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Geographic information — Schema for coverage geometry and functions —

Part 2: Coverage implementation schema

Information géographique — Schéma de la géométrie et des fonctions de couverture —

Partie 2: Schéma de la mise en place de la couverture

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by ISO/TC 211, *Geographic information/geomatics*.

A list of all the parts in the ISO 19123 series, can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Coverages represent digital geospatial information representing space/time-varying phenomena. Common examples include 1-D time series, 2-D imagery, 3-D x/y/t image time series and x/y/z geophysical voxel models, as well as 4-D x/y/z/t climate and ocean data.

This Coverage Implementation Schema (CIS) specifies a concrete, interoperable, conformance-testable coverage information schema. It is based on the abstract concepts of ISO 19123:2005 (which is equivalent to OGC Abstract Topic 6). ISO 19123:2005 specifies an abstract model which is not per se interoperable, i.e. many different and incompatible implementations of the abstract model are possible. CIS, on the other hand, is interoperable in the sense that coverages can be conformance tested, regardless of their data format encoding, down to the level of single "pixels" or "voxels".

Coverages can be encoded in any suitable format (such as GML, JSON[4], GeoTIFF[7], NetCDF[9] or GMLJP2) and can be partitioned, e.g. for a time-interleaved representation. Coverages are independent from service definitions and, therefore, can be accessed through a variety of web based service types, such as the OGC Web Coverage Service (WCS) Standard. This document is a data model whereas WCS is a service model. Both are tentatively separate, thereby allowing different services to process and deliver coverages, such as WFS, WCS, WCPS, WPS, etc. WCS and WCPS are outstanding only in that they offer the most powerful coverage functionality.

Coverages are independent from service definitions and, therefore, can be accessed through a variety of standardized services types, such as the Web Coverage Service (WCS) Standard[6], which is used in the examples in this document. The coverage structure can serve a wide range of coverage application domains, thereby contributing to harmonization and interoperability between and across these domains.

This document implements part of the coverage types described in ISO 19123:2005. Any extension of the coverage types addressed will be left for a future version of this document. ISO 19123:2005 is under review and will be replaced with ISO 19123-1 once the revision is published. ISO 19123-1 will be an extension of ISO 19123:2005 containing additional coverage concepts, so any references to ISO 19123:2005 in this document can be taken as references to the revised standard. The references in this document are to ISO 19123:2005 because this document is a joint standard with OGC, and the equivalent OGC standard "09-146r2 Version 1.0.1 OGC Coverage Implementation Schema (CIS 1.0)" is an existing published standard that makes references to ISO 19123:2005.

This document is a derived work based on the OGC document "Coverage Implementation Schema" OGC 09-146r2. The two documents are NOT word for word identical because each follows the document template required by each organization. However, both documents are functionally equivalent. In particular Clauses 1 to 5 in both the ISO standard (this document) and the OGC standard (OGC 09-146r2) contain the Scope, Normative references, Terms and definitions (and Notation) and Conformance described in the manner required by each organization. Where there are minor differences, such as the definition of "coverage" and "grid", this document makes use of the terms defined in ISO standards and identifies the differences in a note.

Any extension in OGC beyond CIS 1.0 (e.g. the development of CIS 1.1) is an extension beyond this document. ISO and OGC plan to work together to ensure future synchronization of these standards.

This document is a derived work based on OGC standard 09–146r2 Version 1.0.1 OGC Coverage Implementation Schema (CIS 1.0) also known as "OGC® GML Application Schema — Coverages" published 2012–05–11 and copyrighted by the OGC ©2012 and used with permission. OGC standard 09–146r2 Version 1.0.1 is a corrigendum to existing OGC standard 09–146r1 Version 1.0.0 published 2010–10–27.

Geographic information — Schema for coverage geometry and functions —

Part 2: Coverage implementation schema

1 Scope

This document specifies a concrete[1)] implementable, conformance-testable coverage structure based on the abstract schema for coverages defined in the ISO 19123 schema for coverage geometry. This document defines a structure that is suitable for encoding in many encoding formats.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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 19123:2005, *Geographic information — Schema for coverage geometry and functions*

ISO 19136:2007, *Geographic information — Geography Markup Language (GML)*

OGC 07-011, *Abstract Specification Topic 6: The Coverage Type and its Subtypes*, version 7.0 (identical to ISO 19123:2005)

OGC 07-036, *Geography Markup Language (GML) Encoding Standard*, version 3.2.1

OGC 08-094, OGC® SWE *Common Data Model Encoding Standard*, version 2.0

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
abstract test suite
abstract test module specifying all the requirements to be satisfied for conformance

[SOURCE: ISO 19105:2000, 3.4]

1) "concrete" is used here as a contrast to "abstract" in the sense described in the Introduction.

3.1.2
coverage
feature that acts as a function to return values from its range for any direct position within its spatial, temporal or spatiotemporal domain

Note 1 to entry: OGC CIS 1.0 has the definition for coverage: "feature that acts as a function to return values from its range for any direct position within its spatiotemporal domain."[13].

[SOURCE: ISO 19123:2005, 4.1.7, modified — Note 1 to entry has been replaced and the EXAMPLE has been deleted]

3.1.3
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

Note 1 to entry: OGC Abstract Topic 6 has the definition for grid: "network composed of one or more sets of curves in which the members of each set intersect the members of the other sets in an algorithmic way". This accomplishes integration of the 1-D case, thereby enabling general n-D grids.

[SOURCE: ISO 19123:2005, 4.1.23, modified — Note 1 to entry has been replaced]

3.1.4
implementation coverage
feature which is a subclass (specialization) of a coverage as defined in this document

Note 1 to entry: An implementation coverage is a concrete document in some concrete encoding, such as a GeoTIFF file.

Note 2 to entry: The definition of implementation coverage in this standard is functionally identical to GML coverage as defined in the OGC Coverage Implementation Schema [OGC 09-146r2].

3.2 Abbreviated terms

CIS	Coverage Implementation Schema
GeoTIFF	Geo Tagged Image File Format
GML	Geography Markup Language
GMLCOV	GML Application Schema for Coverages
JSON	JavaScript Object Notation
netCDF	network Common Data Format
OGC	Open Geospatial Consortium
SWE	Sensor Web Enablement
TIN	Triangulated Irregular Network
UoM	Unit of Measure
UML	Unified Modeling Language
WCS	Web Coverage Service

4 Conformance

This document defines conformance classes that correspond to identified requirements. These conformance classes are described in Annex A. Any implementation claiming conformance with this document must conform to the abstract conformance class A.1: *gml-coverage* and, in addition, at least one of the concrete conformance classes A.2: *gml*, A.3: *multipart*, and A.4: *special-format*. Requirements and conformance test URIs defined in this document are relative to <http://www.opengis.net/spec/GMLCOV/1.0/>.

5 Notation

5.1 Use of the term "coverage"

The definition of "coverage" in 3.1.2 shall be the generic one provided by ISO 19123 (and equivalently shall be the one in OGC Abstract Topic 6 [OGC 07-011]). The term "implementation coverage" is coined to denote the concrete data structure defined in this document that shall rely on GML [ISO 19136:2007] and equivalently shall rely on GML 3.2.1 [OGC 07-036] and OGC SWE Common 2.0 [OGC 08-094].

