Contents

Annex D
(informative)
Pan-European Geographic Grid for gridded *Orthoimagery* data

This annex explains the need to establish a Pan-European geographic grid for the provision of gridded *Orthoimagery* spatial information (i.e. raster, coverage-based data) aimed at global purposes within the INSPIRE context and defines the characteristics of this grid.

Section 2.2.1 of the *Commission Regulation (EU) No 1089/2010, of 23 November 2010, implementing Directive 2007/2/CE of the European Parliament and of the Council as regards interoperability of spatial data sets and services*, establishes a common grid for Pan-European spatial analysis and reporting.

As stated in Section 2.2.2 of the mentioned regulation, other grids may be specified for specific spatial data themes of the INSPIRE Annexes.

The reasons justifying the recommendation to use a specific geographic grid for gridded European *Orthoimagery* data aimed at global purposes are summarized in 0 of this annex.

D.1 Introduction

The amount of information made available to users will be enormous when INSPIRE services become operative. In order to combine all these data sets or make cross-reference analyses aimed at satisfying Pan-European cross-border needs, it would be highly desirable to make data available in the same coordinate reference system (with its associated datum) to obtain consistent data. This is supported by key use-cases like flood modelling and emergency response. Although they are not equally relevant for every INSPIRE theme dealing with gridded data, it would be highly desirable that all the themes with similar needs makes use of the same geographical grid system in order to maintain their coherence.

Conservation of original values is important when working with raster files, since interpolations directly affect the accuracy of those variables computed from them. As an example, in the case of the elevation property resampling diminishes height values associated to points on the Earth surface.

The different projections allowed by the *INSPIRE Data Specification on Coordinate Reference Systems v3.1* for representation in plane coordinates are recommended in association to a certain range of scales and/or purposes, but problems arise when combining the data using these map projections (due to their inherent characteristics). As an example, ETRS-LAEA is suitable for spatial analysis and reporting, ETRS89-LCC is recommended for mapping at scales smaller than 1:500,000 and ETRS89-TMzn at scales larger than 1:500,000, with the additional inconvenience of using different zones for the whole Europe.

Hence, it would be recommendable to minimise coordinate reference system transformations of the data sets as possible, in order to preserve their quality.

Furthermore, even in the case where data is made available in the same coordinate reference system, when combining raster georeferenced data (coverages) from different sources, limits of pixels (coverage grid cells) usually do not match in x, y coordinates (i.e. maybe they are not aligned due to the fact they were generated by independent production lines). In order to get the proper alignment it is necessary to establish additional rules, such as the origin of a common geographic grid or its orientation.

Section 2.2.1 of the *Commission Regulation (EU) No 1089/2010, on interoperability of spatial data sets and services*, establishes a common grid for Pan-European spatial analysis and reporting (Equal Area Grid). This geographical grid (identified as Grid_ETRS89-LAEA) is based on the ETRS89 Lambert Azimuthal Equal Area coordinate reference system (ETRS89-LAEA) and is proposed as the multipurpose Pan-European standard. However, the Grid_ETRS89-LAEA is not suited for *Orthoimagery* data, because:

- The inherent properties of LAEA projection are inappropriate:

  - The direction of the Geographic North varies as geographical longitude does;
  - The scale gradually decreases from the centre of the projection;
  - Directions are only true directions from this point;
  - Shape distortions increases while moving away from this point.
  - It makes difficult the use of hierarchical levels of grid cell sizes, since resolution varies depending on the position;
- The Grid_ETRS89-LAEA is defined in an equal area projection, suited for thematic spatial analysis and reporting, whereas for *Orthoimagery* data the geometric aspects are important (e.g. conservation of angles, shapes and directions), as it is desirable for reference data.

In prevision of this type of issues, Section 2.2.2 of the mentioned regulation, states that other grids than the Grid_ETRS89-LAEA may be specified for specific spatial data themes of the INSPIRE Annexes. Therefore there is the possibility to solve these issues or minimize them as possible.

As a consequence of all the aspects above, this specification recommends the use of a common geographic grid in Europe to achieve convergence of gridded *Orthoimagery* data sets in terms of datum (already fixed by the *Commission Regulation (EU) No 1089/2010*), coordinate reference system and data sets organization at different levels of detail for data provision.

The Zoned Geographic Grid proposed in D.2 of this annex is aimed at minimize the previous issues. It is defined in geodetic coordinates and follows a structure analogue to DTED (Digital Terrain Elevation Data), which constitutes a valid solution to mitigate the effect of convergence of meridians. Due to this effect, if a geographic grid is defined in equiangular geodetic coordinates, the grid cell dimension on the ground becomes smaller in the longitude axis while the latitude increases, causing undesirable effects in areas with high latitude. This becomes especially problematic in areas near the Polar Regions.

D.2 Zoned Geographic Grid for gridded *Orthoimagery* data

Provision of data in ETRS89-GRS80 geodetic coordinates is aligned with the *Commission Regulation (EU) No 1089/2010, of 23 November 2010, on interoperability of spatial data sets and services*, while is a valid alternative to have continuous data regardless different levels of detail and purposes (as explained in D.1).

The amendment of this Regulation presented as a result of the INSPIRE Annex II and III process establishes the Zoned Geographic Grid, a multi-resolution geographic which may be used as a geo-referencing framework when gridded data is delivered using geodetic coordinates. The characteristics of this grid are defined below.

IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(1) When gridded data is delivered using geodetic coordinates the multi-resolution Zoned Geographic Grid defined in this annex may be used as a geo-referencing framework.

As recommended in Section 6.2.2 of this specification, Pan-European gridded Orthoimagery data in areas within the scope of ETRS89 should be at least made available using geodetic coordinates based on the Zoned Geographic Grid.
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IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(…)

(3) The grid shall be based on the ETRS89-GRS80 geodetic coordinate reference system.

IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(…)

(4) The origin of the grid shall coincide with the intersection point of the Equator with the Greenwich Meridian (GRS80 latitude φ=0; GRS80 longitude λ=0).

IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(…)

(5) The grid orientation shall be south-north and west-east according to the net defined by the meridians and parallels of the GRS80 ellipsoid.

The geographical grid establishes multiple levels of resolution and follows a structure analogue to DTED, dividing the world into different zones in latitude, as shown in the following table:

Table 19 – Latitudinal zones for the common Grid_ETRS89-GRS80zn

Zone	Latitude	Factor
1	0°–50°	1
2	50°–70°	2
3	70°–75°	3
4	75°–80°	4
5	80°–90°	6

It is recognized that a geographical grid with such structure may constitute additional efforts for Member States whose territories intersect the limit of adjoining zones. However, this is perceived as an acceptable solution to mitigate the meridian convergence. It is worth to mention here that most of territories in continental European are included in Zones 1 and 2 (Cape North in Norway is approximately at 71° latitude).

For a given level of resolution:

- The latitude spacing of cells of the geographic grid is the same in the different zones.
- Each zone has a specific longitude spacing for the cells of the geographic grid (equal or greater than the latitude spacing). Last column in the previous table shows the factor by which the latitude spacing is multiplied in each zone to obtain the longitude spacing.

When applying this factor, the cell sizes become approximately square on the ground (while they are rectangular in geodetic coordinates, i.e. 1x2, 1x3, 1x4, 1x6). Only grid cells included in Zone 1 preserve the square condition in geodetic coordinates (1x1).

IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(…)

(2) The resolution levels are defined in Table 1.

NOTE Table 20 in this document

IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(…)

(7) This grid shall be subdivided in zones. The south-north resolution of the grid shall have equal angular spacing. The west-east resolution of the grid shall be established as the product of angular spacing multiplied by the factor of the zone as defined in Table 1.

NOTE Table 20 in this document

The geographic grid is generically designated as Grid_ETRS89-GRS80zn. For identification of an individual resolution level the zone number (*n*) and the cell size (*res*) - in degrees (D), minutes (M), seconds (S), milliseconds (MS) or microseconds (MMS) - has to be included and appended (respectively) to this designator, resulting in the Grid_ETRS89-GRS80z*n_res*.

