

DIN EN ISO 19136-2



ICS 35.240.70

**Geoinformation –
Geography Markup Language (GML) –
Teil 2: Erweitertes Schema und Kodierregeln (ISO 19136-2:2015);
Englische Fassung EN ISO 19136-2:2018**

Geographic information –
Geography Markup Language (GML) –
Part 2: Extended schemas and encoding rules (ISO 19136-2:2015);
English version EN ISO 19136-2:2018

Information géographique –
Langage de balisage en géographie (GML) –
Partie 2: Schémas étendus et règles d'encodage (ISO 19136-2:2015);
Version anglaise EN ISO 19136-2:2018

Gesamtumfang 92 Seiten

DIN-Normenausschuss Bauwesen (NABau)

Nationales Vorwort

Dieses Dokument (EN ISO 19136-2:2018) enthält unter Berücksichtigung des Präsidialbeschlusses 1/2004 den englischen Originaltext der Internationalen Norm ISO 19136-2:2015.

Der Text von ISO 19136-2:2015 wurde vom Technischen Komitee ISO/TC 211 „Geographic information/Geomatics“ erarbeitet und als EN ISO 19136-2:2018 vom Technischen Komitee CEN/TC 287 „Geographic Information“ übernommen, dessen Sekretariat von BSI (Vereinigtes Königreich) gehalten wird.

Der für die deutsche Mitarbeit zuständige Arbeitsausschuss ist der als Spiegelausschuss zum CEN/TC 287 und ISO/TC 211 eingesetzte Arbeitsausschuss NA 005-03-03 AA „Geoinformation“ des DIN-Normenausschusses Bauwesen (NABau).

Die Geography Markup Language (GML) ist eine in XML Schema beschriebene XML Sprache für den Transport und die Speicherung von Geoinformationen, modelliert in Übereinstimmung mit dem konzeptuellen Modellierungssystem, das in der Normenreihe DIN EN ISO 19100 angewendet wird, einschließlich der raumbezogenen und nicht raumbezogenen Eigenschaften von Fachobjekten.

Ein Fachobjekt ist eine „Abstraktion von Phänomenen der realen Welt“ (siehe DIN EN ISO 19101). Eine digitale Repräsentation der realen Welt kann somit als Menge von Fachobjekten verstanden werden. Der Zustand eines Fachobjekts wird wiederum durch eine Menge von Eigenschaften beschrieben, wobei eine Eigenschaft als ein Tripel {Name, Typ, Wert} verstanden werden kann.

Die möglichen Eigenschaften eines Fachobjekts werden durch seine Typfestlegung bestimmt. Die Typfestlegungen sind nach DIN EN ISO 19109 in Anwendungsschemata beschrieben. Ein GML-Anwendungsschema ist eine im XML-Schema beschriebene Repräsentierung eines Anwendungsschemas, die die Codierung von Fachobjekten in XML spezifiziert.

Ein GML-Anwendungsschema kann auf zwei Arten erzeugt werden:

- auf der Basis eines UML-Anwendungsschemas entsprechend DIN EN ISO 19109 und unter Anwendung der in dieser Norm spezifizierten Bedingungen und Regeln;
- unmittelbar im XML-Schema unter Anwendung der in dieser Norm spezifizierten Bedingungen und Regeln.

GML spezifiziert standardisierte XML-Codierungen für häufig verwendete konzeptuelle Typen aus den folgenden Normen und Technischen Spezifikationen:

- ISO/TS 19103, *Geographic information — Conceptual schema language*;
- DIN EN ISO 19107, *Geoinformation — Raumbezugsschema (ISO 19107:2003)*;
- DIN EN ISO 19108, *Geoinformation — Zeitliches Schema (ISO 19108:2002)*;
- DIN EN ISO 19111, *Geoinformation — Koordinatenreferenzsysteme (ISO 19111:2007)*;
- DIN EN ISO 19123, *Geoinformation — Coverage Geometrie und Funktionsschema (ISO 19123:2005)*.

Darüber hinaus legt diese Norm standardisierte XML-Kodierungen für weitere häufig in Anwendungsschemata verwendete, aber bislang noch nicht genormte, Konzepte (z. B. Fachobjekte mit zeitlich veränderbaren Eigenschaften) fest.

Die Festlegung von standardisierten XML-Codierungen zur Verwendung in GML-Anwendungsschemata ermöglicht einen anwendungsübergreifenden Austausch von Geoinformationen.

