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Geographic information — Geography Markup Language (GML) —

Part 2: Extended schemas and encoding rules

Information géographique — Langage de balisage en géographie (GML) —

Partie 2: Schémas étendus et règles d'encodage

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Foreword

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

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

The Geography Markup Language (GML) was originally developed within the Open Geospatial Consortium (OGC). The Committee responsible for this document is ISO/TC 211, *Geographic information/Geomatics*.

ISO 19136 consists of the following parts, under the general title *Geographic Information — Geography Markup Language*:

— *Part 2: Extended schemas and encoding rules*

A future Part 1 will revise and replace the currently available ISO 19136:2007.

Introduction

Geography Markup Language is an XML grammar written in XML Schema for the description of application schemas as well as the transport and storage of geographic information.

The key concepts used by Geography Markup Language (GML) to model the world are drawn from the ISO 19100- series of International Standards and the OpenGIS Abstract Specification.

A feature is an “abstraction of real world phenomena” (ISO 19101); it is a geographic feature if it is associated with a location relative to the Earth. So a digital representation of the real world may be thought of as a set of features. The state of a feature is defined by a set of properties, where each property may be thought of as a {name, type, value} triple.

The number of properties a feature may have, together with their names and types, is determined by its type definition. Geographic features with geometry are those with properties that may be geometry-valued. A feature collection is a collection of features that may itself be regarded as a feature; as a consequence a feature collection has a feature type and thus may have distinct properties of its own, in addition to the features it contains.

Following ISO 19109, the feature types of an application or application domain is usually captured in an application schema. A GML application schema is specified in XML Schema and can be constructed in two different and alternative ways:

— by adhering to the rules specified in ISO 19109 for application schemas in UML, and conforming to both the constraints on such schemas and the rules for mapping them to GML application schemas specified in this part of ISO 19136;

— by adhering to the rules for GML application schemas specified in this part of ISO 19136 for creating a GML application schema directly in XML Schema.

Both ways are supported by this part of ISO 19136. To ensure proper use of the conceptual modelling framework of the ISO 19100- series of International Standards, all application schemas are expected to be modelled in accordance with the General Feature Model as specified in ISO 19109. Within the ISO 19100- series, UML is the preferred language by which to model conceptual schemas.

GML specifies XML encodings, conformant with ISO 19118, of several of the conceptual classes defined in the ISO 19100- series of International Standards and the OpenGIS Abstract Specification. These conceptual models include those defined in:

— ISO/TS 19103, *Geographic information — Conceptual schema language* (units of measure, basic types);

— ISO 19107, *Geographic information — Spatial schema* (geometry and topology objects);

— ISO 19108, *Geographic information — Temporal schema* (temporal geometry and topology objects, temporal reference systems);

— ISO 19109, *Geographic information — Rules for application schemas* (features);

— ISO 19111, *Geographic information — Spatial referencing by coordinates* (coordinate reference systems);

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

— ISO 19148, *Geographic information — Linear referencing.*

The aim is to provide a standardized encoding (i.e. a standardized implementation in XML) of types specified in the conceptual models specified by the International Standards listed above. If every application schema were encoded independently and the encoding process included the types from, for example, ISO 19108, then, without unambiguous and completely fixed encoding rules, the XML encodings would be different. Also, since every implementation platform has specific strengths and weaknesses, it is helpful to standardize XML encodings for core geographic information concepts modelled in the ISO 19100- series of International Standards and commonly used in application schemas.

In many cases, the mapping from the conceptual classes is straightforward, while in some cases the mapping is more complex (a detailed description of the mapping is part of this part of ISO 19136).

In addition, GML provides XML encodings for additional concepts not yet modelled in the ISO 19100-series of International Standards or the OpenGIS Abstract Specification, for example, dynamic features, simple observations or value objects.

Predefined types of geographic feature in GML include coverages and simple observations.

A coverage is a subtype of feature that has a coverage function with a spatiotemporal domain and a value set range of homogeneous 1- to *n*-dimensional tuples. A coverage may represent one feature or a collection of features "to model and make visible spatial relationships between, and the spatial distribution of, Earth phenomena" (OGC Abstract Specification Topic 6) and a coverage "acts as a function to return values from its range for any direct position within its spatiotemporal domain" (ISO 19123).