EXAMPLE The zoned geographical grid at a resolution level of 300 milliseconds in Zone 2 is designated as Grid_ETRS89-GRS80z*2_300MS*.

IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(…)

(8) The grid shall be designated Grid_ETRS89-GRS80z*n_res*, where *n* represents the number of the zone and *res* the cell size in angular units, as specified in Table 1.

NOTE Table 20 in this document

Table 20 – Common Grid_ETRS89-GRS80zn: Latitude spacing (resolution level) and longitude spacing for each zone

Resolution Levels	LATITUDE SPACING (Arc seconds)	LONGITUDE SPACING (Arc seconds)					Cell Size
		Zone 1 (Lat. 0°–50°)	Zone 2 (Lat. 50°–70°)	Zone 3 (Lat. 70°–75°)	Zone 4 (Lat. 75°–80°)	Zone 5 (Lat. 80°–90°)	
LEVEL 0	3600	3600	7200	10800	14400	21600	1D
LEVEL 1	3000	3000	6000	9000	12000	18000	50M
LEVEL 2	1800	1800	3600	5400	7200	10800	30M
LEVEL 3	1200	1200	2400	3600	4800	7200	20M
LEVEL 4	600	600	1200	1800	2400	3600	10M
LEVEL 5	300	300	600	900	1200	1800	5M
LEVEL 6	120	120	240	360	480	720	2M
LEVEL 7	60	60	120	180	240	360	1M

LEVEL 8	30	30	60	90	120	180	30S
LEVEL 9	15	15	30	45	60	90	15S
LEVEL 10	5	5	10	15	20	30	5S
LEVEL 11	3	3	6	9	12	18	3S
LEVEL 12	1,5	1,5	3	4,5	6	9	1500MS
LEVEL 13	1	1	2	3	4	6	1000MS
LEVEL 14	0,75	0,75	1,5	2,25	3	4,5	750MS
LEVEL 15	0,5	0,5	1	1,5	2	3	500MS
LEVEL 16	0,3	0,3	0,6	0,9	1,2	1,8	300MS
LEVEL 17	0,15	0,15	0,3	0,45	0,6	0,9	150MS
LEVEL 18	0,1	0,1	0,2	0,3	0,4	0,6	100MS
LEVEL 19	0,075	0,075	0,15	0,225	0,3	0,45	75MS
LEVEL 20	0,03	0,03	0,06	0,09	0,12	0,18	30MS
LEVEL 21	0,015	0,015	0,03	0,045	0,06	0,09	15MS
LEVEL 22	0,01	0,01	0,02	0,03	0,04	0,06	10MS
LEVEL 23	0,0075	0,0075	0,015	0,0225	0,03	0,045	7500MMS
LEVEL 24	0,003	0,003	0,006	0,009	0,012	0,018	3000MMS
FACTOR	-	1	2	3	4	6	-

The table above shows the latitude spacing (each resolution level), as well as the longitude spacing obtained by applying the factor parameter to each latitudinal zone.

The levels of resolution identified in Table 20 make up a hierarchical geographic grid (which constitute a pyramidal grid structure). Level 8, Level 11 and Level 13 in the previous table correspond to the levels of resolution of the Digital Terrain Elevation Data (DTED) L0, L1 and L2, respectively. Other levels in the table are derived from these taking into account the well-known scale set *GlobalCRS84Pixel* included in the WMTS v1.0.0 specification.

Table 21 illustrates the approximate geographic grid cell size on terrain in latitude at each resolution level.

Table 21 – Approximate Grid_ETRS89-GRS80zn cell size on terrain in latitude at each resolution level

Resolution Levels	Cell Size in Latitude (Latitude Spacing)	Approx. Cell Size on terrain in Latitude
	(Arc seconds)	(Meters)
LEVEL 0	3600	120000
LEVEL 1	3000	100000
LEVEL 2	1800	60000
LEVEL 3	1200	40000
LEVEL 4	600	20000
LEVEL 5	300	10000
LEVEL 6	120	4000
LEVEL 7	60	2000
LEVEL 8	30	1000
LEVEL 9	15	500
LEVEL 10	5	166
LEVEL 11	3	100
LEVEL 12	1,5	50
LEVEL 13	1	33.33
LEVEL 14	0,75	25
LEVEL 15	0,5	16
LEVEL 16	0,3	10
LEVEL 17	0,15	5
LEVEL 18	0,1	3
LEVEL 19	0,075	2.5
LEVEL 20	0,03	1

LEVEL 21	**0,015**	**0.5**
LEVEL 22	**0,01**	**0.33**
LEVEL 23	**0,0075**	**0.25**
LEVEL 24	**0,003**	**0.1**

TG Requirement 1 The coordinates of the top left corner of cells of the Grid_ETRS89-GRS80zn shall be used for cell identification purposes.

The geodetic coordinates of any cell of this Zoned Geographic Grid for a specific zone will always be a multiple of the grid cell size for a given resolution level, as a consequence of establishing a common origin for the geographic grid (φ=0; λ=0).

As a consequence, problems of alignment between raster files (coverages) based on the Grid_ETRS89-GRS80z*n_res* at the same resolution level (grid coverage cell size) disappear. Remaining misalignments correspond only to the difference in absolute positioning and consistency of the data being combined. Especially in the case of very high resolution data, an inherent positional misalignment between coverages originated from two neighbour data providers may be observed, due to the different product specifications and (moreover) to the fact that the cells of the common geographic grid do not necessarily represent the same sampled features on the Earth in both datasets (e.g. because of the occlusions and/or the different angles of observation).

It is recognised that there is a need to enable grid referencing for regions outside of continental Europe, for example for overseas Member States (MS) territories. For these regions, MS are able to define their own geographic grid, although it must follow the same principles as laid down for the Pan-European Grid_ETRS89-GRS80zn and be documented according to ISO 19100 standards.

Such MS defined grids will be based on the International Terrestrial Reference System (ITRS), or other geodetic coordinate reference systems compliant with ITRS in areas that are outside the geographical scope of ETRS89. This follows the Requirement 2 of the Implementing Rule on Coordinate reference systems [INSPIRE-DS-CRS], i.e. compliant with the ITRS means that the system definition is based on the definition of the ITRS and there is a well established and described relationship between both systems, according to ISO 19111:2007 Geographic Information – Spatial referencing by coordinates.

IR Requirement
Annex II, Section 2.2.2
Zoned Geographic Grid

(…)

(6) For grid referencing in regions outside of continental Europe data providers may define their own grid based on a geodetic coordinate reference system compliant with ITRS, following the same principles as laid down for the Pan-European Grid_ETRS89-GRS80zn. In this case, an identifier for the CRS and the corresponding identifier for the grid shall be created.

NOTE The term *continental Europe* means the area within the scope of ETRS89/EVRS.

Annex E
(informative)
Data structure examples

E.1 Introduction

This annex provides several examples illustrating how common orthoimagery products could be mapped, in terms of data structure, to the *orthoimagery* application schema described in section 5. It is intended to help the reader to clearly understand this INSPIRE data specification and in particular, to show data providers the simplest way of making their data INSPIRE compliant.

Please be aware that the term "tiling" used below refers to the file-based cut out of orthorectified images which is performed by data providers for data storage and delivery. This part aims to show that external tiling has no bearing on how to organize data within a data set on a web server, as tiling have to stay invisible to users.

E.2 Examples

E.2.1 Orthoimages derived from single input images (no tiling)

In this first example, the orthoimagery data set contains four orthoimages derived from single images (e.g. non-rectified satellite scenes). The orthoimages have no direct connections between them, while three of them overlap. The range set of each orthoimage is embedded in a single image file (e.g. tiff or jpeg2000 file).

