Open Geospatial Consortium

OGC Coverage Implementation Schema - ReferenceableGridCoverage Extension

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Warning

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Contents

i.   Abstract

The OGC GML Application Schema - Coverages ("GMLCOV") version 1.0 [OGC 09-146r2], recently renamed the OGC Coverage Implementation Schema version 1.0, provides a `ReferenceableGridCoverage` element for representing coverages on a referenceable grid. However, GMLCOV provides no instantiable subtypes of a critical sub-element of `ReferenceableGridCoverage`, `GMLCOV::AbstractReferenceableGrid`. To make use of `ReferenceableGridCoverage`, an extension deriving from GMLCOV would need to be developed. GML 3.3 is not such an extension of GMLCOV, as it is built independently from GMLCOV. Use of the instantiable referenceable grid elements of GML 3.3 with `ReferenceableGridCoverage` violates Requirement 14 of GMLCOV 1.0 and Requirement 24 of the OGC Modular Specification[1].

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[2].

ii.   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

iii.   Preface

The OGC GML Application Schema - Coverages ("GMLCOV") version 1.0 [OGC 09-146r2], recently 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 GMLCOV 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 GMLCOV 1.0, the user of the GML 3.3 referenceable grid elements in the `GML::domainSet` of a `ReferenceableGridCoverage` violates Requirement 14

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[1] OGC 08-131r3, *The Specification Model — A Standard for Modular Specifications*

[2] OGC 15-065r1, OGC *Testbed11 Referenceable Grid Harmonization Engineering Report*

of GMLCOV: "A coverage of type `ReferenceableGridCoverage` **shall** have a domain geometry that is a subtype of `AbstractReferenceableGrid`."

As GML 3.3 and GMLCOV 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[3], in that GML 3.3 is not a conformant extension to GMLCOV 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 GMLCOV 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 GMLCOV 1.0 and GML 3.3 `AbstractReferenceableGrid` elements.

2) `ReferenceableGridBySensorModel` provides access to grid transformations via SensorML 2.0, where the associated SensorML 2.0 documents are recommended to be based on profiles associated with referenceable grid transformations (such as ISO 19130[4] and the Community Sensor Models[5] from NGA).

GMLCOVRGRID is a strict extension[6] of GMLCOV 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 GMLCOV[7], renamed the "Coverage Implementation Standard" or CIS 1.1, all coverages based on GMLCOV 1.0 (retroactively renamed 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

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[3] OGC 08-131r3

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

[5] e.g. NGA.SIG.0002_2.1, *Frame Sensor Model Metadata Profile Supporting Precise Geopositioning*

[6] OGC 08-131r3

[7] OGC 09-146r6, *OGC Coverage Implementation Schema 1.1* (CIS 1.1)

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.

iv.   Submitting organizations

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

European Union Satellite Centre (SatCen)

Institut National de l'Information Géographique et Forestière (IGN)

KeyW Corporation

v.   Submitters

All questions regarding this submission should be directed to the editor or the submitters:

Name	Affiliation
Eric Hirschorn	KeyW
Lucio Colaiacomo	SatCen
Emmanuel Devys	IGN

1. Scope

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

2. Conformance

This standard defines the following requirement and conformance class:

- *gmlcovrgrid*, of URI
  http://www.opengis.net/spec/GMLCOV/GMLCOVRGRID/1.0/req/gmlcovrgrid,
  with a single pertaining conformance class, *gmlcovrgrid*, of URI
  http://www.opengis.net/spec/GMLCOV/GMLCOVRGRID/1.0/conf/gmlcovrgrid.

Standardization target of this document are concrete **GMLCOV 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[8].

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

3. 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* (GMLCOV 1.0), 2012

> Conformance class: http://www.opengis.net/spec/gmlcov/1.0/conf/gml-coverage

OGC: OGC 12-000, *OGC SensorML: Model and XML Encoding Standard*, 2014

> Conformance class: http://www.opengis.net/spec/sensorML/2.0/conf/xml/coreProcess

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[8] cite.opengeospatial.org/teamengine

4. 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 GMLCOV 1.0 apply to this extension standard.

