5 Data content and structure

5.1 Application schemas – Overview

5.1.1 Application schemas included in the IRs

Articles 3, 4 and 5 of the Implementing Rules lay down the requirements for the content and structure of the data sets related to the INSPIRE Annex themes.

IR Requirement
Article 4
Types for the Exchange and Classification of Spatial Objects

1. For the exchange and classification of spatial objects from data sets meeting the conditions laid down in Article 4 of Directive 2007/2/EC, Member States shall use the spatial object types and associated data types, enumerations and code lists that are defined in Annexes II, III and IV for the themes the data sets relate to.

2. Spatial object types and data types shall comply with the definitions and constraints and include the attributes and association roles set out in the Annexes.

3. The enumerations and code lists used in attributes or association roles of spatial object types or data types shall comply with the definitions and include the values set out in Annex II. The enumeration and code list values are uniquely identified by language-neutral mnemonic codes for computers. The values may also include a language-specific name to be used for human interaction.

The types to be used for the exchange and classification of spatial objects from data sets related to the spatial data theme *Orthoimagery* are defined in the following application schemas (see sections):

– Orthoimagery application schema

The application schemas specify requirements on the properties of each spatial object including its multiplicity, domain of valid values, constraints, etc.

NOTE The application schemas presented in this section contain some additional information that is not included in the Implementing Rules, in particular multiplicities of attributes and association roles.

TG Requirement 1	Spatial object types and data types shall comply with the multiplicities defined for the attributes and association roles in this section.

An application schema may include references (e.g. in attributes or inheritance relationships) to common types or types defined in other spatial data themes. These types can be found in a sub-section called "Imported Types" at the end of each application schema section. The common types referred to from application schemas included in the IRs are addressed in Article 3.

IR Requirement
Article 3
Common Types

Types that are common to several of the themes listed in Annexes I, II and III to Directive 2007/2/EC shall conform to the definitions and constraints and include the attributes and association roles set out in Annex I.

NOTE Since the IRs contain the types for all INSPIRE spatial data themes in one document, Article 3 does not explicitly refer to types defined in other spatial data themes, but only to types defined in external data models.

Common types are described in detail in the Generic Conceptual Model [DS-D2.7], in the relevant international standards (e.g. of the ISO 19100 series) or in the documents on the common INSPIRE models [DS-D2.10.x]. For detailed descriptions of types defined in other spatial data themes, see the corresponding Data Specification TG document [DS-D2.8.x].

5.2 Basic notions

This section explains some of the basic notions used in the INSPIRE application schemas. These explanations are based on the GCM [DS-D2.5].

5.2.1 Notation

5.2.1.1. Unified Modeling Language (UML)

The application schemas included in this section are specified in UML, version 2.1. The spatial object types, their properties and associated types are shown in UML class diagrams.

NOTE For an overview of the UML notation, see Annex D in [ISO 19103].

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.

The following important rules related to class inheritance and abstract classes are included in the IRs.

IR Requirement
Article 5
Types

(…)

2. Types that are a sub-type of another type shall also include all this type's attributes and association roles.

3. Abstract types shall not be instantiated.

The use of UML conforms to ISO 19109 8.3 and ISO/TS 19103 with the exception that UML 2.1 instead of ISO/IEC 19501 is being used. The use of UML also conforms to 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.

To model constraints on the spatial object types and their properties, in particular to express data/data set consistency rules, OCL (Object Constraint Language) is used as described in ISO/TS 19103, whenever possible. In addition, all constraints are described in the feature catalogue in English, too.

NOTE Since "void" is not a concept supported by OCL, OCL constraints cannot include expressions to test whether a value is a *void* value. Such constraints may only be expressed in natural language.

5.2.1.2. Stereotypes

In the application schemas in this section several stereotypes are used that have been defined as part of a UML profile for use in INSPIRE [DS-D2.5]. These are explained in Table 1 below.

Table 1 – Stereotypes (adapted from [DS-D2.5])

Stereotype	Model element	Description
applicationSchema	Package	An INSPIRE application schema according to ISO 19109 and the Generic Conceptual Model.
leaf	Package	A package that is not an application schema and contains no packages.
featureType	Class	A spatial object type.
type	Class	A type that is not directly instantiable, but is used as an abstract collection of operation, attribute and relation signatures. This stereotype should usually not be used in INSPIRE application schemas as these are on a different conceptual level than classifiers with this stereotype.
dataType	Class	A structured data type without identity.
union	Class	A structured data type without identity where exactly one of the properties of the type is present in any instance.
enumeration	Class	An enumeration.
codeList	Class	A code list.
import	Dependency	The model elements of the supplier package are imported.
voidable	Attribute, association role	A voidable attribute or association role (see section 5.2.2).
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 type, the property shall receive this stereotype.
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.

5.2.2 Voidable characteristics

The «voidable» stereotype is used to characterise those properties of a spatial object that may not be present in some spatial data sets, even though they may be present or applicable in the real world. This does *not* mean that it is optional to provide a value for those properties.

For all properties defined for a spatial object, a value has to be provided – either the corresponding value (if available in the data set maintained by the data provider) or the value of *void.* A *void* value shall imply that no corresponding value is contained in the source spatial data set maintained by the data provider or no corresponding value can be derived from existing values at reasonable costs.

Recommendation 1 The reason for a *void* value should be provided where possible using a listed value from the VoidReasonValue code list to indicate the reason for the missing value.

The VoidReasonValue type is a code list, which includes the following pre-defined values:

– *Unpopulated*: The property is not part of the dataset maintained by the data provider. However, the characteristic may exist in the real world. For example when the “elevation of the water body above the sea level” has not been included in a dataset containing lake spatial objects, then the reason for a void value of this property would be ‘Unpopulated’. The property receives this value for all spatial objects in the spatial data set.

- *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’. This value is applied only to those spatial objects where the property in question is not known.
- *Withheld*: The characteristic may exist, but is confidential and not divulged by the data provider.

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

The «voidable» stereotype does not give any information on whether or not a characteristic exists in the real world. This is expressed using the multiplicity:
- If a characteristic may or may not exist in the real world, its minimum cardinality shall be defined as 0. For example, if an Address may or may not have a house number, the multiplicity of the corresponding property shall be 0..1.
- If at least one value for a certain characteristic exists in the real world, the minimum cardinality shall be defined as 1. For example, if an Administrative Unit always has at least one name, the multiplicity of the corresponding property shall be 1..*.

In both cases, the «voidable» stereotype can be applied. In cases where the minimum multiplicity is 0, the absence of a value indicates that it is known that no value exists, whereas a value of void indicates that it is not known whether a value exists or not.

EXAMPLE If an address does not have a house number, the corresponding Address object should not have any value for the «voidable» attribute house number. If the house number is simply not known or not populated in the data set, the Address object should receive a value of *void* (with the corresponding void reason) for the house number attribute.

5.2.3 Enumerations

Enumerations are modelled as classes in the application schemas. Their values are modelled as attributes of the enumeration class using the following modelling style:
- No initial value, but only the attribute name part, is used.
- The attribute name conforms to the rules for attributes names, i.e. is a lowerCamelCase name. Exceptions are words that consist of all uppercase letters (acronyms).

IR Requirement
Article 6
Code Lists and Enumerations

(…)

5) Attributes or association roles of spatial object types or data types that have an enumeration type may only take values from the lists specified for the enumeration type.”

5.2.4 Code lists

Code lists are modelled as classes in the application schemas. Their values, however, are managed outside of the application schema.

5.2.4.1. Code list types

The IRs distinguish the following types of code lists.

IR Requirement
Article 6
Code Lists and Enumerations

1) Code lists shall be of one of the following types, as specified in the Annexes:
   a) code lists whose allowed values comprise only the values specified in this Regulation;
   b) code lists whose allowed values comprise the values specified in this Regulation and narrower values defined by data providers;
   c) code lists whose allowed values comprise the values specified in this Regulation and additional values at any level defined by data providers;
   d) code lists, whose allowed values comprise any values defined by data providers.

   For the purposes of points (b), (c) and (d), in addition to the allowed values, data providers may use the values specified in the relevant INSPIRE Technical Guidance document available on the INSPIRE web site of the Joint Research Centre.

The type of code list is represented in the UML model through the tagged value *extensibility*, which can take the following values:

- *none*, representing code lists whose allowed values comprise only the values specified in the IRs (type a);
- *narrower*, representing code lists whose allowed values comprise the values specified in the IRs and narrower values defined by data providers (type b);
- *open*, representing code lists whose allowed values comprise the values specified in the IRs and additional values at any level defined by data providers (type c); and
- *any*, representing code lists, for which the IRs do not specify any allowed values, i.e. whose allowed values comprise any values defined by data providers (type d).

Recommendation 2 Additional values defined by data providers should not replace or redefine any value already specified in the IRs.

NOTE This data specification may specify recommended values for some of the code lists of type (b), (c) and (d) (see section 5.2.4.3). These recommended values are specified in a dedicated Annex.

In addition, code lists can be hierarchical, as explained in Article 6(2) of the IRs.

IR Requirement
Article 6
Code Lists and Enumerations

(…)

2) Code lists may be hierarchical. Values of hierarchical code lists may have a more generic parent value. Where the valid values of a hierarchical code list are specified in a table in this Regulation, the parent values are listed in the last column.