An observation models the act of observing, often with a camera or some other procedure, a person or some form of instrument (Merriam-Webster Dictionary: "an act of recognizing and noting a fact or occurrence often involving measurement with instruments"). An observation is considered to be a GML feature with a time at which the observation took place, and with a value for the observation.

A reference system provides a scale of measurement for assigning values to a position, time or other descriptive quantity or quality.

A coordinate reference system consists of a set of coordinate system axes that is related to the Earth through a datum that defines the size and shape of the Earth.

A temporal reference system provides standard units for measuring time and describing temporal length or duration.

A reference system dictionary provides definitions of reference systems used in spatial or temporal geometries.

Spatial geometries are the values of spatial feature properties. They indicate the coordinate reference system in which their measurements have been made. The "parent" geometry element of a geometric complex or geometric aggregate makes this indication for its constituent geometries.

Temporal geometries are the values of temporal feature properties. Like their spatial counterparts, temporal geometries indicate the temporal reference system in which their measurements have been made.

Spatial or temporal topologies are used to express the different topological relationships between features.

A units-of-measure dictionary provides definitions of numerical measures of physical quantities, such as length, temperature and pressure, and of conversions between units.

Geographic information — Geography Markup Language (GML) —

Part 2: Extended schemas and encoding rules

1 Scope

The Geography Markup Language (GML) is an XML encoding in compliance with ISO 19118 for the transport and storage of geographic information modelled in accordance with the conceptual modelling framework used in the ISO 19100- series of International Standards and including both the spatial and non-spatial properties of geographic features.

This part of ISO 19136 defines the XML Schema syntax, mechanisms and conventions that:

— provide an open, vendor-neutral framework for the description of geospatial application schemas for the transport and storage of geographic information in XML;

— allow profiles that support proper subsets of GML framework descriptive capabilities;

— support the description of geospatial application schemas for specialized domains and information communities;

— enable the creation and maintenance of linked geographic application schemas and datasets;

— support the storage and transport of application schemas and datasets;

— increase the ability of organizations to share geographic application schemas and the information they describe.

Implementers may decide to store geographic application schemas and information in GML, or they may decide to convert from some other storage format on demand and use GML only for schema and data transport.

This part of ISO 19136 builds on ISO 19136:2007 (GML 3.2), and extends it with additional schema components and requirements.

NOTE If an ISO 19109 conformant application schema described in UML is used as the basis for the storage and transportation of geographic information, this part of ISO 19136 provides normative rules for the mapping of such an application schema to a GML application schema in XML Schema and, as such, to an XML encoding for data with a logical structure in accordance with the ISO 19109 conformant application schema.

2 Conformance

This part of ISO 19136 defines XML implementations of concepts used in spatiotemporal datasets. It extends the XML implementations specified in ISO 19136:2007 (GML 3.2). Requirements and conformance classes specified in ISO 19136:2007 also apply for this part of ISO 19136.

XML instances that encode geographic information using one or more of the schemas specified in this part of ISO 19136 are the standardization target of the requirements stated in this part of ISO 19136.

The implementation is described using the XML Schema language and Schematron.

Conformance classes are specified in Clauses 6 to 12 of this part of ISO 19136.

3 Normative references

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

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

ISO 19148:2012, *Geographic information — Linear referencing*

OGC Technical Committee Policies and Procedures: *MIME Media Types for GML*[1)]

ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 13249-3:2011, *Information technology — Database languages — SQL multimedia and application packages — Part 3: Spatial*

4 Terms, definitions, symbols and abbreviated terms

4.1 General

For the purposes of this document, the terms, definitions, symbols abd abbreviated terms listed in ISO 19136:2007 (GML 3.2), Clause 4, apply.

4.2 Terms and definitions

In addition to the terms listed in ISO 19136:2007 (GML 3.2), the following terms and definitions apply.

4.2.1
grid coordinate reference system
grid CRS
coordinate reference system for the positions in a grid that uses a defined coordinate system congruent with the coordinate system described by the GridEnvelope and axisLabels of gml:GridType

Note 1 to entry: A grid CRS uses a defined coordinate system with the same grid point positions and origin as the GridEnvelope, with the same axisLabels, but need not define any limits on the grid size. This coordinate system is sometimes called the internal grid coordinate system.

4.2.2
referenceable grid
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 1 to entry: If the coordinate reference system is related to the Earth by a datum, the grid is a georeferenceable grid.