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

4.1 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 has been copied from ISO 19123, Subclause 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."

4.2 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 2.0 [OGC 12-000] 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."

5. 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.

5.1 Identifiers

The normative provisions in this specification are denoted by the URI

http://www.opengis.net/spec/GMLCOV/GMLCOVRGRID/1.0

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

5.2 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	GMLCOV 1.0 (i.e. CIS 1.0)
sml	http://www.opengis.net/sensorML/2.0	SensorML 2.0
gmlcovrgrid	http://www.opengis.net/gmlcov/gmlcovrgrid/1.0	`ReferenceableGridCoverage` Extension 1.0

Table 1 Namespace mapping conventions

6. Class *gmlcovrgrid*

Class *gmlcovrgrid* lays the foundation for the implementation schema of this extension standard GMLCOVRGRID of GMLCOV 1.0. It is the only requirement class of GMLCOVRGRID, meaning that every compliant coverage instance must conform to the requirements stated here in Clause 6.

Requirement 1 :
A coverage instantiating class *gmlcovrgrid* **shall** conform to Figure 1.
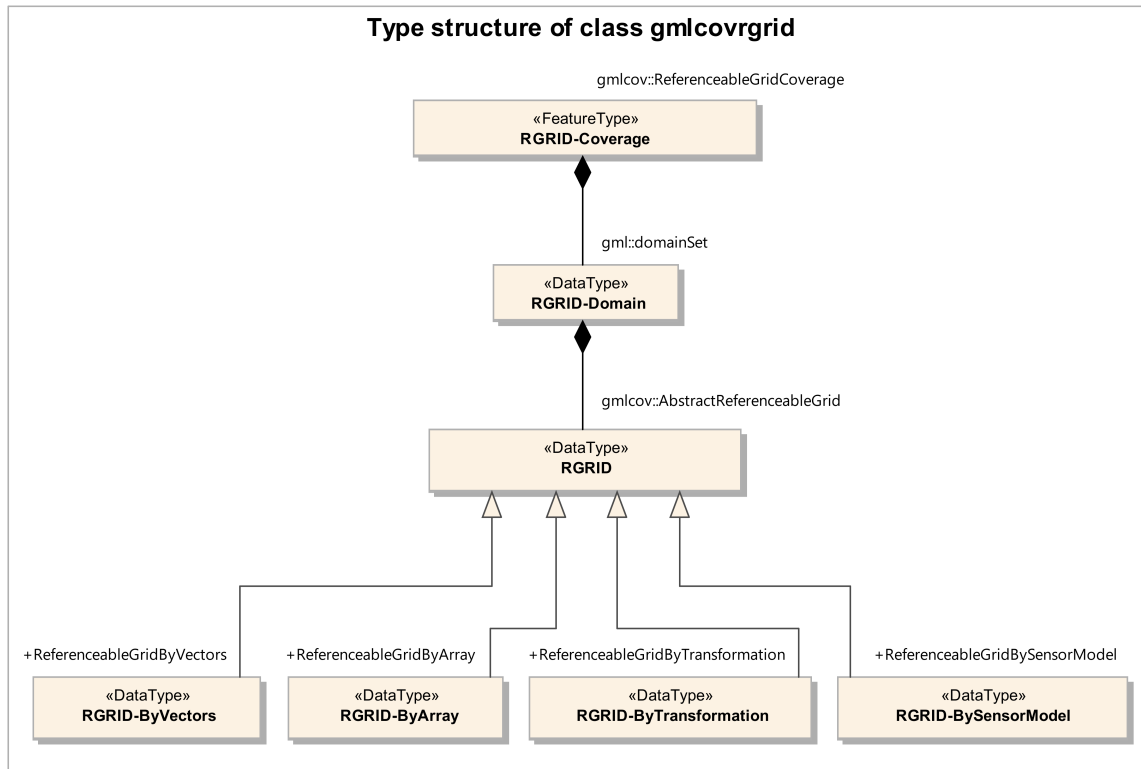
Figure 1: UML diagram of the RGRID-Coverage type structure, as defined by class *gmlcovrgrid*

NOTE   The type structure of class *gmlcovrgrid* follows requirement 14 of parent standard GMLCOV 1.0.

