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OGC Coverage Implementation Schema -

ReferenceableGridCoverage Extension

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Abstract

This *OGC**Coverage**Implementation Schema - ReferenceableGridCoverage Extension* provides a set of referenceable grid elements for use as sub-elements of ReferenceableGridCoverage. Three of these elements have been adapted from GML 3.3, while a fourth emerged from work on a Testbed-11 Engineering Report[[1]](#footnote-1).

Version 1.1 of this standard permits use of the more concise array encoding of sensor model parameters in SensorML 2.1 documents via the new element setEncodedValues.

Keywords

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, extension, GMLCOVRGRID, GMLCOV, coverage, grid, referenceable, domain, GML, SensorML, CIS, WCS

1. Preface

Work towards OGC standards to support sensor model imagery began in 2014 in the GMLJP2 SWG, where members discussed access to elements of SensorML 2.0 and GML 3.3 from the GMLJP2 2.0 schema element GMLJP2ReferenceableGridCoverage. However, it was not until early 2015 that one of us fortuitously began to work with OGC coverage lead Peter Baumann on the Testbed-11 engineering report on “Harmonization of Referenceable Grids”. This work resulted in two change requests that eventually led to this standard.

The first CR recognized that CIS 1.0 needed instantiable ReferenceableGrid elements, as it has only an abstract ReferenceableGrid element, while the second CR proposed to connect CIS 1.0 to SensorML 2.0 by a proposed element ReferenceableGridBySensorModel. At the same time, it was recognized that although the ReferenceableGrid elements of GML 3.3 could be forced to work with the CIS 1.0 schema, such a workaround is not in compliance with an underlying OGC standard called MODSPEC[[2]](#footnote-2) that guides the design and usage of OGC standards.

Through discussions with Peter and through study of the CIS 1.0 document 09-146r2, it was recognized that the structure of a ReferenceableGridCoverage (that GMLJP2ReferenceableGridCoverage is built on) was set in the CIS 1.0 requirements, which ultimately come from ISO TC211. More specifically, as shown in Figure 1, a ReferenceableGridCoverage is followed by a GML domainSet element that must then be followed by an instantiable ReferenceableGrid, and it is the ReferenceableGrid element that determines the grid's set of geolocations. This standard, as a strict extension of CIS 1.0, makes this structure the basis of its single conformance class.

**Figure 1: CIS 1.0 Structure of a ReferenceableGridCoverage**

The Testbed 11 ER led to a gradual change in thinking for us GMLJP2 SWG enthusiasts. No longer were we interested in a solution that only applied to GMLJP2 2.0. It was now clear that these insights should add value not only to GMLJP2 but to any CIS 1.0 -based standard.

The resulting standard, described in this document, strictly extends CIS 1.0 in that no modifications to CIS 1.0 are made. The Extension brings over the 3 ReferenceableGrid elements of GML 3.3 with only minor alterations. Placing the 3 elements in a child standard was done to make them useable (with respect to MODSPEC) with the ReferenceableGridCoverage element of CIS 1.0. The 4th element, ReferenceableGridBySensorModel, is an outcome of the ER. The Extension comes with a schema, found in a single xsd file, which uses the namespace *gmlcovrgrid*.

Version 1.0 of this standard was published in June 2017. A minor revision was published in Jan. 2019 to correct the multiplicities of the sensorInstance and sensorModel sub-elements of the ReferenceableGridBySensorModel element. The current version 1.1 was necessitated by the recently published update to the SensorML standard, on which this standard depends.

For OGC imagery standards (such as GMLJP2) that are based on CIS 1.0 and this standard, new capabilities provided by this standard remove the constraint of only supporting rectified imagery and allow for the support of sensor model imagery. The immense collection of unrectified imagery from airborne and satellite platforms contain a wealth of extra information, which would be lost upon rectification, that may be used for many applications such as 3D scene reconstructions.

As the details of sensor models and their metadata profiles for use with the ReferenceableGridBySensorModel element is beyond the scope of this document, the need for an OGC “Sensor Extension” document is foreseen, either as a Standard or as a Best Practice.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

*Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.*

Security Considerations

No security considerations have been made for this standard.