For the remainder of this document, "coverage" shall be understood as a shorthand for "implementation coverage" unless explicitly stated otherwise.

5.2 UML notation

The conceptual schema specified in this document is described using the Unified Modeling Language (UML) static structure diagram, which shall follow the guidance in ISO 19103, and equivalently shall follow the guidance in OGC Web Service Common [OGC 06-121r9].

NOTE The UML and basic types used to express the diagrams in this document are equivalent to the UML and basic types used in the OGC standard even though the OGC standard is based on an earlier version of ISO 19103:2015.

Several model elements used in this schema are defined in other ISO geographic information standards and OGC standards. The uniqueness of objects is ensured by their namespace.

5.3 Namespace prefix conventions

UML diagrams and XML code fragments adhere to the namespace conventions shown in Table 1. The namespace prefixes used in this document are **not** normative and are merely chosen for convenience, they may appear in examples without being formally declared, and have no semantic significance. The namespaces to which the prefixes correspond are normative.

Table 1 — Namespace mapping conventions

UML prefix	GML prefix	Namespace URL	Description
GML	gml	http://www.opengis.net/gml/3.2	GML 3.2.1
SWE Common	swe	http://www.opengis.net/swe/2.0	SWE Common 2.0
CIS	cis	http://www.opengis.net/cis/1.0	Coverage Implementation Schema 1.0, formerly named GML 3.2.1 Application Schema — Coverages 1.0

6 Coverage model

6.1 Coverage general

This document specifies the coverage structure to be used by ISO geographic information standards and jointly in OGC standards.

This document is described in terms of the Geography Markup Language (GML). This document derives from the OGC standard previously called GMLCOV which has been renamed to be Coverage Implementation Specification (CIS) 1.0[5].

Clause 6 establishes an abstract conformance class whereby "abstract" denotes that a concrete program must implement one of the concrete conformance classes in addition to claim conformance with this document. Although Clause 6 heavily makes use of GML, it does not prescribe that a coverage instance document be encoded in GML. A GML encoding of such coverage structures is established in the conformance class *gml*.

6.2 Overview

In GML (ISO 19136 and OGC GML 3.2.1[14]), all coverage types are derived from the abstract `Coverage` data type. This structure contains a `domainSet` describing the coverage's domain and a `rangeSet` component containing the range values ("pixels", "voxels") of the coverage. This coverage implementation schema extends (ISO 19136 and OGC GML 3.2.1[14]), class `Coverage` with two components, `rangeType` and `metadata`.

— The `rangeType` element describes the coverage's range set data structure. A range value often consists of one or more fields (in remote sensing also referred to as *bands* or *channels*), however, much more general definitions are possible. Range value structure description is based on the OGC SWE Common [OGC 08-094] `DataRecord`.

— The abstract coverage definition is augmented with an extensible slot for metadata. The intended use is to define concrete metadata structures and their semantics in extensions or application profiles.

The following changes apply over the GML (ISO 19136 and OGC GML 3.2.1[14]) specification:

— The property `coverageFunction`, which in GML is associated with every subtype of `Coverage`, is moved up into `Coverage` in the coverage type hierarchy of this document.

NOTE 1 This way, the coverage function is available in any subtype of `Coverage`. This serves to prepare for continuous coverages, like in the case described by the next bullet below.

— The grid coverage types are subtypes of `Coverage` rather than being subtypes of `DiscreteCoverage` as in GML

NOTE 2 This allows representing not only discrete grid coverages, but also continuous coverages by using grids for the reference points in conjunction with a coverage function defining interpolation.

No further changes over GML (ISO 19136 and OGC GML 3.2.1[14]) are made in this document. In particular, no pre-existing component changes its semantics.

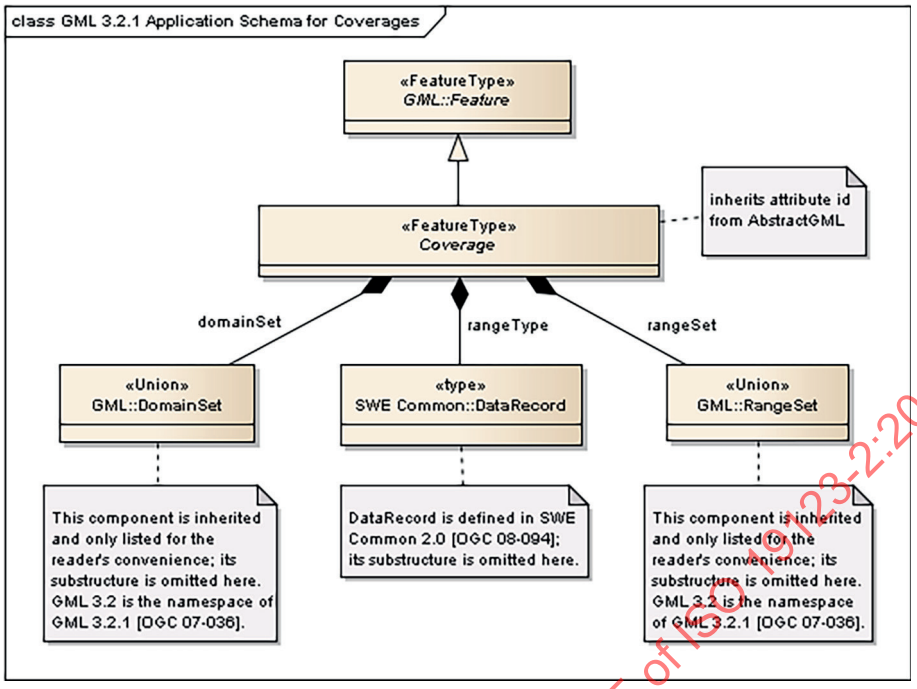

Figure 1 — The Coverage structure

In this document, `Coverage` shall always refer to the definition of this Application Schema and *not* to the GML definition of the same name, unless explicitly stated otherwise.

Figure 1 shows the UML diagram pertaining to this Application Schema.

Requirement 1 /req/gml-coverage/structural-adherence:
Any XML document instantiating a concrete subtype of Coverage **shall** conform with the UML diagram in Figure 1, with Table 2, and with the XML schema defined as part of this document.

Table 2 — The Coverage data structure

Name	Definition	Data type	Multiplicity
`coverage-Function`	GML 3.2.1 coverage function to describe how range values at coverage locations can be obtained	`GML::Coverage-Function`	Zero or one (optional)
`metadata`	Application specific metadata	Any	Zero or more (optional)
`domainSet`	GML 3.2.1 Definition of coverage domain	`GML::DomainSet`	One (mandatory)
`rangeType`	Structure definition of the coverage range values	`SWE::DataRecord`	One (mandatory)
`rangeSet`	GML 3.2.1 Coverage range values	`GML::RangeSet`	One (mandatory)

NOTE 3 UML data type Any is used here with the same meaning as XML's `xsd:any`, which does not have a direct equivalent in UML.

NOTE 4 Following the GML pattern described in [14] on GML level, `SWE::DataRecord` is linked to `rangeType` via an association `SWE::DataRecordPropertyType`.

6.3 CoverageFunction

The `coverageFunction` component is identical in its syntax and meaning to the `coverageFunction` element defined in GML, 19.3.11[14].

