TECHNICAL SPECIFICATION

ISO/TS 19163-1

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Geographic information — Content components and encoding rules for imagery and gridded data —

Part 1: Content model

Information géographique — Composantes de contenu et règles de codage pour l'imagerie et les données maillées —

Partie 1: Modèle de contenu

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 211, *Geographic information/Geomatics*.

ISO 19163 consists of the following parts, under the general title *Geographic information — Content components and encoding rules for imagery and gridded data*:

— *Part 1: Content model* [Technical Specification]

Other parts are planned, but are not yet specified.

Introduction

Geographic imagery and gridded thematic data are widely used in the geospatial community and related fields.

A preliminary work item on imagery and gridded data components, carried out by ISO/TC 211 in 1999 to 2000, provides a summary of the conceptual classification of gridded data based on spatial and attribute properties and identifies five basic components of imagery and gridded data (ISO/TC 211 N 1017). ISO/TS 19101-2, ISO 19123 and ISO/TS 19129 specify domains and ranges of imagery, grids and coverages, and their associated relationships. ISO/TS 19129 breaks down the metadata into discovery, structural, acquisition and quality metadata. However, there are no detailed descriptions on each category and no clear associations with metadata defined in ISO 19115:2003, ISO 19115-2, ISO/TS 19130 and ISO/TS 19130-2.

Imagery is acquired by remote sensors directly or derived from source imagery. Value-added image processing can be used to derive physical properties of a remote object from images (ISO/TS 19101-2). Besides the derived images, imagery can also be integrated with other data sources to produce new gridded coverage data for a specific theme, called thematic data, which is widely used in various applications. However, the characteristics of thematic data are not covered by the existing International Standards and Technical Specifications noted above.

ISO/TS 19130 identifies the type of remote sensors by the measurand of the sensor, e.g. optical radiation, microwave energy and SONAR (acoustic) energy. Images acquired by optical sensors have different appearances and characteristics compared with those by a microwave sensor, e.g. SAR data.

The framework defined in ISO/TS 19129 describes imagery, gridded and coverage data at multiple levels, including an abstract level, a content model level and an encoding level. The first two levels combine a number of well-defined content structures in accordance with ISO 19123 and define the contents of continuous quadrilateral gridded coverages with grids of both constant and variable cell sizes. However, the content model level does not specify the necessary metadata for common understanding when integrating datasets encoded in different formats. At the encoding level, ISO/TS 19129 does not provide the explicit encoding rules for mapping content model to machine-independent encoding structure, which is crucial for the mapping and translation of images in different formats without losing information.

Based on the frameworks defined in ISO/TS 19101-2 and ISO 19123, this Technical Specification specifies the categories of imagery and gridded data and establishes a corresponding hierarchical content model. Categories of imagery and gridded data are defined based on thematic and spatial attributes and sensor types. The content model is then defined to describe the required content components of each category, including the spatial and attribute structures and the critical metadata entries as well. These metadata entries are specified as the minimum required metadata information for the purpose of common understanding. Traditionally, remote sensing data products generally have a header part and a data part. This Technical Specification describes the minimum content requirements for the header part.

For ease of implementation, this Technical Specification defines encoding rules to map the content models to XML-based encodings, following the general encoding rules defined in ISO 19118 and the encoding rules for UML-to-GML application schema defined in ISO 19136:2007, Annex E. Since GMLCOV schema (OGC 09-146r2) is optimized for handling coverages, the coverage component of the schema can be based on GMLCOV.

An increasingly large volume of image and gridded data, both natural and synthetic, is being produced because more remote sensors are becoming available. These data are encoded in diverse formats, such as GeoTIFF, BIIF, HDF-EOS, JPEG 2000, NetCDF and others as described in ISO/TR 19121. These encoding formats follow different data models, preventing them from being interoperable. In order to encode the contents defined in this Technical Specification into these data formats, ISO 19163 has been split into multiple parts with this Technical Specification defining the content components and general encoding rules and the subsequent parts defining the binding between the contents and individual physical data formats.

Geographic information — Content components and encoding rules for imagery and gridded data —

Part 1: Content model

1 Scope

This Technical Specification classifies imagery and regularly spaced gridded thematic data into types based on attribute property, sensor type and spatial property, and defines an encoding-neutral content model for the required components for each type of data. It also specifies logical data structures and the rules for encoding the content components in the structures.

The binding between the content and a specific encoding format will be defined in the subsequent parts of ISO 19163.

This Technical Specification does not address LiDAR, SONAR data and ungeoreferenced gridded data.

The logical data structures and the rules for encoding the content components will be addressed in the subsequent parts of ISO 19163.

2 Conformance

This Technical Specification standardizes the categories of imagery and regularly spaced gridded thematic data as well as their core content models. There is one conformance class for each data category. Any set of imagery and regularly spaced gridded thematic data claiming conformance to this Technical Specification shall satisfy the corresponding requirements defined in the abstract test suite in Annex A.

3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19103:2015, *Geographic information — Conceptual schema language*

ISO 19111, *Geographic information — Spatial referencing by coordinates*

ISO 19115-1, *Geographic information — Metadata — Part 1: Fundamentals*

ISO 19115-2[1)], *Geographic information — Metadata — Part 2: Extensions for imagery and gridded data*

ISO 19123:2005, *Geographic information — Schema for coverage geometry and functions*

ISO/TS 19101-2:2008, *Geographic information — Reference model — Part 2: Imagery*

ISO/TS 19130:2010, *Geographic information - Imagery sensor models for geopositioning*

ISO/TS 19159-1, *Geographic information — Calibration and validation of remote sensing imagery sensors and data — Part 1: Optical sensors*

1) At the publication time of this Technical Specification, only ISO 19115-2:2009, which references to ISO 19115:2003, is available. The new version of ISO 19115-2, which is under revision at the publication time of this Technical Specification, will refer to ISO 19115-1:2014.

4 Terms and definitions

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

4.1
attribute
named property of an entity

Note 1 to entry: Describes a geometrical, topological, thematic, or other characteristic of an entity.

[SOURCE: ISO/IEC 2382:2015, 2121440, modified — Note 1 to entry has been added.]

4.2
binding
specification of a mapping relating the information defined in a *content model* (4.3) (data and metadata) to the data format that carries that information

4.3
content model
information view of an application schema

Note 1 to entry: In this Technical Specification, a content model describes the required content components and their interrelationship of *imagery* (4.12) and gridded *thematic data* (4.14).

[SOURCE: ISO/TS 19129:2009, 4.1.2, modified — Note 1 to entry has been added.]

4.4
conversion rule
rule for converting instances in the input data structure to instances in the output data structure

[SOURCE: ISO 19118:2011, 4.7]

4.5
encoding rule
identifiable collection of *conversion rules* (4.4) that define the encoding for a particular data structure

EXAMPLE XML, ISO 10303-21, ISO/IEC 8211.

Note 1 to entry: An encoding rule specifies the types of data to be converted as well as the syntax, structure and codes used in the resulting data structure.

[SOURCE: ISO 19118:2011, 4.14]

4.6
fused image
image produced by fusing images from multiple sources

4.7
geopositioning
determining the geographic position of an object

[SOURCE: ISO/TS 19130:2010, 4.36, modified]

4.8
georectified
corrected for positional displacement with respect to the surface of the Earth

[SOURCE: ISO 19115-2:2009, 4.12]

4.9
georeferenceable
associated with a *geopositioning* (4.7) information that can be used to convert *grid* (4.10) coordinate values to values of coordinates referenced to an external coordinate reference system related to the Earth by a datum

4.10
grid
network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in an algorithmic way

[SOURCE: ISO 19123:2005, 4.1.23, modified]

4.11
gridded data
data whose *attribute* (4.1) values are associated with positions on a *grid* (4.10) coordinate system

Note 1 to entry: Gridded data are a subtype of coverage data, which represent attribute values of geographic features in terms of a spatial grid.

[SOURCE: ISO 19115-2:2009, 4.17, modified — Note 1 to entry has been added.]

4.12
imagery
representation of phenomena as images produced by electronic and/or optical techniques

Note 1 to entry: The term imagery is often used colloquially with various meanings in different contexts. It is often used to describe any set of gridded, point set or other form of coverage data that can be portrayed.

[SOURCE: ISO/TS 19101-2:2008, 4.14, modified — Note 1 to entry has been added.]

4.13
looks
groups of signal samples in a SAR processor that splits the full synthetic aperture into several sub-apertures, each representing an independent look of the identical scene

Note 1 to entry: The resulting image formed by incoherent summing of these looks is characterized by reduced speckle and degraded spatial resolution.

4.14
thematic data
gridded data (4.11) whose *attribute* (4.1) values describe characteristics of a *grid* (4.10) coverage feature in a grid format

Note 1 to entry: Most gridded thematic data are derived from *imagery* (4.12) data using geophysical/atmospheric inversion algorithms. Gridded thematic data may also be obtained from other sources such as digitization of topographic map sheets.

4.15
ungeoreferenced grid
gridded data (4.11) that does not include any information that can be used to determine a cell's geographic coordinate values

EXAMPLE A digital photo without georectification information included.

5 Symbols and abbreviated terms

5.1 Abbreviated terms

BIIF	Basic Image Interchange Format
CRS	Coordinate Reference System
DEM	Digital Elevation Model
EOS	Earth Observing System
HDF	Hierarchical Data Format
JPEG200	Joint Photographic Experts Group 2000
netCDF	network Common Data Form
SAR	Synthetic aperture radar
TIFF	Tagged Image File Format
UML	Unified Modeling Language

5.2 UML notations

This Technical Specification presents conceptual models of imagery and gridded data, specified in the Unified Modeling Language (UML). ISO 19103 describes the way in which UML is used in the ISO 19100[2)] family of standards. It differs from standard UML only in the existence and interpretation of some special stereotypes, in particular, "CodeList". ISO 19103 specifies the basic data types used in the UML model. The UML diagrams defined in this Technical Specification represent conceptual models only and are not intended for automatic encoding within XML Schema.

Annex B contains a data dictionary for the UML models defined in this Technical Specification.

Table 1 lists the prefixes of UML classes used in the referenced ISO standards in this Technical Specification. IE is the prefix of the UML classes defined in this Technical Specification. In Table 1, the first column describes the prefix used in the packages of the second column and the third column is the ISO standard where the package is defined.

2) This International Standard is under preparation.