Submitting organizations

The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

* European Union Satellite Centre (EU SatCen)
* Institut National de l’Information Géographique et Forestière (IGN)
* Eric Hirschorn

Note: Former OGC organization KEYW submitted revisions 1.0.0 and 1.0.1 of this document.

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# Scope

This ReferenceableGridCoverage Extension specifies instantiable referenceable grid elements supportive of GMLCOV::ReferenceableGridCoverage.

# Conformance

This standard defines the following requirement and conformance class:

* gmlcovrgrid, of URI <http://www.opengis.net/spec/GMLCOV/GMLCOVRGRID/1.1/req/gmlcovrgrid>, with a single pertaining conformance class, *gmlcov*rgrid, of URI <http://www.opengis.net/spec/GMLCOV/GMLCOVRGRID/1.1/conf/gmlcovrgrid>.

The standardization target are concrete **CIS 1.0** **coverage instance documents**, as generated by some service and/or consumed by some client.

Conformance with this standard shall be checked using all the relevant tests specified in Annex A (normative) of this document. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures and the OGC Compliance Testing web site[[3]](#footnote-3).

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

# References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document.

OGC: OGC 09-146r2, *OGC Coverage Implementation Schema* (CIS 1.0), 2012

Conformance class: [http://www.opengis.net/spec/gmlcov/1.0/conf/gml-coverage](http://www.opengis.net/spec/CIS/1.0/conf/gml-coverage)

OGC: OGC 12-000r2, *OGC SensorML: Model and XML Encoding Standard*, 2020

Conformance class: <http://www.opengis.net/spec/sensorML/2.1/conf/xml/coreProcess>

# Terms and Definitions

This document uses the terms defined in Sub-clause 5.3 of [OGC 06-121r8], which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this standard.

The terms and definitions of the coverage standard CIS 1.0 apply to this extension standard.

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

## coordinate

One of a sequence of n numbers designating the position of a point in n-dimensional space.

[ISO 19111]

NOTE: In a coordinate reference system, the coordinate numbers are qualified by units.

## coordinate reference system

A coordinate system that is related to an object by a datum.

[ISO 19111]

NOTE: For geodetic and vertical datums, the object will be the Earth.

## coordinate system

A set of mathematical rules for specifying how coordinates are to be assigned to points.

[ISO 19111]

## curve

A 1-dimensional geometric-primitive, representing the continuous image of a line.

[ISO 19107]

## grid

A 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.

[ISO 19123]

NOTE: The curves partition a space into grid cells

## point

A 0-dimensional geometric primitive, representing a position.

[ISO 19107]

NOTE: The boundary of a point is the empty set.

## referenceable grid

A **grid** associated with a transformation that can be used to convert grid **coordinate** values to values of coordinates referenced to an external **coordinate reference system**.

NOTE This definition was copied from ISO 19123, Sub-clause 4.1.33, which is followed by the caveat: “If the coordinate reference system is related to the earth by a datum, the grid is a georeferenceable grid.”

NOTE An external CRS is a CRS for the grid after the referenceable grid transformation is applied.

## sensor model

A mathematical model for estimating geolocations from data recorded by a remote sensing system

NOTE Sensor models are used in this ReferenceableGridCoverage Extension to represent referenceable grid transformations for any relevant remote sensing system. There are alternative definitions in use by OGC and ISO TC211

According to SensorML 2.1 [OGC 12-000r2] section 4.31: “In line with traditional definitions of the remote sensing community, a sensor model is a type of Location Model that allows one to georegister observations from a sensor (particularly remote sensors).”

According to ISO 19130, which is narrowly focused on imagery, a sensor model is a “mathematical description of the relationship between the three-dimensional object space and the two-dimensional plane of the associated image produced by a sensor.”

# Conventions

This section provides details and examples for any conventions used in the document. Examples of conventions are symbols, abbreviations, use of XML schema, or special notes regarding how to read the document.

## Identifiers

The normative provisions in this specification are denoted by the URI

<http://www.opengis.net/spec/GMLCOV/GMLCOVRGRID/1.1>

All requirements and conformance tests that appear in this document are denoted by partial URIs which are relative to this base.