The type of code list and whether it is hierarchical or not is also indicated in the feature catalogues.

5.2.4.2. Obligations on data providers

IR Requirement
Article 6
Code Lists and Enumerations

(….)

3) Where, for an attribute whose type is a code list as referred to in points (b), (c) or (d) of paragraph 1, a data provider provides a value that is not specified in this Regulation, that value and its definition shall be made available in a register.

4) Attributes or association roles of spatial object types or data types whose type is a code list may only take values that are allowed according to the specification of the code list.

Article 6(4) obliges data providers to use only values that are allowed according to the specification of the code list. The "allowed values according to the specification of the code list" are the values explicitly defined in the IRs plus (in the case of code lists of type (b), (c) and (d)) additional values defined by data providers.

For attributes whose type is a code list of type (b), (c) or (d) data providers may use additional values that are not defined in the IRs. Article 6(3) requires that such additional values and their definition be made available in a register. This enables users of the data to look up the meaning of the additional values used in a data set, and also facilitates the re-use of additional values by other data providers (potentially across Member States).

NOTE Guidelines for setting up registers for additional values and how to register additional values in these registers is still an open discussion point between Member States and the Commission.

5.2.4.3. Recommended code list values

For code lists of type (b), (c) and (d), this data specification may propose additional values as a recommendation (in a dedicated Annex). These values will be included in the INSPIRE code list register. This will facilitate and encourage the usage of the recommended values by data providers since the obligation to make additional values defined by data providers available in a register (see section 5.2.4.2) is already met.

Recommendation 3 Where these Technical Guidelines recommend values for a code list in addition to those specified in the IRs, these values should be used.

NOTE For some code lists of type (d), no values may be specified in these Technical Guidelines. In these cases, any additional value defined by data providers may be used.

5.2.4.4. Governance

The following two types of code lists are distinguished in INSPIRE:

– *Code lists that are governed by INSPIRE (INSPIRE-governed code lists).* These code lists will be managed centrally in the INSPIRE code list register. Change requests to these code lists (e.g. to add, deprecate or supersede values) are processed and decided upon using the INSPIRE code list register's maintenance workflows.

  INSPIRE-governed code lists will be made available in the INSPIRE code list register at *http://inspire.ec.europa.eu/codelist/<CodeListName>*. They will be available in SKOS/RDF, XML and HTML. The maintenance will follow the procedures defined in ISO 19135. This means that the only allowed changes to a code list are the addition, deprecation or supersession of values, i.e. no value will ever be deleted, but only receive different statuses (valid, deprecated, superseded). Identifiers for values of INSPIRE-governed code lists are constructed using the pattern *http://inspire.ec.europa.eu/codelist/<CodeListName>*/<value>.

– *Code lists that are governed by an organisation outside of INSPIRE (externally governed code lists).* These code lists are managed by an organisation outside of INSPIRE, e.g. the World

Meteorological Organization (WMO) or the World Health Organization (WHO). Change requests to these code lists follow the maintenance workflows defined by the maintaining organisations. Note that in some cases, no such workflows may be formally defined.

Since the updates of externally governed code lists is outside the control of INSPIRE, the IRs and these Technical Guidelines reference a specific version for such code lists.

The tables describing externally governed code lists in this section contain the following columns:

- The *Governance* column describes the external organisation that is responsible for maintaining the code list.
- The *Source* column specifies a citation for the authoritative source for the values of the code list. For code lists, whose values are mandated in the IRs, this citation should include the version of the code list used in INSPIRE. The version can be specified using a version number or the publication date. For code list values recommended in these Technical Guidelines, the citation may refer to the "latest available version".
- In some cases, for INSPIRE only a subset of an externally governed code list is relevant. The subset is specified using the *Subset* column.
- The *Availability* column specifies from where (e.g. URL) the values of the externally governed code list are available, and in which formats. Formats can include machine-readable (e.g. SKOS/RDF, XML) or human-readable (e.g. HTML, PDF) ones.

Code list values are encoded using http URIs and labels. Rules for generating these URIs and labels are specified in a separate table.

Recommendation 4	The http URIs and labels used for encoding code list values should be taken from the INSPIRE code list registry for INSPIRE-governed code lists and generated according to the relevant rules specified for externally governed code lists.

NOTE Where practicable, the INSPIRE code list register could also provide http URIs and labels for externally governed code lists.

5.2.4.5. Vocabulary

For each code list, a tagged value called "vocabulary" is specified to define a URI identifying the values of the code list. For INSPIRE-governed code lists and externally governed code lists that do not have a persistent identifier, the URI is constructed following the pattern *http://inspire.ec.europa.eu/codelist/<UpperCamelCaseName>*.

If the value is missing or empty, this indicates an empty code list. If no sub-classes are defined for this empty code list, this means that any code list may be used that meets the given definition.

An empty code list may also be used as a super-class for a number of specific code lists whose values may be used to specify the attribute value. If the sub-classes specified in the model represent all valid extensions to the empty code list, the subtyping relationship is qualified with the standard UML constraint "{complete,disjoint}".

5.2.5 Identifier management

IR Requirement
Article 9
Identifier Management

1. The data type Identifier defined in Section 2.1 of Annex I shall be used as a type for the external object identifier of a spatial object.
2. The external object identifier for the unique identification of spatial objects shall not be changed during the life-cycle of a spatial object.

NOTE 1 An external object identifier is a unique object identifier which is published by the responsible body, which may be used by external applications to reference the spatial object. [DS-D2.5]

NOTE 2 Article 9(1) is implemented in each application schema by including the attribute *inspireId* of type Identifier.

NOTE 3 Article 9(2) is ensured if the *namespace* and *localId* attributes of the Identifier remains the same for different versions of a spatial object; the *version* attribute can of course change.

5.2.6 Geometry representation

IR Requirement
Article 12
Other Requirements & Rules

1. The value domain of spatial properties defined in this Regulation shall be restricted to the Simple Feature spatial schema as defined in Herring, John R. (ed.), OpenGIS® Implementation Standard for Geographic information – Simple feature access – Part 1: Common architecture, version 1.2.1, Open Geospatial Consortium, 2011, unless specified otherwise for a specific spatial data theme or type.

NOTE 1 The specification restricts the spatial schema to 0-, 1-, 2-, and 2.5-dimensional geometries where all curve interpolations are linear and surface interpolations are performed by triangles.

NOTE 2 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 EN ISO 19125-1).

5.2.7 Temporality representation

The application schema(s) use(s) the derived attributes "beginLifespanVersion" and "endLifespanVersion" to record the lifespan of a spatial object.

The attributes "beginLifespanVersion" specifies the date and time at which this version of the spatial object was inserted or changed in the spatial data set. The attribute "endLifespanVersion" specifies the date and time at which this version of the spatial object was superseded or retired in the spatial data set.

NOTE 1 The attributes specify the beginning of the lifespan of the version in the spatial data set itself, which is different from the temporal characteristics of the real-world phenomenon described by the spatial object. This lifespan information, if available, supports mainly two requirements: First, knowledge about the spatial data set content at a specific time; second, knowledge about changes to a data set in a specific time frame. The lifespan information should be as detailed as in the data set (i.e., if the lifespan information in the data set includes seconds, the seconds should be represented in data published in INSPIRE) and include time zone information.

NOTE 2 Changes to the attribute "endLifespanVersion" does not trigger a change in the attribute "beginLifespanVersion".

IR Requirement
Article 10
Life-cycle of Spatial Objects

(…)

3. Where the attributes beginLifespanVersion and endLifespanVersion are used, the value of endLifespanVersion shall not be before the value of beginLifespanVersion.

NOTE The requirement expressed in the IR Requirement above will be included as constraints in the UML data models of all themes.

Recommendation 5 If life-cycle information is not maintained as part of the spatial data set, all spatial objects belonging to this data set should provide a void value with a reason of "unpopulated".

5.2.8 Coverages

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. isolines), grids (e.g. orthoimages, elevation models), etc.

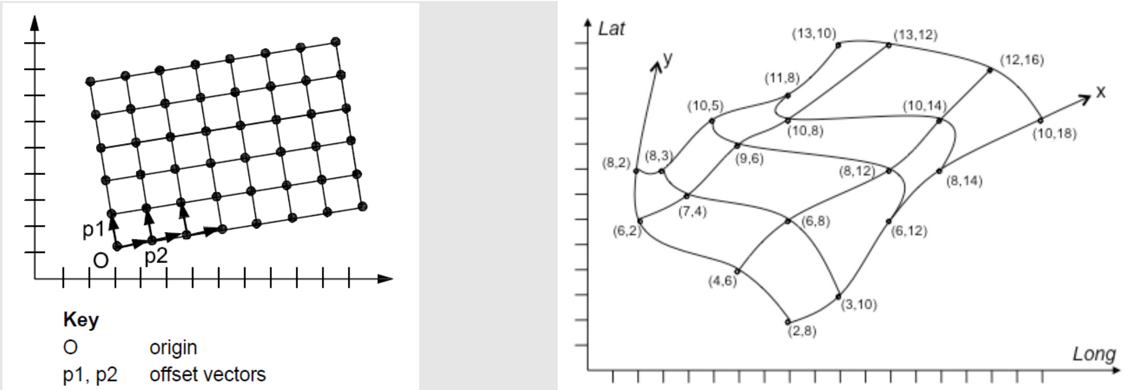
In INSPIRE application schemas, coverage functions are defined as properties of spatial object types where the type of the property value is a realisation of one of the types specified in ISO 19123.

