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GML 3.1.1 common CRSs profile

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i. Preface

This document defines a profile of the Geography Markup Language (GML) version 3.1.1 for encoding definitions of commonly-used Coordinate Reference Systems (CRSs) plus related coordinate Conversions.

This profile can be used without a GML Application Schema, and such use is assumed in this document. However, a GML Application Schema that uses this profile could be specified. For example, an Application Schema could specify a specialized “TransverseMercatorConversion”, as discussed in Annex F. Or an Application Schema could allow or require more information to be encoded for an OperationParameter (such as specified in Subclause 14.3.2 and wctOperationParameter.xsd of OGC Discussion Paper [OGC 05-013]).

Suggested additions, changes, and comments on this document are welcome and encouraged. Such suggestions may be submitted by email message or by making suggested changes in an edited copy of this document.

ii. Document terms and definitions

This document uses the specification terms defined in Subclause 5.3 of [OGC 05-008]. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this specification

iii. Document contributor contact points

All questions regarding this document should be directed to the editor or the contributors:

Name	Organization
Arliss Whiteside	BAE Systems E&IS

iv. Revision history

Date	Release	Editor	Primary clauses modified	Description
2005-10-11	0.0.0	Arliss Whiteside	All	Initial release
2005-11-14	0.0.1	Arliss Whiteside	All	General editing

v. Changes to OGC Specifications

No previously approved OGC™ Specifications need to be changed to accommodate the technical contents of this document.

vi. Future work

Improvements in this document may be desirable.

Foreword

This document specifies a subset profile of the existing OGC Implementation Specification for the Geometry Markup Language (GML) version 3.1.1 [OGC 03-105r1 and 04-093r4], and does not modify it. This is a GML profile as specified in Subclause 22 of [OGC 03-105r1]. This document supersedes Recommendation Paper [OGC 05-011], titled “Recommended XML/GML 3.1.1 encoding of common CRS definitions”.

This document includes six annexes; Annex A is normative and Annexes B through F are informative.

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

Introduction

This document specifies a GML profile for encoding definitions of commonly-used Coordinate Reference Systems (CRSs) plus related coordinate Conversions. This XML schema is a profile of the OGC Geography Markup Language (GML) version 3.1.1, using the separately specified “GML 3.1.1 CRS Support profile”. This profile supports XML encoding of definitions of geographic, projected, vertical, and composite CRSs, plus definitions of coordinate Conversions for projected CRSs.

GML 3.1.1 common CRSs profile

1 Scope

This GML 3.1.1 profile is defined for encoding the definitions of commonly used Coordinate Reference Systems (CRSs) plus related coordinate Conversions. This profile supports XML encoding of definitions of:

- a) Geographic CRSs, 2D and 3D
- b) Projected CRSs, 2D
- c) Vertical CRSs, 1D
- d) Compound CRSs, for combining a projected CRS or 2D geographic CRS with a 1D vertical CRS to produce a 3D CRS
- e) Coordinate Conversions, for defining (map) projected CRSs

This “GML 3.1.1 common CRSs profile” uses the separately specified “GML 3.1.1 CRS Support profile” [OGC 05-094r1], specified to support multiple profiles for encoding the definitions of CRS and related data. This profile is designed for use by a future Web Coordinate Transformation Service (WCTS).

This profile does not support encoding of geocentric, temporal, derived, image, or engineering CRSs, or combining a temporal CRS with another CRS. It also does not support encoding of affine, spherical, polar, cylindrical, linear, and user-defined coordinate systems, or of engineering datums.

2 Compliance

All CRS and CRS-related definitions encoded using this profile shall produce XML documents that are fully compliant with the normative XML Schema Documents associated with this specification, named:

- a) gmlCommonCRSsProfile.xsd
- b) coordinateOperations.xsd
- c) coordinateReferenceSystems.xsd
- d) coordinateSystems.xsd
- e) dataQuality.xsd
- f) datums.xsd

Except for gmlCommonCRSsProfile.xsd, all these XML Schema Documents contain the subset of the corresponding GML 3.1.1 document that is needed by this GML 3.1.1 Common CRSs profile. This was done to facilitate checking that this profile is a strict subset of GML 3.1.1. This also facilitates comparing each document with the original, to determine which elements, attributes, and types were retained, and which were removed.

XML documents compliant with this profile shall (directly or indirectly) import the gmlCommonCRSsProfile.xsd XML Schema Document, which will be available following approval of this document at <http://schemas.opengis.net/gml/3.1.1/Profiles/CommonCRSs/1.0.0/>.

More specifically, compliance with this specification shall be checked using all the relevant tests specified in Annex A (normative).

