9 Delivery

9.1 Updates

IR Requirement
Article 8
Updates

1. Member States shall make available updates of data on a regular basis.
2. All updates shall be made available at the latest 6 months after the change was applied in the source data set, unless a different period is specified for a specific spatial data theme in Annex II.

NOTE In this data specification, no exception is specified, so all updates shall be made available at the latest 6 months after the change was applied in the source data set.

9.2 Delivery medium

According to Article 11(1) of the INSPIRE Directive, Member States shall establish and operate a network of services for INSPIRE spatial data sets and services. The relevant network service types for making spatial data available are:

- *view services* making it possible, as a minimum, to display, navigate, zoom in/out, pan, or overlay viewable spatial data sets and to display legend information and any relevant content of metadata;
- *download services*, enabling copies of spatial data sets, or parts of such sets, to be downloaded and, where practicable, accessed directly;
- *transformation services*, enabling spatial data sets to be transformed with a view to achieving interoperability.

NOTE For the relevant requirements and recommendations for network services, see the relevant Implementing Rules and Technical Guidelines[15].

EXAMPLE 1 Through the Get Spatial Objects function, a download service can either download a pre-defined data set or pre-defined part of a data set (non-direct access download service), or give direct access to the spatial objects contained in the data set, and download selections of spatial objects based upon a query (direct access download service). To execute such a request, some of the following information might be required:

- the list of spatial object types and/or predefined data sets that are offered by the download service (to be provided through the Get Download Service Metadata operation),
- and the query capabilities section advertising the types of predicates that may be used to form a query expression (to be provided through the Get Download Service Metadata operation, where applicable),
- a description of spatial object types offered by a download service instance (to be provided through the Describe Spatial Object Types operation).

EXAMPLE 2 Through the Transform function, a transformation service carries out data content transformations from native data forms to the INSPIRE-compliant form and vice versa. If this operation is directly called by an application to transform source data (e.g. obtained through a download service) that is not yet conformant with this data specification, the following parameters are required:
Input data (mandatory). The data set to be transformed.

- Source model (mandatory, if cannot be determined from the input data). The model in which the input data is provided.

[15] The Implementing Rules and Technical Guidelines on INSPIRE Network Services are available at http://inspire.jrc.ec.europa.eu/index.cfm/pageid/5

– Target model (mandatory). The model in which the results are expected.
– Model mapping (mandatory, unless a default exists). Detailed description of how the transformation is to be carried out.

9.3 Encodings

The IRs contain the following two requirements for the encoding to be used to make data available.

IR Requirement
Article 7
Encoding

1. Every encoding rule used to encode spatial data shall conform to EN ISO 19118. In particular, it shall specify schema conversion rules for all spatial object types and all attributes and association roles and the output data structure used.
2. Every encoding rule used to encode spatial data shall be made available.

NOTE ISO 19118:2011 specifies the requirements for defining encoding rules used for interchange of geographic data within the set of International Standards known as the "ISO 19100 series". An encoding rule allows geographic information defined by application schemas and standardized schemas to be coded into a system-independent data structure suitable for transport and storage. The encoding rule specifies the types of data being coded and the syntax, structure and coding schemes used in the resulting data structure. Specifically, ISO 19118:2011 includes
- requirements for creating encoding rules based on UML schemas,
- requirements for creating encoding services, and
- requirements for XML-based encoding rules for neutral interchange of data.

While the IRs do not oblige the usage of a specific encoding, this Technical Guidance proposes to make data related to the spatial data theme *Orthoimagery* available at least in the default encoding(s) specified in section 9.3.1. In this section, a number of TG requirements are listed that need to be met in order to be conformant with the default encoding(s).

The proposed default encoding(s) meet the requirements in Article 7 of the IRs, i.e. they are conformant with ISO 19118 and (since they are included in this specification) publicly available.

9.3.1 Default Encodings

9.3.1.1. Default encodings for application schema Orthoimagery

Name: Orthoimagery GML Application Schema
Version: version 3.0
Specification: D2.8.II.3 Data Specification on *Orthoimagery* – Technical Guidelines
Character set: UTF-8

The xml schema document is available on the INSPIRE website http://inspire.ec.europa.eu.