To improve alignment with coverage standards on the implementation level (e.g. ISO 19136 and the OGC Web Coverage Service) and to improve the cross-theme harmonisation on the use of coverages in INSPIRE, an application schema for coverage types is included in the Generic Conceptual Model in 9.9.4. This application schema contains the following coverage types:

- *RectifiedGridCoverage*: coverage whose domain consists of a rectified grid – a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system (see Figure 2, left).
- *ReferenceableGridCoverage*: coverage whose domain consists of a referenceable grid – a grid associated with a transformation that can be used to convert grid coordinate values to values of coordinates referenced to a coordinate reference system (see Figure 2, right).

In addition, some themes make reference to the types TimeValuePair and Timeseries defined in Taylor, Peter (ed.), *OGC® WaterML 2.0: Part 1 – Timeseries, v2.0.0,* Open Geospatial Consortium, 2012. These provide a representation of the time instant/value pairs, i.e. time series (see Figure 3).

Where possible, only these coverage types (or a subtype thereof) are used in INSPIRE application schemas.



(Source: ISO 19136:2007) (Source: GML 3.3.0)

Figure 2 – Examples of a rectified grid (left) and a referenceable grid (right)

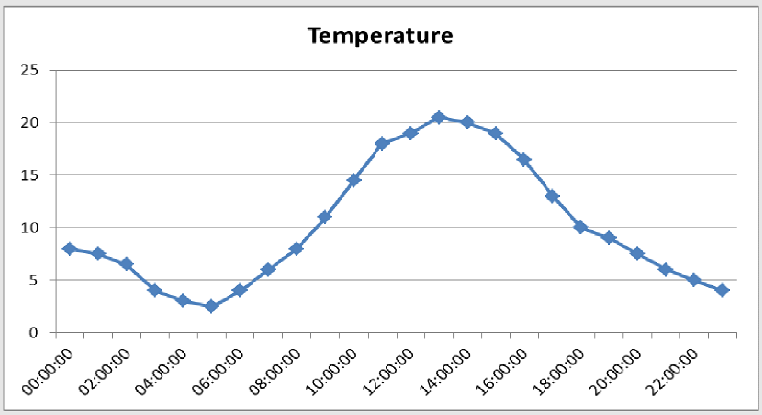


Figure 3 – Example of a time series

5.3 Application schema Orthoimagery

Description
Narrative description

5.3.1 Coverage representation for orthoimagery

Orthoimagery data, which is a kind of raster data, is a simple form of geographic information. It consists of a set of values measuring a radiant energy, organized in a regular array of points together with associated metadata and georeferencing. The coverage approach introduced in 5.1.6 is particularly well-suited for modelling such a data structure.

The attribute values of an orthoimage are arranged using the geometry of a regular quadrilateral grid in two dimensions. Such a grid is a network composed of two sets of equally spaced parallel lines that intersect at right angles. The intersection points are called grid points or sample points. They carry the range values of the coverage, even if the physical quantity is actually measured within a sample space (e.g. image pixel) surrounding them. The areas delimited by the grid lines are called grid cells and support the evaluation of the coverage by interpolation. They are not necessarily square but rectangular. Note that grid cells and sample spaces are two distinct notions. Sample spaces form a network shifted from the one of grid cells, so that each sample space has a corresponding grid point at its centre.
A grid coordinate system is defined by means of the origin and the axes of the grid. Grid coordinates are measured along the axis away from the origin.

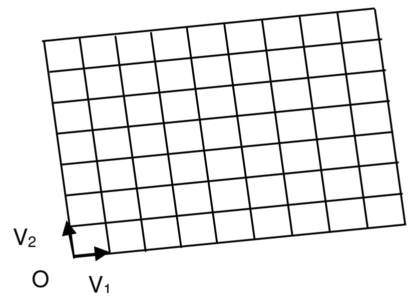


Figure 4 – example of rectified quadrilateral grid

Furthermore, the grid of an orthoimagery coverage is geo-rectified in the sense of ISO 19123. It is related to the Earth through an affine relationship that makes a simple transformation between the grid coordinates and the coordinates in the associated Earth-based reference system. The transform parameters are determined by the location of the grid origin, the orientation of the axis and the grid spacing in each direction within the external coordinate reference system.

Since it depicts continuously-varying phenomena, an orthoimage is inherently a continuous coverage. An associated interpolation method enables the evaluation of the coverage at direct any position between the elements of its domain (e.g. points).

5.3.1.1. Concept of mosaicking

In this specification, mosaicking is defined as the production process that allows the creation of a single orthoimage from several original orthorectified images. It usually involves thorough radiometric processing to give a homogeneous seamless polish to the resulting mosaicked orthoimage.

Figure 5 – mosaicked orthoimage with seamlines

The temporal extent of a mosaic cannot be more accurate than a time interval since the images that constitute the sources are almost always acquired at different dates and times. However, a clear requirement from some users to access the exact date of each pixel within a mosaic has been identified in the use case survey. That is the reason why the orthoimagery application schema provides an approach to spatially indicate acquisition times through linking orthoimage pixels to the temporal attributes of the image sources. In practical terms, it is based on the use of the seamlines that have been created to perform mosaicking process (see 5.3.1.4.6).

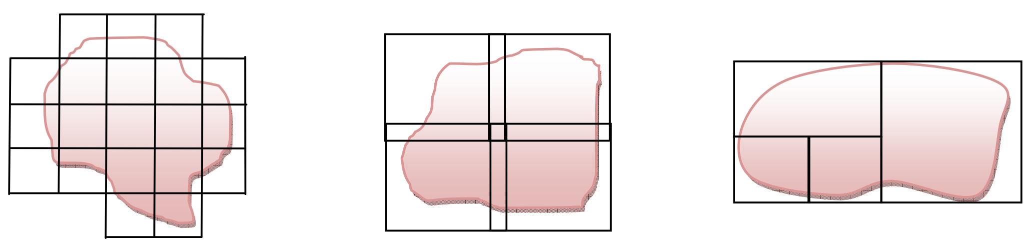
5.3.1.2. Concept of tiling

Different motivations can lead data producers to break orthoimagery data into smaller parts. This process is usually known as “tiling”. However, in fact, this term may encompass different meanings depending on the abstraction level of the description. Three main levels of tiling need to be distinguished:

Firstly, tiling may be internally implemented in file formats (e.g. tiled tiff). By rearranging image content into roughly square tiles instead of horizontally-wide strips, this method improves performances for accessing and processing high-resolution images. Since it basically reflects the storage structure of data, it does not appear in the application schema which is restricted to the conceptual level.

Secondly, high-resolution orthoimages covering broad territories represent large volumes of data that can often not be stored reasonably in a single image file. Data producers usually cut them out into separate individual files to facilitate their storage, distribution and use. The most common tiling scheme used in orthoimagery for this purpose is a simple rectangular grid where tiles edge-match without image overlaps or gaps (**Figure 6** a). However, it is sometimes required that the individual tiles overlap with their neighbours to ensure a certain spatial continuity when handling them (**Figure 6** b). The tiling scheme may also have a less regular geometry with a varying density of tiles (**Figure 6** c).

This file-based data structure is artificial and has no real logical meaning on its own even though it is usually based on grid elements. Therefore it is addressed in the encoding part of this data specification (see section 9.3).



a/ Simple grid with edge-matching tiles

b/ overlaping tiles

c/ varying density of tiles

Figure 6 – various configurations of tiling scheme

Third, large orthoimages can also be divided into subsets that make sense on their own as they describe logical structures (e.g. mapsheets, administrative units like regions or districts, etc.). Unlike the previous case, this type of file-independent tiling is fully in the scope of the conceptual model.

But pragmatically, a reverse view on tiling offers more possibilities and increase data harmonization: indeed, tiling can be seen as well as an aggregation process instead of a split process. So, a collection of orthoimage coverages can be aggregated to make up a larger single coverage. This has the advantages that:

- The input orthoimages may just partially contribute to the aggregated coverage.
- Consequently, the input orthoimages may spatially overlap whenever necessary.

This mechanism called “orthoimage aggregation” later in the document is described in more details below.

5.3.1.3. Data structure

A first data structure level is provided through the concept of coverage. In addition, the orthoimagery application schema offers a second level that consists in grouping coverages themselves in another logical structure. In other words, subsets from several homogeneous orthoimage coverages can be combined so that they build a new orthoimage coverage. The aggregated coverage does not hold directly its own pixel values. It just makes reference to its input coverages, thereby avoiding data duplication. The range set of the coverage is computed on the fly by a service or an application when requested by users.

For applicability, input and aggregated orthoimage coverages shall be part of the same orthoimagery dataset.

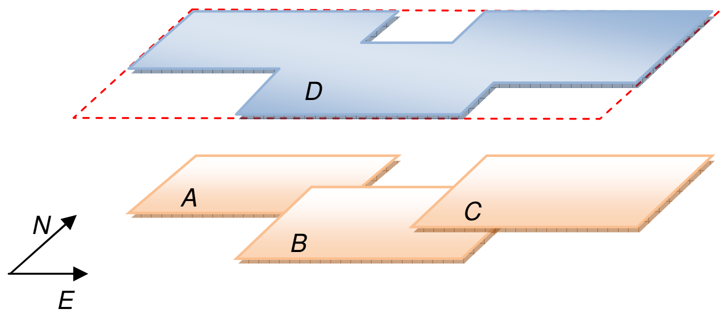


Figure 7 – Orthoimage aggregation principle: overlapping orthoimage coverages A B and C compose the aggregated orthoimage coverage D, the bounding box of which is dotted.