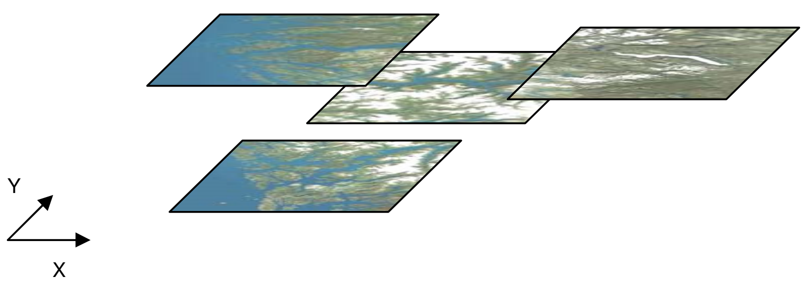

Figure 16 – orthoimages derived from single input images

Each orthoimage should be modelled as an instance of the feature type *OrthoimageCoverage*.

Component	Number of instances	Comment
OrthoimageCoverage	4	
MosaicElement	0	Not applicable
OrthoimageAggregation	0	Not applicable

E.2.2 Orthoimages derived from single input images (with tiling)

This case is similar to the previous, except that every orthoimage is divided into two tiles, so that the range set of each tile is stored in only one image file.

Figure 17 – orthoimages derived from single input images with tiling (tile extents in green)

Tiling does not affect the structure of the data set. As above, each orthoimage should be modelled as an instance of the feature type *OrthoimageCoverage*, without additional instantiations.

Component	Number of instances	Comment
OrthoimageCoverage	4	
MosaicElement	0	Not applicable
OrthoimageAggregation	0	Not applicable

E.2.3 Mosaic of several input images without mosaic elements associated (no tiling)

The orthoimagery data set contains a seamless orthoimage resulting from the mosaicking of several input images. However, the data producer was not in position to provide the delineation of the mosaic elements at lower cost. The range set of the full mosaic is embedded in a single image file.

Figure 18 – mosaic without mosaic elements

The mosaic should be represented as a single *OrthoimageCoverage* instance, without additional instantiations.

Component	Number of instances	Comment
OrthoimageCoverage	1	

MosaicElement	0	Not populated
OrthoimageAggregation	0	Not applicable

E.2.4 Mosaic of several input images without mosaic elements associated (with tiling)

This case is similar to the previous, except that the mosaic of several input images is divided into six tiles, so that the range set of each tile is stored in only one image file.

Figure 19 – mosaic without mosaic elements but with tiling (tile extents in green)

Tiling does not affect the structure of the data set. Indeed, the mosaic should be represented as a single *OrthoimageCoverage* instance.

Component	Number of instances	Comment
OrthoimageCoverage	1	
MosaicElement	0	Not populated
OrthoimageAggregation	0	Not applicable

E.2.5 Mosaic of several input images with mosaic elements associated (no tiling)

The orthoimagery data set consists in a seamless orthoimage resulting from the mosaicking of several input images. The delineation of the mosaic elements with the acquisition dates of the input images are available. The range set of the full mosaic is embedded in a single image file.

Figure 20 – mosaic with mosaic elements

The mosaic should be modelled as an *OrthoimageCoverage* instance linked to seven indirect instances of the feature type *MosaicElement*.

Component	Number of instances	Comment
OrthoimageCoverage	1	
MosaicElement	7	One *MosaicElement* indirect instance by contributing input image
OrthoimageAggregation	0	Not applicable

E.2.6 Mosaic of several input images with with mosaic elements associated (with tiling)

This case is similar to the previous, except that the mosaic of several input images is divided into six tiles, so that the range set of each tile is stored in only one image file.

Figure 21 – mosaic with mosaic elements and tiling (tile extents in green)

As above, the mosaic should be modelled as an *OrthoimageCoverage* instance linked to seven indirect instances of the feature type *MosaicElement*.

Component	Number of instances	Comment
OrthoimageCoverage	1	
MosaicElement	7	One *MosaicElement* indirect instance by contributing input image
OrthoimageAggregation	0	Not applicable

E.2.7 Aggregated orthoimage (no tiling)

The orthoimagery data set is composed of five orthoimages. Four of them are derived from single input images. The last one "dynamically" aggregates three of the first orthoimages by referencing them.

This data organization allows users to access data either through the single orthoimages or through the aggregated orthoimage.

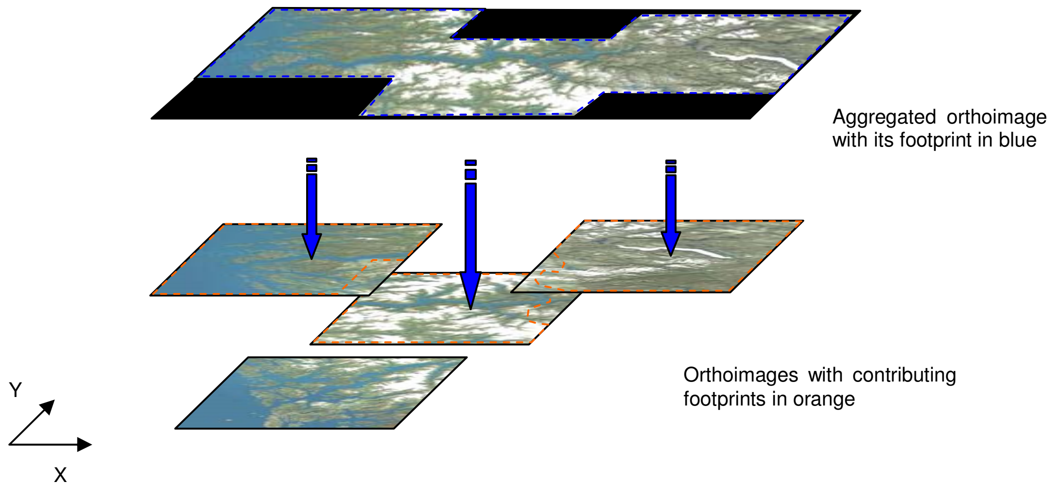

Figure 22 – aggregated orthoimage referring to orthoimages derived from single input images

The four orthoimages calculated from single input images are modelled as *OrthoimageCoverage* instances. The aggregated orthoimage is also implemented as an instance of this feature type, but in addition, it points to its three composing orthoimages by specifying their contributing area thanks to the association class *OrhoimageAggregation*.

Component	Number of instances	Comment
OrthoimageCoverage	5	
MosaicElement	0	Not applicable
OrthoimageAggregation	3	Link between the aggregated orthoimage and its three composing orthoimages

E.3 Conclusion

One could multiply examples by combining mosaicking, tiling and aggregation within data sets. However, it is not in the interest of data producers to increase the complexity of the data structure. Foremost, they should keep in mind the use cases attached to their products when choosing a data organization.

Annex E
(normative)
Encoding rules for TIFF and JPEG 2000 file formats

E.1 Introduction

This annex specifies how to use the TIFF or JPEG 2000 file formats for encoding the range set of grid coverages. Because pixel payload is not sufficient to construct a readable standalone image, additional descriptive information has to be packaged together in the same file, even if it is already provided somewhere else in GML. For this purpose, this part establishes schema conversion rules for all the coverage components of INSPIRE Application Schemas that have a corresponding element in the output TIFF or JPEG 2000 data structures. These conversion rules play an essential role in maintaining consistency between the different representations (i.e. GML, TIFF or JPEG 2000) of the same coverage information.

On the other hand, TIFF specifications and JPEG 2000 Standard offer many options and let some variables open for encoding image data. If this flexibility allows covering most applications, it leads, in turn, to a situation where disparate implementation platforms exist while being potentially incompatible. As a result, interoperability is often unlikely. In order to fill in this gap and to enable a controlled exchange of data across Europe, this annex draws up an implementation profile of TIFF and JPEG 2000 to constraint their usage within the scope of INSPIRE. It amounts to impose external format-dependent restrictions to the applicable values of the properties described in the INSPIRE application schemas.