Table 1 — UML package identifiers

Identifier	Package	International Standard
EX	Extent information	ISO 19115-1
LE	Lineage extended	ISO 19115-2
LI	Lineage	ISO 19115-1
MD	Metadata	ISO 19115-1
MI	Metadata for imagery	ISO 19115-2
SD	Sensor data	ISO/TS 19130
CV	Coverage	ISO 19123
CA	Calibration and validation of sensor	ISO/TS 19159-1
GM	Geometry root	ISO 19107
IE	Content components and encoding rules for imagery and gridded data	ISO 19163

6 Related International Standards

Figure 1 illustrates the relationship between this Technical Specification and other International Standards related to imagery and gridded data. This Technical Specification fits the reference model defined in ISO/TS 19101-2 and follows the abstract content framework defined in ISO 19123. CV_Coverage is chosen as the super-class to establish the content component model of imagery and gridded data.

This Technical Specification refers to metadata related to imagery and gridded data defined in ISO 19115-1 and ISO 19115-2, the sensor information related to acquisition of imagery defined in ISO/TS 19130 and the calibration and validation of sensors defined in ISO/TS 19159-1.

This Technical Specification defines an UML schema for the content model which can be bound with any widely used data formats of imagery and gridded data, such as GeoTIFF, BIIF, JPEG 2000, NetCDF and HDF.

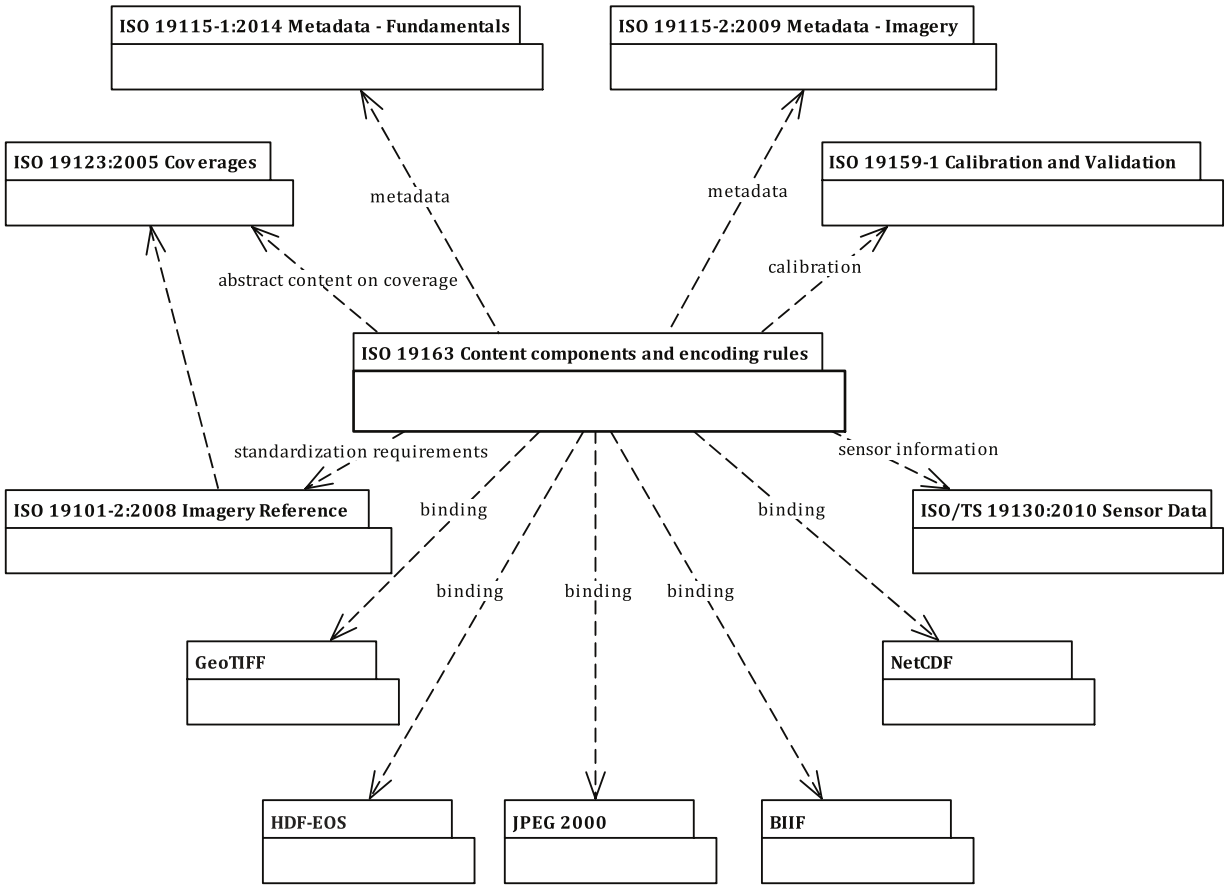

Figure 1 — Relationship with related International Standards

7 Categories of imagery and gridded data

7.1 General

Clause 7 categorizes imagery according to digital sensor types and gridded data according to the attribute and geometry properties. The required content components of each data category are specified in UML content models of Clause 8.

The intention of this Technical Specification is not to define a comprehensive classification system of imagery and gridded data, but to specify the contents of some categories of them. A hierarchical category framework of imagery and gridded data is defined in Figure 2. The root of the framework is Coverage defined in ISO 19123. Imagery and gridded data are a subclass of coverage. The two subclasses of imagery and gridded data, which are imagery data and thematic gridded data, are defined in this Technical Specification.

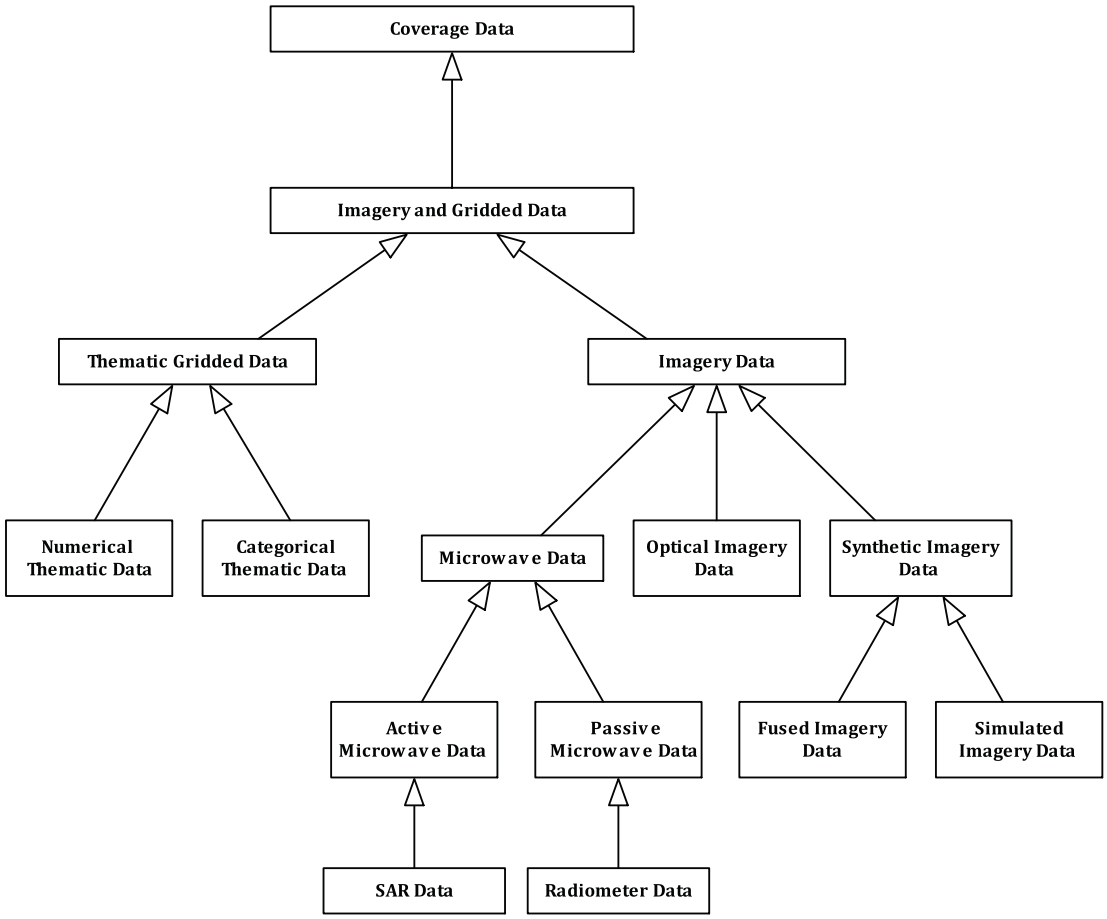

Figure 2 — Categories of imagery and gridded data

7.2 Imagery

Imagery is a kind of coverage whose attribute values are numerical representations of the physical parameters (e.g. radiance) measured by imagery sensors. According to ISO/TS 19101-2, a sensor can be classified as an electromagnetic energy sensor or a mechanical wave energy sensor based on the type of energy sensed by the sensor. The former class is further categorized into an optical sensor, a microwave sensor or a light detection and ranging sensor (LiDAR) according to the measurand of the sensor (ISO/TS 19130). SONAR is a typical example of mechanical wave energy sensor. These sensors produce optical, microwave, LiDAR and SONAR imagery data, respectively.

The data acquired by LiDAR and SONAR, which exhibit distinct characteristics that differ from optical images and microwave data, are not covered by this Technical Specification due to the limit of the scope. These types of data may be addressed in a future extension or subsequent part of ISO 19163.

Optical images are acquired from visible and infrared sensors by detecting the radiation reflected or emitted from target objects (ISO/TS 19101-2). Different materials reflect, absorb or emit radiation at different wavelengths, and accordingly each object type has a spectral signature. Analysing spectral signatures within remotely sensed images identifies differentiation between these objects. Thus, images may be classified depending on the number of spectral bands, for example panchromatic, multispectral and hyperspectral.

Microwave data are classified into active and passive microwave data corresponding to active and passive microwave sensors. Synthetic aperture radar (SAR) is a typical active microwave sensor that uses a series of radar pulses transmitted and received over time from a moving platform to create an image, as specified by ISO/TS 19130.