This mechanism is fully recursive so that an orthoimage coverage can itself be a composition of already-aggregated orthoimage coverages.

Note here that although their concepts are close, orthoimage aggregation and mosaicking differ: the former is not an extensive production process already achieved but a dynamic view to structure datasets.

5.3.1.4. UML Overview

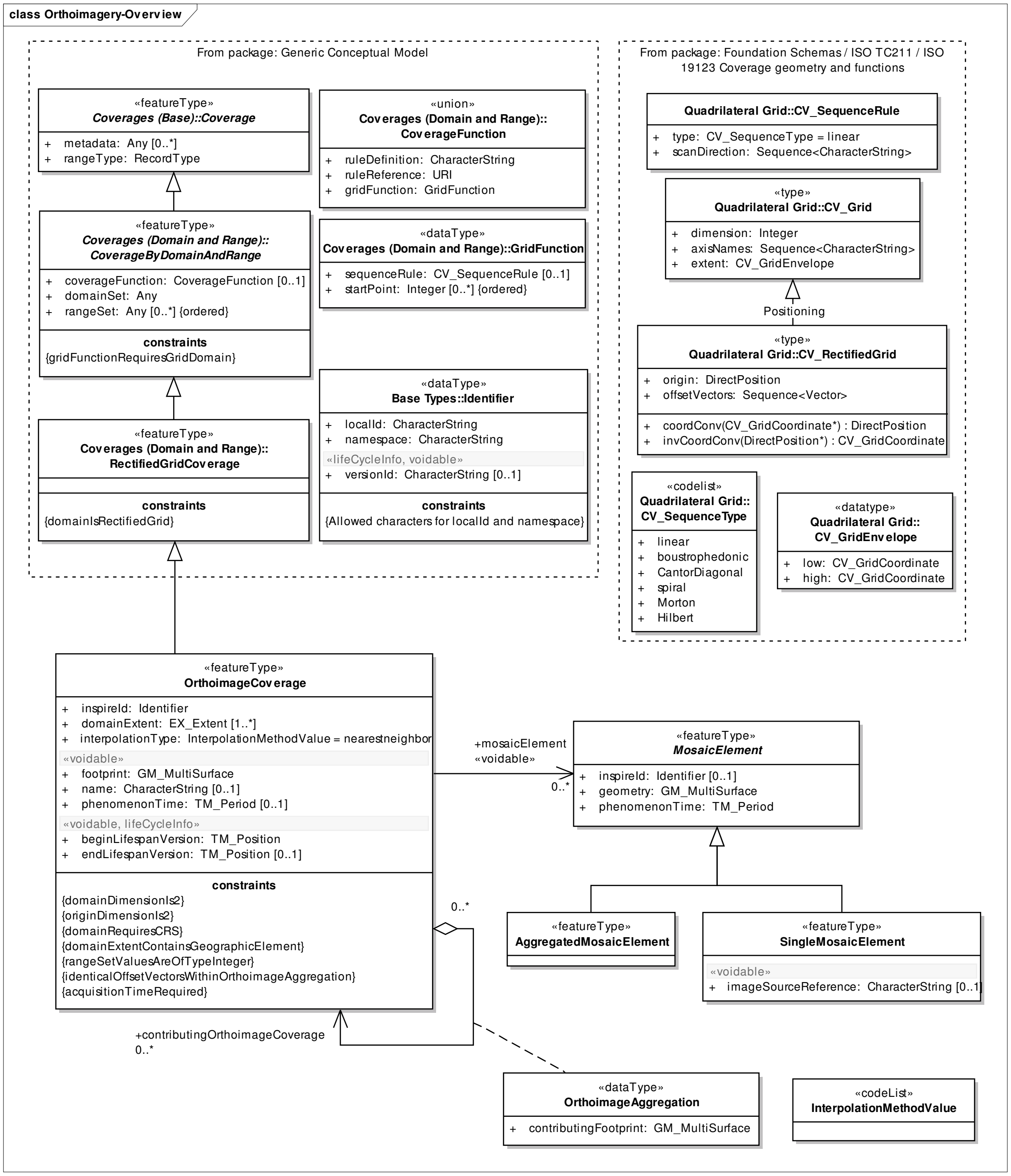


Figure 8 – UML class diagram: Overview of the <application schema name> application schema

5.3.1.4.1. Feature type *OrthoimageCoverage*

The feature type *OrthoimageCoverage* is the core element of the *Orthoimagery* application schema. It is defined by the INSPIRE Directive as "geo-referenced image data of the earth's surface, from either satellite or airborne sensors". It may be derived from one single input image acquired by a sensor or from different input images that have been mosaicked together.

The class *OrthoimageCoverage* specializes the imported type *RectifiedGridCoverage* which is specified in the INSPIRE Generic Conceptual Model, *RectifiedGridCoverage* being itself an implementation of

continuous quadrilateral grid coverages defined by ISO 19123. It inherits five properties necessary to process the coverage:

- *domainSet* defines the spatial domain of the orthoimage coverage, i.e. its geometry (See 5.3.1.4.2).
- *rangeType* describes the characteristics of the range values (See 5.3.1.4.3).
- *rangeSet* contains the feature attribute values associated with the grid points of the domain. All range values shall be of type *Integer* and shall conform to the description provided by the attribute *rangetype*.
- *CoverageFunction*, whose value type is defined in the GCM [DS-D2.5], identifies the rules to be followed in assigning the range values to the grid points. These rules can be externally referenced through an URI (*CoverageFunction::ruleReference*) or directly detailed in the data set as free text (*CoverageFunction::ruleDefinition*) or as configurable elements (*CoverageFunction::gridFunction*). In the last option, the dataType *GridFunction* identifies both the grid coordinates of the point associated with the first value in the rangeSet (*GridFunction::startPoint*) and the method for scanning grid points in the same order as the following range values (*GridFunction::sequenceRule*). The sequencing method, modeled with the ISO 19123 data type *CV_SequenceRule,* is simply determined by its category, e.g. "linear", and a list of signed axis names indicating the order in which to jump to the next grid point.
- *metadata* consists in a placeholder for additional metadata information a data provider decides to provide at a spatial object level (See 5.3.1.4.4).

For a more detailed description of these inherited attributes, see the section 9.9.4 of the Generic Conceptual Model [DS-D2.5].

The attributes *domainExtent* and *interpolationType* stemming from ISO 19123 complete the description of the coverage characteristics. They represent respectively the spatiotemporal extent of the coverage and the interpolation method recommended by the data provider for evaluating the coverage. The *domainExtent* attribute of every *OrthoimageCoverage* instance shall be at least populated with a subtype of the EX_GeographicExtent type, i.e. EX_BoundingPolygon, EX_GeographicBoundingBox or EX_GeographicDescription classes specified in ISO 19115.

Other attributes provide additional information about identification (*inspireId, name*), temporal aspects (*phenomenonTime, beginLifespanVersion,endLifespanVersion)* and refined extent *(footprint*). The property *footprint* of type GM_MultiSurface precisely delineates the geographic areas where the coverage range is of interest (e.g. no nil values).

Figure 9 – footprint and bounding box of an orthoimage (respectively in blue and red)

IR Requirement
Annex III, Section 3.5.2
Requirements for Orthoimage Coverages

(…)

(2) The footprint of an OrthoimageCoverage instance shall be spatially included in its geographic extent that is described through the domainExtent property.

NOTE The inclusion is not necessarily strict, i.e. the footprint may be equal to the geographic extent.

5.3.1.4.2. Attribute *OrthoimageCoverage::domainSet*

The property *domainSet* determines the spatial structure on which the coverage function applies, that is, for orthoimage coverages, a set of grid points, including their convex hull.

By inheritance from *RectifiedGridCoverage*, the value type is restricted to *CV_RectifiedGrid*. This ISO 19123 element allows defining the characteristics of the internal grid structure: the grid dimension, which is obviously constrained to two for orthoimagery (*CV_RectifiedGrid::dimension*), the extent which reports the extreme grid coordinates of the image (*CV_RectifiedGrid::extent*) and the names of the grid axes (*CV_RectifiedGrid::axisNames*).

In addition, *CV_RectifiedGrid* carries the georeference of the orthoimage that consists of the location of the origin of the rectified grid (*CV_RectifiedGrid::origin*), the orientation and direction of the grid axes as well as the spacing between grid lines (*CV_RectifiedGrid::offsetVectors*), all expressed in an external coordinate reference system.

The identification of the coordinate reference system is ensured through the attribute *origin* whose value type, Direct Position (specified in ISO 19107), offers an association to the class SC_CRS from ISO 19111. This association is mandatory in this specification.

By allowing different settings, ISO 19123 leaves it up to implementers to define their own grid coordinates systems. But, although providing plenty of flexibility, this possibility may lead to misinterpretations and consequently to non-interoperability. To prevent this, this data specification promotes the use of a common grid coordinate system for describing the domain of orthoimage coverages within INSPIRE.