## Abbreviated terms

CIS Coverage Implementation Schema

CR Change request

CRS Coordinate Reference System

ER Engineering Report

## Namespace prefix conventions

The following namespaces are used in this document. The prefix abbreviations used constitute conventions used here, but are not normative. The namespaces to which the prefixes refer are normative, however.

| Prefix | Namespace URI | Description |
| --- | --- | --- |
| xsd | http://www.w3.org/2001/XMLSchema | XML Schema namespace |
| gml | http://www.opengis.net/gml/3.2 | GML 3.2.1 |
| gmlcov | http://www.opengis.net/gmlcov/1.0 | CIS 1.0 |
| sml | http://www.opengis.net/sensorML/2.1 | SensorML 2.1 |
| gmlcovrgrid | http://www.opengis.net/gmlcov/gmlcovrgrid/1.1 | ReferenceableGridCoverage Extension 1.1 |

**Table 1 Namespace mapping conventions**

# Background (Non-Normative)

The OGC GML Application Schema - Coverages (“GMLCOV”) version 1.0 [OGC 09-146r2], renamed the OGC Coverage Implementation Schema version 1.0, provides a ReferenceableGridCoverage element for representing coverages on a referenceable grid. For the structure of a ReferenceableGridCoverage to be correct, its GML::domainSet must contain an instantiable subtype of GMLCOV::AbstractReferenceableGrid. Subtypes of this abstract element specify the transformations that map grid positions to coordinates in an external CRS.

While CIS 1.0 defines no instantiable referenceable grid elements, GML 3.3 provides instantiable subtypes of a different AbstractReferenceableGrid, one with namespace GMLRGRID. As the AbstractReferenceableGrid elements of GML 3.3 are not based on the native AbstractReferenceableGrid element of CIS 1.0, the user of the GML 3.3 referenceable grid elements in the GML::domainSet of a ReferenceableGridCoverage violates Requirement 14 of CIS 1.0: “A coverage of type ReferenceableGridCoverage **shall** have a domain geometry that is a subtype of AbstractReferenceableGrid.”

As GML 3.3 and CIS 1.0 both derive from GML 3.2.1, such that there is no direct dependency of one on the other, the user of the GML 3.3 referenceable grid elements in the GML::domainSet of a ReferenceableGridCoverage violates Requirement 24 of the OGC Modular Specification[[4]](#footnote-4), in that GML 3.3 is not a conformant extension to CIS 1.0. The Requirement states: “A specification conformant to this standard shall require all conformant extensions to itself to be conformant to this standard.”

This *OGC**Coverage**Implementation Schema - ReferenceableGridCoverage Extension* standard - henceforth known as the “ReferenceableGridCoverage Extension” - provides a set of native referenceable grid elements, via an extension GMLCOVRGRID of CIS 1.0. GMLCOVRGRID supports the following elements with namespace GMLCOVRGRID.

1) ReferenceableGridByVectors, ReferenceableGridByArray, and ReferenceableGridByTransformation are adapted (with minor changes) from the GML 3.3 schema file *referenceableGrid.xsd*. The changes stem from the need to adjust for a slight difference between the CIS 1.0 and GML 3.3 AbstractReferenceableGrid elements.

2) ReferenceableGridBySensorModel provides access to grid transformations via SensorML 2.1, where the associated SensorML 2.1 documents are recommended to be based on profiles associated with referenceable grid transformations (such as ISO 19130[[5]](#footnote-5) and the Community Sensor Models[[6]](#footnote-6) from NGA).

GMLCOVRGRID is a strict extension[[7]](#footnote-7) of CIS 1.0, in that it assumes without change the normative provisions of its parent standard, including its requirements classes.