Passive microwave sensors measure the energy and/or the phase of microwaves emitted from objects. Passive microwave data can be used to derive various geophysical quantities, such as rainfall, sea surface temperature, vertical water vapour, ocean surface wind speed, sea ice parameters, snow water equivalent and soil surface moisture (ISO/TS 19101-2). There is more than one type of passive microwave data, but this Technical Specification only specifies the contents of microwave imaging radiometer data.

In addition to images acquired directly by a certain sensor, image fusion and image simulation techniques can generate new images from original images, fused image and simulated image. The image fusion techniques allow the integration of images from different sources. The fused image can have complementary multisource characteristics. For example, a higher-spatial-resolution panchromatic image is fused with lower-spatial-resolution multispectral data to provide multispectral information with higher spatial resolution; optical images and SAR data can be merged in order to simultaneously exploit the spectral and textural information.

7.3 Gridded data

Gridded data are a subtype of coverage (ISO 19115-2). In order to avoid the content overlap, this Technical Specification limits gridded data to regularly spaced gridded thematic data whose attribute values are values of a geographic feature (e.g. altitude, leaf area index) and whose geometric state is regularly spaced quadrilateral grid.

Most thematic data are derived from imagery by information retrieval processing with domain-specific or application-specific algorithms. Some thematic data, such as Digital Elevation Model (DEM) and scanned or rasterized data, are not necessarily derived from imagery data. DEM and rasterized data are often integrated with imagery data in various applications, for example a 3D virtual terrain. There are several different geometric states for thematic data, gridded-based, point-based, surface-based and segmented based one (ISO/TS 19101-2). This Technical Specification only defines the content of regular-gridded thematic data.

Thematic data have categorical attributes or numerical attributes of a geographic feature or phenomenon. Typical examples of numerical data are DEM and land surface temperature, and those of categorical data are land cover and land use data. Categorical attributes shall not be interpolated.

8 Content component models

8.1 General

This Technical Specification defines the required content components of imagery and gridded data based on the hierarchical category framework (Figure 2). 8.2 to 8.4 describe these categories using UML model diagrams and the corresponding data dictionary is given in Annex B.

8.2 Imagery and gridded data

8.2.1 General

The structure and association of imagery and gridded data are illustrated in Figure 3. The topmost class of this Technical Specification, IE_ImageryAndGriddedData, is a subclass of CV_Coverage defined in ISO 19123. The information of coordinate reference system is specified in ISO 19111. IE_Georectified and IE_Georeferenceable are aggregated to describe the associate geolocation information of georectified and georeferenceable data, respectively.

The data dictionary of this UML diagram is given in B.1.

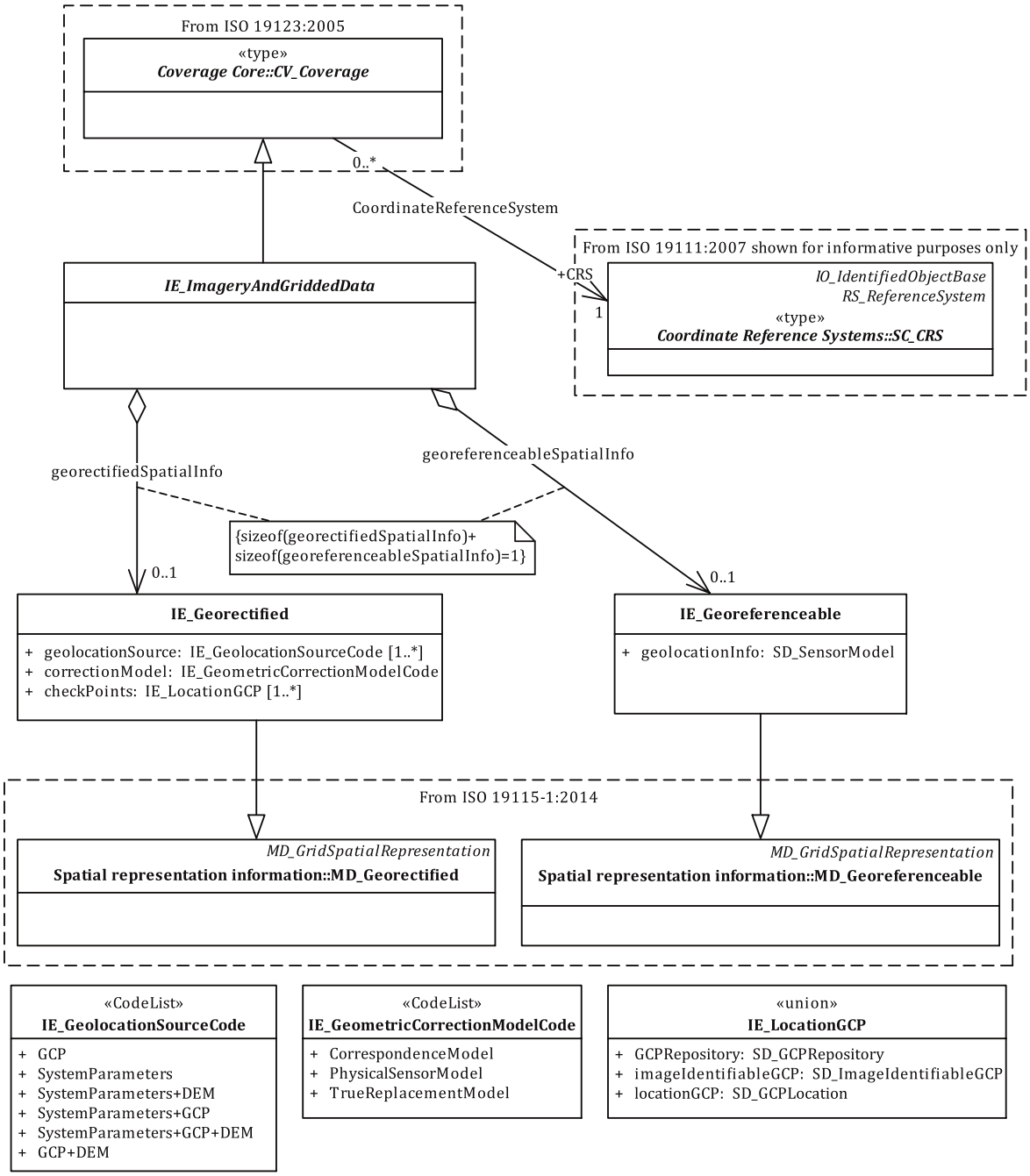

Figure 3 — IE_ImageryAndGriddedData

8.2.2 IE_ImageryAndGriddedData

IE_ImageryAndGriddedData inherits the attributes of CV_Coverage and defines an attribute interpolationType to identify the interpolation method that shall be used to derive a feature attribute value at any direct position.

8.2.3 IE_Georectified

IE_Georectified specifies the source of geolocations and the model used for geometric correction. The attribute *checkPoints* specifies the format and source of ground control points used as check points in a georectified image. The ground control points can be given in coordinates (defined in SD_LocationGCP),

or marked in images or described in texts (defined in SD_ImageIdentifiableGCP), or accessed from a GCP repository based on access restrictions (defined in SD_GCPRepository). SD_LocationGCP inherits the attributes of MI_GCP from ISO 19115-2 and adds a grid coordinate of GCP.

More spatial attributes about the check points and other attributes are inherited from MD_Georectified defined in ISO 19115-1.

8.2.4 IE_Georeferenceable

Geolocation information of georeferenceable data shall be acquired from SD_SensorModel, which defines the geometric correction models. More spatial attributes about georeferenceable data are inherited from MD_Georeferenceable defined in ISO 19115-1.

8.3 Thematic gridded data

8.3.1 IE_ThematicGriddedData

IE_ThematicGriddedData (Figure 4) contains the common characteristics of thematic gridded data. The attribute *dataInfo* provides the basic information about the data (defined in MD_CoverageDescription of ISO 19115-1). The attributes, *annotation* and *geographicFeature*, define vector-based annotations and features overlapped on the gridded data in order to improve the understanding.

The processing and the source for producing the thematic gridded data are described with the attribute *retrievalProcessingInfo* and the attribute *sourceInfo*, respectively.

There are two subtypes of thematic gridded data, categorical and numerical, which are specified with IE_CategoricalGriddedData class and IE_NumericalGriddedData class.

The data dictionary for the UML diagram in 8.3 (Figure 4) is given in B.2.

8.3.2 IE_CategoricalGriddedData

IE_CategoricalGriddedData specifies the number of categories of a categorical data layer (*numberOfCategories*), the description on the classification to produce the categorical data (*classificationDescription*), and the number of bits for recording each value (*bitsPerValue*). IE_CategoricalValueAndColour describes the lookup table of the relationship between each value and its semantics and colour palette of each category. The content of "description" may be a reference to a classification legend item as defined in ISO 19144-1.

8.3.3 IE_NumericalGriddedData

IE_NumericalGriddedData specifies the meaning of the numerical gridded data with the attribute *valueDescription* and inherits the information about the maximum and minimum value, units, bitsPerValue and so on from MD_SampleDimension.