6.4 Metadata

The `metaData` component is a carrier for any kind of application dependent metadata. Hence, no requirements are imposed here.

6.5 RangeType

The `rangeType` component adds a structure description and technical metadata required for an appropriate (however, application independent) understanding of a coverage. For this structure description, the SWE Common `DataRecord` is used.

Requirement 2 /req/gml-coverage/dataRecord:
The range type component of a coverage **shall** conform with the `DataRecord` of SWE Common [OGC 08-094].
Dependency: [OGC 08-094] Clause 7 (http://www.opengis.net/doc/SWE/2.0/clause/7), [OGC 08-094] Clause 8 (http://www.opengis.net/doc/SWE/2.0/clause/8).

NOTE 1 Following GML patterns the `swe:DataRecord` is linked into `gmlcov:AbstractCoverageType` via `swe:DataRecordPropertyType`.

Atomic data types available for range values are those given by the SWE Common data type `AbstractSimpleComponent`. As a range structure contains only structure definitions, but not the values themselves (these sit in the coverage range set component), the optional `AbstractSimpleComponent` component `value` is suppressed in coverages.

Requirement 3 /req/gml-coverage/no-value-in-rangeType:
For all SWE Common AbstractSimpleComponent subtypes in a range type structure, instance multiplicity of the value component **shall** be zero.

NOTE 2 Following [OGC 08-094], omission of the `value` component implies that in a `DataArray` there is no `encoding` component either.

Range values can be structured as records or arrays. Both structuring principles can be nested (and mixed) to any depth for a concrete coverage range structure definition.

Requirement 4 /req/gml-coverage/record-or-dataArray:
Wherever the SWE Common XML schema allows an `AbstractDataComponent` in a coverage range structure the concrete instance **shall** be one of the `AbstractDataComponent` subtypes `DataRecord` and `DataArray`.

NOTE 3 In particular, these `AbstractDataComponent` subtypes are not allowed in range structures: `DataChoice`, `Vector`, `Matrix`.

Within a `DataRecord` contained in a concrete range structure, each of its record components is locally uniquely identified by the record component's `field` attribute, in accordance with the "soft-typing" property introduced by SWE Common.

EXAMPLE The following XML fragment represents a valid range structure; it models the red, green, and blue channel of a Landsat scene. Pixels are defined as unsigned 8-bit quantities where 0 and 255 denote null values:

```
<rangeType>
  <swe:DataRecord>
    <swe:field name="red">
      <swe:Quantity
      definition="http://opengis.net/def/property/OGC/0/Radiance">
        <gml:description>Red Channel</gml:description>
```



```
        <gml:name>Red</gml:name>
        <swe:nilValues>
          <swe:NilValues gml:id="NIL_VALUES">
            <swe:nilValue
      reason="http://www.opengis.net/def/nil/OGC/0/BelowDetectionRange">
                          0
                      </swe:nilValue>
                      <swe:nilValue
                          reason="http://www.opengis.net/def/
                          nil/OGC/0/AboveDetectionRange">
                 255
             </swe:nilValue>
          </swe:NilValues>
        </swe:nilValues>
        <swe:uom code="W/cm2"/>
        <swe:constraint>
          <swe:AllowedValues>
            <swe:interval>0 255</swe:interval>
            <swe:significantFigures>3</swe:significantFigures>
          </swe:AllowedValues>
        </swe:constraint>
      </swe:Quantity>
    </swe:field>
    <swe:field name="green">
        <swe:Quantity
       definition="http://opengis.net/def/property/OGC/0/Radiance">
        <gml:description>Green Channel</gml:description>
        <gml:name>Green</gml:name>
        <swe:nilValues xlink:href="#NIL_VALUES"/>
        <swe:uom code="W/cm2"/>
        <swe:constraint xlink:href="#VALUE_SPACE"/>
      </swe:Quantity>
    </swe:field>
    <swe:field name="blue">
        <swe:Quantity
       definition="http://opengis.net/def/property/OGC/0/Radiance">
        <gml:description>Blue Channel</gml:description>
        <gml:name>Blue</gml:name>
        <swe:nilValues xlink:href="#NIL_VALUES"/>
        <swe:uom code="W/cm2"/>
        <swe:constraint xlink:href="#VALUE_SPACE"/>
      </swe:Quantity>
    </swe:field>
  </swe:DataRecord>
</rangeType>
```

6.6 RangeSet coherence

Both `domainSet` and `rangeType` describe the coverage values given in the `rangeSet`. Hence, consistency must be enforced between them. The pertaining requirements are listed in 6.6.

Requirement 5 /req/gml-coverage/one-range-value-per-position:
For each coordinate position contained in the domain set description of a coverage there **shall** exist exactly one range value in the coverage's range set.

Both duplicates and values omitted are not allowed. For range values not known for some reason nil values can be used.

Requirement 6 /req/gml-coverage/range-structure-consistency:
All range values contained in the range set of a coverage **shall** be consistent with the structure description provided in its range type.

6.7 Specific coverage types

6.7.1 Overview

This document supports all coverage types which GML 3.2.1[14] supports, which implement the discrete coverage types defined in ISO 19123 (listed in parenthesis). The supported types are substitutable from `Coverage` and include

— `MultiPointCoverage` (ISO 19123: `CV_DiscretePointCoverage`),

— `MultiCurveCoverage` (ISO 19123: `CV_DiscreteCurveCoverage`),

— `MultiSurfaceCoverage` (ISO 19123: `CV_DiscreteSurfaceCoverage`),

— `MultiSolidCoverage` (ISO 19123: `CV_DiscreteSolidCoverage`),

— `GridCoverage` (ISO 19123: `CV_DiscreteGridPointCoverage`),

— `RectifiedGridCoverage` (ISO 19123: `CV_DiscreteGridPointCoverage`), and

— `ReferenceableGridCoverage` (added to GML via Change Request [OGC 07-112r3]).

The above coverage types may be used as is, or new coverage types may be constructed by using or deriving from one of the subtypes of `Coverage` or one of its subtypes.

Requirement 7 /req/gml-coverage/coverage-derivation:
The type of the root element of a coverage document instance **shall** be a concrete direct or indirect subtype of `Coverage`.

Figure 2 shows the UML diagram of the coverage hierarchy.

NOTE As in GML, continuous coverages are not currently supported. Consequently, `ContinuousCoverage` does not have any concrete subtype.

6.7.2 Discrete Coverage

The domain set of a discrete coverage consists of either spatial or temporal geometry objects, finite in number. The range set is comprised of a finite number of attribute values each of which is associated to every direct position within any single spatiotemporal object in the domain. In other words, the range values are constant on each spatiotemporal object in the domain. This coverage function maps each element from the coverage domain to an element in its range.

This class serves as the head of a specialization hierarchy which contains `MultiPointCoverage`, `MultiCurveCoverage`, `MultiSurfaceCoverage`, and `MultiSolidCoverage`.

NOTE 1 In GML 3.2.1[14], grid coverages are contained in this class hierarchy as well based on a distinction between discrete and continuous coverages which is not considered state of the art anymore. This Application Schema changes the hierarchy in that coverages are put separately, allowing the modelling of continuous grid coverages.