[SOURCE: ISO 19123:2005, 4.1.33]

1) The latest version at the publication of this part of ISO 19136 is OGC document 09-144r1. The MIME type is currently in the registration process at IETF / IANA. The reference has intentionally been undated so that the reference is to the latest version in case changes to the MIME media type specification are required as part of the registration process.

4.3 Symbols and abbreviated terms

In addition to the symbols and abbreviated terms listed in ISO 19136:2007 (GML 3.2), the following are used in this document:

LRS Linear Referencing System

OWL Web Ontology Language

OWS OGC Web Services

SKOS Simple Knowledge Organization System

5 Conventions

5.1 MIME media types

For exchanging GML instance documents over the internet, the media type "application/gml+xml" is used as specified by the OGC Technical Committee Policies and Procedures: MIME Media Types for GML.

5.2 XML namespaces

The XML namespaces used within this part of ISO 19136 are listed in Table 1. For each namespace, the namespace prefix used within this document and the canonical location of the all-components schema document are provided, too.

Table 1 — XML Namespaces

XML Namespace	Namespace prefix	Canonical location of all-components schema document
http://www.opengis.net/gml/3.2	gml	http://schemas.opengis.net/gml/3.2.1/gml.xsd
http://www.opengis.net/gml/3.3/xbt	gmlxbt	http://schemas.opengis.net/gml/3.3/extdBaseTypes.xsd
http://www.opengis.net/gml/3.3/ce	gmlce	http://schemas.opengis.net/gml/3.3/geometryCompact.xsd
http://www.opengis.net/gml/3.3/tin	gmltin	http://schemas.opengis.net/gml/3.3/tin.xsd
http://www.opengis.net/gml/3.3/lr	gmllr	http://schemas.opengis.net/gml/3.3/linearRef.xsd
http://www.opengis.net/gml/3.3/lrtr	gmllrtr	http://schemas.opengis.net/gml/3.3/linearRefTowardsReferent.xsd
http://www.opengis.net/gml/3.3/lro	gmllro	http://schemas.opengis.net/gml/3.3/linearRefOffset.xsd
http://www.opengis.net/gml/3.3/lrov	gmllrov	http://schemas.opengis.net/gml/3.3/linearRefOffsetVector.xsd
http://www.opengis.net/gml/3.3/rgrid	gmlrgrid	http://schemas.opengis.net/gml/3.3/referenceableGrid.xsd
http://www.opengis.net/gml/3.3/xer	gmlexr	http://schemas.opengis.net/gml/3.3/extdEncRule.xsd
http://www.w3.org/1999/xlink	xlink	http://www.w3.org/1999/xlink.xsd
http://www.w3.org/XML/1998/namespace	xml	http://www.w3.org/2001/xml.xsd
http://www.w3.org/2001/XMLSchema	xs (or default)	n/a

NOTE 1 A GML application schema conforming to this part of ISO 19136 will import the GML 3.2 schema plus zero or more additional GML 3.3 schemas as needed.

EXAMPLE 1 The following GML application schema imports both the GML 3.2 schema and the GML 3.3 compact geometry encoding.

```
<schema
 targetNamespace="http://www.example.org/app"
 xmlns:app="http://www.example.org/app"
 xmlns:gmlce="http://www.opengis.net/gml/3.3/ce"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:xlink="http://www.w3.org/1999/xlink"
 xmlns="http://www.w3.org/2001/XMLSchema"
 xmlns:xml="http://www.w3.org/XML/1998/namespace"
 elementFormDefault="qualified"
 version="1.0.0">
   <import namespace="http://www.opengis.net/gml/3.2"
    schemaLocation="http://schemas.opengis.net/gml/3.2.1/gml.xsd"/>
   <import namespace="http://www.opengis.net/gml/3.3/ce"
    schemaLocation="http://schemas.opengis.net/gml/3.3/geometryCompact.xsd"/>
   <!-- ... -->
   <element name="Parcel" substitutionGroup="gml:AbstractFeature"
    type="app:ParcelType"/>
   <complexType name="ParcelType">
      <complexContent>
         <extension base="gml:AbstractFeatureType">
            <sequence>
               <element name="geometry" type="gml:SurfacePropertyType"/>
               <!-- ... -->
            </sequence>
         </extension>
      </complexContent>
   </complexType>
</schema>
```

NOTE 2 A GML instance conforming to this part of ISO 19136 will directly or indirectly reference the GML 3.2 schema and zero or more additional GML 3.3 schemas as needed. A schema location attribute in the root element of the document has to include the schema of the namespace of the root element.