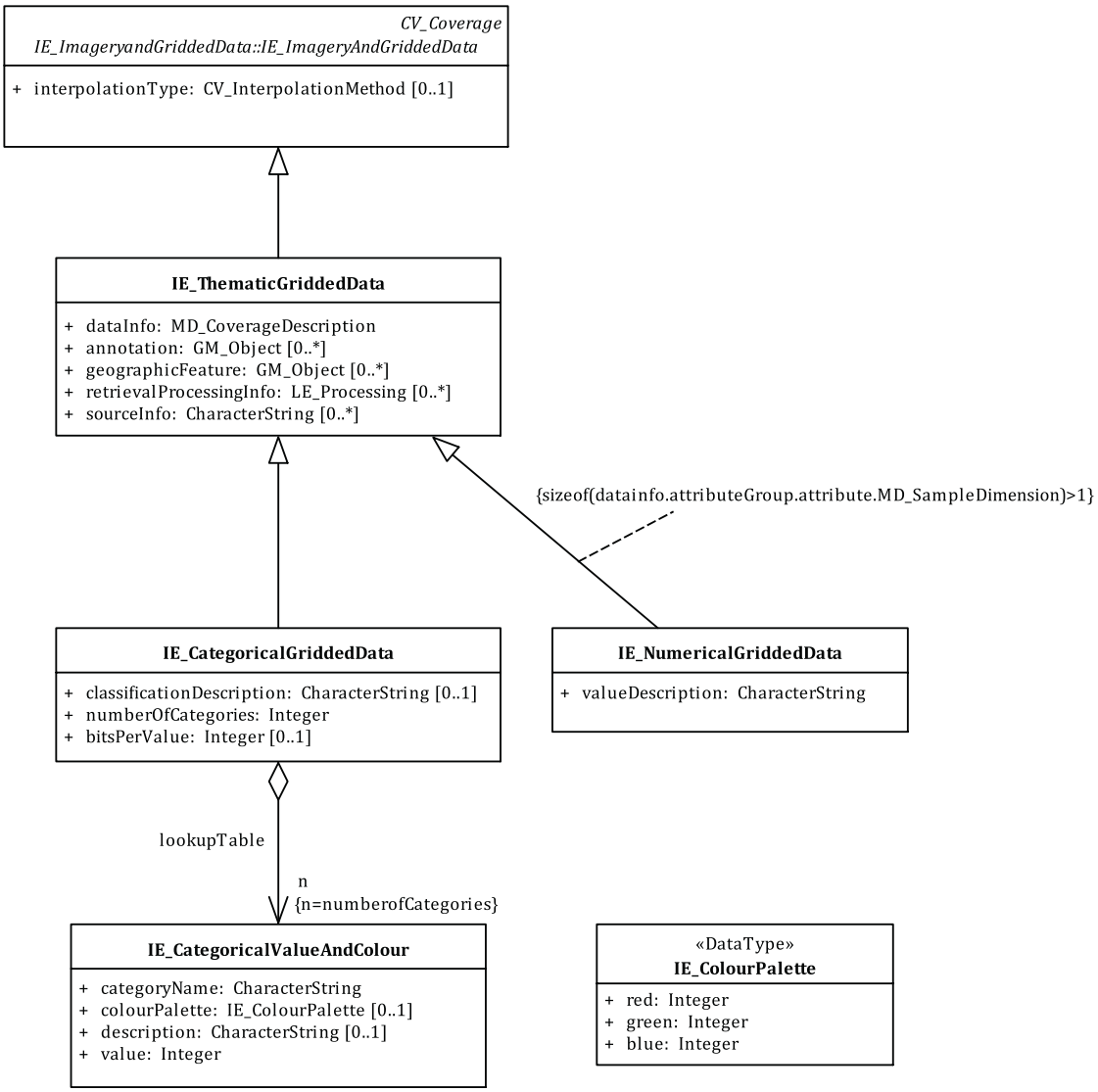

Figure 4 — IE_ThematicGriddedData

8.4 Imagery

8.4.1 IE_Imagery

The class IE_Imagery (Figure 5) inherits the attributes from IE_ImageryAndGriddedData. In addition, IE_Imagery defines the following required information: acquisition time, image parameters, number of bands, platform, sensor, processing action, calibration and validation of sensor.

The attribute *imageDescription* gives the basic parameters on acquiring image data. The attribute *processingAction* records the processing steps being taken on the dataset. LE_ProcessingActionCode lists the possible actions for image processing.

The attribute *radiometricCorrectionType* describes the type of image radiometric correction taken, which is either absolute correction or relative correction. The attribute *sensorCalibrationValidation* with its type *CA_CalibrationValidation* specifies the information required for sensor calibration and validation. *CA_CalibrationValidation* is defined in ISO/TS 19159-1.

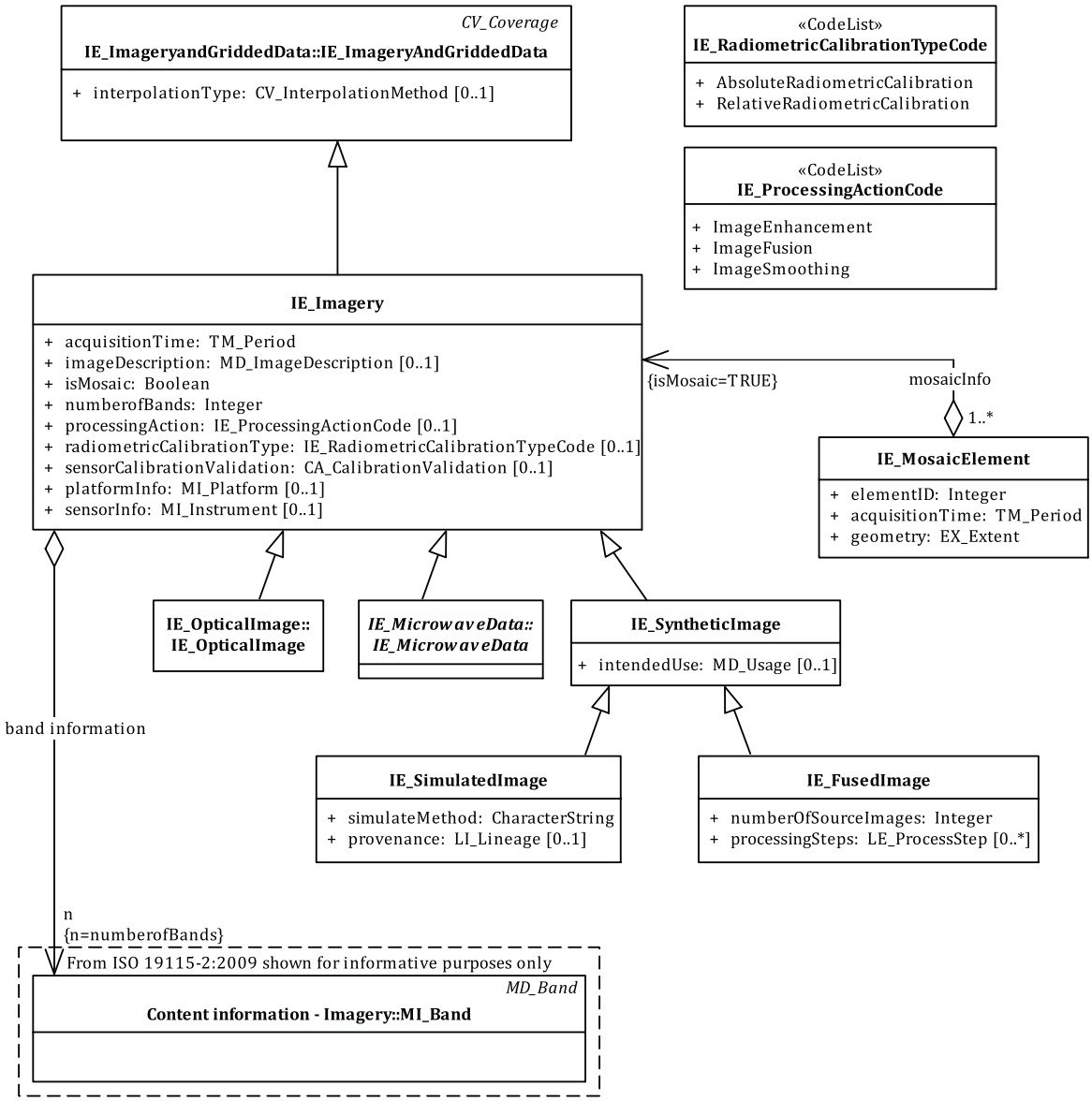

Figure 5 — IE_Imagery

The attribute *sensorInfo*, defined in MI_Instrument of ISO 19115-2, contains basic information about the sensor. The attributes *platformInfo*, defined in MI_Platform of ISO 19115-2, specifies the information of a platform on which the sensor is mounted.

If an image is a mosaic of multiple images, i.e. *IsMosaic = TRUE*, the acquisition time, extent and identification of each image shall be recorded as a mosaic element, IE_MosaicElement. The geometry attribute for the extent can contain multiple polygons, as described in ISO 19115-1.

IE_Imagery associates with n (n = numberofBands) MI_Band classes, each of which describes the information of a band. The detailed information of MI_Band is defined in ISO 19115-2.

According to the categories of imagery and gridded data (Figure 2), IE_Imagery has three subclasses, IE_OpticalImage (8.4.4), IE_MicrowaveData (8.4.5) and IE_SyntheticImage. IE_SyntheticImage defines the intended usage of the imagery and it has two subclasses, IE_FusedImage (8.4.2) and IE_SimulatedImage (8.4.3).

The data dictionary for the UML diagrams in 8.4 (Figure 5 to 9) is given in B.3.

8.4.2 IE_FusedImage

The class IE_FusedImage describes the number of source images and the processing steps used to produce a fused image.

8.4.3 IE_SimulatedImage

The class IE_SimulatedImage describes the method for simulating an image and its provenance.

Simulated images are used to evaluate the characteristics of a sensor system and validate the retrieval algorithms prior to the system being put into the operational environment.

8.4.4 IE_OpticalImage

The class IE_OpticalImage (Figure 6) contains the information specific to images acquired by optical sensors. The attribute *opticalImageType* identifies the type of an optical image, such as a hyperspectral, infrared, multispectral, panchromatic or other image. The attribute *opticalSensorType* specifies the type of an optical sensor.

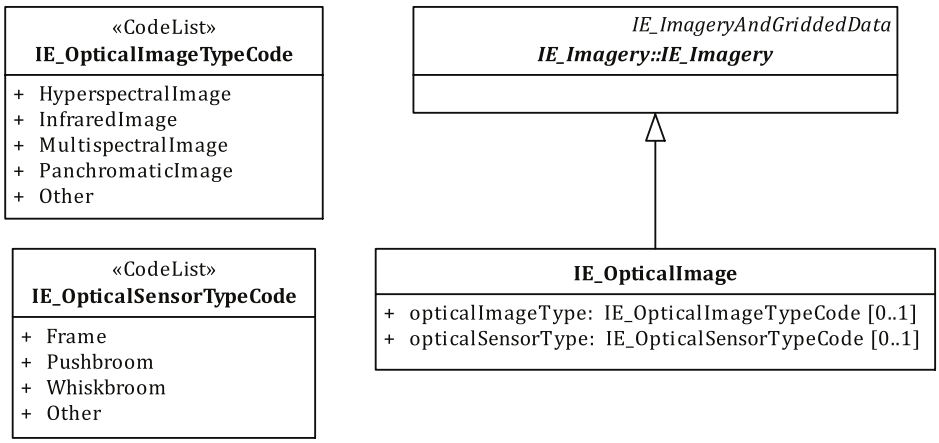

Figure 6 — IE_OpticalImage

8.4.5 IE_MicrowaveData

As shown in Figure 7, IE_MicrowaveData has two subclasses, which are IE_ActiveMWData and IE_PassiveMWData. There is more than one type of active and passive microwave data, but this Technical Specification only specifies the contents of data from SAR (IE_SARData) and microwave radiometers (IE_RadiometerData).