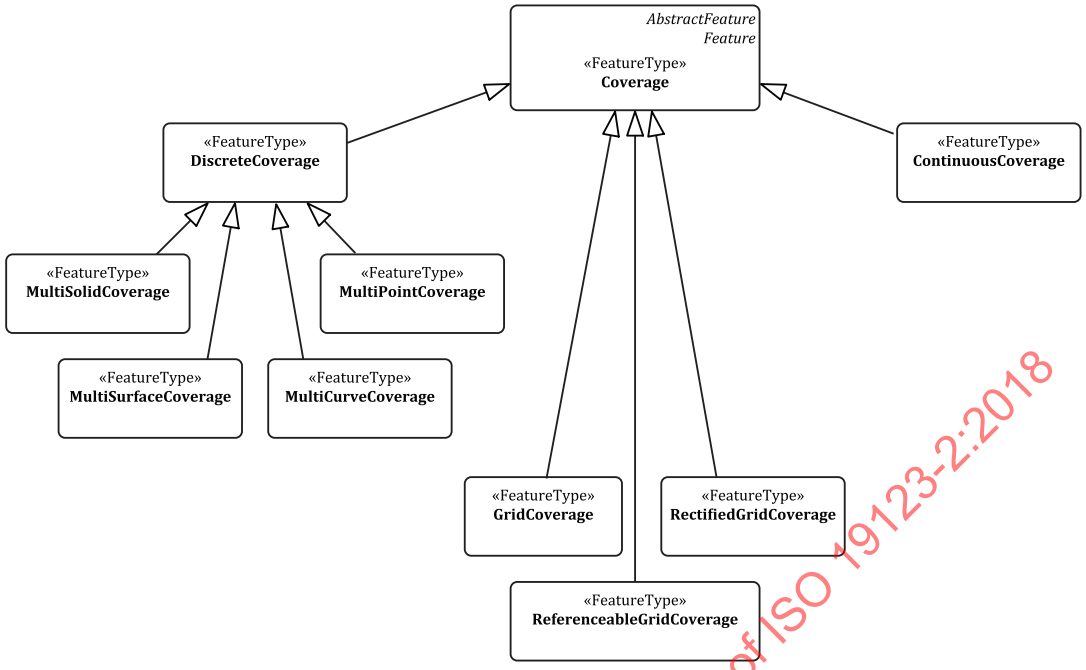

Figure 2 — The Coverage type hierarchy

NOTE 2 The OGC standard "Coverage Implementation Schema" [OGC 09-146r2] contains a clause on Continuous Coverage. However it indicates that "continuous coverages is under reconsideration, therefore use of ContinuousCoverage is not encouraged." It also indicates that "Abstract class ContinuousCoverage serves as the head of a substitution group which can contain any continuous coverage whose type is derived from ContinuousCoverage. It parallels GML::ContinuousCoverage, except that the coverageFunction element has been moved "up" into Coverage."

6.7.3 MultiPointCoverage

In a `MultiPointCoverage` the domain set is a `GM_MultiPoint` that is a collection of arbitrarily distributed geometric points.

Requirement 8 /req/gml-coverage/multiPointCoverage:
A coverage of type `MultiPointCoverage` **shall** have a content model identical with `DiscreteCoverage`, except that the `domainSet` **shall** have `GML::MultiPoint values`.

In the GML representation of a `MultiPointCoverage` the mapping from the domain to the range is straightforward:

— For `gml:DataBlock` encodings, the points of the `gmlcov:MultiPoint` are mapped in document order to the tuples of the data block;

— For `gml:CompositeValue` encodings, the points of the `gmlcov:MultiPoint` are mapped to the members of the composite value in document order;

— For `gml:File` encodings, the points of the `gmlcov:MultiPoint` are mapped to the records of the file in sequential order.

6.7.4 MultiCurveCoverage

In a MultiCurveCoverage the domain is partitioned into a collection of curves comprising a GM_MultiCurve. The coverage function then maps each curve in the collection to a value in the range set.

Requirement 9 /req/gml-coverage/multiCurveCoverage:
A coverage of type MultiCurveCoverage **shall** have a content model identical with DiscreteCoverage, except that the domainSet **shall** have "GML 3.2.1"::MultiCurve values.

In the GML representation of a MultiCurveCoverage the mapping from the domain to the range is straightforward:

— For gml:DataBlock encodings, the curves of the gmlcov:MultiCurve are mapped in document order to the tuples of the data block.

— For gml:CompositeValue encodings, the curves of the gmlcov:MultiCurve are mapped to the members of the composite value in document order.

— For gml:File encodings, the curves of the gmlcov:MultiCurve are mapped to the records of the file in sequential order.

6.7.5 MultiSurfaceCoverage

In a MultiSurfaceCoverage the domain is partitioned into a collection of surfaces comprising a GM_MultiSurface. The coverage function maps each surface in the collection to a value in the range set.

Requirement 10 /req/gml-coverage/multiSurfaceCoverage:
A coverage of type MultiSurfaceCoverage **shall** have a content model identical with DiscreteCoverage, except that the domainSet **shall** have GML::MultiSurface values.

In the GML representation of a MultiSurfaceCoverage the mapping from the domain to the range is straightforward:

— For gml:DataBlock encodings, the surfaces of the gmlcov:MultiSurface are mapped in document order to the tuples of the data block.

— For gml:CompositeValue encodings, the surfaces of the gmlcov:MultiSurface are mapped to the members of the composite value in document order.

— For gml:File encodings, the surfaces of the gmlcov:MultiSurface are mapped to the records of the file in sequential order.

6.7.6 MultiSolidCoverage

In a MultiSolidCoverage the domain is partitioned into a collection of solids comprising a GM_MultiSolid. The coverage function then maps each solid in the collection to a value in the range set.

Requirement 11 /req/gml-coverage/multiSolidCoverage:
A coverage of type MultiSolidCoverage **shall** have a content model identical with DiscreteCoverage, except that the domainSet **shall** have GML::MultiSolid values.

In the GML representation of a MultiSolidCoverage the mapping from the domain to the range is straightforward:

— For gml:DataBlock encodings the solids of the gmlcov:MultiSolid are mapped in document order to the tuples of the data block.

— For gml:CompositeValue encodings the solids of the gmlcov:MultiSolid are mapped to the members of the composite value in document order.

— For gml:File encodings the solids of the gmlcov:MultiSolid are mapped to the records of the file in sequential order.

6.7.7 GridCoverage

A GridCoverage is a discrete point coverage in which the domain is a geometric grid of points encoded using gml:Grid (not its subtypes gml:RectifiedGrid or a subtype of AbstractReferenceableGrid). Note that this is similar to the MultiPointCoverage except that a gml:Grid shall be used to describe the domain.

Requirement 12 /req/gml-coverage/gridCoverage:
A coverage of type GridCoverage shall have a domain that is a GML::Grid.

NOTE Such geometric positioning is introduced in the RectifiedGridCoverage.