E.2 TIFF format

E.2.1 Format overview

The Tagged Image File Format (TIFF) is a binary file format for storing and interchanging raster images. Originally developed by the company Aldus (Adobe Systems), it is in the public domain since 1992, the year of the latest release of the specifications (revision 6.0 [TIFF]). TIFF has become a popular “de facto standard” for high colour-depth digital images. It is widely used in image handling applications, covering various themes such as *Orthoimagery*.

TIFF specifications are divided into two parts. Part 1: Baseline TIFF defines all the features that every reader must support, while Part 2: TIFF Extensions provides additional format structures designed for specialized applications, that are not necessarily taken into account by all TIFF readers (e.g. JPEG or LZW compression, tiling, CMYK images).

As highlighted in the format name, the TIFF data structure is based on the definition of tags for describing the characteristics of images. To be more precise, a TIFF file contains an image file header pointing to one or several image file directory (IFD). The image file header fixes the technical properties of the file, such as the byte order (e.g. little-endian or big-endian) or the offset of the first byte. An image file directory holds the complete description of an image by means of fields or entries. Each IFD entry consists of a tag identifying the field, the field type (e.g. byte, ASCII, short int), the number of values and the values themselves or an offset to the values. The location of the actual image data within the file is given by the combination of information elements expressed in some fields.

E.2.2 INSPIRE TIFF profile for grid coverage data

This section lists the requirements and the constraints to be applied to the TIFF format when encoding INSPIRE *Orthoimagery* data sets in this format. It should be read in conjunction with the table in section E.2.3 which provides more detailed information. Some of the rules presented here are directly inspired by

the GeoTIFF Profile for Georeferenced Imagery [DGIWG-108] edited by DGIWG for the military community.

General rules

TG Requirement 2	Encoding of INSPIRE *Orthoimagery* data sets by using TIFF format shall conform to Baseline TIFF extended to LZW Compression.

NOTE Baseline TIFF is described in the part 1 of the TIFF specification 6.0 [TIFF], while the TIFF extension on LZW Compression is addressed in part 2.

TIFF files must be identified as such by network services by using a predefined Internet media type or MIME type.

TG Requirement 3	A file claiming to encode coverage elements in TIFF shall receive the *image/tiff* MIME type registered in RFC 3302.

NOTE The absence of the optional application parameter here does not necessarily imply that the encoded TIFF image is Baseline TIFF.

Data structure

Even though TIFF specifications allow describing multiple related images in a single file by using more than one Image File Directory (IFD), Baseline TIFF readers are not required to decode any IFD beyond the first one. In order to ensure alignment with Baseline TIFF, all indispensable information has to be included in the first IFD.

TG Requirement 4	A TIFF file shall not contain more than two image file directories (IFD).

TG Requirement 5	The first IFD shall carry the range set of the grid coverage. In the case of two IFD, the second shall be used to support a transparency mask.

NOTE As a consequence, the different bands of a same image cannot be split in separate IFDs.

The use of a second IFD is admitted for encoding an optional transparency mask, which is common for geographic raster data. This kind of ancillary information describes precisely the meaningful area of the image in the first IFD. It is useful at least for portrayal considerations. A transparency mask is a bi-level image matching pixel by pixel the image depicted in the first IFD. The pixel value 1 in the transparency mask means that the corresponding pixel in the image itself is significant. Conversely, the value 0 means that the corresponding pixel in the image holds a no data value (e.g. unknown, withheld). Typically, it must be made transparent when displaying the image.
The image file directory assigned to a transparency mask must receive the following TIFF tag values:

- BitsPerSample = 1
- Colormap: not used
- ImageDescription = ‘transparency mask’
- ImageLength = ImageLength of the first IFD
- ImageWidth = ImageWidth of the first IFD
- NewSubFileType: all bits equal 0, except bit 2 = 1
- PhotometricInterpretation = 4
- SamplesPerPixel = 1

Grid coordinate system

Baseline TIFF supports only one type of orientation for grid coverages, that is, one type of grid coordinate system.

TG Requirement 6	The origin of the grid coordinate system shall be the upper left corner of the grid coverage. The axis 'row' and 'column' shall be oriented downward and to the right.

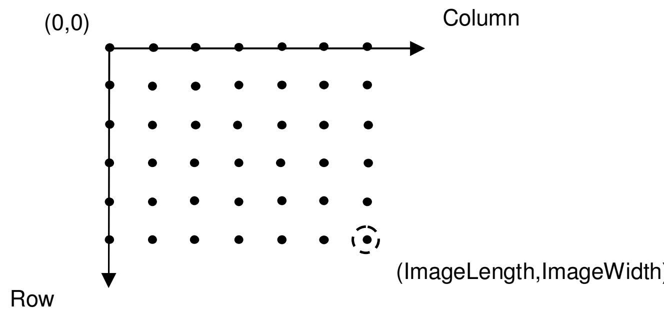

Figure 9. referenced grid as defined by Baseline TIFF

Range values

The Baseline TIFF specifications cover four image types: bi-level, greyscale, palette-colour and full-colour images. Multi-band images are allowed but not fully addressed: baseline TIFF readers are intended to skip over the extra components gracefully, using the values of the SamplesPerPixel and BitsPerSample fields.

Recommendation 1	The image data of a TIFF file should contain either 1 (bi-level, greyscale and palette-colour), 3 (RGB) or 4 bands (RGB with associated alpha data).

NOTE 1 Alpha data, which provides opacity information, is stored as an additional component per pixel. A 4-bands RGB image must have the following TIFF tag values: SamplesPerPixel = 4, PhotometricInterpretation = 2 (RGB) and ExtraSamples = 1 (associated alpha data).

NOTE 2 Encoding multispectral images in TIFF is running the risk of losing a part of the coverage range set, since many software applications are not able to support more than three colours.

Recommendation 2	To encode multispectral images, the use of other more appropriated formats, such as JPEG 2000, is recommended.

Open issue 1: The lack of a part of the coverage range set is a well-identified problem for the orthoimage delivery in the frame of the Control with Remote Sensing (CwRS) program of the MARS Unit of JRC. When data is delivered in TIFF, we occasionally receive only 3 out of the initial 4 four channels of the VHR satellite data (usually the colour infrared is the missing one). The lack of this information might be crucial for certain applications. In that respect we might think (in case of availability of multispectral data) to encourage the data producers to provide more than one RGB files, holding different band combinations – natural; colour infrared; false colour composite. It is a common practice in the frame of the CwRS, although it required additional efforts. Same delivery approach can be valid for JPEG2000 as well.

For better performances, it is preferable to encode the range values as arrays of type SHORT, BYTE or LONG, depending on the type of data.

TG Requirement 7	For imagery, the range values shall be expressed as unsigned integers coded on 8 or 16 bits, except for bi-level images which are 1-bit data. For other gridded

	data (e.g. elevation data, measured data), they shall be stored as 8 or 16-bits integers, signed or unsigned, or as 32-bits floating points.

NOTE If the original data do not satisfy this requirement, they will be converted in a representation using the next higher power of 2.

TG Requirement 8	In the case of multi-band images, the number of bits per component shall be the same for all the bands.

TG Requirement 9	In the case of multi-band images, the planar configuration shall be *Chunky* format, i.e. the bands are interleaved.

NOTE The range values of a same grid point in its different bands are stored contiguously. For instance, RGB data is stored as RGBRGBRGBRGB...

Compression

Data compression can be used within this profile to reduce the size of a file, provided that it does not distort the original range values after an encoding-decoding cycle. This condition allows, for example, ensuring the preservation of nil values.

TG Requirement 10	The range value data shall be either uncompressed or lossless compressed with packbit or LZW compression schemes.

NOTE As a TIFF extension, LZW compression is not supported by Baseline TIFF. However, it is included in this profile since its use is widespread, essentially for both its simplicity and its efficiency.

Internal tiling

The TIFF extension defined in section 15 of the specifications focuses on the way of laying out the image content into roughly square tiles. This method, as an alternative to the standard repartition of the range within separate strips, improves the access to data. However, it may cause some interoperability problems too. It is therefore better not to use it and to restrict oneself to Baseline TIFF.