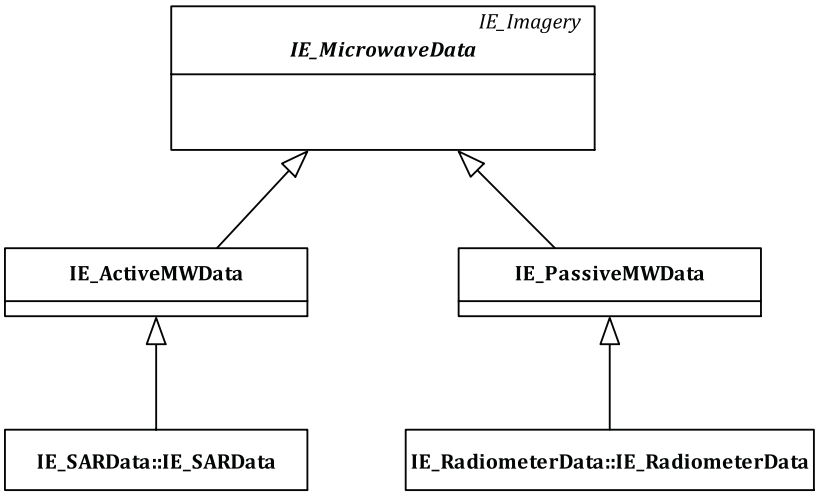

Figure 7 — IE_MicrowaveData

8.4.6 IE_SARData

The class IE_SARData (Figure 8) contains characteristics of SAR data.

IE_SARData includes the basic information on the system's wavelength, incidence angle, SAR imaging mode and sensor. IE_SARSensor represents the SAR sensor and platform information. It includes a series of IE_OrbitParameters to interpolate the precise orbit information of the sensor during image acquisition. It also includes a series of IE_SARDopplerCentroidParameters to allow the calculation of the Doppler centroid for a certain point in time during the image acquisition.

IE_SARDopplerCentroidParameter gives a point in time for which the given values are valid and three polynomial coefficients from which the Doppler centroid can be calculated:

$$DopperCentroid = \sum_{i=0}^{2} polynomial\_coeff_i (t - t_{ref})^i \quad (1)$$

where $polynomial\_coeff_i$ is the coefficient given in the IE_SARDopplerCentroidParameter with the exponent = i and t_{ref} is the reference point given in IE_SARDopplerCentroidParameter.

IE_SARComplexData represents a SAR image containing the complex backscattering information including real and imaginary values. It includes a sequence of IE_SARComplexLayerTypesCode for the characterization of the layers in the complex SAR image, the SAR sensor information, as well as the line and pixel spacing in seconds.

IE_SARAmplitudeData represents a SAR image containing only the amplitude information. It includes SAR sensor information, an optional calibration value, as well as the number of looks in azimuth and range direction.

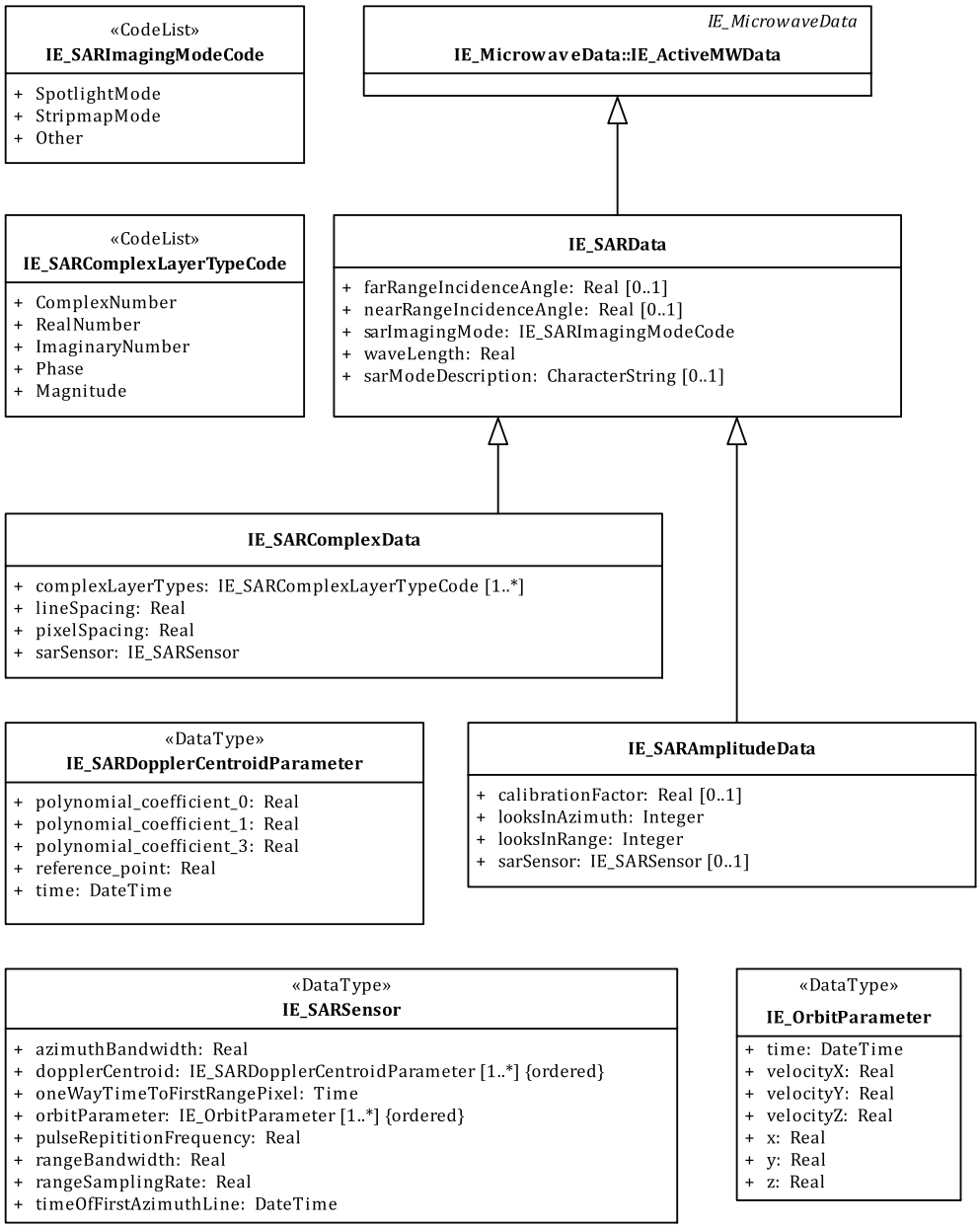

Figure 8 — IE_SARData

8.4.7 IE_RadiometerData

The class IE_RadiometerData specifies the attributes of data acquired from a microwave imaging radiometer (Figure 9). The attribute *scanningMode* presents the scanning mode of the radiometer.

The attribute *PMWBand* identifies the information relating to bands used in the radiometer. A radiometer may have more than one band and each band may have several channels, each of which has a specific width, centre frequency and absorption property.

The attribute *apertureType* specifies the aperture type of the radiometer.

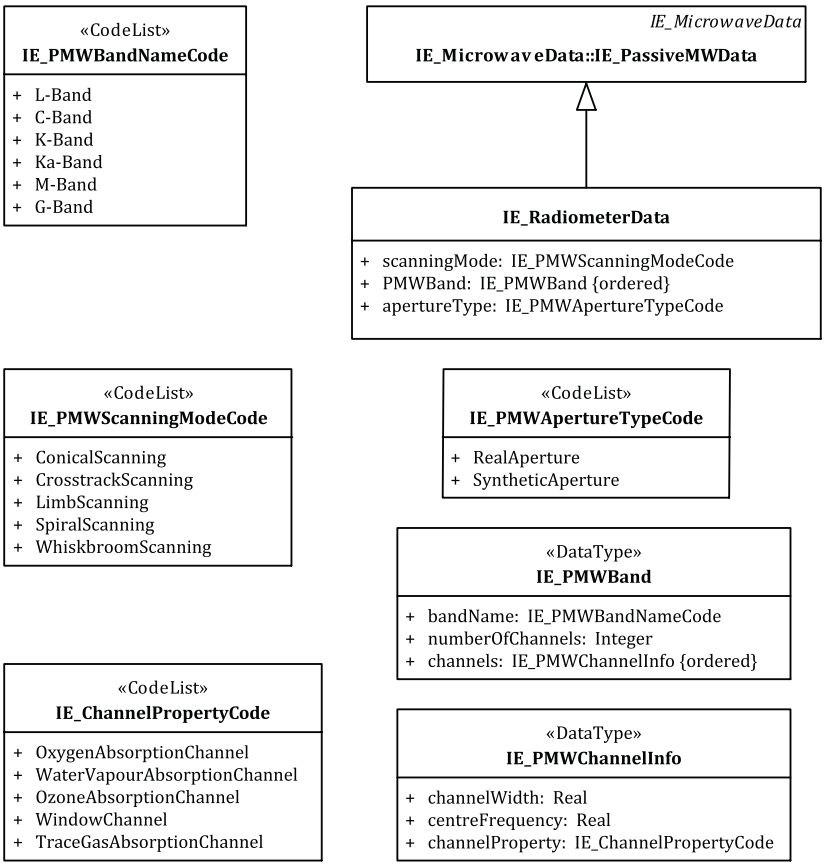

Figure 9 — IE_PassiveMWData

9 General approach for encoding (informative)

The critical issue for interoperability between heterogeneous systems is to define the semantics of the content and the logical structures of geographic data. This shall be done in an application schema. Clause 8 defines an UML-based application schema for imagery and gridded data, which gives a foundation for a common understanding of the data. Any data format can be used to encode imagery and gridded data compliant with this UML-based application scheme according to certain application requirements. For instance, imagery and gridded data can be encoded with GMLCOV for the purpose of transmitting by OGC Web Coverage Service (WCS) or the same data can be encoded as BIIF for other uses.