In order to address ambiguities in the gml:Grid definition, this GML Application Schema for Coverages imposes additional constraints on the use of a gml:Grid within a gmlcov:GridCoverage. (Specifically, there is no provision in the gml:Grid definition to express the relationship between the grid positions and this geometry's coordinate reference system, which will always exist in some contexts, such as a Web Coverage Service. This coordinate reference system will be explicitly referenced in the srsName attribute of the gml:SRSReferenceGroup of gml:Grid, or be inherited from an enclosing container element, such as the gml:Envelope of this gmlcov:GridCoverage.) Since provision for expressing a relationship does not exist, whenever used in gmlcov:GridCoverage, the relationship shall be simple. In this simple relationship, the dimension attribute of the gml:Grid shall be identical to the dimension of the geometry's coordinate system, the axes of the gml:Grid shall be identical to the axes of the geometry's coordinate system (which requires that the axisLabels be identical to those in the coordinate system definition), and the limits shall be treated as being expressed as coordinates in the geometry's coordinate reference system.

Clearly these additional constraints are quite limiting, in that gridded datasets whose Reference points happen to exist exactly at integral coordinates of a spatial coordinate system at a spacing of exactly one in all coordinate dimensions are exceedingly rare, unless that coordinate system is part of a gml:ImageCRS. Nevertheless, the gmlcov:GridCoverage is available for such purposes.

It is recommended that the more sensible provisions of the gmlcov:RectifiedGridCoverage or gmlcov:ReferenceableGridCoverage be utilized for all gridded datasets, since their domains can accommodate the simple provisions of the gmlcov:GridCoverage as well as more complex referencing situations.

Since this GridCoverage uses Coverage, it can be used for both discrete and continuous coverages.

6.7.8 RectifiedGridCoverage

A RectifiedGridCoverage is a discrete point coverage based on a rectified grid. It is similar to the grid coverage except that the points of the grid are geometrically referenced.

Requirement 13 /req/gml-coverage/rectifiedGridCoverage:
A coverage of type RectifiedGridCoverage **shall** have a domain that is a GML::RectifiedGrid geometry.

Since this RectifiedGridCoverage uses Coverage, it can be used for both discrete and continuous coverages.

6.7.9 ReferenceableGridCoverage

A ReferenceableGridCoverage is an implementation of ISO 19123 DiscreteGrid-PointCoverage for a ReferenceableGrid domain.

NOTE 1 Support for referenceable grid is limited to the provisions made by ISO 19136-2:2015.

Requirement 14 /req/gml-coverage/referenceableGridCoverage:
A coverage of type `ReferenceableGridCoverage` **shall** have a domain geometry that is a subtype of `AbstractReferenceableGrid`.

Since this `ReferenceableGridCoverage` uses the `gmlcov:AbstractCoverageType`, it can be used for both discrete and continuous coverages.

NOTE 2 The equivalent of this element has been added to GML 3.2.1 in OGC by approved Change Request 07-112r3 and, therefore, has been added to this document as well.

6.8 Complete coverage example

EXAMPLE The following is a complete `RectifiedGridCoverage` instance:

```
<?xml version="1.0" encoding="UTF-8" ?>
<gmlcov:RectifiedGridCoverage
    xmlns="http://www.w3.org/2001/XMLSchema"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:xlink="http://www.w3.org/1999/xlink"
    xmlns:gmlcov="http://www.opengis.net/gmlcov/1.0"
    xmlns:gml="http://www.opengis.net/gml/3.2"
    xsi:schemaLocation=
        "http://www.opengis.net/gmlcov/1.0
    http://schemas.opengis.net/gmlcov/1.0/gmlcovAll.xsd"
    gml:id="C001">
    <gml:boundedBy>
        <gml:Envelope srsName=
     "http://www.opengis.net/def/crs/EPSG/0/4326" axisLabels="Lat Long"
            uomLabels="deg deg" srsDimension="2">
            <gml:lowerCorner>1 1</gml:lowerCorner>
            <gml:upperCorner>3 3</gml:upperCorner>
        </gml:Envelope>
    </gml:boundedBy>
    <gml:domainSet>
        <gml:RectifiedGrid gml:id="RG001_C001"
            srsName="http://www.opengis.net/def/crs/EPSG/0/4326"
     axisLabels="Lat Long"
           uomLabels="deg deg" dimension="2">
            <gml:limits>
                <gml:GridEnvelope>
                    <gml:low>0 0</gml:low>
                    <gml:high>9999 9999</gml:high>
                </gml:GridEnvelope>
            </gml:limits>
            <gml:axisLabels>Lat Long</gml:axisLabels>
            <gml:origin>
                <gml:Point gml:id="P001_C001"
         srsName=
"http://www.opengis.net/def/crs/EPSG/0/4326">
                    <gml:pos>99. 99.9</gml:pos>
                </gml:Point>
            </gml:origin>
            <gml:offsetVector>1 0</gml:offsetVector>
            <gml:offsetVector>0 1</gml:offsetVector>
        </gml:RectifiedGrid>
    </gml:domainSet>
    <rangeType>
       <swe:DataRecord>
            <swe:field name="white">
               <swe:Quantity definition="http://opengis.net/
                def/property/OGC/0/Radiance">
                   <gml:description>Panchromatic</gml:description>
                   <gml:name>White</gml:name>
                   <swe:nilValues>
                       <swe:nilValue
       reason="http://www.opengis.net/def/nil/OGC/0/BelowDetectionRange">
```

```
                        0
                    </swe:nilValue>
                    <swe:nilValue
    reason="http://www.opengis.net/def/nil/OGC/0/AboveDetectionRange">
                        255
                    </swe:nilValue>
                </swe:nilValues>
                <swe:uom code="W/cm2"/>
                <swe:constraint>
                    <swe:AllowedValues>
                        <swe:interval>0 255</swe:interval>
                        <swe:significantFigures>3
                        </swe:significantFigures>
                    </swe:AllowedValues>
                </swe:constraint>
            </swe:Quantity>
        </swe:field>
    </swe:DataRecord>
</rangeType>
<gml:coverageFunction>
    <gml:GridFunction>
        <gml:sequenceRule axisOrder="+1+2">
    Linear
  </gml:sequenceRule>
        <gml:startPoint>0 0</gml:startPoint>
    </gml:GridFunction>
</gml:coverageFunction>
<gml:rangeSet>
    <DataBlock>
        <rangeParameters/>
        <tupleList>
            1  2  3  4  5
            6  7  8  9  10
            11 12 13 14 15
        </tupleList>
    </DataBlock>
</gml:rangeSet>
</gmlcov:RectifiedGridCoverage>
```

The above example, which is verbatim adopted from OGC CIS 1.0, shows the structure on principle (i.e. syntactically). Coordinates have not been picked to semantically reflect a real-world situation — see, e.g. the envelope and domain set coordinates. Concretely, bounding box coordinate upper bounds greater than 180° (here: 9999) should be avoided. However, for the sake of consistency with the OGC standard, the example has not been modified.

7 GML representation requirements class

Requirements class *gml-coverage* establishes how coverages are represented in the GML encoding format. Its identifying URL is given by http://www.opengis.net/spec/GMLCOV/1.0/req/gml-coverage.

NOTE Clause 6 establishes a conceptual model of a coverage, independent from its encoding. While UML and GML are used for establishing this, Clause 6 does not anticipate a GML encoding. A GML representation is established by Clause 6 instead.

Requirement 15 /req/gml/coverage:
In a coverage encoded in GML, the coverage structure represented **shall** conform with conformance class *gml-coverage*.
Dependency: http://www.opengis.net/spec/GMLCOV/1.0/req/gml-coverage.