3 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

European Petroleum Survey Group: *EPSG Geodesy Parameters V 6.6*, available through <http://www.epsg.org/>

IETF RFC 2141 (May 1997), *URN Syntax*, R. Moats
<<http://www.ietf.org/rfc/rfc2141.txt>>

IETF RFC 2396 (August 1998), *Uniform Resource Identifiers (URI): Generic Syntax*, Berners-Lee, T., Fielding, N., and Masinter, L., eds.,
<<http://www.ietf.org/rfc/rfc2396.txt>>

ISO 19105:2000, *Geographic information — Conformance and Testing*

OGC 03-105r1, *OpenGIS Geography Markup Language (GML) Implementation Specification*, Version 3.1.0,

OGC 04-092r4, *GML 3.1.1 schemas*

OGC 05-008, *OGC Web Services Common Specification*, Version 1.0.0

OGC 05-010, *URNs of definitions in ogc namespace* (Recommendation Paper), Version 1.0.0

OGC 05-094r1, *GML 3.1.1 CRS support profile* (proposal)

W3C, *Extensible Markup Language (XML) 1.0* (Second Edition), W3C Recommendation, 6 October 2000, <http://www.w3.org/TR/REC-xml>

W3C, *XML Schema Part 1: Structures*, <http://www.w3.org/TR/xmlschema-1>

W3C, *XML Schema Part 2: Datatypes*, <http://www.w3.org/TR/xmlschema-2>

W3C, *Namespaces in XML*, <http://www.w3.org/TR/1999/REC-xml-names-19990114>

In addition to this document, this specification includes six normative XML Schema Document files. Following approval of this specification, these documents will be posted online at the URL: <http://schemas.opengis.net/gml/3.1.1/Profiles/CommonCRSs/1.0.0/>. These XML Schema Document files are also bundled with the present document. In the event of a discrepancy between the bundled and online versions of the XML Schema files, the online files shall be considered authoritative.

4 Terms and definitions

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

4.1

affine coordinate system

coordinate system in Euclidean space with straight axes that are not necessarily mutually perpendicular

4.2

Cartesian coordinate system

coordinate system which gives the position of points relative to n mutually perpendicular axes

NOTE n is 1, 2 or 3 for the purposes of this specification.

4.3

compound coordinate reference system

coordinate reference system using at least two independent **coordinate reference systems** describing horizontal position and/or vertical position and/or temporal position or positions

NOTE A compound coordinate reference system does not contain another compound coordinate reference system.

4.4

concatenated operation

coordinate operation consisting of sequential application of multiple **coordinate operations**

4.5

coordinate

one of a **sequence** of n numbers designating the position of a point in n -dimensional space

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

4.6

coordinate conversion

change of **coordinates**, based on a one-to-one relationship, from one **coordinate reference system** to another based on the same **datum**

EXAMPLE Between ellipsoidal and Cartesian coordinate systems or between geographic coordinates and projected coordinates, or change of units such as from radians to degrees or feet to meters.

NOTE A coordinate conversion uses parameters which have specified values, not empirically determined values.

4.7

coordinate operation

change of **coordinates**, based on a one-to-one relationship, from one **coordinate reference system** to another

NOTE Supertype of coordinate transformation and coordinate conversion.

4.8

coordinate reference system

coordinate system which is related to the real world by a **datum**

NOTE For geodetic and vertical datums, it will be related to the Earth.

4.9

coordinate set

dataset of **coordinate tuples** related to the same **coordinate reference system**

4.10

coordinate system

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

4.11

coordinate transformation

change of **coordinates** from one **coordinate reference system** to another **coordinate reference system** based on a different **datum** through a one-to-one relationship

NOTE A coordinate transformation uses parameters which are derived empirically by a set of points with known coordinates in both coordinate reference systems.

4.12

datum

parameter or set of parameters that define the position of the origin, the scale, and the orientation of a **coordinate reference system**

4.13

dimension

coordinate dimension

number of measurements or axes needed to describe a position in a **coordinate system**
[ISO 19107]

4.14**easting*****E***

distance in a **coordinate system**, eastwards (positive) or westwards (negative) from a north-south reference line

4.15**ellipsoid**

surface formed by the rotation of an ellipse about a main axis

NOTE In this specification, ellipsoids are always oblate, meaning that the axis of rotation is always the minor axis.

4.16**ellipsoidal coordinate system****geodetic coordinate system**

coordinate system in which position is specified by **geodetic latitude**, **geodetic longitude** and (in the three-dimensional case) **ellipsoidal height**, associated with one or more **geographic coordinate reference systems**

4.17**ellipsoidal height****geodetic height*****h***

distance of a point from the **ellipsoid** measured along the perpendicular from the **ellipsoid** to this point positive if upwards or outside of the **ellipsoid**

NOTE Only used as part of a three-dimensional ellipsoidal coordinate system and never on its own.