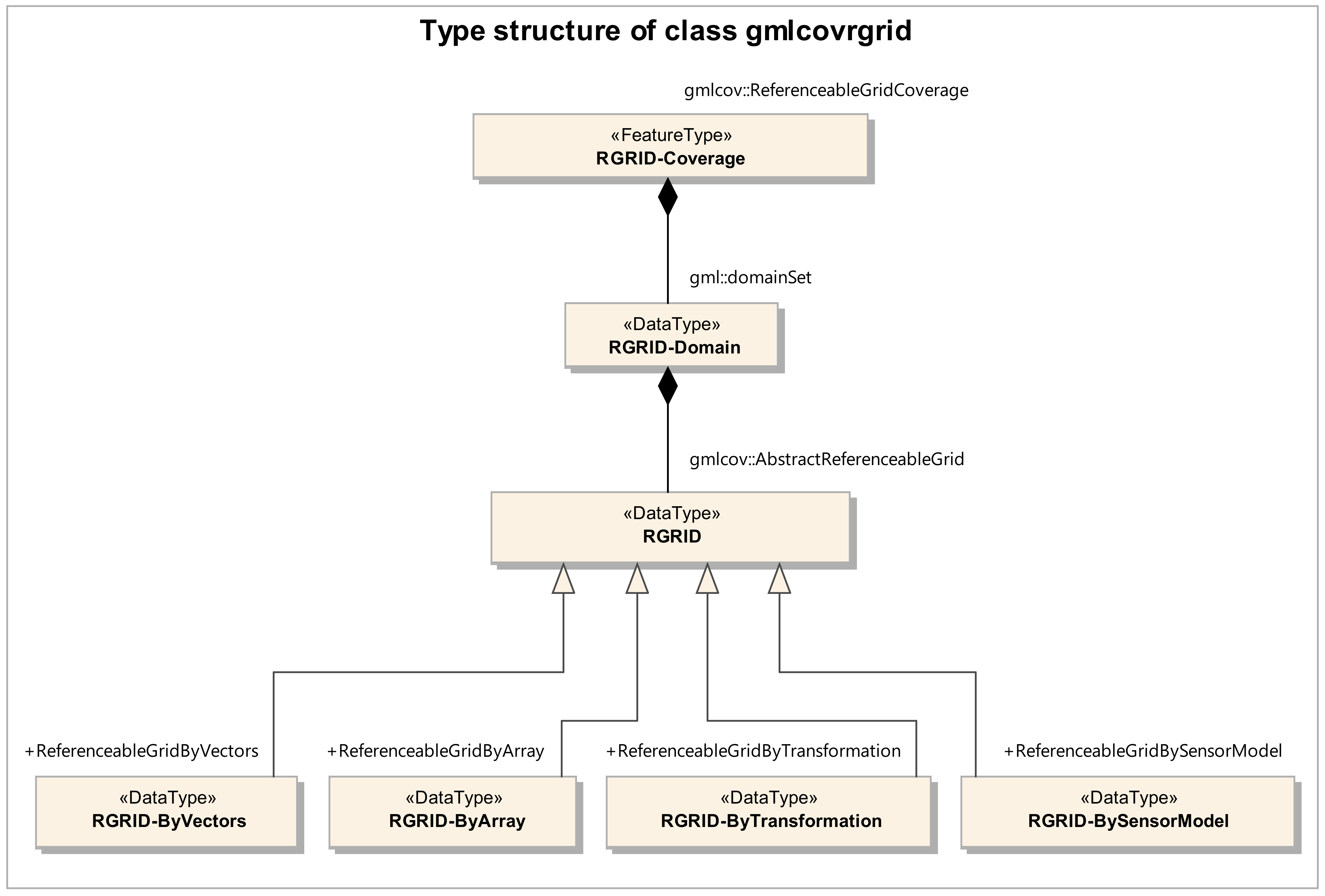
According to Requirement 1 of version 1.1 of CIS[[8]](#footnote-8), all coverages based on CIS 1.0 continue to be valid. Thus, a ReferenceableGridCoverage Extension is an extension standard applicable to CIS 1.1 as well as to CIS 1.0.

As the details of sensor models and their metadata profiles for use with the ReferenceableGridBySensorModel element is beyond the scope of this document, the need for an OGC “Sensor Extension” document is foreseen, either as a Standard or as a Best Practice.

# Class *gmlcovrgrid*

Class *gmlcovrgrid* lays the foundation for the implementation schema of the GMLCOVRGRID extension of the CIS 1.0 standard. This is the only requirement class for GMLCOVRGRID. This means that every compliant coverage instance must conform to the requirements stated here in Clause 7.

**Requirement 1 : /req/gmlcovrgrid/coverage-structure**  
A coverage instantiating class *gmlcovrgrid* **shall** conform to Figure 2.