Requirement 16 /req/gml/content-type:
In a coverage encoded in GML, the IETF RFC 2387[2] `Content-Type` parameter of this coverage document **shall** have a value of "application/gml+xml".

Requirement 17 /req/gml/special-format:
A coverage document **shall** be conformant with OCG GML [07-036] conformance class A.1.9.
Dependency: OCG GML [07-036] conformance class A.1.9.

8 Multipart representation requirements class

8.1 Coverages as multipart messages

A coverage can be represented as a multipart/related message document[4] consisting of a GML-encoded part containing the coverage data minus its range set followed by a second part containing an encoding of the coverage range set in some standard encoding format. This establishes requirements class *multipart*. Its identifying URL is given by http://www.opengis.net/spec/GMLCOV/1.0/req/multipart.

NOTE This encoding type describes a self-contained coverage document. The *gml-coverage* conformance class, as per GML specification, additionally allows a remote URL to be used for referencing coverage constituents. The difference between both encodings is that coverages conforming to *gml-coverage* are a single GML document containing references to any other place, resolvable by the reader in any context, whereas a *multipart* coverage contains all constituents as sub-documents in the file itself.

Requirement 18 /req/multipart/coverage:
In a coverage encoded in a multipart message, the coverage structure represented **shall** conform with conformance class *gml-coverage*.
Dependency: http://www.opengis.net/spec/GMLCOV/1.0/req/gml-coverage.

Requirement 19 /req/multipart/multipart-mime:
A coverage encoded in a multipart message **shall** consist of a multipart MIME document as specified by IETF RFC 2387 [2].

Requirement 20 /req/multipart/content-type:
In a coverage encoded in a multipart message, the IETF RFC 2387[2] `Content-Type` parameter of this coverage document **shall** have a value of "`Multipart/Related`".

Requirement 21 /req/multipart/number-of-components:
A coverage encoded in a multipart message **shall** consist of two parts.

Requirement 22 /req/multipart/start:
In a coverage encoded in a multipart message, the IETF RFC 2387[2] Type parameter of this coverage document **shall** have a value of "application/gml+xml".

8.2 First part: GML coverage

Requirement 23 /req/multipart/gml-coverage:
In a coverage encoded in a multipart message, the first part **shall** consist of a GML document of type `gmlcov:AbstractCoverageType`.

Requirement 24 /req/multipart/use-file:
In a coverage encoded in a multipart message, in the first part the `/gmlcov:AbstractCoverage/gml:rangeSet` element **shall** contain a `gml:File` element.

Requirement 25 /req/multipart/rangeParameters-role:
In a coverage encoded in a multipart message, in the first part the `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:rangeParameters/@xlink:role` attribute **shall** contain the URL identifier of a conformance class of an OGC data encoding standard.

Requirement 26 /req/multipart/rangeParameters-arcrole:
In a coverage encoded in a multipart message, in the first part the `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:rangeParameters/@xlink:arcrole` attribute **shall** contain the value "`fileReference`".

Requirement 27 /req/multipart/rangeParameters-href:
In a coverage encoded in a multipart message, in the first part the `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:rangeParameters/@xlink:href` attribute **shall** contain a value identical to `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:fileReference` contents.

Requirement 28 /req/multipart/fileReference:
In a coverage encoded in a multipart message, in the first part the `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:fileReference` element **shall** contain a local "cid" (Content-ID) URL as specified by IETF RFC 2392[3] to the second part of the multipart message.

EXAMPLE The following MIME message represents a valid multipart coverage structure (assuming all "..." substituted by proper XML and with a proper TIFF file instead of the second-to-last line):

```
Content-Type: Multipart/Related; boundary=wcs;
        start="GML-Part"
        type="text/xml"
--wcs
Content-type: text/xml
Content-ID: GML-Part
<?xml version="1.0" …>
<gmlcov:RectifiedGridCoverage …>
  <gml:domainSet>…</gml:domainSet>
  <gml:rangeSet>
    <gml:File>
      <gml:rangeParameters xlink:href="grey.tif"
       xlink:role="http://www.opengis.net/spec/WCS_coverage-encoding_geotiff/1.0/"
       xlink:arcrole="fileReference"/>
      <gml:fileReference>grey.tif</gml:fileReference>
      <gml:fileStructure/>
      <gml:mimeType>image/tiff</gml:mimeType>
```

```
    </gml:File>
  </gml:rangeSet>
  <gmlcov:rangeType>…</gmlcov:rangeType>
</gmlcov:RectifiedGridCoverage>
--wcs
Content-Type: image/tiff
Content-Description: coverage data
Content-Transfer-Encoding: binary
Content-ID: grey.tif
Content-Disposition: INLINE
...binary TIFF data...
--wcs—
```

Requirement 29 /req/multipart/mimeType:
In a coverage encoded in a multipart message, in the first part the `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:mimeType` **shall** contain that MIME type string which is defined in the standard referenced in the `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:rangeParameters/@xlink:role` attribute.

NOTE The contents of the `gml:File/gml:compression` element is left undefined as this element is currently not used by this document.

8.3 Second part: encoded coverage range set

Requirement 30 /req/multipart/target-content-disposition:
In a coverage encoded in a multipart message, the IETF RFC 2387[2] `Content-Disposition` parameter of this coverage document **shall** be present and have a value of "`inline`" (not case sensitive).

NOTE This follows IETF RFC 2183[1].

Requirement 31 /req/multipart/target-mimetype:
In a coverage encoded in a multipart message the MIME type identifier of the second part **shall** be identical to the value of `/gmlcov:AbstractCoverage/gml:rangeSet/gml:File/gml:mimeType` in the first part of the multipart coverage.

Requirement 32 /req/multipart/target-encoding:
In a coverage encoded in a multipart message the second part **shall** conform to the encoding specified in the `/gmlcov:AbstractCoverage/gml:File/gml:rangeParameters/@xlink:role` value in the first part of the multipart coverage.

Requirement 33 /req/multipart/consistent:
In a coverage encoded in a multipart message the coverage components encoded in the second message part, when decoded from the format on hand into GML, **shall** be consistent with the coverage components of the first part of the multipart coverage.
Dependency: http://www.opengis.net/spec/GMLCOV/1.0/req/gml-coverage.