E.2.3 Mapping between TIFF and GML data structures

The following table indicates how to fill the content of TIFF tags for grid coverages in the context of INSPIRE. On the other hand, it gives the rules to be applied for ensuring the consistency of TIFF files with the *Orthoimagery* GML Application(s) Schema(s). It does not address the encoding of the possible transparency mask (See 0).

The columns *Tag name*, *Code*, *Type*, *Card.* and *Description* remind respectively the name, the code, the type, the maximum number of occurrences and the description of each Baseline TIFF tag within the meaning of the TIFF specification. The column *Obligation* informs if the tag is considered to be mandatory (M), conditional (C), optional (O) or inadequate (I). The column *Restricted values* specifies the values allowed for the tag in the context of INSPIRE. The column *Mapping to GML elements* establishes a correspondence between the tag values and the corresponding GML elements of the coverage whose type is one of those specified in the Generic Conceptual Model (e.g. RectifiedGridCoverage). N/A means not applicable.

Table 10. Baseline TIFF implementation profile and Mapping between TIFF tags and the associated object elements from the Orthoimagery GML Application Schema

Tag name	Code	Type	Card.	Description	Obligation	Restricted values	Mapping to GML elements (including restrictions)
Artist	315	ASCII	1	Person who created the image	O	-	N/A
BitsPerSample	258	Short	SamplesPerPixel	Number of bits per component	M	1 for bi-level images For imagery, constrained to **8** or **16** bits-per-pixel-per-band (e.g. 8 8 8 or 16 16 16 for RGB images). For other gridded data, 8, 16 and 32 bits-per-pixel-per-band	For each band *i*, rangeType.field[*i*].constraint.interval = "0 *2^BitsPerSample[i]-1*"
CellLength	265	Short	1	The length of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file.	I	This field should be never used	N/A
CellWidth	264	Short	1	The width of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file.	I	This field should be never used	N/A
ColorMap	320	Short	3*(2**BitsPerSample)	A colour map for palette colour images	C	Only for palette colour images	N/A
Compression	259	Short	1	Compression scheme used on the image data	M	**1** for uncompressed data **5** for LZW compression **32773** for PackBits compression of greyscale and palette-colour data	N/A
Copyright	33432	ASCII	1..*	Copyright notice	O	-	N/A
DateTime	306	ASCII	20	Date and time of image creation	O	The Gregorian calendar should be used as a reference system for date values, and the Universal Time Coordinated (UTC) as a reference system for time values (local time is not recommended because offset from UTC can not be expressed in TIFF).	N/A NOTE the field DateTime should not be confused with the properties *phenomenonTime* and *beginLifespanVersion* that report other types of temporal information.

Tag name	Code	Type	Card.	Description	Obligation	Restricted values	Mapping to GML elements (including restrictions)
ExtraSample	338	Short	1..*	Description of extra components	C	Only when extra samples are present **1** for 4-bands RGB images with alpha channel	N/A
FillOrder	266	Short	1	The logical order of bits within a byte.	O	**1** (default)	N/A
FreeByteCounts	289	Long	1	For each string of contiguous unused bytes in a TIFF file, the number of bytes in the string.	I	This field should be never used	N/A
FreeOffsets	288	Long	1	For each string of contiguous unused bytes in a TIFF file, the byte offset of the string.	I	This field should be never used	N/A
GrayResponseCurve	291	Short	2**BitsPerSample	For greyscale data, the optical density of each possible pixel value.	I	This field should be never used	N/A
GrayResponseUnit	290	Short	1	The precision of the information contained in the GrayResponseCurve	I	This field should be never used	N/A
HostComputer	316	ASCII	1..*	The computer and/or operating system in use at the time of image creation.	O	**-**	N/A
ImageDescription	270	ASCII	1..*	Description of the image subject.	O	-	N/A
ImageLength	257	Short or Long	1	The number of rows in the image.	M	-	domainSet.extent.high.coordValues[*0*]-domainSet.extent.low.coordValues[*0*]=ImageLength
ImageWidth	256	Short or Long	1	The number of columns in the image, i.e. the number of pixels per row.	M	-	domainSet.extent.high.coordValues[*1*]-domainSet.extent.low.coordValues[*1*]=ImageWidth
Make	271	ASCII	1	The scanner manufacturer.	O	-	N/A
MaxSampleValue	281	Short	SamplesPerPixel	The maximum component value used.	O	This field should be used only for statistical purposes	N/A
MinSampleValue	280	Short	SamplesPerPixel	The minimum component value used.	O	This field should be used only for statistical purposes	N/A
Model	272	ASCII	1	The scanner model name or number.	O	-	N/A
NewSubfileType	254	Long	1	A general indication of the kind of data contained in this subfile.	O	**0**	N/A

Tag name	Code	Type	Card.	Description	Obligation	Restricted values	Mapping to GML elements (including restrictions)
Orientation	274	Short	1	The orientation of the image with respect to the rows and columns.	M	**1** (default)	domainSet.extent.low.coordValues="0 0"
PhotometricInterpretation	262	Short	1	Colour space of the image data.	M	**1** for bi-level and greyscale images (0 is black) **2** for RGB images **3** for palette-colour images	N/A
PlanarConfiguration	284	Short	1	How the components of each pixel are stored.	M	**1** which means, for RGB data, that the data is stored as RGBRGBRGB…	rangeSet.fileStructure="Record Interleaved"
ResolutionUnit	296	Short	1	Unit of measurement for XResolution and YResolution.	M	**2** which means dpi (dot per inch)	N/A
RowsPerStrip	278	Short or Long	1	Number of rows per strip.	C Not used if tiling	It is recommended to choose this value such that each strip is about 8K bytes.	N/A
SampleFormat	399	Short	SamplesPerPixel	This field specifies how to interpret each data sample in a pixel.	M	**1** for imagery (unsigned integer data) 1, 2 or 3 for gridded data	For imagery, for each band *i*, rangeType.field[*i*].constraint.interval[0] = "0"
SamplesPerPixel	277	Short	1	Number of components per pixel.	M	**1** usually for bi-level, greyscale and palette-colour images **3** or **4** usually for RGB images (the 4th component being used for alpha channel)	rangeType.field.size()=SamplesPerPixel
SmaxSampleValue	341	Field type that best matches the sample data	SamplesPerPixel	The maximum value for each sample. This tag is used in lieu of MaxSampleValue when the sample type is other than integer.	I	This field should be never used	N/A
SminSampleValue		Field type that best matches the sample data	SamplesPerPixel	The minimum value for each sample. This tag is used in lieu of MaxSampleValue when the sample type is other than integer.	I	This field should be never used	N/A
Software	305	ASCII	1..*	Name and version number of the software package(s) used to create the image.	O	-	N/A

Tag name	Code	Type	Card.	Description	Obligation	Restricted values	Mapping to GML elements (including restrictions)
StripByteCounts	279	Short or Long	StripPerImage	For each strip, number of bytes in the strip after compression.	C Not used if tiling	-	N/A
StripOffsets	273	Long	StripPerImage	For each strip, the byte offset of that strip	C Not used if tiling	-	N/A
Thresholding	263	Short	1	For black and white TIFF files that represent shades of gray, the technique used to convert gray to black and white pixels.	I	This field should be never used	N/A
TileWidth	322	Short or Long		The tile width in pixels. This is the number of columns in each tile.	C if tiling	-	N/A
TileLength	323	Short or Long		The tile length (height) in pixels. This is the number of rows in each tile.	C if tiling	-	N/A
TileOffsets	324	Long		For each tile, the byte offset of that tile, as compressed and stored on disk.	C if tiling	-	N/A
TileByteCount	325	Short or Long		For each tile, the number of (compressed) bytes in that tile.	C if tiling	-	N/A
Xresolution	282	Rational		The number of pixels per ResolutionUnit in the ImageWidth direction.	M	-	N/A
Yresolution	283	Rational		The number of pixels per ResolutionUnit in the ImageLength direction.	M	-	N/A

In addition, the description of the coverage grid function must reflect the baseline ordering used by TIFF format to store the range values within a file. The following mapping must be applied:

coverageFunction.gridFunction.sequenceRule.type = “linear” AND coverageFunction.gridFunction.sequenceRule.scanDirection = “+2 +1”

E.2.4 Theme-specific requirements and recommendations

TG Requirement 11	For orthoimagery, the range values shall be expressed as unsigned integers coded on 8 or 16 bits, except for bi-level images which are 1-bit data.