**Figure 2: UML diagram of the RGRID-Coverage referenceable grid type structure, as defined by class *gmlcovrgrid***

The referenceable grid type structure of class *gmlcovrgrid* follows requirement 14 (**/req/gml-coverage/ReferenceableGridCoverage)** of parent standard CIS 1.0: “A coverage of type ReferenceableGridCoverage **shall** have a domain geometry that is

a subtype of AbstractReferenceableGrid.”

Sub-clauses 7.1 through 7.4 of this standard defines four instantiable referenceable grid types of class *gmlcovrgrid* that are generalizations of the GMLCOV::AbstractReferenceableGrid type that is defined in CIS 1.0.

The attributes dimension and srsName of AbstractReferenceableGrid are used to define the number of grid axes and the name of the SRS of the external CRS, respectively.

The class *gmlcovrgrid* XML schema specifies ReferenceableGridByVectors, ReferenceableGridByArray, and ReferenceableGridByTransformation that were adapted from GML 3.3[[9]](#footnote-9) and its associated schema file *referenceableGrid.xsd*. There is no dependency of the XML schema *gmlcovrgrid* on GML 3.3.

The GML 3.3 sub-clauses 10.4 through 10.7 defining its referenceable grid types remain useful as a guide for use of the adapted GMLCOVRGRID types defined in this extension. This is especially true for its examples of use. See GML 3.3 sub-clause 10.4 for ReferenceableGridByArray, sub-clause 10.5 for ReferenceableGridByVectors, and sub-clause 10.6 for ReferenceableGridByTransformation.

The class *gmlcovrgrid* XML schema also specifies ReferenceableGridBySensorModel that was developed for the Testbed-11.

## RGRID-ByVectors

The RGRID-ByVectors type defines a referenceable grid by specifying an origin and a set of offset vectors, with related multiplicative coefficients that scale the offset vectors to generate a (potentially) irregularly spaced grid.

**Requirement 2 : /req/gmlcovrgrid/by-vectors**  
An RGRID-ByVectors **shall** be defined by the structures of Table 2, Table 3, and by GMLCOVRGRID::ReferenceableGridByVectors as defined in the XML Schema accompanying this standard.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Definition** | **Data type** | **Multiplicity** |
| origin | The origin of the referenceable grid in the external CRS | GML:: PointPropertyType | One (mandatory) |
| generalGridAxis | Used to define an offset vector and support parameters | GeneralGridAxisPropertyType | One or more (mandatory) |

**Table 2: RGRID-ByVectors structure**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Definition** | **Data type** | **Multiplicity** |
| offsetVector | Specifies a vector in the external CRS | GML:: VectorType | One (mandatory) |
| coefficients | Specifies a set of multiplicative coefficients over the grid points | GML:: doubleList | One (mandatory) |
| gridAxesSpanned | The names of the grid axes spanned by the coefficients | GML:: NCNameList | One (mandatory) |
| sequenceRule | Specifies the order in which the coefficients are applied to the grid points | GML:: SequenceRuleType | One (mandatory) |

**Table 3: GeneralGridAxis structure**

NOTE RGRID-ByVectors generalizes the mechanism used for the GML 3.2.1 RectifiedGrid, which similarly uses offset vectors but in a much more restrictive way. For a RectifiedGrid, each offset vector is always aligned with a single grid direction, while for a ReferenceableGridByVectors such a restriction does not hold in general.

A generalGridAxis is followed by a GeneralGridAxis that fully specifies an offset vector and its support parameters. The GeneralGridAxis subelement offsetVector specifies a single vector in the external CRS. The subelement coefficients specifies a corresponding set of coefficients that multiply their respective offsetVector at grid points that span one or more of the grid dimensions, which are named with the gridAxesSpanned subelement. Finally, the order in which the coefficients are applied over the grid points is indicated using the sequenceRule subelement.

## RGRID-ByArray

The RGRID-ByArray type defines a referenceable grid by listing an array of grid point locations explicitly, as a sequence of direct positions in a defined sequence order over the grid.