Recommendation 6 The grid origin, which is located at grid coordinates (0, 0), should be the upper left point of the orthoimage coverage.

Recommendation 7 The grid axes should be called “x” and “y”, considering that x axis extends to the right and y axis extends downwards.

NOTE These recommendations are based on the most widespread convention in orthoimagery.

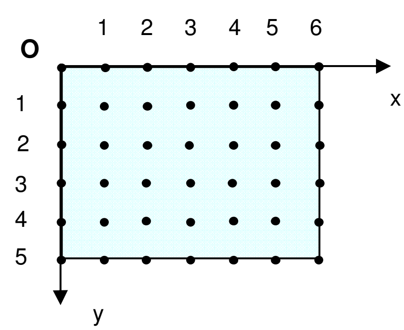


Figure 10 – recommended grid coordinate system

5.3.1.4.3. Attribute *OrthoimageCoverage::rangeType*

The property *rangeType* is devoted to the description of the range value structure of the coverage. It can be considered as technical metadata making easier the interpretation of the orthoimage content. RangeType is described in the Generic Conceptual Model with the basic type RecordType specified in ISO 19103. But it is encoded with the element DataRecord defined in the SWE Common [OGC 08-094r1], provided that the value attribute of the fields listed by the DataRecord is not used. Indeed, DataRecord must behave in this context like a descriptor without containing the actual data values themselves.

DataRecord is defined in [OGC 08-094r1] as “a composite data type composed of one to many fields, each of which having its own name and type definition”.

In orthoimagery, DataRecord should correspond to the collection of bands or “channels” of the image. Each field specifying a given band should hold an instance of the data type Count, since the property measured by sensors is represented as digital numbers (DN) without explicit units of measure.

This rangeType representation allows a clear description of many usual orthoimage characteristics such as the number of bands (instance multiplicity of the attribute DataRecord::field), the bands identification (attribute Count::definition), the bands description (attribute Count::description), the number of bits per sample (attribute Count::constraint) or the list of no data values that are present in the coverage (Count::nilValues). NIL value elements identify the reserved values that are used to stand in for missing actual values, and indicate, for each one, the corresponding reason precisely (e.g. detection limit, security, etc.).

The data type Quantity can also be used instead of Count to describe integer values. But in this case, the unit of measure (Quantity::uom attribute) shall be specified. If the unit is not an integer multiple of a typical unit, a GML description that expresses for example a linear relationship with a basic unit (e.g. genus 1.536895 Wm 2.Sr-1 + 23) must be provided by reference through an URI.

EXAMPLE 1 The following XML extract shows how the rangeType of a 8-bits per band RGB image with a nil value of 255 can be encoded:

```
<gmlcov:rangeType>
 <swe:DataRecord>
  <swe:field  name="red">
    <swe:Count definition="http://inspire.jrc.ec.europa.eu/definition/Radiance">
      <swe:description>Radiance measured on red Channel</swe:description>
      <swe:nilValues>
        <swe:NilValues gml:id="NIL_VALUES">
          <swe:nilValue reason="="http://inspire.jrc.ec.europa.eu/definition/nilValue">
            255
          </swe:nilValue>
        </swe:NilValues>
      </swe:nilValues>
      <swe:constraint>
        <swe:AllowedValues gml:id="VALUE_SPACE">
          <swe:interval>0 255</swe:interval>
        </swe:AllowedValues>
      </swe:constraint>
    </swe:Count>
  </swe:field>
  <swe:field name="green">
     <swe:Count definition=" http://inspire.jrc.ec.europa.eu/definition/Radiance ">
       <swe:description> Radiance measured on green Channel</swel:description>
       <swe:nilValues xlink:href="#NIL_VALUES"/>
       <swe:constraint xlink:href="#VALUE_SPACE"/>
     </swe:Count>
  </swe:field>
  <swe:field name="blue">
    <swe:Count definition=" http://inspire.jrc.ec.europa.eu/definition/Radiance ">
      <swe:description> Radiance measured on blue Channel</swe:description>
      <swe:nilValues xlink:href="#NIL_VALUES"/>
      <swe:constraint xlink:href="#VALUE_SPACE"/>
    </swe:Count>
  </swe:field>
```

```
  </swe:DataRecord>
</gmlcov:rangeType>
```

EXAMPLE 2 This additional example illustrates how to describe the values of a 16-bits monochromatic image with the provision of a link to the associated physical measure:

```
<gmlcov:rangeType>
  <swe:DataRecord>
    <swe:field  name="near-infrared">
        <swe:Quantity   definition="http://inspire.jrc.ec.europa.eu/definition/Radiance">
           <gml:description>Radiance measured on red Channel</gml:description>
           <swe:uom code=" http://inspire.jrc.ec.europa.eu/uom/NIR"/>
           <swe:constraint>
              <swe:AllowedValues>
                 <swe:interval>0 65535</swe:interval>
                 <swe:significantFigures>5</swe:significantFigures>
              </swe:AllowedValues>
           </swe:constraint>
        </swe:Quantity>
    </swe:field>
  </swe:DataRecord>
</gmlcov:rangeType>
```

5.3.1.4.4. Attribute *OrthoimageCoverage::metadata*

The property metadata can be used to provide additional information on an orthoimage coverage at spatial object level. The value type has been set to *any* as default, to allow data providers to choose freely which metadata model to use. For proper use, however, the value type must be restricted, in extensions or application profiles, to any kind of data type defining an application-specific metadata structure.

As specified in *Guidelines for the use of Observations & Measurements and Sensor Web Enablement-related standards in INSPIRE Annex II and III data specification development* [DS-D2.9] there are three classes that are suitable to provide metadata information within a coverage:

- MI_Metadata: acquisition source
- OM_Observation
- ObservingCapability

In this regard, it is worth to apply the OM_Observation class defined in ISO 19156 on which is based the metadata model used in another European Interoperability infrastructure, the GMES Space Component Data Access (GSCDA). In particular the model used is the Earth Observation application profile developed by OGC for satellite data defined in [OGC 10-157r3].
This application profile is specifically intended to provide detailed information on data acquisition (payload, sensor, acquisition time, illumination, elevation, or incidence), quality measurements (degradation, histograms, snow, cloud and quality mask) and processing procedure (product type, processors and algorithm used).

Should a data provider be willing to provide metadata information at spatial object level using the Observations and Measurements model, he has to follow the requirement below.

IR Requirement
Annex III, Section 3.5.2
Requirements for Orthoimage Coverages

(…)

(3) The value type of the metadata property carried by the spatial object type OrthoimageCoverage shall be set to OM_Observation when using the Observation and Measurement metadata model defined in ISO 19156:2011.

Note OM_Observation is the root class for the Observations and Measurements model. Naturally this class can be substituted by any of the derived classes specified in the application profiles of Observations and Measurements, for instance the Earth Observation Metadata profile of Observations and Measurements [OGC 10-157r3].

Other application profile of OM_Observation model can be developed for domain specific purpose (e.g airborne Orthoimagery) starting from the specialised observation types defined in [DS-D2.9]. In particular, being the orthoimageCoverage class a subclass of RectifiedGridCoverage, the GridObservation specialisation should be used as it represent an observation having as result either a RectifiedGridCoverage or a ReferenceableGridCoverage. It is important to note that the specialisations provided in [DS-D2.9] are intended for the representation of data and not metadata, so they have to be properly adapted for this purpose. In particular the *result* element of the GridObservation class should be omitted or modified in order to not impose the repletion of the coverage information already represented by the OrthoimageCoverage class in this data specification.

Under no circumstances the use of this property may exempt from reporting (mandatory) dataset-level metadata addressed in section 8.

5.3.1.4.5. OrthoimageCoverage aggregation

As stated in 5.3.1.3, an *OrthoimageCoverage* instance can be an aggregation of other *OrthoimageCoverage* instances. However certain conditions are required:

IR Requirement
Annex III, Section 3.5.2
Requirements for Orthoimage Coverages

(…)

(4) All the OrthoimageCoverage instances to which an aggregated OrthoimageCoverage instance refers, shall be consistent. This means that they shall share the same range type, Coordinate Reference System and resolution. They shall also support grid alignment, i.e. the grid points in one OrthoimageCoverage instance line up with grid points of the other OrthoimageCoverage instances, so that grid cells do not partially overlap.

The data structure is implemented by the recursive UML aggregation linking the *OrthoimageCoverage* class to itself. The *OrthoimageAggregation* association class indicates through the *contributingFootprint* attribute which geographic data areas of an input coverage are reused in the composed coverage.

IR Requirement
Annex III, Section 3.5.2
Requirements for Orthoimage Coverages

(…)

(5) The contributing footprint of an OrthoimageCoverage instance referred by an aggregated OrthoimageCoverage instance shall be spatially included in its own footprint.

NOTE In other words, contributing footprints shall contain valid data areas.

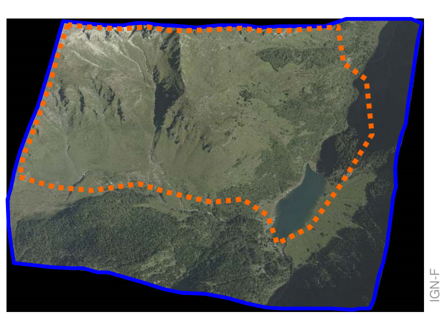


Figure 11 – footprint and contributing footprint of an orthoimage referred by an aggregated orthoimage (respectively in blue and orange)

> **IR Requirement**
> *Annex III, Section 3.5.2*
> **Requirements for Orthoimage Coverages**
>
> (…)
>
> (6) The contributing footprints of any two OrthoimageCoverage instances referred by the same aggregated OrthoimageCoverage instance shall be either adjacent or disjoint.