4.18**engineering coordinate reference system**

coordinate reference system that is defined for and usually used in a contextually local sense, which may be an area, significantly less than the complete surface of the earth or a moving platform and its vicinity

EXAMPLE Local engineering and architectural coordinates, grids, and drawings; also: vessel navigation systems and coordinate reference systems associated with orbiting spacecraft.

4.19**flattening*****f***

ratio of the difference between the semi-major (*a*) and **semi-minor axis** (*b*) of an **ellipsoid** to the **semi-major axis**; $f = (a - b)/a$

NOTE Sometimes inverse flattening $1/f = a/(a-b)$ is given instead; $1/f$ is also known as reciprocal flattening.

4.20**geodetic datum**

datum describing the relationship of a 3D or 2D **coordinate system** to the Earth

4.21

geodetic latitude
ellipsoidal latitude

φ

angle from the equatorial plane to the perpendicular to the **ellipsoid** through a given point, northwards treated as positive

4.22

geodetic longitude
ellipsoidal longitude

λ

angle from the **prime meridian** plane to the **meridian** plane of a given point, eastward treated as positive

4.23

geographic coordinate reference system
coordinate reference system using an **ellipsoidal coordinate system** and based on an **ellipsoid** that approximates the shape of the Earth

NOTE A geographic coordinate system can be 2D or 3D. In a 3D geographic coordinate system, the third dimension is height above the ellipsoid surface.

4.24

geoid

level surface which best fits **mean sea level** either locally or globally

NOTE “Level surface” means an equipotential surface of the Earth’s gravity field which is everywhere perpendicular to the direction of gravity.

4.25

gravity-related height

H

height dependent on the Earth’s gravity field

NOTE In particular, orthometric height or normal height, which are both approximations of the distance of a point above the mean sea level.

4.26

Greenwich meridian

meridian that passes through the position of the Airy Transit Circle at the Royal Observatory Greenwich, United Kingdom

NOTE Most geodetic datums use the Greenwich meridian as the prime meridian. Its precise position differs slightly between different datums.

4.27

height

h, H

distance of a point from a chosen reference surface measured upward along a line perpendicular to that surface

NOTE A height below the reference surface will have a negative value.

4.28

image coordinate reference system

engineering coordinate reference system applied to locations in images

4.29

image datum

engineering datum which defines the origin of an **image coordinate reference system**

4.30

map projection

coordinate conversion from an **ellipsoidal coordinate system** to a plane

4.31

mean sea level

average level of the surface of the sea over all stages of tide and seasonal variations

NOTE Mean sea level in a local context normally means mean sea level for the region calculated from observations at one or more points over a given period of time. Mean sea level in a global context differs from a global **geoid** by not more than 2 m.

4.32

meridian

intersection of an **ellipsoid** by a plane containing the **semi-minor axis** of the **ellipsoid**

NOTE This term is often used for the pole-to-pole arc rather than the complete closed figure.

4.33

northing

N

distance in a **coordinate system**, northwards (positive) or southwards (negative) from an east-west reference line

4.34

pixel

smallest element of a digital image to which attributes are assigned

NOTE This term originated as a contraction of “picture element”.

4.35

prime meridian

zero meridian

meridian from which the longitudes of other **meridians** are quantified

4.36

projected coordinate reference system

coordinate reference system derived from a two-dimensional **geographic coordinate reference system** by applying a **map projection** and using a **Cartesian coordinate system**

4.37

semi-major axis

a

semi-diameter of the longest axis of an **ellipsoid**

NOTE This equates to the semi-diameter of the ellipsoid measured in its equatorial plane.

4.38

semi-minor axis

b

semi-diameter of the shortest axis of an **ellipsoid**

NOTE The shortest axis coincides with the rotation axis of the ellipsoid and therefore contains both poles.

4.39

sequence

finite, ordered collection of related items (objects or values) that may be repeated [ISO 19107]

4.40

unit

unit of measure

defined quantity in which dimensioned parameters are expressed

NOTE In this International Standard, the subtypes of units are length units, angular units, time units, scale units and pixel spacing units.

4.41

vertical coordinate reference system

one-dimensional **coordinate reference system** used for **gravity-related height** or **depth** measurements

4.42

vertical datum

datum describing the relation of **gravity-related heights** or **depths** to the Earth

NOTE In most cases the vertical datum will be related to mean sea level. Ellipsoidal heights are treated as related to a three-dimensional ellipsoidal coordinate system referenced to a geodetic datum. Vertical datums include sounding datums (used for hydrographic purposes), in which case the heights may be negative heights or depths.