Clause 6 of this extension standard defines four instantiable referenceable grid types of class *gmlcovrgrid* that are generalizations of the `GMLCOV::AbstractReferenceableGrid` type that is defined in GMLCOV 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 XML schema of class *gmlcovrgrid* specifies `ReferenceableGridByVectors`, `ReferenceableGridByArray`, and

`ReferenceableGridByTransformation` that have been adapted from GML 3.3[9] and its associated schema file *referenceableGrid.xsd*. There is no dependency of the XML schema of *gmlcovrgrid* on GML 3.3.

The GML 3.3 document's respective sections on its referenceable grid types remain useful as a guide for use of these adapted GMLCOVRGRID types, especially for its examples of use. See section 10.4 for `ReferenceableGridByArray`, section 10.5 for `ReferenceableGridByVectors`, and section 10.6 for `ReferenceableGridByTransformation`.

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

6.1   RGRID-ByVectors

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

Requirement 2 :
An RGRID-ByVectors **shall** be defined by the structures of Table 2, Table 3, and by `GMLCOVRGRID::ReferenceableGridByVectors` of 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)

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[9] OGC 10-129r1, *OGC Geographic Markup Language (GML) — Extended schemas and encoding rules*

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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 RectifiedGrid of GML 3.2.1, 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 subelement `offsetVector` of `GeneralGridAxis` 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.

6.2   RGRID-ByArray

RGRID-ByArray 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 :
An RGRID-ByArray **shall** be defined by the structure of Table 4, and by
GMLCOVRGRID::ReferenceableGridByArray of the XML Schema
accompanying this standard.

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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

6.3   RGRID-ByTransformation

RGRID-ByTransformation 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 :
An RGRID-ByTransformation **shall** be defined by the structure of Table 5, and by `GMLCOVRGRID::ReferenceableGridByTransformation` of 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

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NOTE   This type was originally proposed and discussed in depth in an OGC Change Request[10]. Subelement `gridCRS` is discussed there in detail.

In GML 3.3, `gridCRS` is a sub-element of `gmlrgrid::AbstractReferenceableGrid`. However, `gridCRS` is not present in the `AbstractReferenceableGrid` of GMLCOV 1.0. As a result, subelement `gridCRS` has been included in the RGRID-ByTransformation structure. In addition, it is included in the RGRID-BySensorModel structure.

6.4   RGRID-BySensorModel

RGRID-BySensorModel fully defines a sensor model (via SensorML 2.0) 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`) plus a respective set of variable instantiations (using `SML::sensorInstance`). A sequence of CRS is optionally defined in `gridCRS`.

Requirement 5 :
An RGRID-BySensorModel **shall** be defined by the structure of Table 6, and by `GMLCOVRGRID::ReferenceableGridBySensorModel` of the XML Schema accompanying this standard.

Name	Definition	Data type	Multiplicity
`sensorModel`	SensorML model yielding the direct positions of the grid	`SML:: AbstractProcessPropertyType`	One (mandatory)
`sensorInstance`	Parameter values for the sensor model	`SML:: AbstractProcessPropertyType`	Zero or one (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 2.0 Requirement 13) that its associated SensorML 2.0 document reference its parent `sensorModel` via a `SML::typeOf` specification.

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[10] OGC 09-091r1, GML 3.2.1 change request – Add ReferencedGridByTransformation

If a `sensorInstance` is specified, it is recommended that its associated SensorML 2.0 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 2.0 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 this Application Schema.

A.1 Conformance Test Class: *gmlcovrgrid*

Test Purpose: Requirement 1

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 Purpose: Requirement 2

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 Purpose: Requirement 3

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 Purpose: Requirement 4

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 Purpose: Requirement 5

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