EXAMPLE 2 A sample instance for the GML application schema from example 1 as returned from a Web Feature Service. The GML schemas are imported by the GML application schema that is referenced from the instance document:


```
<wfs:FeatureCollection
 timeStamp="2011-04-03T05:40:00Z"
 numberMatched="12"
 numberReturned="12"
 xmlns:wfs="http://www.opengis.net/wfs/2.0"
 xmlns:app="http://www.example.org/app"
 xmlns:gmlce="http://www.opengis.net/gml/3.3/ce"
 xmlns:gml="http://www.opengis.net/gml/3.2"
 xmlns:xlink="http://www.w3.org/1999/xlink"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation=" http://www.example.org/app http://www.example.org/app.xsd
   http://www.opengis.net/wfs/2.0 http://schemas.opengis.net/wfs/2.0/wfs.xsd">
   <wfs:member>
      <app:Parcel gml:id="o1">
         <app:geometry>
         <gmlce:SimplePolygon gml:id="g1"
             srsName="http://www.opengis.net/def/crs/EPSG/0/4258">
               <gml:posList>50 6 50 7 51 7 51 6</gml:posList>
         </gmlce:SimplePolygon>
         </app:geometry>
         <!-- ... -->
      </app:Parcel>
   </wfs:member>
   <!-- ... -->
</wfs:FeatureCollection>
```

5.3 Deprecated parts of previous versions of GML

The verb "**deprecate**" provides notice that the referenced portion is being retained for backwards compatibility with earlier versions but may be removed from or superseded in this or a future version.

6 Additional base types

6.1 Target namespace

All schema components specified in Clause 6 are in the target namespace:

http://www.opengis.net/gml/3.3/xbt

6.2 Localisable strings

6.2.1 LanguageStringType

The type `gmlxbt:LanguageStringType` adds an optional `xml:lang` attribute to `xs:string`. It is provided as a base type for linguistic text for use within the GML schemas and in GML application schemas.

```
<complexType name="LanguageStringType">
   <simpleContent>
      <extension base="xs:string">
         <attribute ref="xml:lang"/>
      </extension>
   </simpleContent>
</complexType>
```

NOTE The name "LanguageStringType" was selected to align the naming with the equivalent type in the OWS Common standard.

6.2.2 Additional types based on LanguageStringType

The following types from GML 3.2 are defined in the http://www.opengis.net/gml/3.3/xbt schema with the same content model as in GML 3.2 with the exception that `gmlxbt:LanguageStringType` is used in place of `xs:string`:

— `gml:CodeType`,

— `gml:CodeWithAuthorityType`

In addition, the global property elements `gmlxbt:description` and `gmlxbt:remarks` have an optional `xml:lang` attribute in their content model. These elements are in the substitution group of the GML 3.2 property element with the same local name.

— `gmlxbt:description`

— `gmlxbt:remarks`.

6.3 TimePositionUnion

In GML 3.2 the simple type `gml:TimePositionUnion` is a union of XML Schema simple types which instantiate the subtypes for temporal position described in ISO 19108. These are:

— `gml:CalDate` (`union of xs:date, xs:gYearMonth and xs:gYear`)

— `xs:time`

— `xs:dateTime`

— `xs:anyURI`

— `xs:decimal`

ISO 8601:2004, 4.1.2 specifies the Calendar Date and its representations with reduced accuracy (i.e., YYYY-MM and YYYY). `gml:CalDate` is designed to support their encoding.

ISO 8601:2004, 4.1.3 specifies the Ordinal Date, which is composed from the calendar year and the calendar day of the year (YYYY-DDD).

ISO 8601:2004, 4.1.4 specifies the Week Date, which is composed from the calendar year, the calendar week and the calendar day of the week (YYYY-Www-D). ISO 8601:2004, 4.1.4.3 specifies a Week Date representation with reduced accuracy that omits the day of the week component (YYYY-Www).