E.3 JPEG 2000 format

E.3.1 Format overview

JPEG 2000 is a wavelet compression for storing and interchanging raster. Other wavelet compressions exist like ECW or MrSid. JPEG 2000 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information* in collaboration with ITU-T. The identical text is published as ITU-T Rec. T.800. First version was published in 2000. JPEG 2000 is known as a very efficient format to distribute and access large imagery data.

JPEG 2000 Standard is defined by ISO 15444 serie (from 15444-1 to 15444-12). The two parts dealing with 2D still imagery encoding and then interesting for INSPIRE raster and gridded coverages are:

- ISO 15444-1: Core Coding System, defining how coders and decoders shall behave and how shall be structured a JPEG 2000 codestream. This part also defines JP2 format, the simpler wrapper for JPEG 2000 encoded data.
- ISO 15444-2: Extensions, defining extensions for JPEG 2000 codestream (new makers) and JPX format. This part deals with extended capabilities; only a minor part (2 extra boxes) are useful for GMLJP2, and then for INSPIRE (see TG Requirement 21).

JPEG 2000 is complex

- The JPEG 2000 codestream, which directly contains compressed data. This stream contains markers and segment markers which allow decoding and accessing data.
- The format which is the wrapper of the JPEG 2000 codestream. It is possible to only distribute the codestream (extension file .j2c), but to have a more comprehensive file, it's recommended to wrap this stream inside a format, whose the most common is JP2, described by Annex I of ISO 15444-1 (extension file .jp2) which adds some boxes describing encoded data.

The figure below shows the JP2 file structure. n is the number of Colour Specification Boxes (n=1 for INSPIRE). m is the number of JPEG 2000 codestreams (in our case as there is only one codestream m=1). :

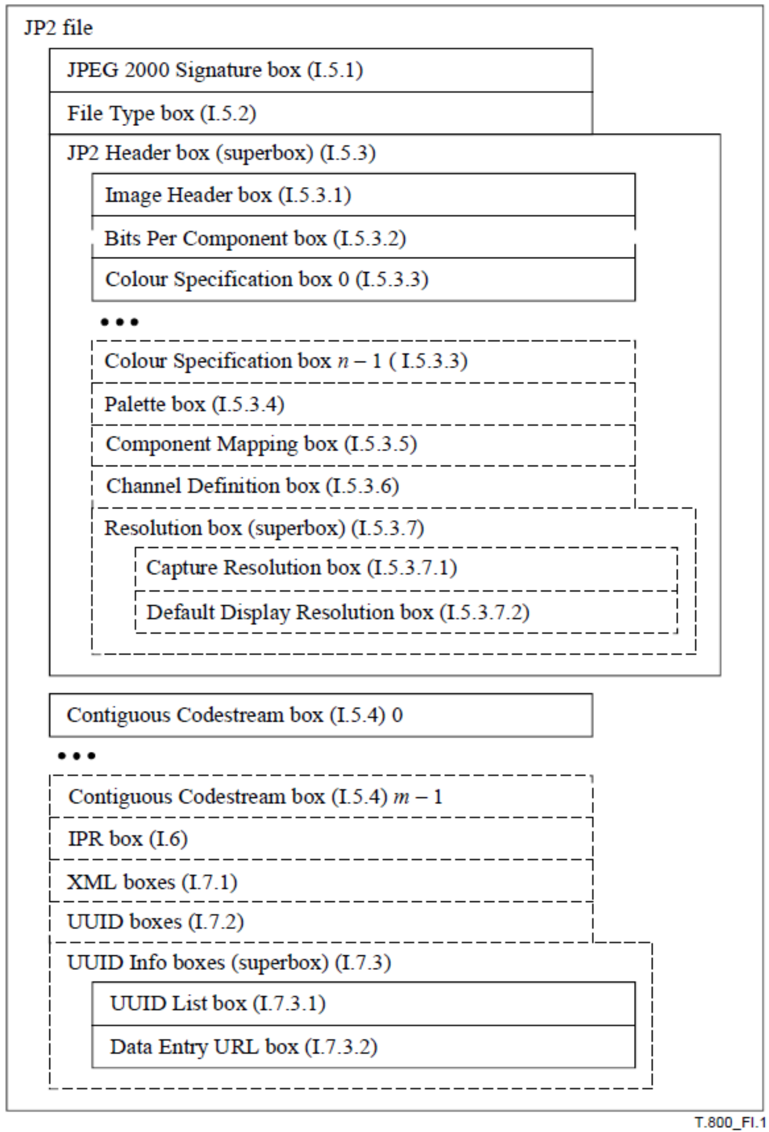

Figure 23 : JP2 file structure

E.3.2 JPEG 2000 profile for INSPIRE Orthoimagery data

This section lists the requirements and the constraints to be applied to JPEG 2000 when encoding INSPIRE *Orthoimagery* data sets in this format. It should be read in conjunction with the table in section 0 which provides more detailed information.

General rules

TG Requirement 12	Encoding of INSPIRE *Orthoimagery* data sets by using JPEG 2000 shall conform to profile 1 of ISO 15444-1 in general case. In the case of delivering GMLJP2 files, GMLJP2 standard [OGC 05-047r3] shall apply.

NOTE GMLJP2 Standard is based on ISO 15444-1, extended by the use of boxes “association” and “label” defined by JPX format in ISO 15444-2 (see GMLJP2 standard for more details).

JPEG 2000 files must be identified as such by network services by using a predefined Internet media type or MIME type

TG Requirement 13	A file claiming to encode coverage elements in JPEG 2000 shall receive the *image/jp2* MIME type registered in RFC 3745.

NOTE GMLJP2 uses extended boxes from JPX format, so it would suggest a *image/jpx* MIME type but GMLJP2 Standard Working Group recommends the use of *image/jp2* MIME Type because "association" and "label" boxes are just minor extensions of JP2 (defined in JPX format by Annex M of ISO 15444-2). Claiming conformance to JP2 allows GMLJP2 data to be supported by more visualisation software (some tools could stop reading JPEG 2000 files when seeing image/jpx MIME type). In the case of a software only compliant with ISO 15444-1 (reading strict JP2 files), the image and the GML (in the XML box) will be read and only the association between the two will be not interpreted.

So in both cases, pure JPEG 2000 or GML embedded in JPEG2000 (GMLJP2), *image/jp2* MIME type shall be used.

Data structure

Even though JPEG 2000 Standard (and more precisely JP2 format) allows describing multiple codestreams in a single file by using more than one jp2c, only one is required to encode range sets of gridded coverages.

TG Requirement 14	The range set of the grid coverage shall be carried by only one jp2c box (one codestream per JPEG 200 file).

NOTE As a consequence, the different components of a same image can not be split in separate codestreams.

Grid coordinate system

JPEG 2000 Standard defines the origin of the grid coordinate system as being the upper left corner of the grid coverage. The axis 'X' and 'Y are oriented to the right and downward.