Auf der Basis dieser Festlegungen

- spezifiziert diese Norm ein offenes, herstellerneutrales System für die Beschreibung von raumbezogenen Anwendungsschemata für den Transport und die Speicherung von Geoinformationen in XML,
- unterstützt sie Profile, die geeignete Untermengen von in GML beschriebenen Eigenschaften unterstützen,
- unterstützt sie die Beschreibung von raumbezogenen Anwendungsschemata für spezialisierte Bereiche und Informationsgemeinschaften,
- ermöglicht sie die Erzeugung und Pflege von miteinander verbundenen raumbezogenen Anwendungsschemata und Datenbeständen,
- unterstützt sie die Speicherung und den Transport von Anwendungsschemata und Datenbeständen,
- erhöht sie die Fähigkeit von Organisationen, raumbezogene Anwendungsschemata und die Informationen, die sie beschreiben, auszutauschen.

Dieser Teil 2 der ISO 19136 legt die XML-Syntax, Mechanismen und Vereinbarungen fest, um

- einen offenen und herstellerneutralen Rahmen für die Beschreibung von raumbezogenen Anwendungsschemata für den Transport und die Speicherung von geographischen Informationen in XML zur Verfügung zu stellen;
- Profile und geeignete Untermengen vom GML-spezifischen beschreibenden Möglichkeiten zu erlauben;
- die Beschreibung von raumbezogenen Anwendungsschemata für spezielle Fachgebiete und Nutzergruppen zu unterstützen;
- die Herstellung und Pflege von vernetzten Anwendungsschemata und Datensätzen zu ermöglichen;
- die Speicherung und den Transport von Anwendungsschemata und Datensätzen zu unterstützen;
- die Möglichkeiten von Organisationen zur Abgabe von Anwendungsschemata und der Information, die diese beschreiben zu verbessern.

Dieser Teil der ISO 19136 basiert auf ISO 19136:2007 (GML 3.2) und erweitert diese Norm um weitere Schemakomponenten und Anforderungen.

Nationaler Anhang NA (informativ)

Begriffe

Die Benennungen der folgenden Begriffe entsprechen den Benennungen in der Englischen Fassung.

4.2.1

Gitterkoordinatenreferenzsystem

Gitter-CRS

Koordinatenreferenzsystem für die Positionen in einem Gitter, das ein festgelegtes Koordinatensystem verwendet, das mit dem durch das „GridEnvelope“ (Gitterwerk) und die „axisLabels“ (Achsenbezeichnungen) von `gml:GridType` beschriebenen Koordinatensystem kongruent ist

Anmerkung 1 zum Begriff: Ein Gitter-CRS verwendet ein festgelegtes Koordinatensystem mit den gleichen Gitterpunktpositionen als Ursprung wie das Gitterwerk und mit den gleichen Achsenbezeichnungen, kommt aber ohne eine Festlegung der Gittergröße aus. Dieses Koordinatensystem wird manchmal als inneres Gitterkoordinatensystem bezeichnet.

4.2.2

referenzierfähiges Gitter

mit einer Umwandlung im Zusammenhang stehendes Gitter, das verwendet werden kann, um die Werte der Gitterkoordinaten in die Werte von Koordinaten umzuwandeln, die auf ein externes Koordinatenreferenzsystem verweisen

Anmerkung 1 zum Begriff: Wenn das Koordinatenreferenzsystem anhand von Ortsdaten mit der Erde in Beziehung gebracht werden kann, so handelt es sich bei dem Gitter um ein georeferenzierbares Gitter.

[QUELLE: ISO 19123:2005, 4.1.33]

Nationaler Anhang NB (informativ)

Englisch-deutsche Fachwörterliste

application schema	Anwendungsschema
association	Beziehung, Relation, Assoziation
attribute	Attribut
boundary	Grenze
child element	Kindelement
closure	Abschluss
codelist	Codeliste
codespace, namespace	Namensraum
coordinate	Koordinate
coordinate reference system	Koordinatenreferenzsystem
coordinate system	Koordinatensystem
coverage	Coverage
curve	Kurve, Linie
data type	Datentyp
datum	Datum
direct position	Position
domain	Bereich
edge	Kante
element	Element
face	Masche
feature	Feature
function	Funktion
geodetic datum	geodätisches Datum
geometric object	Geometrieobjekt
geometric primitive	geometrisches Primitiv
geometry property	Geometrieeigenschaft
GML application schema	GML-Anwendungsschema
GML document	GML-Dokument
GML profile	GML-Profil
GML schema	GML-Schema
grid	Gitter

node	Knoten
object	Objekt
point	Punkt
property	Eigenschaft
schema	Schema
schema document	Schemadokument
sequence	Sequenz
set	Menge
spatial object	raumbezogenes Objekt
surface	Fläche
tag	Tag
topological object	topologisches Objekt
tuple	Tupel
UML application schema	UML-Anwendungsschema
Uniform Resource Identifier (URI)	Uniform Resource Identifier (URI)