4.43

geographic information

information concerning phenomena implicitly or explicitly associated with a location relative to the Earth [ISO 19101]

4.44

profile

specified logical subset of XML Schema specified elements and types, defined to enhance interoperability and to curtail ambiguity [adapted from GML 3.0]

4.45**sequence**

finite, ordered collection of related items (objects or values) that may be repeated [ISO 19107]

4.46**Uniform Resource Identifier (URI)**

simple and extensible means for identifying a resource; a short string or address; classified as a name, a locator, or both [RFC 2396]

5 Conventions**5.1 Abbreviated terms**

The abbreviated terms used in this document include:

CRS	Coordinate Reference System
GML	Geography Markup Language
IETF	Internet Engineering Task Force
ISO	International Organization for Standardization
OGC	Open Geospatial Consortium
OWS	OGC Web Service, or Open Web Service
WCTS	Web Coordinate Transformation Service
UML	Unified Modeling Language
URI	Universal Resource Identifier
URL	Uniform Resource Locator
URN	Universal Resource Name
XML	Extensible Markup Language
1D	One Dimensional
2D	Two Dimensional
3D	Three Dimensional

5.2 UML notation

The diagrams that appear in this specification are presented using the Unified Modeling Language (UML) static structure diagram, as described in Subclause 5.2 of [OGC 05-008].

6 Common CRSs profile

6.1 Background

GML 3.1.1 includes six XML Schema Documents for encoding definitions of Coordinate Reference Systems (CRSs) and Coordinate Operations, namely: (listed alphabetically)

- a) coordinateOperations.xsd
- b) coordinateReferenceSystems.xsd
- c) coordinateSystems.xsd
- d) dataQuality.xsd
- e) datums.xsd
- f) referenceSystems.xsd

However, this set of XML Schema Documents supports many abilities that are rarely used. Therefore, multiple CRS-related profiles of this part of GML 3.1.1 are expected to be useful and specified, where each profile is significantly simpler and thus easier to understand and use.

This profile was produced by retaining only those parts of the above listed XML Schema Documents which are needed by commonly-used coordinate reference systems. This profile was defined to build on the GML 3.1.1 CRS Support profile, which includes the needed profile of referenceSystems.xsd and all other GML Schema documents.

6.2 Overview

This document specifies a GML 3.1.1 profile for XML encoding of the definitions of the most commonly-used coordinate reference systems (CRSs), including geographic, projected, vertical, and compound CRSs. More specifically, this profile retains the following XML elements:

- a) GeographicCRS in coordinateReferenceSystems.xsd, which is used to define geographic CRSs
- b) ProjectedCRS in coordinateReferenceSystems.xsd, which is used to define projected CRSs
- c) Conversion in coordinateOperations.xsd, which is used to define the coordinate conversion required in the definitions of each projected CRS
- d) VerticalCRS in coordinateReferenceSystems.xsd, which is used to define vertical CRSs

- e) CompoundCRS in coordinateReferenceSystems.xsd, which is used to define compound CRSs, especially for combining a projected CRS or 2D geographic CRS with a 1D vertical CRS to produce a 3D CRS

In addition to the above listed XML elements, the elements, attributes, and types needed to support those were also retained. For example, other retained non-abstract GML object elements include:

- a) VerticalDatum, GeodeticDatum, Ellipsoid, and PrimeMeridian in datums.xsd
- b) CoordinateSystemAxis, EllipsoidalCS, CartesianCS, and VerticalCS in coordinateSystems.xsd
- c) OperationMethod and OperationParameter in coordinateOperations.xsd

Essentially all other parts of the CRS-related XML Schema Documents were removed, including all deprecated parts. For example, non-abstract GML object elements removed included:

- a) GeocentricCRS, DerivedCRS, EngineeringCRS, ImageCRS, and TemporalCRS from coordinateReferenceSystems.xsd
- b) TemporalCS, LinearCS, UserDefinedCS, SphericalCS, PolarCS, CylindricalCS, and ObliqueCartesianCS from coordinateSystems.xsd
- c) EngineeringDatum, ImageDatum, and TemporalDatum from datums.xsd
- d) ConcatenatedOperation, PassThroughOperation, Transformation, parameterValueGroup, and OperationParameterGroup from coordinateOperations.xsd

This GML 3.1.1 Common CRSs profile removes optional and alternative contents elements from the retained XML elements and types, when these options and alternatives are rarely used for defining the supported Coordinate Reference Systems (CRSs) and Coordinate Operations. The removed contents elements included:

- a) metaDataProperty, from CoordinateSystemAxisBaseType and AbstractCoordinateSystemBaseType in coordinateSystems.xsd
- b) metaDataProperty, from AbstractDatumBaseType, PrimeMeridianBaseType, and EllipsoidBaseType in datums.xsd
- c) metaDataProperty, from AbstractCoordinateOperationBaseType, AbstractGeneralConversionType, OperationMethodBaseType, OperationParameterBaseType in coordinateOperations.xsd
- d) dmsAngleValue, from ParameterValueType in coordinateOperations.xsd
- e) AbstractPositionalAccuracyType, absoluteExternalPositionalAccuracy, relativeInternalPositionalAccuracy, and covarianceMatrix in dataQuality.xsd

6.3 XML schema documents

This GML 3.1.1 Common CRSs profile is specified in the six normative XML Schema Documents included in the zip file with this text document, which are named:

- a) gmlCommonCRSsProfile.xsd
- b) coordinateOperations.xsd
- c) coordinateReferenceSystems.xsd
- d) coordinateSystems.xsd
- e) dataQuality.xsd
- f) datums.xsd

NOTE 1 Although referenceSystems.xsd is a CRS-related schema document, parts of it are required in all other CRS-related GML profiles, so it is included in the separate CRS Support profile.

NOTE 2 Also included in the zip file with this document are copies of the GML 3.1.1 CRS Support profile XML Schema Documents, and of all the XML document examples listed in Clauses 7 through 11, so that those examples can be used as templates.

All these XML Schema Documents contain documentation of the meaning of each element and attribute, and this documentation shall be considered normative as specified in Subclause 11.6.3 of [OGC 05-008].

After OGC acceptance of a Version 1.0.0 of this specification, these XML Schema Documents will also be posted online at the URL <http://schemas.opengis.net/gml/3.1.1/Profiles/CommonCRSs/1.0.0>. In the event of a discrepancy between the bundled and online versions of the XML Schema Documents, the online files shall be considered authoritative.

6.4 CRS definitions use

These CRS definitions are usually not required to be transferred between servers and clients that use OGC Web Services (OWS) Implementation Specifications. However, these definitions shall be used when relevant in defining coordinate operations (including Conversions and Transformations), and shall be referenced by those coordinate operation definitions.

References to these CRSs shall be in the form of the anyURI data type specified by XML Schema. As specified in Subclause 10.3 of “OWS common implementation specification” [OGC 05-008], such an anyURI value can be either a URL with standard form or a URN in the “ogc” URN namespace. As specified in Subclause 7.1 of “URNs for definitions in the ogc namespace” [OGC 05-010], URNs in the “ogc” URN namespace can be used to reference any CRS defined in the EPSG database. As specified in Subclause 8.2 of the same document, URNs in the “ogc” URN namespace can be used to reference any CRS defined in Annex B of WMS 1.3 [OGC 04-024].

7 Geographic CRS XML encoding

7.1 Summary

When using this GML 3.1.1 profile, the definition of each Geographic coordinate reference system (CRS) shall be XML encoded using the GeographicCRS element, defined in the attached normative XML Schema Document named coordinateReferenceSystems.xsd. The GML objects contained or referenced in this GeographicCRS are indicated in this XML document skeleton:

```
<GeographicCRS>
  <usesEllipsoidalCS>
    <EllipsoidalCS>
      <usesAxis> (two or three)
        <CoordinateSystemAxis></CoordinateSystemAxis>
      </usesAxis>
      <usesAxis>
        <CoordinateSystemAxis></CoordinateSystemAxis>
      </usesAxis>
    </EllipsoidalCS>
  </usesEllipsoidalCS>
  <usesGeodeticDatum>
    <GeodeticDatum>
      <usesPrimeMeridian>
        <PrimeMeridian></PrimeMeridian>
      </usesPrimeMeridian>
      <usesEllipsoid>
        <Ellipsoid></Ellipsoid>
      </usesEllipsoid>
    </GeodeticDatum>
  </usesGeodeticDatum>
</GeographicCRS>
```

NOTE 1 The UML class diagrams contained in Subclause C.2 provide graphical views of the contents of the GeographicCRS XML element.

This skeleton XML document indicates that:

- a) A GeographicCRS element shall contain one usesEllipsoidalCS and one usesGeodeticDatum elements (in addition to other mandatory and optional information).
- b) That usesEllipsoidalCS element shall reference or contain the definition of one EllipsoidalCS.
- c) That EllipsoidalCS definition element shall contain an ordered sequence of two or three usesAxis elements.
- d) Each of those usesAxis elements shall reference or contain the definition of one CoordinateSystemAxis. The referenced or listed axis order shall be used for position coordinates in that GeographicCRS, with the specified units and directions of each axis.

NOTE 2 The two axes of a GeographicCRS are usually named geodetic latitude and geodetic longitude, with coordinates listed in that order and with both latitude and longitude values given in decimal degrees.

