vallée, ftp://ftp.ign.fr/ign/COGIT/THESES

[68] Gröger, G., Kolbe, T., Czerwinski, A.: Candidate OpenGIS® CityGML Implementation Specification (City Geography Markup Language), Open Geospatial Consortium Inc, OGC 07-

[69] Haunert J.-H. 2005. Link based Conflation of Geographic Datasets. 8th ICA workshop on generalisation and multiple representation, A Coruña, Spain, July 2005.

[70] ISO/DTS 19104, Geographic Information – Terminology

[71] Lamine K. and S. Mustiere, 2005, “Integration de données transfrontalieres relatives à la randonnée pedestre” Laboratoire COGIT, Paris 6. European Project WoW: Walk on Web; IST-2-004688-STP.

[72] Mustière S. 2006. Results on experiments on automated matching of networks. Proceedings of the ISPRS Workshop on Multiple Representation and Interoperability of Spatial Data, Hanover, pp.92-100

[73] Mustière S. and van Smaalen J. 2007. Databases Requirements for Generalisation and Multiple Representations. To be published in “Generalisation of Geographic Information : Cartographic Modelling and Applications”, W. Mackaness, A. Ruas et T. Sarjakoski (eds), Elsevier.

[74] Questionnaire on Unique Identifiers http://www.ec-gis.org/inspire/reports/surveys/Questionaire_ui_v2_0.pdf

[75] Questionnaire on the use of the elements of the spatial and temporal schema http://www.ec-gis.org/inspire/reports/surveys/Questionnaire_gtt_v2_0.pdf

[76] Racine JB, 1981, "Problématiques et méthodologie : de l'implicite à l'explicite" dans H. Isuard, JB Racine et H Raynard (ed.) Problématiques de la géographie Paris, PUF le géographe.

[77] Rousseaux Frédéric, Bonin Olivier (2003) Toward a coherent integration of 2D linear data into a DTM . International Cartographic Conference 2003 (ACI), Durban, South Africa.

[78] Ruas A 2004 « Le changement de niveau de détail dans la représentation de l'information géographique » HDR University of Marne la Vallée ftp://ftp.ign.fr/ign/COGIT/HDR/

[79] Ruas A., Bianchin A., 2002, "Echelle et Niveau de détail" dans A. Ruas (ed.) Généralisation et représentation multiple, Paris, Hermes Lavoisier, Chapitre 1, p25-44.

[80] Sheeren D., 2005, « Méthodologie d'évaluation de la cohérence inter-représentations pour l'intégration de bases de données spatiales. Une approche combinant l'utilisation de métadonnées et l'apprentissage automatique. PhD Thesis, University of Paris 6, 292 p. ftp://ftp.ign.fr/ign/COGIT/THESES

[81] Sheeren, D., Mustière, S., Zucker, J.-D. 2004, Consistency Assessment Between Multiple Representations of Geographical Databases: a Specification-Based Approach. Proc. of the 11th International Symposium on Spatial Data Handling, Leicester, UK.

[82] Tóth, Katalin, 2006,INSPIRE Multiple-Representation and Data Consistency Workshop - Report, JRC IES