English Version

Geographic information —
Geography Markup Language (GML) —
Part 2: Extended schemas and encoding rules
(ISO 19136-2:2015)

Information géographique —
Langage de balisage en géographie (GML) —
Partie 2: Schémas étendus et règles d'encodage
(ISO 19136-2:2015)

Geoinformation —
Geography Markup Language (GML) —
Teil 2: Erweitertes Schema und Kodierregeln
(ISO 19136-2:2015)

This European Standard was approved by CEN on 10 March 2017.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN ISO 19136-2:2018 E

European foreword

The text of ISO 19136-2:2015 has been prepared by Technical Committee ISO/TC 211 "Geographic information/Geomatics" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 19136-2:2018 by Technical Committee CEN/TC 287 "Geographic Information" the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2019, and conflicting national standards shall be withdrawn at the latest by March 2019.

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

This document supersedes EN ISO 19136:2009.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 19136-2:2015 has been approved by CEN as EN ISO 19136-2:2018 without any modification.

Contents

Page

Foreword	vi
Introduction	vii
1 Scope	1
2 Conformance	1
3 Normative references	2
4 Terms, definitions, symbols and abbreviated terms	2
4.1 General	2
4.2 Terms and definitions	2
4.3 Symbols and abbreviated terms	3
5 Conventions	3
5.1 MIME media types	3
5.2 XML namespaces	3
5.3 Deprecated parts of previous versions of GML	4
6 Additional base types	5
6.1 Target namespace	5
6.2 Localisable strings	5
6.2.1 LanguageStringType	5
6.2.2 Additional types based on LanguageStringType	5
6.3 TimePositionUnion	5
6.4 Requirements class	7
6.5 Conformance	7
7 Compact Encodings of Commonly Used GML Geometries	8
7.1 Target namespace	8
7.2 Introduction	8
7.3 SimplePolygon	8
7.4 SimpleRectangle	9
7.5 SimpleTriangle	10
7.6 SimpleArcString	10
7.7 SimpleArc	11
7.8 SimpleArcByCenterPoint	11
7.9 SimpleArcStringByBulge	12
7.10 SimpleArcByBulge	12
7.11 SimpleCircle	13
7.12 SimpleCircleByCenterPoint	13
7.13 SimpleMultiPoint	14
7.14 MultiPointPropertyType	14
7.15 Requirements class	14
7.16 Conformance	14
8 Triangulated Irregular Networks	15
8.1 Target namespace	15
8.2 Introduction	15
8.3 TriangulatedSurface	15
8.4 SimpleTrianglePatch	15
8.5 TIN	16
8.6 TINElement	16
8.7 TINElementPropertyType	17
8.8 TINElementType	17
8.9 Requirements class	19
8.10 Conformance	20
9 Linear Referencing	20
9.1 Target namespaces	20

9.2	Introduction	20
9.3	Basic Linear Referencing	21
9.3.1	Target namespace	21
9.3.2	Introduction	21
9.3.3	PositionExpression	21
9.3.4	PositionExpressionPropertyType	21
9.3.5	LinearElement	22
9.3.6	LinearElementPropertyType	23
9.3.7	StartValueType	23
9.3.8	LinearReferencingMethod	23
9.3.9	LinearReferencingMethodPropertyType	24
9.3.10	DistanceExpressionType	24
9.3.11	DistanceExpressionPropertyType	25
9.3.12	AlongReferent	25
9.3.13	AlongReferentPropertyType	25
9.3.14	Referent	26
9.3.15	ReferentPropertyType	27
9.3.16	MeasureType	27
9.3.17	LRMNameType	27
9.3.18	LRMTypeType	31
9.3.19	ReferentTypeType	32
9.3.20	LinearSRS	33
9.3.21	LinearSRSPROPERTYType	33
9.4	Linear Referencing Towards Referent	34
9.4.1	Target namespace	34
9.4.2	Introduction	34
9.4.3	DualAlongReferent	34
9.4.4	DualAlongReferentPropertyType	34
9.5	Linear Referencing Offset	35
9.5.1	Target namespace	35
9.5.2	Introduction	35
9.5.3	LRMWithOffset	35
9.5.4	LRMWithOffsetPropertyType	35
9.5.5	LateralOffsetDistanceExpressionType	36
9.5.6	LateralOffsetExpressionType	36
9.5.7	VerticalOffsetExpressionType	37
9.5.8	LateralOffsetDirectionType	38
9.5.9	VerticalOffsetDirectionType	39
9.5.10	LateralOffsetLinearSRS	39
9.5.11	LateralOffsetLinearSRSPROPERTYType	40
9.6	Linear Referencing Offset Vectors	41
9.6.1	Target namespace	41
9.6.2	Introduction	41
9.6.3	VectorOffsetDistanceExpressionType	41
9.6.4	VectorOffsetExpressionType	41
9.6.5	VectorOffsetLinearSRS	42
9.6.6	VectorOffsetLinearSRSPROPERTYType	45
9.7	Requirements classes	45
9.8	Conformance	47
10	ReferenceableGrid	48
10.1	Target namespace	48
10.2	Clarifications to ISO 19123:2005	48
10.3	AbstractReferenceableGrid	49
10.4	ReferenceableGridByArray	50
10.5	ReferenceableGridByVectorsType, ReferenceableGridByVectors	51
10.6	ReferenceableGridByTransformation	57
10.7	gridCRS	58
10.8	Coverages using ReferenceableGrid	58