**Requirement 3 : /req/gmlcovrgrid/by-array**  
An RGRID-ByArray **shall** be defined by the structure of Table 4, and by GMLCOVRGRID::ReferenceableGridByArray as defined in the XML Schema accompanying this standard.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Definition** | **Data type** | **Multiplicity** |
| GML::posList  (for example) | Specifies the array of grid point locations in the external CRS, via either a GML::posList or a sequence of GML::pos or GML::Point objects. | GML:: geometricPositionList Group | One (mandatory) |
| sequenceRule | Specifies the sequence order of the grid point locations over the grid. | GML:: SequenceRuleType | One (mandatory) |

**Table 4: RGRID-ByArray structure**

## RGRID-ByTransformation

The RGRID-ByTransformation type specifies either a GML::Transformation or a GML::ConcatenatedOperation to specify the relationship between positions in the source CRS and corresponding positions in the target CRS. A sequence of CRS to be used is optionally defined in gridCRS.

**Requirement 4 : /req/gmlcovrgrid/by-transformation**  
An RGRID-ByTransformation **shall** be defined by the structure of Table 5, and by GMLCOVRGRID::ReferenceableGridByTransformation as defined in the XML Schema accompanying this standard.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Definition** | **Data type** | **Multiplicity** |
| transformation | A general coordinate transformation using a sequence of operations based on GML::method that have an unbounded set of GML::parameterValue | GML:: TransformationPropertyType | Zero or one (optional) |
| concatenatedOperation | An ordered sequence of two or more coordinate operations | GML:: ConcatenatedOperation PropertyType | Zero or one (optional) |
| gridCRS | An optional sequence of CRS definitions used by the transformation or the concatenatedOperation | GridCRSPropertyType | Zero or one (optional) |

**Table 5: RGRID-ByTransformation structure**

NOTE This type was originally proposed and discussed in depth in an OGC Change Request[[10]](#footnote-10). Subelement gridCRS is discussed there in detail.

In GML 3.3 sub-clause 10.7, gridCRS is a sub-element of gmlrgrid::AbstractReferenceableGrid. However, gridCRS is not present in the CIS 1.0 AbstractReferenceableGrid. As a result, subelement gridCRS is included in the RGRID-ByTransformation structure. In addition, AbstractReferenceableGrid is included in the RGRID-BySensorModel structure.

## RGRID-BySensorModel

The RGRID-BySensorModel type fully defines a sensor model (based on the OGC SensorML 2.1 standard) that is used to geolocate the referenceable grid. Such a sensor model involves two inputs: One or more sensor model descriptions containing free variables (using SML::sensorModel) and a respective set of variable instantiations (using SML::sensorInstance). A sequence of CRS is optionally defined in gridCRS.

**Requirement 5 : /req/gmlcovrgrid/by-sensor-model**  
An RGRID-BySensorModel **shall** be defined by the structure of Table 6, and by GMLCOVRGRID::ReferenceableGridBySensorModel as defined in the XML Schema accompanying this standard.

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Definition** | **Data type** | **Multiplicity** |
| sensorModel | SensorML model yielding the direct positions of the grid | SML:: AbstractProcessPropertyType | One or more (mandatory) |
| sensorInstance | Parameter values for the sensor model | SML:: AbstractProcessPropertyType | Zero or more (optional) |
| gridCRS | An optional sequence of CRS definitions used by sensorModel | GridCRSPropertyType | Zero or one (optional) |

**Table 6: RGRID-BySensorModel structure**

NOTE Both sensorModel and sensorInstance are subtypes of SML::AbstractProcessProperty that can be followed by instantiable subtypes of SML::AbstractProcess, which include SML::SimpleProcess, SML::AggregateProcess, SML::PhysicalSystem, and SML::PhysicalComponent.

If a sensorInstance is specified, it is recommended (following SensorML 2.1 Requirement 13) that its associated SensorML 2.1 document reference its parent sensorModel via a SML::typeOf specification.

If a sensorInstance is specified, it is recommended that its associated SensorML 2.1 document specify a set of parameter values consistent with the free variables of its parent sensorModel. If a sensorInstance is *not* specified, it is recommended that the parameter values are instead specified within the associated SensorML 2.1 document of the mandatory sensorModel.

Annex A: Conformance Class Abstract Test Suite

(Normative)

This Annex specifies an Abstract Test Suite that shall be passed in completeness by any implementation claiming conformance with the extension defined in this standard.