NOTE Two polygons are adjacent if they share one or more sides or portions of sides, without any interior point in common.

> **IR Requirement**
> *Annex III, Section 3.5.2*
> **Requirements for Orthoimage Coverages**
>
> (…)
>
> (7) The union of the contributing footprints of the OrthoimageCoverage instances referred to by the same aggregated OrthoimageCoverage instance shall determine the footprint of the aggregated OrthoimageCoverage instance.

The range set of an aggregated orthoimage coverage is directly determined by the range sets of the orthoimage coverages it refers to. Each grid point of the aggregated orthoimage coverage receives the range value of the orthoimage coverage the contributing footprint of which contains the given position. If the grid point is not located within the contributing footprint of any orthoimage coverage, it receives a nil value specified in the range type of the aggregated orthoimage coverage.

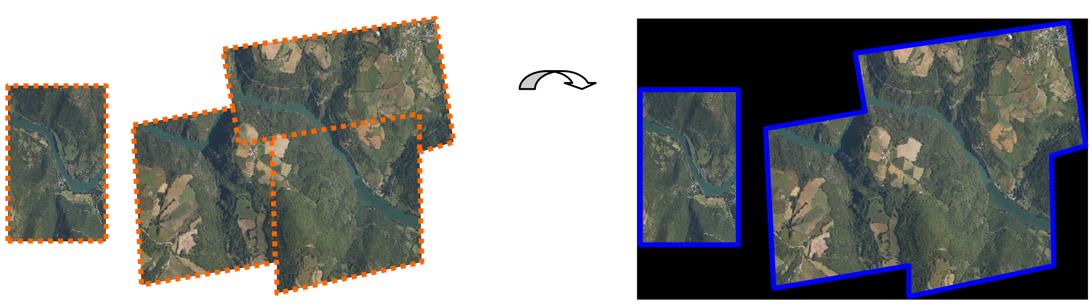


Figure 12 – construction of the aggregated orthoimage coverage (footprint in blue) from subsets of the contributing orthoimage coverages (contributing footprints in orange)

5.3.1.4.6. Feature types *MosaicElement, SingleMosaicElement* and *AggregatedMosaicElement*

The abstract feature type *MosaicElement* provides users with the acquisition time of a part of a mosaiced orthoimage. It consists of an association between a time period (attribute *phenomenonTime)* and a multi-surface (attribute *geometry*). As a spatial object type whose indirect instances may be referenced by other spatial objects, it also carries a unique object identifier (*inspireId* attribute).

Acquisition time is usually supplied for each individual original image that contributes to a mosaic, since there is a natural relationship between the two notions. But it can refers as well to sets of input images sharing the same temporal extent. For example, input images may be grouped by dates of capture if hours, minutes and seconds are not specified. In order to distinguish between these two cases, *MosaicElement* must be implemented through one of its subtypes, namely *SingleMosaicElement* and *AggregatedMosaicElement*, depending on the mode selected.

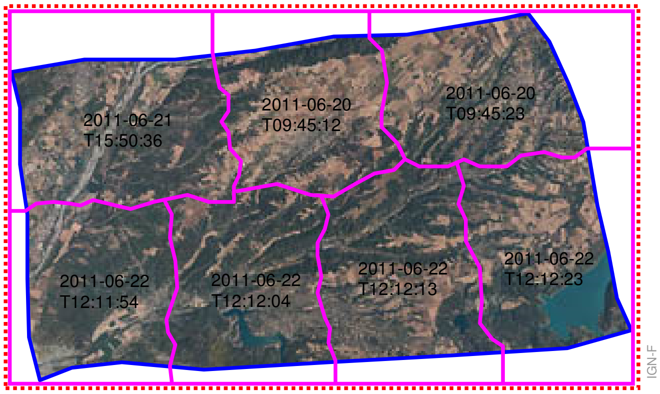
SingleMosaicElement links the acquisition date and time of a single input image to the contributing area, in the mosaic, of this same input image. Data providers may possibly give the reference of the image source through the attribute *imageSourceReference*. Whereas *AggregatedMosaicElement* links the common capture time of several input images to the unified contributing area, in the mosaic, of these input images. In both cases, the geometry of the spatial object is constructed from the seamlines used to assemble the original images.

To maintain the clarity of the concepts, it is important not to mix objects of type *SingleMosaicElement* and *AggregatedMosaicElement* to describe a same mosaic of orthoimages.

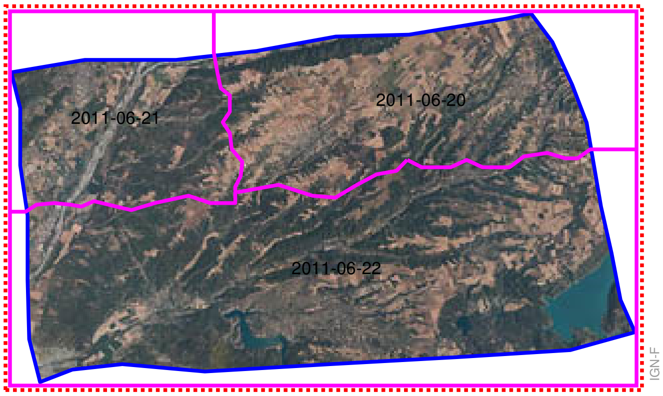
IR Requirement
Annex III, Section 3.5.3
Requirements for mosaic elements

(1) All the mosaic elements related to an OrthoimageCoverage instance shall be of the same type i.e. either *SingleMosaicElement* or *AggregatedMosaicElement*.

NOTE An *AggregatedMosaicElement* instance may refer to only one input image if at least one other *AggregatedMosaicElement* instance associated to the same mosaic affects several input images.



Use of SingleMosaic-Element objects



Use of AggregatedMosaicElement objects

Figure 13 – two different representations of the temporal aspects of a same orthoimage mosaic. The footprint and the spatial extent of the orthoimage coverage are respectively drawn in blue and dashed red.

IR Requirement
Annex III, Section 3.5.3
Requirements for mosaic elements

(…)

(2) The geometries delineating any two *MosaicElement* instances related to the same *OrthoimageCoverage* instance shall be either adjacent or disjoint.

IR Requirement
Annex III, Section 3.5.3
Requirements for mosaic elements

(…)

(3) The union of the geometries delineating all *MosaicElement* instances related to the same *OrthoimageCoverage* instance shall include its footprint and be contained in its geographic domain extent.

NOTE Mosaic elements form an exhaustive partition of the footprint of the related orthoimage coverage when their union is strictly equal to this footprint.

The use of the feature type *MosaicElement* and its subtypes only makes sense for mosaiced orthoimage coverages. In the case where the orthoimage coverage derives from a single image, the *OrthoimageCoverage::phenomenonTime* attribute should be sufficient to satisfy the user requirement.

Recommendation 8	The use of the feature type *MosaicElement* and its subtypes *SingleMosaicElement* and *AggregatedMosaicElement* should be restricted to the precise description of the temporal characteristics of mosaiced orthoimage coverages.

MosaicElement instances may refer as well to aggregated orthoimage coverages if they are composed of mosaiced orthoimage coverages. In this particular case, mosaic elements are the result of a combination between the contributing footprints and the mosaic elements of the contributing orthoimage coverages. Typically, such mosaic elements will be pre-calculated and linked to the aggregated orthoimage coverage.
Data providers are free to choose the appropriate level(s) where to provide mosaic elements.

5.3.1.5. Consistency between spatial data sets

<u>Consistency between data sets:</u>

While an actual need to combine orthoimagery datasets exists, in practice, achieving geometrical consistency is complicated for at least three reasons:
- Spatial resolutions (i.e. Ground Sample Distances) must be strictly identical.
- Grid points (i.e. pixels) must be aligned.
- Edge-matching between orthoimagery datasets along local or national boundaries is mostly impossible to realize: the rectangular extent of orthoimages usually covers a territory larger than the real, rarely regular, area of interest and the superfluous area is often filled with radiometric information.

The technical characteristics mentioned above are defined in the existing data products specifications which are not harmonised across Europe. That is why the present INSPIRE data specification does not set out specific requirements to ensure consistency between orthoimagery data sets.

However, it comes up with a solution for pan-European and cross-border use cases by establishing a common European grid for raster data (see Annex C). Note that the issue of edge-matching along boundaries is not addressed given its complexity due to the wide variety of use cases.

<u>Consistency with other themes at the same level of detail:</u>

Orthoimagery data implicitly contain rich semantic information making it reference data for most of other INSPIRE themes. Besides, orthoimages are very often used as background for extracting or displaying spatial objects from other themes (e.g. hydrography, cadastral parcels, land cover, geology etc.).

This requires a certain level of geometrical consistency so that thematic spatial objects and expected semantic content of the orthoimage may match within the limits of the sum of their respective accuracy. In particular, one must keep in mind that the characteristics of the Digital Elevation Model used for the rectification process (e.g. surface type or resolution) directly determine the consistency or inconsistency between this theme and the others. For example, above-ground objects like buildings may appear geometrically shifted from the orthoimage if a Digital Terrain Model, that only represents the topographic surface of the land floor, was used. However, as the thematic content of orthoimages is implicit and not interpreted, it is not possible to identify relevant consistency rules.