10.9	Requirements classes.....	58
10.10	Conformance.....	59
11	Code lists, dictionaries and definitions.....	60
11.1	Overview.....	60
11.2	Requirements class.....	61
11.3	Conformance.....	62
12	Encoding rule.....	62
12.1	Target namespace.....	62
12.2	Improved conversion rule.....	62
12.2.1	Conversion rule changes.....	62
12.2.2	Requirements class.....	64
12.2.3	Conformance.....	65
12.3	Association class conversion rule.....	67
12.3.1	Overview.....	67
12.3.2	Requirements class.....	68
12.3.3	Conformance.....	69
12.4	Encoding rule extensions.....	70
12.4.1	Overview.....	70
12.4.2	gmlexr:extendedEncodingRule.....	70
12.4.3	Requirements class.....	70
12.4.4	Conformance class.....	71
	Annex A (informative) Linear referencing method examples.....	73
	Bibliography.....	78

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. 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. 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 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 and 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	Name-space 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	gmlrtr	http://schemas.opengis.net/gml/3.3/linearRefTowardsReferent.xsd
http://www.opengis.net/gml/3.3/lro	gmlro	http://schemas.opengis.net/gml/3.3/linearRefOffset.xsd
http://www.opengis.net/gml/3.3/lrov	gmlrov	http://schemas.opengis.net/gml/3.3/linearRefOffsetVector.xsd
http://www.opengis.net/gml/3.3/rgrid	gmlr-grid	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 `gmlxht: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 `gmlxht:LanguageStringType` is used in place of `xs:string`:

- `gml:CodeType`,
- `gml:CodeWithAuthorityType`

In addition, the global property elements `gmlxht:description` and `gmlxht: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.

- `gmlxht:description`
- `gmlxht: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`. `gmlxht:TimePositionUnion` is provided to accommodate representations of these sibling date-representations from ISO 8601:2004 by adding `gmlxht:OrdDate` and `gmlxht:WeekDate` to the union.

```
<simpleType name="TimePositionUnion">
  <union memberTypes="gml:CalDate gmlxht:OrdDate gmlxht: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 `gmlxht: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 `gmlxht: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 <code>gmlxht:TimePositionUnit</code> , <code>gmlx-bt:OrdDate</code> or <code>gmlxht:WeekDate</code> 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 <code>gmlxht:TimePositionUnit</code> 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 <code>gmlxht:TimePositionUnit</code> . Pass if no errors reported. Fail otherwise.
	Test type Capability

7 Compact Encodings of Commonly Used GML Geometries

7.1 Target namespace

All schema components specified in Clause 7 are in the target namespace:

<http://www.opengl.net/gml/3.3/ce>

7.2 Introduction

The simplified geometry encodings presented in Clause 7 conform to the spatial schema (ISO 19107), but are offered as compact encoding alternatives to some of the existing GML geometries specified in GML 3.2. The compact encodings follow the idea of the compact `gml:LineString` encoding, which represents a curve that is equivalent to the `gml:Curve` encoding restricted to the use of `gml:LineStringSegment` elements as depicted in Figure 1.

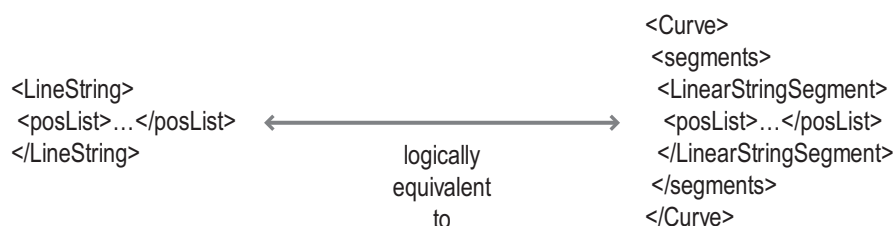


Figure 1 — LineString encoding

7.3 SimplePolygon

A `gmlce:SimplePolygon` is a specialized polygon that has a simplified encoding of the logically equivalent `gml:Surface` with a single `gml:PolygonPatch` as its surface patch consisting of a single `gml:LinearRing` as its exterior boundary and does not have any interior boundary. See Figure 2.

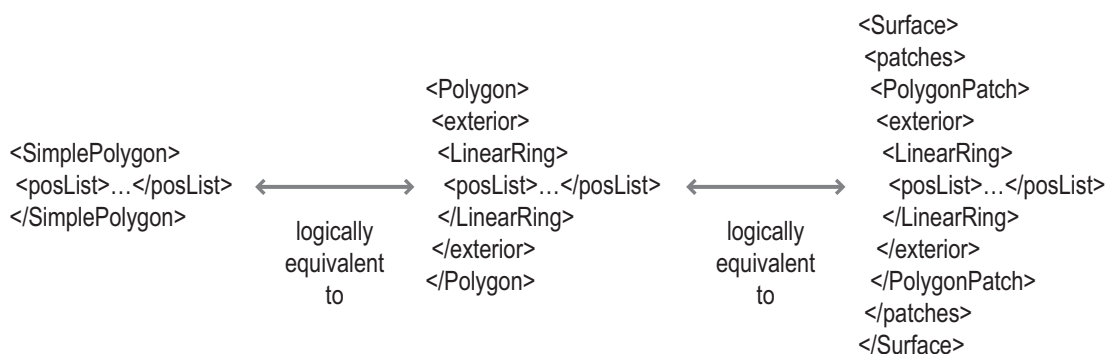


Figure 2 — SimplePolygon encoding

NOTE The boundary of a `gmlce:SimplePolygon` is coplanar and the polygon uses planar interpolation in its interior.

The usage of the term ‘simple’ here refers to a specialized polygon with a simplified encoding, which is *simply* connected (no interior rings) and uses a simple closed curve (no self-crossings) to represent its single boundary ring. The schema element declaration and corresponding type definition is as follows:

```
<element name="SimplePolygon"
  type="gml:SimplePolygonType"
  substitutionGroup="gml:AbstractSimplePolygon"/>
```

```
<element name="AbstractSimplePolygon" type="gml:AbstractSurfaceType"
  substitutionGroup="gml:AbstractSurface"/>

<complexType name="SimplePolygonType">
  <complexContent>
    <extension base="gml:AbstractSurfaceType">
      <sequence>
        <choice>
          <choice minOccurs="3" maxOccurs="unbounded">
            <element ref="gml:pos"/>
            <element ref="gml:pointProperty"/>
          </choice>
          <element ref="gml:posList"/>
        </choice>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

The last coordinate does not have to repeat the first coordinate in this simplified encoding, so only three control points are required to specify a simple polygon. For this reason, the inner choice declaration above has the corresponding occurrence constraint `minOccurs="3"`.

7.4 SimpleRectangle

A `gmlce:SimpleRectangle` is the special case of a simple polygon, which has exactly 4 control points in its boundary encoding representing the 4 corners of the rectangle. See Figure 3.

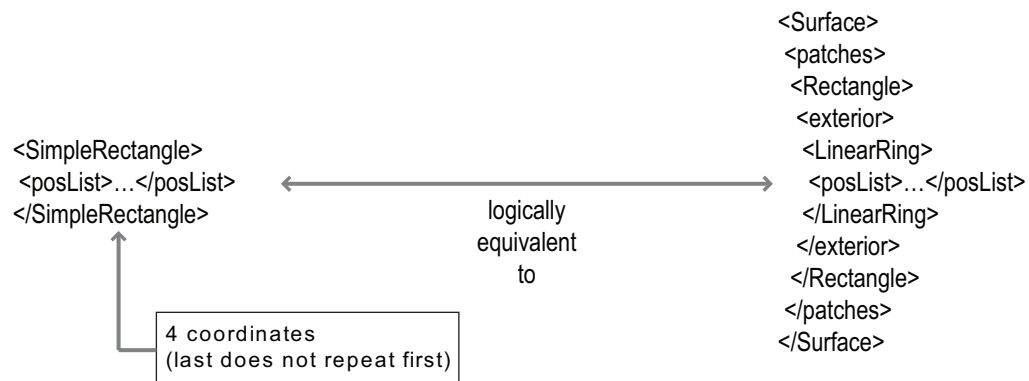


Figure 3 — SimpleRectangle encoding

NOTE The boundary of a `gmlce:SimpleRectangle` is coplanar and the polygon uses planar interpolation in its interior.