Name: GML Application Schema for Coverages (for the coverage domain)
Version: version 1.0.0
Specification: OGC GML Application Schema – Coverages [OGC 09-146r2]
Character set: UTF-8

The xml schema documents are available from *http://schemas.opengis.net/gmlcov/1.0/*.

Two formats are described below for the range set. At least one of the following shall be provided (not necessarily both).

Name: TIFF (for the coverage range)
Version: 6.0
Specification: TIFF Baseline
Character set: UTF-8

NOTE The Geographic Tagged Image File Format (GeoTiff), associates geo-referencing information with TIFF imagery and gridded data by supplying metadata as TIFF tags. Since it fully complies with the TIFF 6.0 specifications, it may be implemented in place of TIFF format to meet this requirement.

Name: jpeg2000 (for the coverage range)
Version: -
Specification: ISO 15444-1
Character set: UTF-8

TG Requirement 6	If the format used for encoding the coverage range also includes information about the coverage domain, this information shall be consistent with the information encoded using the GML Application Schema for Coverages.

Name: GML Application Schema for Coverages (for the coverage domain and range)
Version: version 1.0.0
Specification: OGC GML Application Schema – Coverages [OGC 09-146r2]
Character set: UTF-8

The xml schema documents are available from *http://schemas.opengis.net/gmlcov/1.0/*.

NOTE The GML Application Schema – Coverages is to be used to encode both the domain and the range of the coverage.

EXAMPLE The following is a complete RectifiedGridCoverage instance (taken from [OGC 09-146r2]), using the base type RectifiedGridCoverage defined in the OGC GML Application Schema – Coverages available from *http://schemas.opengis.net/gmlcov/1.0/*.

```
<?xml version="1.0" encoding="UTF-8" ?>
<gmlcov:RectifiedGridCoverage
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
   xmlns:xlink="http://www.w3.org/1999/xlink"
   xmlns:gmlcov="http://www.opengis.net/gmlcov/1.0"
   xmlns:gml="http://www.opengis.net/gml/3.2"
   xsi:schemaLocation=
      "http://www.opengis.net/gmlcov/1.0 http://schemas.opengis.net/gmlcov/1.0/gmlcovAll.xsd"
   gml:id="C001">
   <gml:boundedBy>
      <gml:Envelope srsName="http://www.opengis.net/def/crs/EPSG/0/4326" axisLabels="Lat Long"
         uomLabels="deg deg" srsDimension="2">
         <gml:lowerCorner>1 1</gml:lowerCorner>
         <gml:upperCorner>3 3</gml:upperCorner>
      </gml:Envelope>
   </gml:boundedBy>
   <gml:domainSet>
      <gml:RectifiedGrid gml:id="RG001_C001"
         srsName="http://www.opengis.net/def/crs/EPSG/0/4326" axisLabels="Lat Long"
        uomLabels="deg deg" dimension="2">
         <gml:limits>
            <gml:GridEnvelope>
               <gml:low>0 0</gml:low>
               <gml:high>9999 9999</gml:high>
            </gml:GridEnvelope>
         </gml:limits>
```

```
        <gml:axisLabels>Lat Long</gml:axisLabels>
        <gml:origin>
          <gml:Point gml:id="P001_C001" srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
            <gml:pos>99. 99.9</gml:pos>
          </gml:Point>
        </gml:origin>
        <gml:offsetVector>1 0</gml:offsetVector>
        <gml:offsetVector>0 1</gml:offsetVector>
      </gml:RectifiedGrid>
    </gml:domainSet>
    <rangeType>
      <swe:DataRecord>
        <swe:field name="white">
          <swe:Quantity definition="http://opengis.net/def/property/OGC/0/Radiance">
            <gml:description>Panchromatic</gml:description>
            <gml:name>White</gml:name>
            <swe:nilValues>
              <swe:nilValue reason="http://www.opengis.net/def/nil/OGC/0/BelowDetectionRange">
                0
              </swe:nilValue>
              <swe:nilValue reason="http://www.opengis.net/def/nil/OGC/0/AboveDetectionRange">
                255
              </swe:nilValue>
            </swe:nilValues>
            <swe:uom code="W/cm2"/>
            <swe:constraint>
              <swe:AllowedValues>
                <swe:interval>0 255</swe:interval>
                <swe:significantFigures>3</swe:significantFigures>
              </swe:AllowedValues>
            </swe:constraint>
          </swe:Quantity>
        </swe:field>
      </swe:DataRecord>
    </rangeType>
    <gml:coverageFunction>
      <gml:GridFunction>
        <gml:sequenceRule axisOrder="+1 +2">Linear</gml:sequenceRule>
        <gml:startPoint>0 0</gml:startPoint>
      </gml:GridFunction>
    </gml:coverageFunction>
    <gml:rangeSet>
      <DataBlock>
        <rangeParameters/>
        <tupleList>
          1  2  3  4  5
          6  7  8  9  10
          11 12 13 14 15
        </tupleList>
      </DataBlock>
    </gml:rangeSet>
</gmlcov:RectifiedGridCoverage>
```