- e) That usesGeodeticDatum element shall reference or contain the definition of one GeodeticDatum.
- f) That GeodeticDatum definition element shall contain one usesPrimeMeridian and one usesEllipsoid elements
- g) That usesPrimeMeridian element shall reference or contain the definition of one PrimeMeridian.
- h) That usesEllipsoid element shall reference or contain the definition of one Ellipsoid.

7.2 XML document full example

An example XML document completely defining a GeographicCRS is:

```
<?xml version="1.0" encoding="UTF-8"?>
<GeographicCRS xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG4277">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-05-->
  <srsName>OSGB 1936</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.0:">4277</name>
  </srsID>
  <usesEllipsoidalCS>
    <EllipsoidalCS gml:id="EPSG6402">
      <csName>ellipsoidal</csName>
      <csID>
        <name codeSpace="urn:ogc:def:cs:EPSG:6.0:">6402</name>
      </csID>
      <usesAxis>
        <CoordinateSystemAxis gml:id="EPSG9901"
gml:uom="urn:ogc:def:uom:OGC:0.0:degree">
          <name>Geodetic latitude in north direction with degree
units</name>
          <axisID>
            <name
codeSpace="urn:ogc:def:axis:EPSG:6.0:">9901</name>
          </axisID>
          <axisAbbrev>Lat</axisAbbrev>
          <axisDirection>north</axisDirection>
        </CoordinateSystemAxis>
      </usesAxis>
      <usesAxis>
        <CoordinateSystemAxis gml:id="EPSG9902"
gml:uom="urn:ogc:def:uom:OGC:0.0:degree">
          <name>Geodetic longitude in east direction with degree
units</name>
          <axisID>
```

```

        <name
codeSpace="urn:ogc:def:axis:EPSG:6.0:">9902</name>
        </axisID>
        <axisAbbrev>Lon</axisAbbrev>
        <axisDirection>east</axisDirection>
    </CoordinateSystemAxis>
</usesAxis>
</EllipsoidalCS>
</usesEllipsoidalCS>
<usesGeodeticDatum>
    <GeodeticDatum gml:id="EPSG6277">
        <datumName>OSGB 1936</datumName>
        <datumID>
            <name codeSpace="urn:ogc:def:datum:EPSG:6.0:">6277</name>
        </datumID>
        <usesPrimeMeridian>
            <PrimeMeridian gml:id="EPSG8901">
                <meridianName>Greenwich</meridianName>
                <meridianID>
                    <name
codeSpace="urn:ogc:def:meridian:EPSG:6.0:">8901</name>
                    </meridianID>
                    <greenwichLongitude>
                        <angle uom="urn:ogc:def:uom:OGC:1.0:degree">0</angle>
                    </greenwichLongitude>
                </PrimeMeridian>
            </usesPrimeMeridian>
        <usesEllipsoid>
            <Ellipsoid gml:id="EPSG7001">
                <ellipsoidName>Airy 1830</ellipsoidName>
                <ellipsoidID>
                    <name
codeSpace="urn:ogc:def:ellipsoid:EPSG:6.0:">7001</name>
                    </ellipsoidID>
                    <semiMajorAxis
uom="urn:ogc:def:uom:OGC:1.0:meter">6377563.396</semiMajorAxis>
                    <secondDefiningParameter>
                        <inverseFlattening
uom="urn:ogc:def:uom:OGC:1.0:unity">299.3249646</inverseFlattening>
                    </secondDefiningParameter>
                </Ellipsoid>
            </usesEllipsoid>
        </GeodeticDatum>
    </usesGeodeticDatum>
</GeographicCRS>

```

NOTE This example XML document can be used as a template, and edited to produce definitions of other GeographicCRSs.

7.3 XML document simple example

The above example XML document can be simplified by referencing CRS components that are defined by the EPSG and are used for multiple geographic CRSs, becoming:

```

<?xml version="1.0" encoding="UTF-8"?>
<GeographicCRS xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG4277">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06-->
  <srsName>OSGB 1936</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.0:">4277</name>
  </srsID>
  <usesEllipsoidalCS xlink:href="urn:ogc:def:cs:EPSG:6.0:6402"/>
  <usesGeodeticDatum>
    <GeodeticDatum gml:id="EPSG6277">
      <datumName>OSGB 1936</datumName>
      <datumID>
        <name codeSpace="urn:ogc:def:datum:EPSG:6.0:">6277</name>
      </datumID>
      <usesPrimeMeridian
xlink:href="urn:ogc:def:meridian:EPSG:6.0:8901"
xlink:title="Greenwich"/>
        <usesEllipsoid>
          <Ellipsoid gml:id="EPSG7001">
            <ellipsoidName>Airy 1830</ellipsoidName>
            <ellipsoidID>
              <name
codeSpace="urn:ogc:def:ellipsoid:EPSG:6.0:">7001</name>
            </ellipsoidID>
            <semiMajorAxis
uom="urn:ogc:def:uom:OGC:1.0:meter">6377563.396</semiMajorAxis>
            <secondDefiningParameter>
              <inverseFlattening
uom="urn:ogc:def:uom:OGC:1.0:unity">299.3249646</inverseFlattening>
            </secondDefiningParameter>
          </Ellipsoid>
        </usesEllipsoid>
      </GeodeticDatum>
    </usesGeodeticDatum>
  </GeographicCRS>