The schema element declaration and corresponding type definition is as follows:

```
<element name="SimpleRectangle" type="gmlce:SimpleRectangleType"
  substitutionGroup="gmlce:AbstractSimplePolygon"/>

<complexType name="SimpleRectangleType">
  <complexContent>
    <extension base="gml:AbstractSurfaceType">
      <sequence>
        <choice>
          <choice minOccurs="4" maxOccurs="4">
            <element ref="gml:pos"/>
            <element ref="gml:pointProperty"/>
          </choice>
          <element ref="gml:posList"/>
        </choice>
      </sequence>
    </extension>
```

```
</complexContent>
</complexType>
```

7.5 SimpleTriangle

A `gmlce:SimpleTriangle` is the special case of a simple polygon, which has exactly 3 control points in its boundary encoding representing the 3 corners of the triangle. See Figure 4.

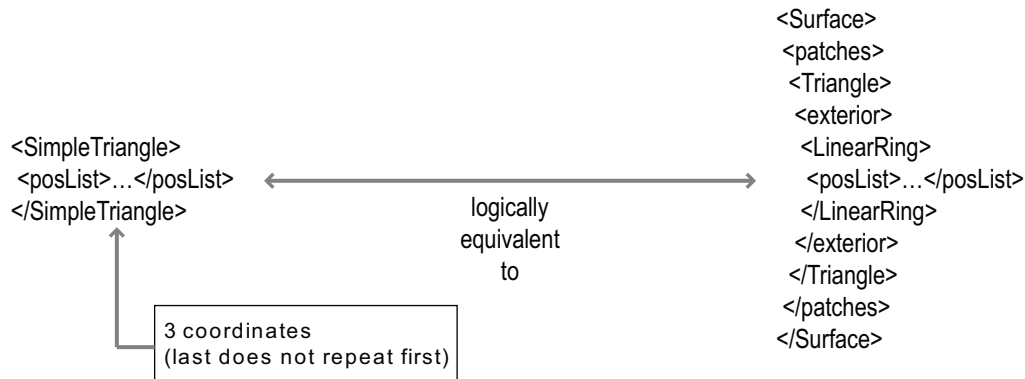


Figure 4 — SimpleTriangle encoding

The schema element declaration and corresponding type definition is as follows:

```
<element name="SimpleTriangle" type="gmlce:SimpleTriangleType"
substitutionGroup="gmlce:AbstractSimplePolygon"/>
```

```
<complexType name="SimpleTriangleType">
  <complexContent>
    <extension base="gml:AbstractSurfaceType">
      <sequence>
        <choice>
          <choice minOccurs="3" maxOccurs="3">
            <element ref="gml:pos"/>
            <element ref="gml:pointProperty"/>
          </choice>
          <element ref="gml:posList"/>
        </choice>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

EXAMPLE

```
<gmlce:SimpleTriangle gml:id="ID000"
  srsName="http://www.opengis.net/def/crs/EPSG/0/4326">
  <gml:posList>50 10 49 10 49.5 11</gml:posList>
</gmlce:SimpleTriangle>
```

7.6 SimpleArcString

A `gmlce:SimpleArcString` is a specialized curve that has a simplified encoding of the logically equivalent `gml:Curve` with one or more `gml:Arc` segments. The schema element declaration and corresponding type definition is as follows:

```
<element name="SimpleArcString" type="gmlce:SimpleArcStringType"
  substitutionGroup="gmlce:AbstractSimpleArcString"/>

<element name="AbstractSimpleArcString" type="gml:AbstractCurveType"
  substitutionGroup="gml:AbstractCurve"/>

<complexType name="SimpleArcStringType">
  <complexContent>
    <extension base="gml:AbstractCurveType">
```

```

<sequence>
  <choice>
    <choice minOccurs="3" maxOccurs="unbounded">
      <element ref="gml:pos"/>
      <element ref="gml:pointProperty"/>
    </choice>
    <element ref="gml:posList"/>
  </choice>
</sequence>
<attribute name="interpolation" type="gml:CurveInterpolationType"
fixed="circularArc3Points"/>
<attribute name="numArc" type="integer"/>
</extension>
</complexContent>
</complexType>

```

7.7 SimpleArc

A `gmlce:SimpleArc` is a specialized curve that has a simplified encoding of the logically equivalent `gml:Curve` with a single `gml:ArcString` segment. See Figure 5.

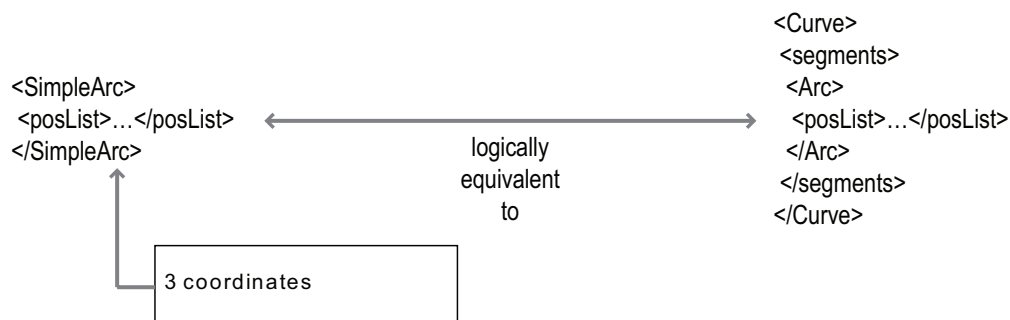


Figure 5 — SimpleArc encoding

The schema element declaration and corresponding type definition is as follows:

```

<element name="SimpleArc" type="gmlce:SimpleArcType"
  substitutionGroup="gmlce:AbstractSimpleArcString"/>

<complexType name="SimpleArcType">
  <complexContent>
    <extension base="gml:AbstractCurveType">
      <sequence>
        <choice>
          <choice minOccurs="3" maxOccurs="3">
            <element ref="gml:pos"/>
            <element ref="gml:pointProperty"/>
          </choice>
          <element ref="gml:posList"/>
        </choice>
      </sequence>
      <attribute name="interpolation" type="gml:CurveInterpolationType"
fixed="circularArc3Points"/>
      <attribute name="numArc" type="integer" fixed="1"/>
    </extension>
  </complexContent>
</complexType>

```

7.8 SimpleArcByCenterPoint

A `gml:SimpleArcByCenterPoint` is a specialized curve that has a simplified encoding of the logically equivalent `gml:Curve` with a single `gml:ArcByCenterPoint` segment. As with the `gml:ArcByCenterPoint`, this representation can be used only in 2D. The schema element declaration and corresponding type definition is as follows:

```
<element name="SimpleArcByCenterPoint" type="gmlce:SimpleArcByCenterPointType"
  substitutionGroup="gmlce:AbstractSimpleArcString"/>

<complexType name="SimpleArcByCenterPointType">
  <complexContent>
    <extension base="gml:AbstractCurveType">
      <sequence>
        <choice>
          <choice>
            <element ref="gml:pos"/>
            <element ref="gml:pointProperty"/>
          </choice>
          <element ref="gml:posList"/>
        </choice>
        <element name="radius" type="gml:LengthType"/>
        <element name="startAngle" type="gml:AngleType"/>
        <element name="endAngle" type="gml:AngleType"/>
      </sequence>
      <attribute name="interpolation" type="gml:CurveInterpolationType"
fixed="circularArcCenterPointWithRadius"/>
      <attribute name="numArc" type="integer" use="required" fixed="1"/>
    </extension>
  </complexContent>
</complexType>
```

NOTE Start and end angle are mandatory in this encoding unlike `gml:ArcByCentrePoint`.

7.9 SimpleArcStringByBulge

A `gmlce:SimpleArcStringByBulge` is a specialized curve that has a simplified encoding of the logically equivalent `gml:Curve` with one or more `gml:ArcByBulge` segments. The schema element declaration and corresponding type definition is as follows:

```
<element name="SimpleArcStringByBulge" type="gmlce:SimpleArcStringByBulgeType"
  substitutionGroup="gmlce:AbstractSimpleArcString"/>

<complexType name="SimpleArcStringByBulgeType">
  <complexContent>
    <extension base="gml:AbstractCurveType">
      <sequence>
        <choice>
          <choice minOccurs="2" maxOccurs="unbounded">
            <element ref="gml:pos"/>
            <element ref="gml:pointProperty"/>
          </choice>
          <element ref="gml:posList"/>
        </choice>
        <element name="bulge" type="double" maxOccurs="unbounded"/>
        <element name="normal" type="gml:VectorType" maxOccurs="unbounded"/>
      </sequence>
      <attribute name="interpolation" type="gml:CurveInterpolationType"
fixed="circularArc2PointWithBulge"/>
      <attribute name="numArc" type="integer"/>
    </extension>
  </complexContent>
</complexType>
```

7.10 SimpleArcByBulge

A `gml:SimpleArcByBulge` is a specialized curve that has a simplified encoding of the logically equivalent `gml:Curve` with one `gml:ArcByBulge` segment. The schema element declaration and corresponding type definition is as follows:

```
<element name="SimpleArcByBulge" type="gmlce:SimpleArcByBulgeType"
  substitutionGroup="gmlce:AbstractSimpleArcString"/>