The application scheme defined in this Technical Specification provides a use-case-driven model for imagery and gridded data carrying commonly used information. Different encoding formats have varying degrees of capability to carry the information elements defined in this application schema. Information loss may result if the target format cannot support all the model elements defined in this Technical Specification. This loss is due to the limitations of the particular encoding format and is to be expected. Furthermore, if the source format contains information beyond the capability represented by this content model, this information will also be lost. That is, the bridging model will establish a core set of elements that may be encoded in different imagery formats bounded only by the limitations of the target format (Figure 10).

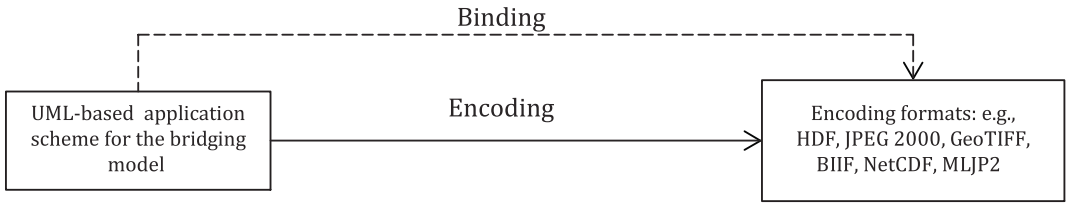

Figure 10 — General approach for encoding

The UML-based application schema specified in this Technical Specification is the input data structure and the output data structure of each encoding and is defined in the particular encoding format specification bound to the bridging model. GMLCOV provides a structure that supports many bindings.

This Technical Specification defines an UML schema for the content model. It does not define any XML schema. All encodings, including any XML encodings, are defined in the bound encoding formats that are specified separately.

Annex A
(normative)

Abstract test suite

A.1 General

Imagery and gridded data produced or provided as specified in Clause 8 and Annex B shall meet the requirements specified in this abstract test suite. This abstract test suite applies to any profile derived from this Technical Specification.

A.2 Imagery and gridded data

For any imagery and gridded dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset has the attributes defined in IE_ImageryAndGriddedData and the attributes defined in its associated classes, IE_Georectified and IE_Georeferenceable.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.2.

d) Test type: Basic.

A.3 Thematic gridded data

For a thematic gridded dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.2 and has the attributes defined in IE_ThematicGriddedData.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.3.1.

d) Test type: Basic.

A.4 Categorical gridded data

For a categorical gridded dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.3 and has the attributes defined in IE_CategoricalGriddedData.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.3.2.

d) Test type: Basic.

A.5 Numerical gridded data

For a numerical gridded dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.3 and has the attributes defined in IE_NumericalGriddedData.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.3.3.

d) Test type: Basic.

A.6 Imagery

For an image dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.2 and has the attributes defined in IE_Imagery.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.1.

d) Test type: Basic.

A.7 Synthetic image

For a synthetic image dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.6 and has the attributes defined in IE_SyntheticImage.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.1.

d) Test type: Basic.

A.8 Fused image

For a fused image dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.7 and has the attributes defined in IE_FusedImage.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.2.

d) Test type: Basic.

A.9 Simulated image

For a simulated image dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.7 and has the attributes defined in IE_SimulatedImage.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.3.

d) Test type: Basic.

A.10 Optical image

For an optical image dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.6 and has the attributes defined in IE_OpticalImagery.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.4.

d) Test type: Basic.

A.11 Microwave data

For a microwave dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.6 and has the attributes defined in IE_MicrowaveData.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.5.

d) Test type: Basic.

A.12 SAR data

For a SAR dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.11 and has the attributes defined in IE_SARData.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.6.

d) Test type: Basic.

A.13 Radiometer data

For a radiometer dataset, the test shall consist of the following.

a) Test purpose: Verify that the dataset satisfies the requirements of A.11 and has the attributes defined in IE_RadiometerData.

b) Test method: Inspect the contents of the dataset and the relative documentation.

c) Reference: 8.4.7.

d) Test type: Basic.

Annex B
(normative)

Data dictionary of content component models

B.1 Imagery and gridded data

B.1.1 General

Tables B.1 to B.4 define the detailed information of the classes included in the UML model in Figure 3.

B.1.2 IE_ImageryAndGriddedData

Table B.1 — General information on imagery and gridded data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
1.	**IE_ImageryAndGriddedData**	**Root entity that defines the general information about imagery or gridded data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (CV_Coverage)**	
2.	Interpolation Type	Interpolation method that shall be used to derive a feature attribute value at any direct position	O	1	Class	CV_InterpolationMethod (ISO 19123)
3.	Role name: georectifiedSpatialInfo	Spatial information about georectified imagery and gridded data	O	1	Class	IE_Georectified (B.1.3)
4.	Role name: georeferenceableSpatialInfo	Spatial information about georeferenceable imagery and gridded data	O	1	Class	IE_Georeferenceable (B.1.4)

B.1.3 IE_Georectified

Table B.2 — Information on georectified imagery and gridded data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
5.	**IE_Georectified**	**Provides information about the geometric correction of the georectified data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Aggregated Class (IE_ImageryAndGriddedData)**	
6.	geolocationSource	Type of the source of geolocation	M	N	Class	<<CodeList>> IE_GeolocationSourceCode (B.4.1)
7.	correctionModel	Model used in geometric correction of the thematic data	M	1	Class	<<CodeList>> IE_GeometricCorrectionModelCode (B.4.2)
8.	checkPoints	Points which are used to check the accuracy of georectified result	M	N	Class	<<union>> IE_LocationGCP (B.1.5)

B.1.4 IE_Georeferenceable

Table B.3 — Information on georeferenceable imagery and gridded data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
9.	**IE_Georeferenceable**	**Information about geopositioning of the georeferenceable data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Aggregated Class (IE_ImageryAndGriddedData)**	
10.	geolocationInfo	Information to be used to geolocate images	M	1	Class	SD_SensorModel (ISO/TS 19130)

B.1.5 IE_LocationGCP

Table B.4 — Location ground control points <<Union>>

	Name	Definition	Obligation	Max occurrence	Data type	Domain
11.	**IE_LocationGCP**	**Information about the control points used to georectify images**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Class <<Union>>**	
12.	locationGCP	Control points given in coordinates in imagery grid	C/ GCPReopository and imageIdentifiableGCP not documented?	1	Class	SD_GCPLocation (ISO/TS 19130)

Table B.4 *(continued)*

	Name	Definition	Obligation	Max occurrence	Data type	Domain
13.	GCPRepository	Information required to obtain ground control point from a repository of ground control points	C/ locationGCP and imageIdentifiableGCP not documented?	1	Class	SD_GCPRepository (ISO/TS 19130)
14.	imageIdentifiableGCP	Ground control point that is either marked in an image or described so that the user can find it in an image	C/ locationGCP and GCPRepository not documented?	1	Class	SD_ImageIdentifiableGCP (ISO/TS 19130)

B.2 Thematic gridded data

B.2.1 General

Tables B.5 to B.9 define the detailed information of the classes included in the UML model in Figure 4.

B.2.2 IE_ThematicGriddedData

Table B.5 — General information on thematic gridded data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
15.	**IE_ThematicGriddedData**	**Define information of the content component of thematic data which is limited to regularly spaced gridded data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_ImageryAndGriddedData)**	
16.	dataInfo	Basic information about the thematic gridded data	M	1	Class	MD_CoverageDescription (ISO 19115-1)
17.	annotation	Information about the annotation overlapped on the data	O	N	Class	GM_Object (ISO 19107)
18.	geographicFeatures	Information about the vector-based features overlapped on the data	O	N	Class	GM_Object (ISO 19107)
19.	retrievalProcessingInfo	Information about the process for retrieving the thematic gridded data	O	N	Class	LE_Processing (ISO 19115-1)
20.	sourceInfo	Information about the data source used to produce the thematic gridded data	O	N	Character String	
21.	**IE_CategoricalGriddedData**	**Additional information for categorical gridded data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_ThematicGriddedData)**	**IE_CategoricalGriddedData (B.2.3)**
22.	**IE_NumericalGriddedData**	**Additional information for numerical gridded data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_ThematicGriddedData)**	**IE_NumericalGriddedData (B.2.4)**

B.2.3 IE_CategoricalGriddedData

Table B.6 — Categorical gridded data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
23.	**IE_Categorical GriddedData**	**Specific information for categorical gridded data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_ThematicGridded Data)**	
24.	classification Description	Information on the classification to generate categorical data	O	1	Character String	Free text
25.	numberOfCategories	Number of categories expressed in a layer	M	1	Integer	
26.	bitsPerValue	Number of bits used to present one value	O	1	Integer	
27.	*Role name:* lookupTable	Detailed information of each category involved in the categorical gridded data		n (n = number OfCategories)	Association	IE_Categorical ValueAndColour (B.2.5)

B.2.4 IE_NumericalGriddedData

Table B.7 — Numerical gridded data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
28.	**IE_Numerical GriddedData**	**Specific information for numerical gridded data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_ThematicGridded Data)**	
29.	valueDescrption	Information about the value presented by the numerical layer (e.g. altitude, temperature)	M	1	Character String	Free text

B.2.5 IE_CategoricalValueAndColour

Table B.8 — Categorical value and colour

	Name	Definition	Obligation	Max occurrence	Data type	Domain
30.	**IE_Categorical ValueAndColour**	**Define information describing each layer of the thematic data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Aggregated Class (IE_CategoricalGriddedData)**	
31.	categoryName	Basic description of a class	M	1	Character String	Free text
32.	value	Integer value to a class	M	1	Integer	
33.	colourPalette	Information of colour palette used to display a specific category	O	1	Class	<<DataType>> IE_ColourPalette (B.2.6)

B.2.6 IE_ColourPalette

Table B.9 — Colour palette

	Name	Definition	Obligation	Max occurrence	Data type	Domain
34.	**IE_Colour Palette**	**Define information of colour palette used to display a specific category**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Class**	
35.	red	Value of red colour	M	1	Integer	
36.	green	Value of green colour	M	1	Integer	
37.	blue	Value of blue colour	M	1	Integer	

B.3 Imagery

B.3.1 General

Tables B.10 to B.25 define the detailed information of the classes included in the UML model in Figures 5 to 9.