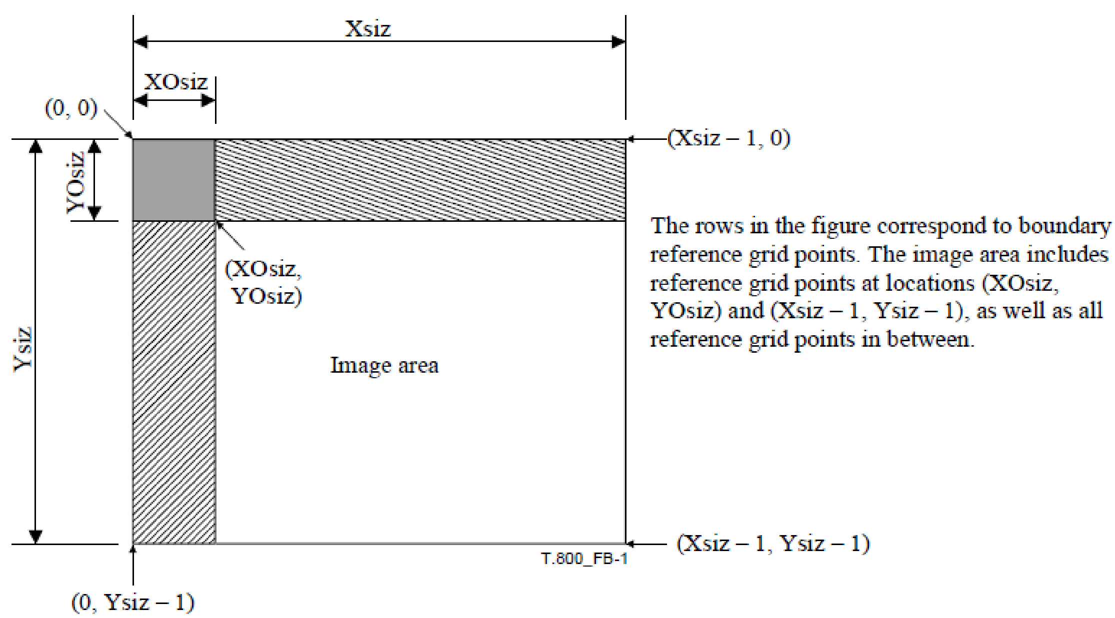

Figure 24 : referenced grid as defined by JPEG 2000

Source : ISO 15444-1

Range values

ISO 15444-1 allows a lot of image types with multiband composition. Within the scope of INSPIRE, following types are addressed: bilevel, greyscale, palette-colour, full-colour images (known as RGB images) and multispectral images. So the image data of a JPEG 2000 file can contain either 1 (bilevel, greyscale and palette-colour), 3 bands (RGB) or more bands (multispectral images). An additional band for opacity may also be used.

The use of palette-colour in JPEG 2000 is restricted to a mapping from one component to RGB data.

These components are described trough markers in the JPEG 2000 codestream (see Table 12) and boxes in the JP2 format (see Table 13).

TG Requirement 15	For imagery, the range values shall be expressed as unsigned integers coded on 8 or 16 bits, except for bi-level images which are 1-bit data. For other gridded data (e.g. elevation data, measured data), they shall be stored as 8 or 16-bits integers, signed or unsigned, or as 32-bits.

JPEG2000 (ISO 15444-1) does not allow to encode data as floats (only integers), but in general you can choose a Unit of measure for which your results are integers. For elevation, use centimetres (cm) instead of metres (m).

NOTE If the original data do not satisfy this requirement, they will be converted in a representation using the next higher power of 2.

TG Requirement 16	In the case of multi-band images, the number of bits per component shall be the same for all the bands.

Opacity channel

JP2 format allows to describe opacity channel (trough Channel Definition Box or CDEF) and then to display multiple files without overlapping issues. Opacity channel can be defined for RGB or greyscales images. The following table gives example of an RGB image with alpha channel. CDF defines the 3 RGB components and then the alpha channel which applies to the all 3 RGB ones.

Table 11. Definition of opacity channel with CDEF box

<table>
<tr><td colspan="5">CDEF box</td></tr>
<tr><td>Hexadecimal</td><td colspan="3">Numeric conversion (2 bits)</td><td>interprétation</td></tr>
<tr><td>00 04</td><td colspan="3">4</td><td>4 components</td></tr>
<tr><td>00 00 00 00 00 01 |
00 01 00 00 00 02
00 02 | 00 00 00 03
00 03 00 01 | 00 00</td><td>0
1
2
3</td><td>0
0
0
1</td><td>1
2
3
0</td><td>component 0 is red R
component 1 is green G
component 2 is blue B
component 3 is an opacity channel related to all other component</td></tr>
<tr><td></td><td>Component number</td><td>signification</td><td>Colour of the component</td><td></td></tr>
</table>

NOTE In this case, bit depth shall be defined for each of the four components trough the bpcc boxes in the JP2 Header Box.

JPEG 2000 allows defining opacity channel on more than 1 bit to have a scale of transparency. In pur case, we're just interested in full transparency and full opacity. So, within the scope of INSPIRE, it is recommended to code it on only 1 bit (0= transparent, 1=opaque)

Recommendation 3	In the case of an opacity channel, the bit depth should be 1-bit.

Compression

JPEG 2000 codestream allows both lossless and lossy compression. Lossless compression is important for some themes because you can't allow any loss of information. For example in Land Cover, or Land Use, you encode a code which represents a class. For other themes, a lossy compression without visual effect can be also interesting. JPEG 2000 lossy compression is very powerful with which you can compress imagery data by 1:10 or more without visual effect. For example, 1:30 is commonly used for RGB data compression.

Internal tiling

JPEG 2000 allows internal tiling within the codestream. Profile 1 of ISO 15444-1 already requires no tiling (i.e. the image = 1 tile) or tiling with tiles size bigger than 1024x1024 pixels. There is no further requirement.

Resolutions

JPEG 2000 codestream encode the full resolution image but has mechanisms to directly access (without any computation) particular sub-resolutions. So the JPEG 2000 file contains a pyramid of resolution. The number of decomposition Nd defines the smallest image you can access whose size is reduced by 2^{Nd} (compared to the full image). Profile 1 of ISO 15444-1 requires that the number of decomposition shall be such as: Height/2^{Nd} ≤128 pixels and Width/2^{Nd} ≤128 pixels (height and width of the full resolution image).

For example for a 2048x1024 image, the number of decomposition is 4, and the smallest thumbnail image is 128x64 pixels.

There is no further requirement.

Region of interest

When encoding in a lossy mode, JPEG 2000 allows to encode some image regions with better quality and then deteriorate the quality of other areas. This capability shall not be used.

TG Requirement 17	JPEG 2000 codestream shall not encode Region Of Interest (RGN marker segment).

Precincts

A precinct is a sub-division of a tile-component, within a each resolution, used for limiting the size of packets. It improves a lot data decompression time and then visualisation.

Recommendation 4	It is recommended to use precincts in JPEG 2000 files to enable fast decompression and visualisation.

NOTE Precincts size needs to be specified too, but this will be defined according to the tile size, image size and other JPEG 2000 parameters.

Other options

JPEG 2000 allows more options:
- Quality layers, i.e. the capability to different levels of compressions within the same JPEG 200 file.
- Presence of markers, some allowing fast data access (TLM, PLT), other allowing error resiliency, ..
- Encoding order; the codestream can be arranged in different ways depending the order you want the data to be decompressed.

- Colour transformation, from RGB to three other decorrelated components (ICT or RCT transformations).

These choices depend on data size, data access (through network services, via FTP, via USB stick, …) and then can't be made here.

Georeferencing

Georeference information can be provided by different mechanisms directly within the JPEG 2000 file:
- Case of pure JPEG 2000, georeference is provided through the 'uuid' box (GeoJP2 mechanism uses Geotiff tags to reference the image, see *http://www.lizardtech.com/support/kb/docs/geotiff_box.txt*).
- Case of GMLJP2 , georeference is provided through GML data.

E.3.3 Mapping between JPEG 2000 and GML data structures

The following table indicates how to fill the content of TIFF tags for grid coverages in the context of INSPIRE. On the other hand, it gives the rules to be applied for ensuring the consistency of JPEG 2000 files with the *Orthoimagery* GML Application(s) Schema(s). It does not address the encoding of the possible transparency mask.