```

8 Projected CRS XML encoding

8.1 Summary

When using this GML 3.1.1 profile, the definition of each Projected coordinate reference system (CRS) shall be XML encoded using the ProjectedCRS element, defined in the attached normative XML Schema Document named coordinateReferenceSystems.xsd. The GML objects contained or referenced in this ProjectedCRS are indicated in this XML document skeleton:


```

<ProjectedCRS>
  <baseCRS>
    <GeographicCRS></GeographicCRS>
  </baseCRS>
  <definedByConversion>
    <Conversion></Conversion>
  </definedByConversion>
  <usesCartesianCS>
    <CartesianCS>
      <usesAxis>
        <CoordinateSystemAxis></CoordinateSystemAxis>
      </usesAxis>
      <usesAxis>
        <CoordinateSystemAxis></CoordinateSystemAxis>
      </usesAxis>
    </CartesianCS>
  </usesCartesianCS>
</ProjectedCRS>

```

NOTE 1 The UML class diagrams contained in Subclause C.3 provide graphical views of the contents of the ProjectedCRS XML element.

This skeleton XML document indicates that:

- a) A ProjectedCRS element shall contain one baseCRS, one definedByConversion, and one usesCartesianCS elements (in addition to other mandatory and optional information).
- b) That baseCRS element shall reference or contain the definition of one GeographicCRS, as specified in Clause 7.
- c) That definedByConversion shall reference or contain the definition of one Conversion, as specified in Clause 9.
- d) That usesCartesianCS shall reference or contain the definition of one CartesianCS.
- e) That CartesianCS definition element shall contain an ordered sequence of two usesAxis elements.
- f) Each of those usesAxis elements shall reference or contain the definition of one CoordinateSystemAxis. The referenced or listed axis order shall be used for position coordinates in that ProjectedCRS, with the specified units and directions of each axis.

NOTE 2 The two axes of a ProjectedCRS are often named Easting and Northing, not always in that order, with values often given in metres.

8.2 XML document full example

An example XML document completely defining a ProjectedCRS is:

```

<?xml version="1.0" encoding="UTF-8"?>
<ProjectedCRS xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"

```

```

xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG27700">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-05-->
  <srsName>OSGB 1936 / British National Grid</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.0:">27700</name>
  </srsID>
  <baseCRS xlink:href="urn:ogc:def:crs:EPSG:6.0:4277"/>
  <definedByConversion
xlink:href="urn:ogc:def:coordinateOperation:EPSG:6.0:19916"/>
  <usesCartesianCS>
    <CartesianCS gml:id="EPSG4400">
      <csName>Easting and Northing in metres</csName>
      <csID>
        <name codeSpace="urn:ogc:def:cs:EPSG:6.0:">4400</name>
      </csID>
      <usesAxis>
        <CoordinateSystemAxis gml:id="EPSG9906"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
          <name>Easting in east direction with metre units </name>
          <axisID>
            <name
codeSpace="urn:ogc:def:axis:EPSG:6.0:">9906</name>
            </axisID>
            <axisAbbrev>E</axisAbbrev>
            <axisDirection>east</axisDirection>
          </CoordinateSystemAxis>
        </usesAxis>
        <usesAxis>
          <CoordinateSystemAxis gml:id="EPSG9907"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
            <name>Northing in north direction with metre units
</name>
            <axisID>
              <name
codeSpace="urn:ogc:def:axis:EPSG:6.0:">9907</name>
              </axisID>
              <axisAbbrev>N</axisAbbrev>
              <axisDirection>north</axisDirection>
            </CoordinateSystemAxis>
          </usesAxis>
        </CartesianCS>
      </usesCartesianCS>
    </ProjectedCRS>

```

This example references the baseCRS, which is a GeographicCRS such as discussed in Subclause 7.1. This example also references the definedByConversion, which is a coordinate Conversion such as discussed in Subclause 9.1.

NOTE This example XML document can be used as a template, and edited to produce definitions of other ProjectedCRSs.