5.3.1.6. Identifier management

Each OrthoimageCoverage object shall receive a unique external identifier as specified in the Generic Conceptual Model [DS-D2.5]. This identifier is carried by the inspireId attribute.

The version identifier property of the INSPIRE base type *Identifier* allows to distinguish between the different versions of the orthoimages. In this data specification, the concept of 'version' is restricted to the reprocessing of orthoimages using the same input images in order to correct the former data (see 5.3.1.9).

Note that national agencies often use the term ‘version’ in a different meaning than above:
- As a code to describe what production process has been used to create the orthoimage (e.g. a reference to the product specification).
- As an edition/revision code to describe how many times an orthoimagery product has been made on a specific area with different sets of images acquired at different dates.
These codes are not a part of life-cycle information as understood by INSPIRE. But they may be introduced in the local identifier included in the INSPIRE identifier or in the discovery metadata as lineage elements.

IR Requirement
Annex III, Section 3.5.1
Requirements on external object identifiers

(1) If an orthoimage is updated based on new source data, the updated objects shall receive a new external object identifier.

5.3.1.7. Modelling of object references

Object referencing, as described in the Generic conceptual Model [DS-D2.5] clause 13, is not applied in the *Orthoimagery* Application Schema.

However, the device of orthoimages aggregation takes a similar approach within a single dataset in the sense that it prevents data duplication by sharing common feature attributes: aggregated orthoimages reference their contributing orthoimages using the unique INSPIRE identifier provided.

5.3.1.8. Geometry representation

Given the nature of orthoimagery data, only two-dimensional geometries can be supported by orthoimagery spatial objects.

IR Requirement
Annex III, Section 3.5.4
Requirements on reference systems

(1) Data theme *Orthoimagery* shall be restricted to two-dimensional geometries.

5.3.1.9. Temporality representation

A change of version should occur only when the orthoimage is reprocessed using the same input images from the same dates, for example to correct geometrical or radiometrical defects, to take into account an improved or modified Digital Elevation Model or when an enhanced processing algorithm is available.

This data specification does not attach the notion of version to the real world objects or the geographic areas depicted in orthoimages. For example, the same region can appear on different orthoimage coverages that do not constitute, however, the successive versions of a same coverage. Even though an orthoimage contains an infinity of features that can potentially be extracted, it is simpler to consider it as a single feature that is the result of the observation of real world phenomena by a sensor, at a specific time. Thus, a new acquisition campaign over a given area is rather a new observation than an update (i.e. a new version) and it is difficult to see an orthoimage resulting from this new capture as being the same spatial object as the previous orthoimage on the same area, especially if extents or footprints do not match. Therefore, an orthoimage that has been derived from new input image data will be a new spatial object, with a new external object identifier.

In addition, the application schema includes the time of data capture. Such information is very useful to the users as it provides the temporal characteristics of the depicted scene, which is a fundamental component for understanding the content of orthoimages. Moreover, in the context of data maintenance, this temporal element provides a simple distinction between the different revisions of an orthoimage coverage over a same area.

For these reasons, information about the acquisition time of the data contained in orthoimages is required through a constraint, at least in one of the following ways:

- By filling in the attribute *phenomenonTime* of the feature type *OrthoimageCoverage*.
- By filling in the attributes *phenomenonTime* of the feature type *MosaicElement*.

Recommendation 9	Whenever used, the attributes phenomenonTime carried by the feature types *OrthoimageCoverage* and *MosaicElement* should at least be filled with the year(s), the month(s) and the date(s) of the data acquisition.

5.3.2 Feature catalogue

Feature catalogue metadata

Application Schema	INSPIRE Application Schema Orthoimagery
Version number	3.0

Types defined in the feature catalogue

Type	Package	Stereotypes
AggregatedMosaicElement	Orthoimagery	«featureType»
InterpolationMethodValue	Orthoimagery	«codeList»
MosaicElement	Orthoimagery	«featureType»
OrthoimageAggregation	Orthoimagery	«dataType»
OrthoimageCoverage	Orthoimagery	«featureType»
SingleMosaicElement	Orthoimagery	«featureType»

5.3.2.1. Spatial object types

5.3.2.1.1. AggregatedMosaicElement

AggregatedMosaicElement	
Name:	aggregated mosaic element
Subtype of:	MosaicElement
Definition:	Mosaic element relating to several input images that share the same acquisition time at a given level of definition (e.g. day, month).
Description:	NOTE The geometry of an aggregated mosaic element corresponds to the union of the contributing areas, in the mosaic, of several input images.
Stereotypes:	«featureType»

5.3.2.1.2. MosaicElement

MosaicElement (abstract)	
Name:	mosaic element
Definition:	Abstract type identifying both the contributing area and the acquisition time of one or several input images used to generate a mosaicked orthoimage coverage.
Description:	NOTE The main purpose of this feature type is the provision of a mechanism for describing the spatial distribution of the acquisition dates and times over a mosaicked orthoimage. The acquisition time can be supplied either for each individual input image, or for sets of input images grouped together according to temporal criteria.
Stereotypes:	«featureType»
Attribute: inspireId	
Name:	inspire identifier

MosaicElement (abstract)

Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE 1 An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon. NOTE 2 This property should be used to reference indirect MosaicElement instances from Orthoimage instances unambiguously.
Multiplicity:	0..1

Attribute: geometry

Name:	geometry
Value type:	GM_MultiSurface
Definition:	Geometric representation spatially delineating the date and time of acquisition of the several input images that contribute to the final mosaic.
Description:	NOTE The boundaries of the geometries are commonly based on the seamlines used for the mosaicking process.
Multiplicity:	1

Attribute: phenomenonTime

Name:	phenomenon time
Value type:	TM_Period
Definition:	Description of the observation/acquisition extent in time of the input image(s).
Description:	NOTE 1 This temporal extent refers to the interval of time in wich the input image(s) was/were acquired by the sensor. NOTE 2 When the acquisition is considered as instantaneous, despite the exposure time, the end date and time can be identical to the begin date and time. EXAMPLE 1 begin: 2011-10-30 end: 2011-10-30 EXAMPLE 2 begin: 2011-06-07T14:31:02Z end: 2011-06-07T16:10:54Z.
Multiplicity:	1

5.3.2.1.3. OrthoimageCoverage

OrthoimageCoverage

Name:	orthoimage coverage
Subtype of:	RectifiedGridCoverage
Definition:	Raster image of the Earth surface that has been geometrically corrected ("orthorectified") to remove distortion caused by differences in elevation, sensor tilt and, optionally, by sensor optics.
Description:	NOTE 1 An orthoimage coverage is a continuous coverage based on a rectified quadrilateral grid. It is provided with an interpolation method to evaluate value records at any direct position within its domain. NOTE 2 An orthoimage coverage can be derived from one single input image or from different input images which have been mosaicked and merged together. NOTE 3 An orthoimage coverage may be an aggregation of subsets extracted from other orthoimage coverages. For the avoidance of data duplication, this kind of aggregated orthoimage is dynamically constructed thanks to references to the contributing orthoimage coverages .
Stereotypes:	«featureType»

Attribute: inspireId

Name:	inspire identifier

OrthoimageCoverage	
Value type:	Identifier
Definition:	External object identifier of the spatial object.
Description:	NOTE An external object identifier is a unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object. The identifier is an identifier of the spatial object, not an identifier of the real-world phenomenon.
Multiplicity:	1
Attribute: domainExtent	
Name:	domain extent
Value type:	EX_Extent
Definition:	Extent of the spatiotemporal domain of the coverage.
Description:	SOURCE [ISO 19123] NOTE 1 The data type EX_Extent is defined in ISO 19103. Extents may be specified in both space and time. NOTE 2 The domain extent shall be specified in space at least by using a subtype of EX_GeographicExtent (EX_BoundingPolygon, EX_GeographicBoundingBox or EX_GeographicDescription). The whole geographic extent of the orthoimage coverage is affected, including areas where grid points hold nil reason values.
Multiplicity:	1..*
Attribute: footprint	
Name:	footprint
Value type:	GM_MultiSurface
Definition:	Geographic area enclosing valid data of the orthoimage coverage.
Description:	NOTE 1 The footprint shall be enclosed in the geographic domain extent that it refines. NOTE 2 This property is mandatory if the OrthoimageCoverage instance is an aggregation of other OrthoimageCoverage instances or if mosaic elements are provided.
Multiplicity:	1
Stereotypes:	«voidable»
Attribute: interpolationType	
Name:	interpolation type
Value type:	InterpolationMethodValue
Definition:	Mathematical method which shall be used to evaluate a continuous coverage, i.e. determine the values of the coverage at any direct position within the domain of the coverage.
Description:	NOTE 1 Nearestneighbor is set as a default value in case where this information is omitted by data producers. NOTE 2 A continuous grid coverage that uses nearest neighbour interpolation acts as a discrete surface coverage.
Multiplicity:	1
Attribute: name	
Name:	name
Value type:	CharacterString
Definition:	Free text name of the orthoimage coverage.
Description:	NOTE This field is intended to hold a name that a data provider may use in addition to the inspire identifier EXAMPLE 1 "Orthofoto's, middenschalig, kleur, provincie Limburg, opname 2011" is