EXAMPLE The following sketches a valid multipart coverage (contents of second part omitted):

```
Content-Type: Multipart/Related; boundary=wcs;
        start="GML-Part"
        type="application/gml+xml"

--wcs
Content-type: application/gml+xml
```



```
Content-ID: GML-Part

<?xml version="1.0" encoding="UTF-8"?>
<gmlcov:RectifiedGridCoverage
 xmlns:wcs="http://www.opengis.net/wcs/2.0"
 xmlns:ows="http://www.opengis.net/ows/2.0"
 xmlns:ogc="http://www.opengis.net/ogc"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xmlns:xlink="http://www.w3.org/1999/xlink"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:gmlcov="http://www.opengis.net/gmlcov/1.0
"
 xmlns:swe="http://www.opengis.net/swe/2.0
"
xsi:schemaLocation="http://www.opengis.net/wcs/2.0
   http://schemas.opengis.net/wcs/2.0/wcsAll.xsd "
 gml:id="grey">
  <gml:boundedBy>
    <gml:Envelope srsName="http://www.opengis.net/def/crs/EPSG/0/32611"
     axisLabels="x y" uomLabels="m m" srsDimension="2">
      <gml:lowerCorner>5 5</gml:lowerCorner>
      <gml:upperCorner>395 295</gml:upperCorner>
    </gml:Envelope>
  </gml:boundedBy>
  <gml:domainSet>
    <gml:RectifiedGrid dimension="2" gml:id="grid_grey">
      <gml:limits>
        <gml:GridEnvelope>
          <gml:low>0 0</gml:low>
          <gml:high>39 29</gml:high>
        </gml:GridEnvelope>
      </gml:limits>
      <gml:axisLabels>x y</gml:axisLabels>
      <gml:origin>
        <gml:Point gml:id="grid_origin_grey"
         srsName="http://www.opengis.net/def/crs/EPSG/0/32611">
          <gml:pos>5.000000 5.000000</gml:pos>
        </gml:Point>
      </gml:origin>
      <gml:offsetVector
       srsName="http://www.opengis.net/def/crs/EPSG/0/32611">10.000000
        0
      </gml:offsetVector>
      <gml:offsetVector
       srsName="http://www.opengis.net/def/crs/EPSG/0/32611">
        0
10.000000
      </gml:offsetVector>
    </gml:RectifiedGrid>
  </gml:domainSet>
  <gml:rangeSet>
    <gml:File>
      <gml:rangeParameters xlink:href="cid:grey.tif"
       xlink:role="http://www.opengis.net/spec/WCS_coverage-
encoding_geotiff/1.0/"
      xlink:arcrole="fileReference"/>
       <gml:fileReference>cid:grey.tif</gml:fileReference>
      <gml:fileStructure/>
      <gml:mimeType>image/tiff</gml:mimeType>
    </gml:File>
  </gml:rangeSet>
  <gmlcov:rangeType>
    <swe:DataRecord>
      <swe:field name="grey">
        <swe:Quantity
         definition="http://www.opengis.net/def/property/OGC/0/Radiance">
          <swe:description>Grey band</swe:description>
          <swe:nilValues/>
          <swe:uom code="W.m-2.sr-1.nm-1"/>
          <swe:constraint>
            <swe:AllowedValues>
```

```
            <swe:interval>-32768 32767</swe:interval>
          </swe:AllowedValues>
        </swe:constraint>
      </swe:Quantity>
    </swe:field>
  </swe:DataRecord>
 </gmlcov:rangeType>
</gmlcov:RectifiedGridCoverage>
--wcs
Content-Type: image/tiff
Content-Description: coverage data
Content-Transfer-Encoding: binary
Content-ID: grey.tif
Content-Disposition: inline
--wcs--
```

9 Special format requirements class

Requirements class *special-format* establishes how coverages are represented in encoding formats other than GML. Its identifying URL is given by http://www.opengis.net/spec/GMLCOV/1.0/req/special-format.

NOTE Such formats can be able to encode only parts of a coverage, and they can be able to encode only specific categories of coverages.

Requirement 34 /req/special/coverage:
In a coverage encoded in a multipart message, the coverage structure represented **shall** conform with conformance class *gml-coverage*.
Dependency: http://www.opengis.net/spec/GMLCOV/1.0/req/gml-coverage.

Requirement 35 /req/special/special-format:
A coverage document not encoded in GML **shall** be conformant with some OGC data format encoding standard.
Dependency: OCG format encoding standards.

EXAMPLE A 2-D rectified grid coverage can be represented by a GeoTIFF file.

Annex A
(normative)

Abstract test suite

This Annex specifies an abstract test suite which shall be passed in completeness by any implementation claiming conformance with this document.

Tests identifiers below are relative to <http://www.opengis.net/cis/1.0> or <http://www.opengis.net/spec/GMLCOV/1.0/>.

For A.1 the OGC URI identifier of the conformance class is:
<http://www.opengis.net/cis/1.0/conf/gml-coverage> or
<http://www.opengis.net/spec/GMLCOV/1.0/conf/gml-coverage>.

For A.2 the OGC URI identifier of the conformance class is:
<http://www.opengis.net/cis/1.0/conf/gml> or
<http://www.opengis.net/spec/GMLCOV/1.0/conf/gml>.

For A.3 the OGC URI identifier of the conformance class is:
<http://www.opengis.net/cis/1.0/conf/multipart> or
<http://www.opengis.net/spec/GMLCOV/1.0/conf/multipart>.

For A.4 the OGC URI identifier of the conformance class is:
<http://www.opengis.net/cis/1.0/conf/special-format> or
<http://www.opengis.net/spec/GMLCOV/1.0/conf/special-format>.

A.1 Conformance Test Class: gml-coverage

A.1.1 Document validates

Test id: **/conf/gml-coverage/structural-adherence**

Test purpose: **/req/gml-coverage/structural-adherence:**
Any XML document instantiating a concrete subtype of `Coverage` **shall** conform with the UML diagram in Figure 1, with Table 2, and with the XML schema defined as part of this standard.

Test method: If the coverage instance document is encoded in XML, load the document into an XML validator. Test passes if the document is a valid concrete subtype of `gmlcov:AbstractCoverageType`.

A.1.2 DataRecord range structure

Test id: **/conf/gml-coverage/dataRecord**

Test purpose: **/req/gml-coverage/dataRecord:**
The range type component of a coverage **shall** conform with the `DataRecord` of SWE Common [OGC 08-094].

Dependency: [OGC 08-094] Clause 7 (http://www.opengis.net/doc/SWE/2.0/clause/7), [OGC 08-094] Clause 8 (http://www.opengis.net/doc/SWE/2.0/clause/8),

Test method: Validate the coverage instance under test against SWE Common by evaluating its conformance test suite.

Test passes if all SWE Common tests applicable pass.

A.1.3 No value component in rangeType

Test id: **/conf/gml-coverage/no-value-in-rangeType**

Test purpose: **req/gml-coverage/no-value-in-rangeType:**
For all SWE Common AbstractSimpleComponent subtypes in a range type structure, instance multiplicity of the value component **shall** be zero.

Test method: In the instance document under test, inspect all SWE Common `AbstractSimpleComponent` subtypes in a range type structure and check that no value component is present.

One way of doing so is to evaluate this Schematron rule:

```
< sch:rule context = ”//swe:Quantity |
//swe:QuantityRange |//swe:Count|//swe:CountRange |
//swe:Time | //swe:TimeRange | //swe:Boolean |
//swe:Category | //swe:CategoryRange |
//swe:Text” > < sch:assert
test = ”count(./swe:value) = 0”/ > </sch:rule>
```

Test passes if constraint holds.

A.1.4 Admissible DataRecord subtypes

Test id: **/conf/gml-coverage/record-or-dataArray**

Test purpose: **/req/gml-coverage/record-or-dataArray**:
Wherever the SWE Common XML schema allows an `AbstractDataComponent` in a coverage range structure the concrete instance **shall** be one of the `AbstractDataComponent` subtypes `DataRecord` and `DataArray`.