<complexType name="SimpleArcByBulgeType">
  <complexContent>
```

```

<extension base="gml:AbstractCurveType">
  <sequence>
    <choice>
      <choice minOccurs="2" maxOccurs="2">
        <element ref="gml:pos"/>
        <element ref="gml:pointProperty"/>
      </choice>
      <element ref="gml:posList"/>
    </choice>
    <element name="bulge" type="double" maxOccurs="unbounded"/>
    <element name="normal" type="gml:VectorType" maxOccurs="unbounded"/>
  </sequence>
  <attribute name="interpolation" type="gml:CurveInterpolationType"
fixed="circularArc2PointWithBulge"/>
  <attribute name="numArc" type="integer" fixed="1"/>
</extension>
</complexContent>
</complexType>

```

7.11 SimpleCircle

A `gmlce:SimpleCircle` is a specialized curve that has a simplified encoding of the logically equivalent `gml:Curve` with a single `gml:Circle` segment. See Figure 6.

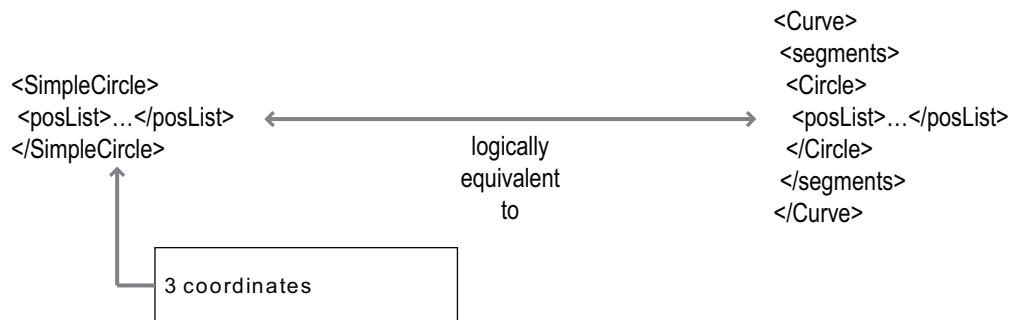


Figure 6 — SimpleCircle encoding

Consistent with `gml:Circle`, a `gmlce:SimpleCircle` is an arc whose ends coincide to form a simple closed loop. The three control points shall be distinct non-co-linear points for the circle to be unambiguously defined. The arc is simply extended past the third control point until the first control point is encountered.

The schema element declaration and corresponding type definition is as follows:

```

<element name="SimpleCircle" type="gmlce:SimpleArcType"
  substitutionGroup="gmlce:AbstractSimpleArcString"/>

```

7.12 SimpleCircleByCenterPoint

A `gmlce:SimpleCircleByCenterPoint` is a specialized curve that has a simplified encoding of the logically equivalent `gml:Curve` with a single `gml:CircleByCenterPoint` segment. As with the `gml:CircleByCenterPoint`, this representation can be used only in 2D. The schema element declaration and corresponding type definition is as follows:

```

<element name="SimpleCircleByCenterPoint"
  type="gmlce:SimpleArcByCenterPointType"
  substitutionGroup="gmlce:AbstractSimpleArcString"/>

```

Start and end angles are mandatory and should not be identical; they should differ by 360 degrees.

7.13 SimpleMultiPoint

`gmlce:SimpleMultiPoint` implements, and provides a simplified encoding for, ISO 19107 `GM_MultiPoint` (see ISO 19107:2003, 6.5.4). A `gmlce:SimpleMultiPoint` consists of a list of `DirectPositions`.

```
<complexType name="SimpleMultiPointType">
  <complexContent>
    <extension base="gml:AbstractGeometricAggregateType">
      <sequence>
        <element ref="gml:posList"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<element name="SimpleMultiPoint" type="gmlce:SimpleMultiPointType"
substitutionGroup="gml:AbstractGeometricAggregate" />
```

7.14 MultiPointPropertyType

A property that has a collection of points as its value domain may either be an appropriate geometry element encapsulated in an element of this type or an `XLink` reference to a remote geometry element (where remote includes geometry elements located elsewhere in the same document). The rules stated in ISO 19136:2007, 7.2.3.4 apply.

```
<complexType name="MultiPointPropertyType">
  <choice minOccurs="0">
    <element ref="gml:MultiPoint"/>
    <element ref="gmlce:SimpleMultiPoint"/>
  </choice>
  <attributeGroup ref="gml:AssociationAttributeGroup"/>
  <attributeGroup ref="gml:OwnershipAttributeGroup"/>
</complexType>
```

7.15 Requirements class

Table 4 specifies the requirements class “Compact Geometry Encoding”.

Table 4 — Requirements class “Compact Geometry Encoding”

Requirements Class	
http://www.opengis.net/spec/GML/3.3/req/ce	
Target type	Data instance
Name	Compact Geometry Encoding
Dependency	http://www.opengis.net/doc/IS/GML/3.2/clause/2.4
Requirement	http://www.opengis.net/spec/GML/3.3/req/ce/valid Any XML node whose content model is specified using schema components in the http://www.opengis.net/gml/3.3/ce schema SHALL be well-formed and valid.

7.16 Conformance

Table 5 specifies the conformance class “Compact Geometry Encoding”.