B.3.2 IE_Imagery

Table B.10 — General information on imagery

	Name	Definition	Obligation	Max occurrence	Data type	Domain
38.	**IE_Imagery**	**Defines the information of the content component of imagery**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Imagery AndGrid dedData)**	
39.	acqusitionTime	Date and time for acquiring the image	O	1	Class	<<Type>> TM_Period (ISO 19108)
40.	imageDescrip tion	The basic information on acquiring the image	O	1	Class	MD_Image Description (ISO 19115-1)
41.	isMosaic	Identify if the image is generated by mosaic of multiple images	O	1	Boolean	
42.	numberOfBands	Number of bands involved in an image	M	1	Integer	
43.	processingAction	Information about the processing operation on the image	O	1	Class	<<CodeList>> IE_Processing ActionCode (B.4.4)
44.	radiometricCor rectionType	Type of radiometric correction done on the image	O	1	Class	<<CodeList>> IE_Radiometric CorrectionType Code (B.4.3)
45.	sensorCalibra tionValidation	Calibration and validation done on the sensor which acquires the image	O	1	Class	CA_Calibration Validation (ISO/ TS 19159-1)

Table B.10 *(continued)*

	Name	Definition	Obligation	Max occurrence	Data type	Domain
46.	sensorInfo	Information about sensor which acquires the image	O	1	Class	MI_Instrument (ISO 19115-2)
47.	platformInfo	Information about the platform on which the image is acquired	O	1	Class	MI_Platform (ISO 19115-2)
48.	**IE_SyntheticImage**	**Defines specific characteristics of synthetic image**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Imagery)**	**IE_Synthetic Image (B.3.3)**
49.	**IE_FusedImage**	**Defines specific characteristics of fused image**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Synthetic Image)**	**IE_FusedImage (B.3.4)**
50.	**IE_Simulated Image**	**Defines specific characteristics of simulated image**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Synthetic Image)**	**IE_Simulated Image (B.3.5)**
51.	**IE_OpticalImage**	**Defines specific characteristics of optical images**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Imagery)**	**IE_Optical Image (B.3.6)**
52.	**IE_Microwave Data**	**Defines specific characteristics of microwave data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Imagery)**	**IE_Microwave Data(B.3.7)**
53.	*Role name:* mosaicInfo	Information of each mosaicked image	C/isMosaic =True?	1	Association	IE_MosaicElement (B.3.17)
54.	*Role name:* band information	Information of each band involved in the image	M	n(n = number OfBands)	Association	MI_Band (ISO 19115-2)

B.3.3 IE_SyntheticImage

Table B.11 — Synthetic image

	Name	Definition	Obligation	Max occurrence	Data type	Domain
55.	**IE_Synthetic Image**	**Defines specific characteristics of synthetic image**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Imagery)**	
56.	intendedUse	Intended use of a simulated image	O	1	Class	MD_Usage (ISO 19115-1)

B.3.4 IE_FusedImage

Table B.12 — Fused image

	Name	Definition	Obligation	Max occurrence	Data Type	Domain
57.	**IE_FusedImage**	**Defines information about a fused image**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Synthetic Image)**	
58.	numberOf SourceImages	Number of source images fused into a new image	M	1	Integer	Integer
59.	processingSteps	Processing steps during image fusion	O	N	Class	LE_Proces singStep (ISO 19115-2)

B.3.5 IE_SimulatedImage

Table B.13 — Simulated image

	Name	Definition	Obligation	Max occurrence	Data type	Domain
60.	**IE_Simulated Image**	**Defines specific characteristics of simulated image**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Synthetic Image)**	**59~61**
61.	simulateMethod	Method of simulation	M	1	Character String	Free text
62.	provenance	Source data used to produce the simulated image	O	1	Class	LI_Lineage (ISO 19115-2)

B.3.6 IE_OpticalImage

Table B.14 — Optical image

	Name	Definition	Obligation	Max occurrence	Data type	Domain
63.	**IE_OpticalImage**	**Defines specific characteristics of optical images**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Imagery)**	
64.	opticalImage Type	Type of the optical image	M	1	Class	<<CodeList>> IE_OpticalIm ageTypeCode (B.4.5)
65.	opticalSensor Type	Type of an optical sensor acquiring the image	O	1	Class	<<CodeList>> IE_OpticalSen sorTypeCode (B.4.6)

B.3.7 IE_MicrowaveData

Table B.15 — Microwave data

	Name	Definition	Obligation	Max occurrence	Data Type	Domain
66.	**IE_Microwave Data**	**Defines specific characteristics of microwave data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Imagery)**	
67.	**IE_ActiveMW Data**	**Defines specific characteristics of active microwave data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Micro waveData)**	
68.	**IE_SARData**	**Defines specific characteristics of SAR data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_ActiveM WData)**	**IE_SARData (B.3.8)**
69.	**IE_PassiveMW Data**	**Defines specific characteristics of passive microwave data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_Micro waveData)**	
70.	**IE_Radiometer Data**	**Defines specific characteristics of radiometer data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_PassiveM WData)**	**IE_Radiometer Data (B.3.14)**

B.3.8 IE_SARData

Table B.16 — SAR data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
71.	**IE_SARData**	**Defines specific characteristics of SAR images**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_ActiveMic rowaveIm age)**	
72.	farRangeInci denceAngle	Incidence angle in far range	O	1	Real	Real
73.	nearRangeInci denceAngle	Incidence angle in near range	O	1	Real	Real
74.	sarImagingMode	Provides information about the SAR imaging mode used to acquire the image	M	1	Class	<<CodeList>> IE_SARImag ingModeCode (B.4.7)
75.	sarModeDescrip tion	Provides additional information about the SAR mode, including description of new and sensor specific modes	O	1	Character String	Free text

Table B.16 *(continued)*

	Name	Definition	Obligation	Max occurrence	Data type	Domain
76.	wavelength	Radar wavelength in metre	M	1	Real	Real
77.	**IE_SARComplexData**		**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_SARData)**	**IE_SARComplexData (B.3.9)**
78.	**IE_SARAmplitudeData**		**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_SARData)**	**IE_SARAmplitudeData (B.3.10)**

B.3.9 IE_SARComplexData

Table B.17 — SAR complex data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
79.	**IE_SARComplexData**		**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_SARData)**	
80.	complexLayerTypes	Characterizes the complex layers	M	N	Class	IE_SARComplexLayerTypeCode (B.4.8)
81.	lineSpacing	Spacing of the image in azimuth direction (slow-time) in seconds	M	1	Real	Real
82.	pixelSpacing	Spacing of the image in range direction (fast-time) in seconds	M	1	Real	Real
83.	sarSensor	Provides information about the SAR sensor	M	1	Class	IE_SARSensor (B.3.11)

B.3.10 IE_SARAmplitudeData

Table B.18 — SAR amplitude data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
84.	**IE_SARAmplitudeData**		**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_SARData)**	
85.	calibrationFactor	Calibration value	O	1	Real	Real
86.	looksInAzimuth	Number of looks in azimuth direction	M	1	Integer	Integer
87.	looksInRange	Number of looks in range direction	M	1	Integer	Integer
88.	sarSensor	Provides information about the SAR sensor	O	1	Class	IE_SARSensor (B.3.11)

B.3.11 IE_SARSensor

Table B.19 — SAR sensor <<DataType>>

	Name	Definition	Obligation	Max occurrence	Data type	Domain
89.	**IE_SARSensor**	**Defines specific characteristics of the SAR sensor**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Class <<DataType>>**	
90.	azimuthBandwidth	System bandwidth in azimuth direction (slow-time)	M	1	Real	Real
91.	dopplerCentroidParameter	A series of parameters used to calculate the Doppler centroid over the whole image	M	N	OrderedSet (B.4.13)	IE_SARDopplerCentroidParameter (B.3.12)
92.	oneWayTimeToFirstRangePixel	Signal's one way time-of-flight from the sensor to the first pixel in range direction (fast-time)	M	1	Real	Real
93.	orbitParameter	A series of parameters used to calculate the orbit position of the sensor over the image acquisition time	M	N	OrderedSet (B.4.13)	IE_OrbitParameter (B.3.13)
94.	pulseRepetitionFrequency	Pulse repetition frequency in Hz	M	1	Real	Real
95.	rangeBandwidth	System bandwidth in range direction (fast-time)	M	1	Real	Real
96.	rangeSamplingRate	System sampling rate in range direction (fast-time)	M	1	Real	Real
97.	timeOfFirstAzimuthLine	Signal time of the first line in azimuth direction (slow-time)	M	1	DateTime	DateTime (ISO 19103)

B.3.12 IE_SARDopplerCentroidParameter

Table B.20 — Doppler centroid parameter <<DataType>>

	Name	Definition	Obligation	Max occurrence	Data type	Domain
98.	**IE_SARDopplerCentroidParameter**	**Gives the information necessary to calculate the Doppler centroid for a given point in time**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Class <<DataType>>**	
99.	time	Date and time of the orbit information described within this IE_DopplerCentroidParameter	M	1	Class	DateTime (ISO 19103)
100.	polynomial_coefficient_0	Coefficient with exponent 0 for the calculation of the Doppler centroid via a 2nd degree polynomial function (see Formula 1)	M	1	Real	Real
101.	polynomial_coefficient_1	Coefficient with exponent 1 for the calculation of the Doppler centroid via a 2nd degree polynomial function (see Formula 1)	M	1	Real	Real

Table B.20 *(continued)*

	Name	Definition	Obligation	Max occurrence	Data type	Domain
102.	polynomial_coefficient_2	Coefficient with exponent 2 for the calculation of the Doppler centroid via a 2nd degree polynomial function (see Formula 1)	M	1	Real	Real
103.	reference_point	Reference point for the calculation of the Doppler centroid via a 2nd degree polynomial function (see Formula 1)	M	1	Real	Real

B.3.13 IE_OrbitParameter

Table B.21 — Orbit parameter <<DataType>>

	Name	Definition	Obligation	Max occurrence	Data type	Domain
104.	IE_OrbitParameter	Gives the orbit information for a certain point in time	Use obligation from referencing object	Use maximum occurrence from referencing object	Class <<DataType>>	
105.	time	Date and time of the orbit information described within this IE_OrbitParameter	M	1	Class	DateTime (ISO 19103)
106.	x	x-coordinate of the sensor in an Earth-centric coordinate system	M	1	Real	Real
107.	y	y-coordinate of the sensor in an Earth-centric coordinate system	M	1	Real	Real
108.	z	z-coordinate of the sensor in an Earth-centric coordinate system	M	1	Real	Real
109.	velocityX	Velocity of the sensor in x-direction in m/s	M	1	Real	Real
110.	velocityY	Velocity of the sensor in y-direction in m/s	M	1	Real	Real
111.	velocityZ	Velocity of the sensor in z-direction in m/s	M	1	Real	Real