OrthoimageCoverage	
	the name used by the Flemish Geographic Information Agency (AGIV) to indicate the OrthoImageCoverage Instance holding the orthophotomosaic covering the administrative unit 'provincie Limburg' at a resolution of 25 cm 'middenschalig' acquired in the year 2011 'opname 2011' EXAMPLE 2 "BDOrtho coverage on Savoie at 50 cm - 2011" could be the name of an OrthoimageCoverage instance corresponding to a subset of the BDOrtho product of IGN France, the orthophoto of the "department" Savoie (an administrative unit) at a resolution of 50 cm.
Multiplicity:	0..1
Stereotypes:	«voidable»
Attribute: phenomenonTime	
Name:	phenomenon time
Value type:	TM_Period
Definition:	Description of the observation/acquisition extent in time.
Description:	NOTE 1 This temporal extent refers to the range in time in which the image(s) contributing to the orthoImage coverage has/have been acquired. NOTE 2 When the acquisition is considered as instantaneous, despite the exposure time, the end date and time can be identical to the begin date and time. EXAMPLE 1 begin: 2011-10-30 end: 2011-10-30 EXAMPLE 2 begin: 2011-06-07T14:31:02Z end: 2011-06-07T16:10:54Z.
Multiplicity:	0..1
Stereotypes:	«voidable»
Attribute: beginLifespanVersion	
Name:	begin lifespan version
Value type:	TM_Position
Definition:	Temporal position at which this version of the spatial object was inserted or changed in the spatial data set.
Description:	NOTE Since this information is not always automatically recorded by a system, but can be captured manually, the provision of the time is not required here. That is the reason why TM_Position was chosen as value type instead of DateTime, which is, however, commonly used in other INSPIRE data specifications.
Multiplicity:	1
Stereotypes:	«voidable,lifeCycleInfo»
Attribute: endLifespanVersion	
Name:	end lifespan version
Value type:	TM_Position
Definition:	Temporal position at which this version of the spatial object was superseded or retired from the spatial data set.
Description:	NOTE Since this information is not always automatically recorded by a system, but can be captured manually, the provision of the time is not required here. That is the reason why TM_Position was chosen as value type instead of DateTime, which is, however, commonly used in other INSPIRE data specifications.
Multiplicity:	0..1
Stereotypes:	«voidable,lifeCycleInfo»
Association role: contributingOrthoimageCoverage [the association has additional attributes - see association class OrthoimageAggregation]	
Value type:	OrthoimageCoverage
Definition:	Reference to the orthoimage coverages that compose an aggregated orthoimage coverage.

OrthoimageCoverage	
Multiplicity:	0..*

Association role: mosaicElement

Value type:	MosaicElement
Definition:	Spatial representation of the acquisition time of a mosaicked orthoimage coverage.
Description:	NOTE This association shall be used only when the orthoimage coverage is a mosaic.
Multiplicity:	0..*
Stereotypes:	«voidable»

Constraint: acquisitionTimeRequired

Natural language:	The acquisition time of the orthoimage coverage shall be provided through the phenomenonTime attribute or the mosaicElement association
OCL:	inv: phenomenonTime->notEmpty() or mosaicElement->notEmpty()

Constraint: domainDimensionIs2

Natural language:	The dimension of the grid used shall always be 2
OCL:	inv: domainSet.dimension=2

Constraint: domainExtentContainsGeographicElement

Natural language:	The domainExtent attribute shall be at least populated with a subtype of EX_GeographicExtent
OCL:	inv: domainExtent.geographicElement->size()>=1

Constraint: domainRequiresCRS

Natural language:	The coordinate reference system used to reference the grid shall be provided
OCL:	inv: domainSet.origin.coordinateReferenceSystem->notEmpty()

Constraint: identicalOffsetVectorsWithinOrthoimageAggregation

Natural language:	All the OrthoimageCoverage instances to which an aggregated OrthoimageCoverage instance refers shall share the same orientation of grid axes and the same grid spacing in each direction
OCL:	Inv: contributingOrthoimageCoverage->forAll(v | v.domainSet.offsetVectors = self.domainSet.offsetVectors)

Constraint: originDimensionIs2

Natural language:	The origin of the grid shall be described in two dimensions
OCL:	inv: domainSet.origin.dimension=2

Constraint: rangeSetValuesAreOfTypeInteger

Natural language:	The values in the range set shall be described by the Integer type
OCL:	inv: rangeSet->forAll(v | v.oclIsKindOf(Integer))

5.3.2.1.4. SingleMosaicElement

SingleMosaicElement	
Name:	single mosaic element
Subtype of:	MosaicElement
Definition:	Mosaic element relating to a single input image.
Description:	NOTE The geometry of a single mosaic element corresponds exactly to the contributing area, in the mosaic, of the single input image.
Stereotypes:	«featureType»

Attribute: imageSourceReference

SingleMosaicElement	
Name:	image source reference
Value type:	CharacterString
Definition:	Reference to the input image.
Description:	NOTE 1 There is no restriction on the nature of the input image. It can be raw or pre-processed or orthorectified, for instance. NOTE 2 modelling and delivery of input images lie outside the scope of the present specification. NOTE 3 Identifiers of the input images should be URIs in the "http" scheme (See D2.7) though full national or local codes are allowed. EXAMPLE: http://land.data.gov.uk/id/imagery/2011-5864726.
Multiplicity:	0..1
Stereotypes:	«voidable»

5.3.2.2. Data types

5.3.2.2.1. OrthoimageAggregation

OrthoimageAggregation (association class)	
Name:	orthoimage aggregation
Definition:	Geometrical characteristics of the orthoimage aggregation.
Stereotypes:	«dataType»
Attribute: contributingFootprint	
Name:	contributing footprint
Value type:	GM_MultiSurface
Definition:	Geometric representation delineating the geographic area of an orthoimage coverage that contributes to the aggregated orthoimage coverage.
Multiplicity:	1

5.3.2.2.2. OrthoimageAggregation

OrthoimageAggregation (association class)	
Name:	orthoimage aggregation
Definition:	Geometrical characteristics of the orthoimage aggregation.
Stereotypes:	«dataType»
Attribute: contributingFootprint	
Name:	contributing footprint
Value type:	GM_MultiSurface
Definition:	Geometric representation delineating the geographic area of an orthoimage coverage that contributes to the aggregated orthoimage coverage.
Multiplicity:	1

5.3.2.3. Code lists

5.3.2.3.1. InterpolationMethodValue

InterpolationMethodValue	
Name:	interpolation method value
Definition:	List of codes that identify the interpolation methods which may be used for evaluating orthoimage coverages.
Description:	NOTE 1 This INSPIRE-governed code list is derived from the code list CV_InterpolationMethod specified in ISO 19123. CV_InterpolationMethod is not used as such because not actually implemented. NOTE 2 Example values: nearestneighbor, bilinear, biquadratic, bicubic, etc...
Extensibility:	none

InterpolationMethodValue	
Identifier:	http://inspire.ec.europa.eu/codelist/InterpolationMethodValue
Values:	The allowed values for this code list comprise only the values specified in *Annex C* .

5.3.2.4. Imported types (informative)

This section lists definitions for feature types, data types and enumerations and code lists that are defined in other application schemas. The section is purely informative and should help the reader understand the feature catalogue presented in the previous sections. For the normative documentation of these types, see the given references.

5.3.2.4.1. CharacterString

CharacterString	
Package:	Text
Reference:	Geographic information -- Conceptual schema language [ISO/TS 19103:2005]

5.3.2.4.2. EX_Extent

EX_Extent	
Package:	Extent information
Reference:	Geographic information -- Metadata [ISO 19115:2003/Cor 1:2006]

5.3.2.4.3. GM_MultiSurface

GM_MultiSurface	
Package:	Geometric aggregates
Reference:	Geographic information -- Spatial schema [ISO 19107:2003]

5.3.2.4.4. Identifier

Identifier	
Package:	Base Types
Reference:	INSPIRE Generic Conceptual Model, version 3.4 [DS-D2.5]
Definition:	External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.
Description:	NOTE1 External object identifiers are distinct from thematic object identifiers. NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object. NOTE 3 The unique identifier will not change during the life-time of a spatial object.

5.3.2.4.5. RectifiedGridCoverage

RectifiedGridCoverage	
Package:	Coverages (Domain and Range)
Reference:	INSPIRE Data Specifications – Base Models – Coverage Types, version 1.0 [DS-D2.10.2]
Definition:	Coverage whose domain consists of a rectified grid
Description:	A rectified grid is a grid for which there is an affine transformation between the grid coordinates and the coordinates of a coordinate reference system. NOTE This type can be used for both discrete and continuous coverages.

5.3.2.4.6. TM_Period

TM_Period	
Package:	Temporal Objects
Reference:	Geographic information -- Temporal schema [ISO 19108:2002/Cor 1:2006]

5.3.2.4.7. TM_Position

TM_Position	
Package:	Temporal Reference System

TM_Position	
Reference:	Geographic information -- Temporal schema [ISO 19108:2002/Cor 1:2006]

INSPIRE governed code lists are given in Annex C.

5.3.3 Externally governed code lists

The externally governed code lists included in this application schema are specified in the tables in this section.