Test method: Inspect the instance document under test and check the above constraint. One way of doing so is to evaluate this Schematron rule:

```
<sch:rule>
<sch:assert test="descendant-or-self::*
    [name()='swe:DataRecord' or
     name()='swe:DataArray']"
>
</sch:rule>
```

Test passes if constraint holds.

A.1.5 Exactly one range value

Test id: **/conf/gml-coverage/one-range-value-per-position**

Test purpose: **/req/gml-coverage/one-range-value-per-position:**
For each coordinate position contained in the domain set description of a coverage there **shall** exist exactly one range value in the coverage's range set.

Test method: Inspect the instance document under test and check, for each possible location as defined in the coverage's domain set, that there is exactly one corresponding value in the range set.

Test passes if all constraints evaluate to true.

A.1.6 Range values adhere to range structure definition

Test id: **/conf/gml-coverage/range-structure-consistency**

Test purpose: **/req/gml-coverage/range-structure-consistency:**
All range values contained in the range set of a coverage **shall** be consistent with the structure description provided in its range type.

Test method: Inspect the instance document under test and check, for each range value tuple:

— Number of tuple components adheres to range structure definition.

— Data type of each atomic value conforms to the corresponding data type specification in the range structure definition.

— Value of attribute `uom` in `gml:QuantityList` in `gml:rangeSet` consistent with value of attributes `code` in `swe:uom` and `definition` in `swe:Quantity` in `gmlcov:rangeType`.

Test passes if all constraints evaluate to true.

A.1.7 Coverage type correctly derived

Test id: **/conf/gml-coverage/coverage-derivation**

Test purpose: **/req/gml-coverage/coverage-derivation:**
The type of the root element of a coverage document instance **shall** be a concrete direct or indirect subtype of `Coverage`.

Test method: Check whether the XML type of the root element of the instance document under test

— is not abstract

— is a direct or indirect subtype of `gmlcov:AbstractCoverage`.

Test passes if constraints evaluate to true.

A.1.8 Correct structure of multi-point coverage

Test id: **/conf/gml-coverage/multiPointCoverage**

Test purpose: **/req/gml-coverage/multiPointCoverage:**
A coverage of type `MultiPointCoverage` **shall** `have` a content model identical with `DiscreteCoverage`, except that the `domainSet` **shall** `have` `GML::MultiPoint` values.

Test method: Check the XML type of the root element of the instance document under test.

— If type is `MultiPointCoverage`: check whether the document's `domainSet` element contains values of type `gml:MultiPoint`.

— otherwise: pass test.

Test passes if constraints evaluate to true.

A.1.9 Correct structure of multi-curve coverage

Test id: **/conf/gml-coverage/multiCurveCoverage**

Test purpose: **/req/gml-coverage/multiCurveCoverage**:
A coverage of type `MultiCurveCoverage` **shall** have a content model identical with `DiscreteCoverage`, except that the `domainSet` **shall** have `"GML 3.2.1"::MultiCurve` values.

Test method: Check the XML type of the root element of the instance document under test.

— If type is `MultiCurveCoverage`: check whether the document's `domainSet` element contains values of type `gml:MultiCurve`.

— otherwise: pass test.

Test passes if constraints evaluate to true.

A.1.10 Correct structure of multi-surface coverage

Test id: **/conf/gml-coverage/multiSurfaceCoverage**

Test purpose: **/req/gml-coverage/multiSurfaceCoverage:**
A coverage of type `MultiSurfaceCoverage` **shall** `have` a content model identical with `DiscreteCoverage`, except that the `domainSet` **shall** have `GML::MultiSurface` values.

Test method: Check the XML type of the root element of the instance document under test.

— If type is `MultiSurfaceCoverage`: check whether the document's `domainSet` element contains values of type `gml:MultiSurface`.

— otherwise: pass test.

Test passes if all constraints evaluate to true.

A.1.11 Correct structure of multi-solid coverage

Test id: **/conf/gml-coverage/multiSolidCoverage**

Test purpose: **/req/gml-coverage/multiSolidCoverage:**
A coverage of type `MultiSolidCoverage` **shall** have a content model identical with `DiscreteCoverage`, except that the `domainSet` **shall** have `GML::MultiSolid` values.

Test method: Check the XML type of the root element of the instance document under test.

— If type is `MultiSolidCoverage`: check whether the document's `domainSet` element contains values of type `gml:MultiSolid`.

— otherwise: pass test.

Test passes if all constraints evaluate to true.

A.1.12 Correct structure of grid coverage

Test id: **/conf/gml-coverage/gridCoverage**

Test purpose: **/req/gml-coverage/gridCoverage:**
A coverage of type `GridCoverage` **shall** have a domain that is a `GML::Grid`.

Test method: Check the XML type of the root element of the instance document under test.

— If type is `GridCoverage`: check whether the document's `domainSet` element is a `gml:Grid`.

— otherwise: pass test.

Test passes all if constraints evaluate to true.

A.1.13 Correct structure of rectified grid coverage

Test id: **/conf/gml-coverage/rectifiedGridCoverage**

Test purpose: **/req/gml-coverage/rectifiedGridCoverage:**
A coverage of type `RectifiedGridCoverage` **shall** have a domain that is a `GML::RectifiedGrid` geometry.

Test method: Check the XML type of the root element of the instance document under test.

— If type is `RectifiedGridCoverage`: check whether the document's `domainSet` element is a `gml:RectifiedGrid`.

— otherwise: pass test.

Test passes if all constraints evaluate to true.

A.1.14 Correct structure of referenceable grid coverage

Test id: **/conf/gml-coverage/referenceableGridCoverage**

Test purpose: **/req/gml-coverage/referenceableGridCoverage:**
A coverage of type `ReferenceableGridCoverage` **shall** have a domain geometry that is a subtype of `AbstractReferenceableGrid`.

Test method: Check the XML type of the root element of the instance document under test.

— If type is `ReferenceableGridCoverage`: check whether the document's `domainSet` element is in the substitution group of `AbstractReferenceableGrid`.

— otherwise: pass test.

Test passes if all constraints evaluate to true.

A.2 Conformance Test Class: gml

A.2.1 GML coverage

Test id: **/conf/gml/coverage**

Test purpose: **/req/gml/coverage**: In a coverage encoded in GML, the coverage structure represented **shall** conform with conformance class *gml-coverage*.

Test method: If the coverage instance document under test is encoded in XML, check that the coverage is a valid concrete subtype of `gmlcov:AbstractCoverageType`.

Test passes if constraint holds.

A.2.2 GML content type

Test id: **/conf/gml/content-type**

Test purpose: **/req/gml/content-type**: In a coverage encoded in GML, the IETF RFC 2387 [2] `Content-Type` parameter of this coverage document **shall** have a value of "application/gml+xml".

Test method: If the coverage instance document under test is encoded in GML, check that the IETF RFC 2387[2] `Content-Type` parameter of this coverage document has a value of "application/gml+xml".

Test passes if constraint holds.

A.2.3 GML special format

Test id: **/conf/gml/special-format**

Test purpose: **/req/gml/special-format**: A coverage document **shall** be conformant with OCG GML [07–036] conformance class A.1.9.
Dependency: OCG GML [07–036] conformance class A.1.9.

Test method: Validate the coverage document under test against OCG GML [07–036] conformance class A.1.9 test suite.

Test passes if all test applicable pass.