9.3.1.1.1. Encoding rules used

Introducing encoding formats other than GML for representing coverage elements requires the definition of encoding rules to map the *Orthoimagery* application schema to the resulting specific data structure unambiguously.

Recommendation 32 The encoding of coverage components in the file formats specified above should conform to the rules specified in Annex E.

NOTE The GeoTiff format, as a specific extension of the Baseline TIFF Format, is also affected by this recommendation.

9.3.1.1.2. Specific mappings from UML classes to GML/XML Schema types and elements

In addition to the mappings between conceptual UML classes and the associated GML object element, XML Schema type and GML property type provided in Table D.2 of ISO 19136 (GML), the mappings included in have been used to generate the GML application schema.

Table 7. Mappings between conceptual UML classes and the associated GML object elements, XML Schema types and GML property types

UML class	GML object element	GML type	GML property type
RectifiedGridCoverage	gmlcov:RectifiedGridCoverage	gmlcov:AbstractDiscreteCoverageType	n/a

9.3.1.1.3. External tiling

External tiling is a common practice to facilitate data management when the physical size of the range set carried by a coverage is too large. It consists in spreading the range values across multiple tiles, each tile being stored in a separate file.

Such a mechanism is routinely implemented by network services, but as an invisible internal optimization. Users just see the concept of one object, i.e. the coverage, without being aware of how the range set is actually stored on servers to meet randomly imposed access constraints. To respond to a request, the range values are directly picked up in the corresponding data files. For the data provider, this has the advantage that such structures can be reorganized dynamically when access patterns or data properties change, without users knowing it.

This method is sufficient when users need to extract only subparts in a large coverage. However, it does not resolve the case where users try to download the whole coverage in a single step, as the volume of the result becomes too important to be properly managed. The range set of the delivered coverage has to be split again, but on the user side this time.

Since current encoding standards such as GML, TIFF or jpeg 2000 have no means to fully describe external tiling, this will be supported by dividing the requested coverage into “sub-coverages” whose range set can be embedded in a single file. For simplicity, all “sub-coverages” will be provided in the same data set. The tiling scheme will be determined manually by the user or automatically by applications or processing services. This data specification places no constraints on how to set up tiling schemes.
Although this approach is not entirely satisfactory from a conceptual standpoint, it allows exceeding the limits of technology that is still not mature enough on this aspect.

9.3.1.1.4. Range values geolocalisation

Display devices often render the range values of grid coverages as small usually square or rectangular surfaces, also called pixels, and many encoding formats, which are oriented towards portrayal, stick to this approach. But the representation as surfaces has the disadvantage of offering different ways to localize the range values. For instance, some conventions consider the coordinates of the pixel centre whereas others take the coordinates of the upper left corner into account. Such discrepancies might be the source of offsets leading to misalignments.

Data providers should particularly pay attention to this issue when using an encoding format in addition to GML to georeference a coverage (e.g. GeoTiff). They must make sure that the georeferencing information provided in the external encoding format is consistent with the one expressed in GML according to ISO 19123. Adding or subtracting ½ pixel to the coordinates of the tie points in the two dimensions is often sufficient to ensure consistency.

Consider the example of an orthoimage represented as a grid coverage. The origin O has the geographic coordinates (4°20'00'', 50°50'00''), while the row and column spacing are both 20''. GeoTiff defines two raster coordinates systems which differ in the choice of the origin. The "PixelIsPoint" raster grid space sets its origin at the centre of the first pixel (the point O in the figure below), whereas the "PixelIsArea" raster grid space, has its origin at the upper left corner of the image (the point C in the figure below). In the former case, the origin will hold the coordinates (0, 0) in the grid reference system and (4°20'00'', 50°50'00'') in the coordinate reference system. In the latter case, the origin will have the coordinates (0, 0) in the grid reference system and (4°19'50'', 50°49'50'') in the coordinate reference system.