Conformance Test Class: *gmlcovrgrid*

|  |  |
| --- | --- |
| **Test Id:** | /conf/gmlcovrgrid/coverage-structure |
| **Test Purpose:** | Requirement 1: /req/gmlcovrgrid/coverage-structure |
| **Test Method:** | Verify that the coverage under test has a type structure that follows the UML model defined by this requirement. Verify that all necessary elements are present.  Test passes if all checks pass. |
| **Test Id:** | /conf/gmlcovrgrid/by-vectors |
| **Test Purpose:** | Requirement 2: /req/gmlcovrgrid/by-vectors |
| **Test Method:** | Verify that the coverage under test contains the information structures defined by this requirement. Verify that the document body validates against the schema being part of this standard.  Test passes if all checks pass. |
| **Test Id:** | /conf/gmlcovrgrid/by-array |
| **Test Purpose:** | Requirement 3: /req/gmlcovrgrid/by-array |
| **Test Method:** | Verify that the coverage under test contains the information structures defined by this requirement. Verify that the document body validates against the schema being part of this standard.  Test passes if all checks pass. |
| **Test Id:** | /conf/gmlcovrgrid/by-transformation |
| **Test Purpose:** | Requirement 4: /req/gmlcovrgrid/by-transformation |
| **Test Method:** | Verify that the coverage under test contains the information structures defined by this requirement. Verify that the document body validates against the schema being part of this standard.  Test passes if all checks pass. |
| **Test Id:** | /conf/gmlcovrgrid/by-sensor-model |
| **Test Purpose:** | Requirement 5: /req/gmlcovrgrid/by-sensor-model |
| **Test Method:** | Verify that the coverage under test contains the information structures defined by this requirement. Verify that the document body validates against the schema being part of this standard.  Test passes if all checks pass. |

Annex B: Revision history

(non-normative)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Date** | **Release** | **Author** | **Paragraph modified** | **Description** |
| 2016-05-04 | 1.0.0 | Eric Hirschorn | All | First draft |
| 2016-08-01 | 1.0.0 | Scott Simmons | All | Change name of “Implementation Schema for Coverages” to “Coverage Implementation Schema” and minor formatting fixes |
| 2016-09-18 | 1.0.0 | Eric Hirschorn | All | Changes resulting from OAB review held on 2016-08-16 and additional discussions with Peter Baumann. |
| 2017-04-25 | 1.0.0 | Eric Hirschorn | Preface | Edits due to approval of CIS 1.1 |
| 2018-10-10 | 1.0.1 | Eric Hirschorn | Table 6 | Correct multiplicity |
| 2020-08-10 | 1.1 | Eric Hirschorn, Emmanuel Devys | All references to SensorML 2.0 and GMLCOVRGRID 1.0 | Changed to references to Sensor ML 2.1 and GMLCOVRGRID 1.1 |
| 2020-11-29 | 1.1 | Eric Hirschorn | All | Changes requested by Carl Reed from the OGC AOB review |
| 2020-12-06 | 1.1 | Eric Hirschorn | Preface, Clause 7, and Annex A.1 | Changes requested by Gobe Hobona and the OGC-NA |

1. OGC 15-065r1, OGC *Testbed11 Referenceable Grid Harmonization Engineering Report* [↑](#footnote-ref-1)
2. OGC 08-131r3, *The Specification Model — A Standard for Modular Specifications* [↑](#footnote-ref-2)
3. [cite.opengeospatial.org/teamengine](http://cite.opengeospatial.org/teamengine) [↑](#footnote-ref-3)
4. OGC 08-131r3 [↑](#footnote-ref-4)
5. ISO/TS 19130:2010, *Geographic information - Imagery sensor models for geopositioning* [↑](#footnote-ref-5)
6. e.g. NGA.SIG.0002\_2.1, *Frame Sensor Model Metadata Profile Supporting Precise Geopositioning* [↑](#footnote-ref-6)
7. OGC 08-131r3 [↑](#footnote-ref-7)
8. OGC 09-146r6, *OGC Coverage Implementation Schema 1.1* (CIS 1.1) [↑](#footnote-ref-8)
9. OGC 10-129r1, *OGC Geographic Markup Language (GML) — Extended schemas and encoding rules* [↑](#footnote-ref-9)
10. OGC 09-091r1, GML 3.2.1 change request ‒ Add ReferencedGridByTransformation [↑](#footnote-ref-10)