As described by the Format overview section, the JP2 format contains the JPEG 2000 codestream. Both have elements that need to be consistent with GML. The first table deals with mappings between the JPEG 2000 codestream and GML, whereas the second table deals with mappings between JP2 boxes and GML elements.

The columns *marker/box*, *description*, *Type*, *Card.* and Conditions/*Values* remind respectively the marker code/box name, its description, its obligation/maximum number of occurrences allowed by JPEG 2000 standard (ISO 15444-1). The column *values* specifies the values allowed for the marker in the context of INSPIRE. The column *Mapping to GML elements* establishes a correspondence between these makers values and the corresponding GML elements of the coverage whose type is one of those specified in the Generic Conceptual Model (e.g. RectifiedGridCoverage). N/A means not applicable.

Table 12. mapping between markers in JPEG 2000 codestream and GML elements

Marker	Description	Card.	Values	Mapping GML
SIZ	Marker code (Image and tile size)	1		N/A
Lsiz	Length of marker segment	1		N/A
Rsiz	Denotes capabilities that a decoder needs to properly decode the codestream	1	0000 0000 0000 0010 Codestream restricted as described for Profile 0 from Table A.45	N/A
Xsiz	Width of the reference grid	1		= domainSet.limits.high[0]
Ysiz	Height of the reference grid	1		= domainSet.limits.high[1]
X0siz	Horizontal offset from the origin of the reference grid to the left side of the image area	1		= domainSet.limits.low[0]
YOsiz	Vertical offset from the origin of the reference grid to the top side of the image area.	1		= domainSet.limits.low[1]
XTsiz	Width of one reference tile with respect to the reference grid.	1		N/A
YTsiz	Height of one reference tile with respect to the reference grid	1		N/A
XTOsiz	Horizontal offset from the origin of the reference grid to the left side of the first tile	1		N/A
YTOsiz	Vertical offset from the origin of the reference grid to the top side of the first tile	1		N/A
Csiz	Number of components in the image	1	1 for greyscale imagery 3 for RGB data …	rangeType.field.size()
$Ssiz^i$	Precision (depth) in bits and sign of the ith component samples	1/component	x000 0000 to x010 101 Component sample bit depth = value + 1. x=0 (unsigned values) x=1 (signed values)	For each band i, rangeType.field[i].constraint.interval = "0 2^[Ssiz^i+1]-1"
$XRsiz^i$	Horizontal separation of a sample of ith component with respect to the reference grid	1/component	In most case $XRsiz^i$ =1 for all components	N/A
$YRsiz^i$	Vertical separation of a sample of ith component with respect to the reference grid	1/component	In most case $YRsiz^i$ =1 for all components	N/A

For each component i of the image, its size is defined by :

$$Width^i = (Xsiz - X0siz)/XRsiz^i$$
$$Height^i = (Ysiz - Y0siz)/YRsiz^i$$

Table 13. Mapping between boxes in JP2 format and GML elements

Box name	Type	Description	Card.	Conditions/Values	Mapping GML
JPEG 2000 Signature box	'jP\040\040'	The combination of the particular type and contents for this box enable an application to detect a common set of file transmission errors.	1	'<CR><LF><0x87><LF>'	N/A
File Type box	'ftyp'		1		N/A
BR		Brand. This field specifies the Recommendation | International Standard which completely defines this file.		'jp2\040' meaning is 15444-1, Annex I	N/A
MinV		Minor version. This parameter defines the minor version number of this JP2 specification for which the file complies.	1		N/A
CL		Compatibility list. This field specifies a code representing this Recommendation | International Standard, another standard, or a profile of another standard, to which the file conforms.	1..*	At least 'jp2\040' + 'jpx\040' for GMLJP2 images	N/A
JP2 Header box	'jp2h'		1		N/A
ihdr	'ihdr'	Image Header box	1		N/A
HEIGHT		Image area height	1	Ysiz – Y0siz	domainSet.limits.high[1]-domainSet.limits.low[1]
WIDTH		Image area width	1	Xsiz – X0siz	domainSet.limits.high[0]-domainSet.limits.low[0]
NC		Number of components	1	= Csiz	= rangeType.field.size() if no use of palette-colour data. If use of a colour palette NC=1, rangeType.field.size()=3.
BPC		Bits per component	1	If the bit depth of all components in the codesteam is the same (sign an precision) = Ssiz^i	For each band i, rangeType.field[i].constraint.interval = “0 2^[Ssiz^i+1]-1” if no use of palette-colour data. If use of a palette colour, there is no relation.

		C		Compression type		7 (Other values are reserved for ISO use)	N/A
		UnkC		Colourspace Unknown.	1	0 (colourspace of the image is known and correctly specified in the Colourspace Specification boxes within the file) 1 (if the colourspace of the image is not known)	N/A
		IPR		Intellectual Property	1		N/A
	bpc^i		'bpcc'	Bits per component	Optional Required if component have different bit depth	x000 0000 to x010 101 Component sample bit depth = value + 1. x=0 (unsigned values) x=1 (signed values)	For each band i, rangeType.field[i].constraint.interval = "0 2^[Ssiz^i+1]-1"
	colr^i		'colr'	Each Colour Specification box defines one method by which an application can interpret the colourspace of the decompressed image data	1		N/A
		METH		Specification method	1	1 (Enumerated Colourspace) 2 (Restricted ICC profile) other values (Reserved for other ISO use)	N/A
		PREC		Precedence	1	0 (field reserved for ISO use)	
		APPROX		Colourspace approximation.	1	0	N/A
		EnumCS		Enumerated colourspace	1	16 (sRGB as defined by IEC 61966-2-1) 17 (greyscale) 18 (sYCC as defined by IEC 61966-2-1 Amd. 1) other values (Reserved for other ISO uses)	N/A
	pclr		'pclr'	Palette box. This box specifies a palette that can be used to create channels from components.	0..1		N/A

	cmap		'cmap'	Component Mapping box. The Component Mapping box defines how image channels are identified from the actual components decoded from the codestream.	0..1		N/A
	cdef		'cdef'	Channel Definition box	Optional		The description provided shall be consistent with the rangeType description
		N		Number of channel descriptions	1		= rangeType.field.size()
		Cni		Channel index	1/channel		N/A
		Typi		Channel type	1/channel	0 This channel is the colour image data for the associated colour. 1 (Opacity) 2 (Premultiplied opacity)	N/A
		Asoci		Channel association	1/channel	0 (This channel is associated as the image as a whole) 1 to (216– 2) This channel is associated with a particular colour as indicated by this value) 216– 1 This channel is not associated with any particular colour.	N/A
	res		'resd'		Optional		N/A
		resc		Capture Resolution box.	Optional		N/A
		resd		Default Display Resolution box.	Optional		N/A
Contiguou Codestream box			‘jp2c’	This box contains the codestream as defined by Annex A of ISO 15444-1.	1	Contains the encoded data in JPEG 2000.	
Intellectual property box			‘jp2i’	This box contains intellectual property information about the image.	Optional		N/A
XML Box			‘xml\040’	Box for XML formatted information to a JP2 file.	Optional		The place to provide GML within JPEG 2000 (see OGC standard for more details).
UUID box			‘uuid’	Box for additional information to a file without risking conflict with other vendors	Optional		The place to provide GeoJP2 georeference. Shall be consistent with georeference given by the origin of the grid “domainSet.origin” and the offset vector “domainSet.offsetVector”.
UUID info box			‘uinf’	Box for providing access to additional information associated with a UUID.	Optional		N/A

	UUID list box	'ulst'	This box specifies a list of UUIDs.	Optional		N/A
	URL box	'url\040'	This box specifies a URL.	Optional		N/A

E.3.4 Theme-specific requirements and recommendations

TG Requirement 18	For orthoimagery, the range values shall be expressed as unsigned integers coded on 8 or 16 bits, except for bi-level images which are 1-bit data.