The ISO 8601:2004 Ordinal Date and Week Date with reduced accuracy are commonly used in some communities (for example, aviation) but are not supported by `gml:TimePositionUnion`. `gmlxbt:TimePositionUnion` is provided to accommodate representations of these sibling date-representations from ISO 8601:2004 by adding `gmlxbt:OrdDate` and `gmlxbt:WeekDate` to the union.

```
<simpleType name="TimePositionUnion">
   <union memberTypes="gml:CalDate gmlxbt:OrdDate gmlxbt:WeekDate time dateTime anyURI
decimal"/>
</simpleType>

<simpleType name="OrdDate">
   <restriction base="string">
      <pattern value="-?[0-9]{4}-[0-9]{3}"/>
   </restriction>
</simpleType>

<simpleType name="WeekDate">
   <restriction base="string">
      <pattern value=" -?[0-9]{4}-W(0[1-9]|[1-4][0-9]|5[0-3])(-[1-7])?"/>
   </restriction>
</simpleType>
```


The lexical space of `gmlxbt:OrdDate` consists of finite-length sequences of characters of the form

'-'? yyyy '-' ddd

where:

— '-'? yyyy is a four-or-more digit optionally negative-signed numeral that represents the year; if more than four digits, leading zeros are prohibited, and '0000' is prohibited (note that a plus sign is not permitted);

— the '-' is a separator between parts of the date;

— the ddd is a three-digit numeral that represents the calendar day of the year where the first calendar day of any calendar year is represented by '001' and subsequent calendar days are numbered in ascending sequence.

The lexical space of `gmlxbt:WeekDate` consists of finite-length sequences of characters of the form

'-'? yyyy '-W' ww ('-' d)?

where:

— '-'? yyyy is a four-or-more digit optionally negative-signed numeral that represents the year; if more than four digits, leading zeros are prohibited, and '0000' is prohibited (note that a plus sign is not permitted);

— the '-W' is a separator indicating that week-of-year follows;

— the ww is a two-digit numeral that represents the calendar week of the year where the first calendar week of any calendar year is represented by '01' and subsequent calendar weeks are numbered in ascending sequence;

— the '-' d (if present) is a one-digit numeral that represents the calendar day of the week where Monday shall be identified as calendar day '1' of any calendar week, and subsequent calendar days of the same calendar week shall be numbered in ascending sequence to Sunday (calendar day '7').

6.4 Requirements class

Table 2 specifies the requirement class “Basic type (extensions)”.

Table 2 — Requirements class “Basic types (extensions)”

Requirements Class	
http://www.opengis.net/spec/GML/3.3/req/xbt	
Target type	Data instance
Name	Basic types (extensions)
Dependency	**http://www.opengis.net/doc/IS/GML/3.2/clause/2.4**
Requirement	**http://www.opengis.net/spec/GML/3.3/req/xbt/valid** Any XML node whose content model is specified using schema components in the http://www.opengis.net/gml/3.3/xbt schema SHALL be well-formed and valid.
Requirement	**http://www.opengis.net/spec/GML/3.3/req/xbt/iso8601** Any XML node whose content model is specified using `gmlxbt:TimePositionUnit`, `gmlxbt:OrdDate` or `gmlxbt:WeekDate` SHALL conform to ISO 8601:2004.

6.5 Conformance

Table 3 specifies the conformance class “Basic types (extensions)”.

Table 3 — Conformance class “Basic types (extensions)”

Conformance Class		
http://www.opengis.net/spec/GML/3.3/conf/xbt		
Requirements	**http://www.opengis.net/spec/GML/3.3/req/xbt**	
Dependency	**http://www.opengis.net/doc/IS/GML/3.2/clause/2.4**	
Test	**http://www.opengis.net/spec/GML/3.3/conf/xbt/valid**	
	Requirement	**http://www.opengis.net/spec/GML/3.3/req/xbt/valid**
	Test purpose	Verify that any XML node whose content model is specified using schema components in the http://www.opengis.net/gml/3.3/xbt schema is well-formed and valid.
	Test method	Validate the XML document using the XML schema document http://schemas.opengis.net/gml/3.3/extdBasicTypes.xsd. Pass if no errors reported. Fail otherwise.
	Test type	Basic
Test	**http://www.opengis.net/spec/GML/3.3/conf/xbt/iso8601**	
	Requirement	**http://www.opengis.net/spec/GML/3.3/req/xbt/iso8601**
	Test purpose	Verify that any XML node whose content model is specified using `gmlxbt:TimePositionUnit` conforms to ISO 8601:2004.
	Test method	Validate the XML document using the Schematron document http://schemas.opengis.net/gml/3.3/iso8601.sch. Replace “{nodesOfTypeTimePositionUnion}” in the file with an Xpath expression to all nodes with a content model of `gmlxbt:TimePositionUnit`. Pass if no errors reported. Fail otherwise.
	Test type	Capability