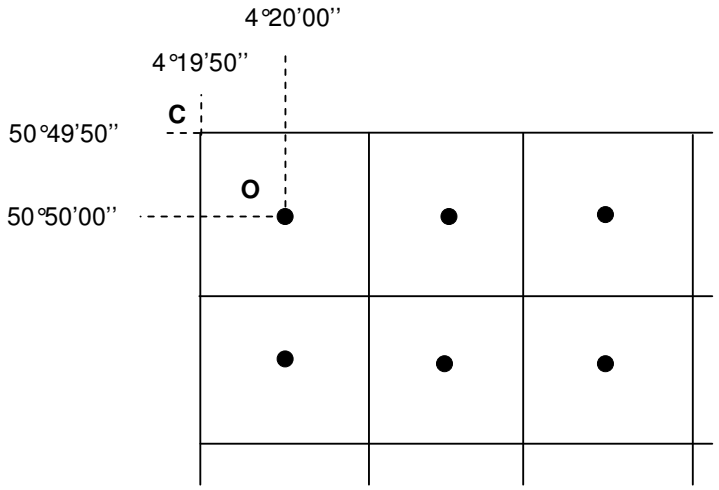

Figure 15 : Pixel representation as grid points or as areas

9.4 Options for delivering coverage data

For coverages, different encodings may be used for the domain and the range of the coverage. There are several options for packaging the domain and range encoding when delivering coverage data through a download service, as discussed below[16].

Multipart representation

For performance reasons, binary file formats are usually preferred to text-based formats such as XML for storing large amounts of coverage data. However, they cannot directly constitute an alternative to pure GML, since their own data structure might often not support all the ISO 19123 elements used to describe coverages in the conceptual model.

The OGC standard GML Application Schema for coverages [OGC 09-146r2] offers a format encoding which combines these two approaches. The first part consists of a GML document representing all coverage components except the range set, which is contained in the second part in some other encoding format such as 'well known' binary formats'. Some information in the second part may be redundant with the GML content of the first part. In this case, consistency must be necessarily ensured, for example by defining a GML mapping of the additional encoding format.

[16] Further details and examples will be included in a future version of the Guidelines for the encoding of spatial data [DS-D2.7].

The advantage of this multipart representation is that coverage constituents are not handled individually but as a whole. This is not really the case with GML which also allows the encoding of the value side of the coverage in external binary files, but via references to remote locations.

TG Requirement 7	Coverage data encoded as multipart messages shall comply with the multipart representation conformance class defined in GML Application Schema for Coverages [OGC 09-146r2].

NOTE The GML Application Schema for Coverages establishes a one-to-one relationship between coverages and multipart document instances.

Reference to an external file

The range set can be encoded within the XML structure as an external binary file using the gml:File element. This has the benefit of efficiently storing the range set data within an external file that is of a well-known format type, for example TIFF or GeoTIFF. This method of encoding is of most use for the storage of large files.

Encoding the range inline

This option encodes the range set data within the XML inline. This is encoded as a DataBlock element. This encoding provides much greater visibility for the range set values, however, this comes at the cost of reduced efficiency. This method of encoding would therefore only be suitable for small datasets.

Encoding the domain inside a JPEG 2000 file

This option consists in packaging all the components of one or several coverages, including the domain expressed in GML, in a single JPEG 2000 file. It is based on the OGC standard GML in JPEG 2000 for Geographic Imagery [OGC 05-047r2], also known as GMLJP2, which specifies how to use GML within the XML boxes of JPEG 2000 files.

TG Requirement 8	Coverage data encoded in standalone JPEG 2000 files shall comply with the OGC standard GML in JPEG 2000 for Geographic Imagery [OGC 05-047r2].

TG Requirement 8 implies that all the encoding rules presented in GMLJP2 shall be strictly followed for including GML within JPEG 2000 data files correctly. For the sake of harmonization, the encoding rules adopted for the multipart message encoding should also apply to the GMLJP2 encoding.

Recommendation 33	The encoding of coverage components in GMLJP2 within a JPEG 2000 file should conform to the rules specified in the Guidelines for the encoding of spatial data [DS-D2.7].