B.3.14 IE_RadiometerData

Table B.22 — Radiometer data

	Name	Definition	Obligation	Max occurrence	Data type	Domain
112.	**IE_Radiometer Data**	**Gives the information necessary to radiometer data**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Specified Class (IE_PassiveM WData)**	
113.	scanningMode	Scanning mode of the passive microwave radiometer	M	1	Class	<<CodeList>> IE_PMWScan ningModeCode (B.4.9)
114.	PMWBand	Band information of the passive microwave radiometer	M	1	OrderedSet (B.4.13)	<<DataType>> IE_PMWBand (B.3.15)
115.	apertureType	Type of aperture of the passive microwave radiometer	M	1	Class	<<CodeList>> IE_PMWAper tureTypeCode (B.4.10)

B.3.15 IE_PMWBand

Table B.23 — PMW band <<DataType>>

	Name	Definition	Obligation	Max occurrence	Data type	Domain
116.	**IE_PMWBand**	**Gives the specific infor- mation of band for passive microwave sensor**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Class <<DataType>>**	
117.	bandName	Name of band of the passive microwave radiometer	M	1	Class	<<CodeList>> IE_PMWBand NameCode (B.4.11)
118.	numberOfChan nels	Number of channels of a band	M	1	Integer	
119.	channels	Characteristics of channels	M	1	OrderedSet (B.4.13)	<<DataType>> IE_PMWChanne lInfo (B.3.16)

B.3.16 IE_PMWChannelInfo

Table B.24 — PMW channel information <<DataType>>

	Name	Definition	Obligation	Max occurrence	Data type	Domain
120.	**IE_PMWChannelInfo**	**Gives the specific information of a channel in a band for passive microwave sensor**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Class <<DataType>>**	
121.	channelWidth	Width of a channel in a band	M	1	Real	
122.	CentreFrequency	Centre frequency of a channel in a band	M	1	Real	
123.	ChannelProperty	Property of a channel	M	1	Class	<<CodeList>> IE_ChannelPropertyCode (B.4.12)

B.3.17 IE_MosaicElement

Table B.25 — Mosaic element <<DataType>>

	Name	Definition	Obligation	Max occurrence	Data type	Domain
124.	**IE_MosaicElement**	**The information of each mosaic element**	**Use obligation from referencing object**	**Use maximum occurrence from referencing object**	**Class <<DataType>>**	
125.	elementID	Identification of a mosaic element	M	1	Integer	
126.	acquisitionTime	Centre frequency of a channel in a band	M	1	Class	<<Type>> TM_Period (ISO 19108)
127.	geometry	Extent of a mosaic element	M	1	Class	EX_Extent (ISO 19115-1)

B.4 Codelists and enumerations

B.4.1 IE_GeolocationSourceCode

Tables B.26 to B.37 provides the domain codes and definitions of <<CodeList>> defined in the models of Clause 8.

Table B.26 — IE_GeolocationSourceCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_GeolocationSourceCode	GeometricCorrectionMethod	Method for geometric correction carried out on imagery
2.	SystemParameters	001	Source of geolocation information is from system parameters of the observation system
3.	GCP	002	Source of geolocation information is from Ground Control Point

Table B.26 *(continued)*

	Name	Domain code	Definition
4.	SystemParameters+DEM	004	Source of geolocation information is based on the combination of system parameters of the observation system and an existing DEM
5.	SystemParameters+GCP	005	Source of geolocation information is based on the combination of system parameters of the observation system and Ground Control Point
6.	SystemParameters+GCP+DEM	006	Source of geolocation information is based on the combination of system parameters of the observation system, Ground Control Point and an existing DEM
7.	GCP+DEM	007	Source of geolocation information is based on the combination of Ground Control Point and DEM

B.4.2 IE_GeometricCorrectionModelCode

Table B.27 — IE_GeometricCorrectionModelCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_GeometricCorrectionModel Code	GeometricCorrection Model	Model for geometric correction of imagery and gridded data
2.	Physical sensor model	001	Sensor model based on the physical configuration of a sensing system, as defined in ISO/TS 19130
3.	True replacement model	002	Model using functions whose coefficients are based on a physical sensor model, as defined in ISO/TS 19130
4.	Correspondence model	003	Functional relationship between ground and image coordinates based on the correlation between a set of ground control points and their corresponding image coordinates, as defined in ISO/TS 19130

B.4.3 IE_RadiometricCorrectionTypeCode

Table B.28 — IE_RadiometricCorrectionTypeCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_RadiometricCorrectionType Code	RadiometricCorrection TypeCode	Type for radiometric correction carried on imagery
2.	Relative radiometric correction	001	A data preprocessing technique used to eliminate radiometric problems in images by multiple looks at same object from different vantage points
3.	Absolute radiometric correction	002	A data preprocessing technique used to eliminate radiometric problems in images with model atmosphere in conjunction with *in situ* atmospheric measurements

B.4.4 IE_ProcessingActionCode

Table B.29 — IE_ProcessingActionCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_ProcessingActionCode	ProcessingAction	Processing actions carried out on image
2.	Image enhancement	001	A processing to adjust images more suitable for display or further image analysis by sharpening, brightening or other relative operations
3.	Image fusion	002	A processing to fuse more than two images into one
4.	Image smoothing	003	A processing to remove noise of an image

B.4.5 IE_OpticalImageTypeCode

Table B.30 — IE_OpticalImageTypeCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_OpticalImageTypeCode	OpticalImageTypeCode	Type of an optical image
2.	Hyperspectral image	001	Imagery with hundreds of narrow spectral bands acquired by a hyperspectral instrument
3.	Infrared image	002	Image formed in infrared band of the electromagnetic spectrum by an infrared instrument
4.	Multispectral image	003	Image with multiple bands acquired by a multispectral instrument
5.	Panchromatic image	004	A single band image generally displayed as shades of grey
6.	Other	005	Other images which are not covered by the list

B.4.6 IE_OpticalSensorTypeCode

Table B.31 — IE_OpticalSensorTypeCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_OpticalSensorTypeCode	OpticalSensorTypeCode	Type of an optical sensor
2.	Frame	001	Sensor that detects and collects all of the data for an image (frame/rectangle) at an instant of time
3.	Pushbroom	002	Sensor that collects a single cross-track image line at one time and constructs a larger image from a set of adjacent lines resulting from the along-track motion of the sensor
4.	Whiskbroom	003	Sensor that sweeps a detector forming cross-track image line(s) and constructs a larger image from a set of adjacent lines using the along-track motion of the sensor's collection platform
5.	Other	004	Other sensor which are not covered by the list

B.4.7 IE_SARImagingModeCode

Table B.32 — IE_SARImagingModeCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_SARImagingModeCode	SarImagingModeCode	Type of imaging mode of SAR
2.	StripmapMode	001	SAR mode in which the antenna beam is fixed throughout the collection of an image
3.	SpotlightMode	002	SAR mode in which the antenna beam is steered to illuminate one area during collection
4.	Other	003	Other imaging modes used to acquire SAR data

B.4.8 IE_SARComplexLayerTypeCode

Table B.33 — IE_SARComplexLayerTypeCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_SARComplexLayerTypeCode	SARComplexLayerTypeCode	
2.	ComplexNumber	001	Pixel values of the layer are the complex number
3.	RealNumber	002	Pixel values of the layer are the real part of the complex number
4.	ImaginaryNumber	003	Pixel values of the layer are the imaginary part of the complex number
5.	Phase	004	Pixel values of the layer are the phase of the complex number
6.	Magnitude	005	Pixel values of the layer are the magnitude of the complex number

B.4.9 IE_PMWScanningModeCode

Table B.34 — IE_PMWScanningModeCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_PMWScanningModeCode	PMWScanningModeCode	Type of working mode of an passive microwave sensor
2.	ConicalScanning	001	The radar beam is rotated in a small circle around the “boresight” axis, which is pointed at the target
3.	CrosstrackScanning	002	Scanning perpendicular to the platform moving track
4.	LimbScanning	003	A scanning mode which scans the atmospheric limb, made by varying the angle of the elevation mirror while the azimuth mirror remains at a fixed angle
5.	SpiralScanning	004	A scanning mode which scans an object starting from the centre and outwarding spirally
6.	WhiskbroomScanning	005	A scanning mode which sweeps a detector forming cross-track image line(s)

B.4.10 IE_PMWApertureTypeCode

Table B.35 — IE_PMWApertureTypeCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_PMWApertureTypeCode	PMWApertureTypeCode	Type of aperture of an passive microwave sensor
2.	RealAperture	001	Aperture of a physical antenna
3.	SyntheticAperture	002	Effective aperture through simulating the use of a long physical antenna by collecting multiple returns from each target as the actual antenna moves along the track

B.4.11 IE_PMWBandNameCode

Table B.36 — IE_PMWBandNameCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_PMWBandNameCode	PMWBandNameCode	Name of the band of an passive microwave sensor
2.	L band	001	L Band(1 GHz to 2 GHz)
3.	C band	002	C band (4 GHz to 8 GHz)
4.	K band	003	K band (18 GHz to 27 GHz)
5.	Ka band	004	Ka Band (27 GHz to 40 GHz)
6.	M band	005	M Band (50 GHz to 75 Ghz)
7.	G band	006	G Band (140 GHz to 220 GHz)

B.4.12 IE_ChannelPropertyCode

Table B.37 — IE_ChannelPropertyCode<<CodeList>>

	Name	Domain code	Definition
1.	IE_ChannelPropertyCode	ChannelPropertyCode	The channel property of an passive microwave sensor
2.	Oxygen absorption channel	001	Microwave channel where the oxygen in the atmosphere absorbs the microwave radiation
3.	Water vapour absorption channel	002	Microwave channel where the water vapour absorbs the microwave radiation
4.	Ozone absorption channel	003	Microwave channel where the ozone in the atmosphere absorbs the microwave radiation
5.	Window channel	004	Microwave channel where the atmosphere has little attenuation
6.	Trace gas absorption channel	005	Microwave channel where the trace gases of the atmosphere absorbs the microwave radiation

B.4.13 OrderedSet

“orderedSet” is one of the property keywords to define collection semantics for attributes (ISO 19103). “orderedSet” means a collection with ordered and unique elements. The detailed information is documented in ISO 19103:2015, 7.3.1.

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