8.3 XML document simple example

The above example XML document can be simplified by referencing CRS components that are defined by the EPSG and are used for multiple geographic CRSs, becoming:

```
<?xml version="1.0" encoding="UTF-8"?>
<ProjectedCRS xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG27700">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06-->
  <srsName>OSGB 1936 / British National Grid</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.0:">27700</name>
  </srsID>
  <baseCRS xlink:href="urn:ogc:def:crs:EPSG:6.0:4277"/>
  <definedByConversion
xlink:href="urn:ogc:def:coordinateOperation:EPSG:6.0:19916"/>
    <usesCartesianCS xlink:href="urn:ogc:def:cs:EPSG:6.0:4400"/>
  </ProjectedCRS>
```

9 Coordinate conversion XML encoding

9.1 Summary

When using this GML 3.1.1 profile, the definition of each coordinate Conversion shall be XML encoded using the Conversion element, defined in the attached normative XML Schema Document named coordinateOperations.xsd. The GML objects contained or referenced in this Conversion element are indicated in this XML document skeleton:

```
<Conversion>
  <usesMethod>
    <OperationMethod>
      <usesParameter> (one or more)
        <OperationParameter></OperationParameter>
      </usesParameter>
      <usesParameter>
        <OperationParameter></OperationParameter>
      </usesParameter>
    </OperationMethod>
  </usesMethod>
  <usesValue></usesValue> (one or more)
  <usesValue></usesValue>
</Conversion>
```

NOTE The UML class diagrams contained in Subclause C.4 provide graphical views of the contents of the Conversion XML element.

This skeleton XML document indicates that:

- a) A Conversion element shall contain one usesMethod and one or more usesValue elements (in addition to other mandatory and optional information).

- b) That usesMethod element shall reference or contain the definition of one OperationMethod.
- c) That OperationMethod definition element shall contain an ordered sequence of one or more usesParameter elements.
- d) Each of those usesParameter elements shall reference or contain the definition of one OperationParameter.
- e) Each of those usesValue elements shall contain one parameter value.

9.2 XML document full example

An example XML document completely defining a coordinate Conversion is:

```
<?xml version="1.0" encoding="UTF-8"?>
<Conversion xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG19916">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-05-->
  <!-- SourceCRS: EPSG:4277 OSGB 1936 -->
  <!-- TargetCRS: EPSG:27700 OSGB 1936 / British National Grid -->
  <coordinateOperationName>Transverse
Mercator</coordinateOperationName>
  <coordinateOperationID>
    <name
codeSpace="urn:ogc:def:coordinateOperation:EPSG:6.3:">19916</name>
  </coordinateOperationID>
  <usesMethod>
    <OperationMethod gml:id="EPSG9807">
      <methodName>Transverse Mercator</methodName>
      <methodID>
        <name codeSpace="urn:ogc:def:method:EPSG:6.3:">9807</name>
      </methodID>
      <methodFormula>See Section 1.4.6 "Transverse Mercator" of EPSG
Guidance Note 7, December 2000. </methodFormula>
      <sourceDimensions>2</sourceDimensions>
      <targetDimensions>2</targetDimensions>
      <usesParameter>
        <OperationParameter gml:id="EPSG8801">
          <parameterName>Latitude of natural
origin</parameterName>
          <parameterID>
            <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8801</name>
          </parameterID>
        </OperationParameter>
      </usesParameter>
      <usesParameter>
        <OperationParameter gml:id="EPSG8802">
```

```

        <parameterName>Longitude of natural
origin</parameterName>
        <parameterID>
            <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8802</name>
            </parameterID>
        </OperationParameter>
    </usesParameter>
    <usesParameter>
        <OperationParameter gml:id="EPSG8805">
            <parameterName>Scale factor at natural
origin</parameterName>
            <parameterID>
                <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8805</name>
                </parameterID>
            </OperationParameter>
        </usesParameter>
        <usesParameter>
            <OperationParameter gml:id="EPSG8806">
                <parameterName>False Easting</parameterName>
                <parameterID>
                    <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8806</name>
                    </parameterID>
                </OperationParameter>
            </usesParameter>
            <usesParameter>
                <OperationParameter gml:id="EPSG8807">
                    <parameterName>False Northing</parameterName>
                    <parameterID>
                        <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8807</name>
                        </parameterID>
                    </OperationParameter>
                </usesParameter>
            </usesMethod>
        </usesMethod>
        <usesValue>
            <value uom="urn:ogc:def:uom:OGC:1.0:degree">49</value>
            <valueOfParameter xlink:href="#EPSG8801" xlink:title="Latitude of
natural origin"/>
        </usesValue>
        <usesValue>
            <value uom="urn:ogc:def:uom:OGC:1.0:degree">-2</value>
            <valueOfParameter xlink:href="#EPSG8802" xlink:title="Longitude
of natural origin"/>
        </usesValue>
        <usesValue>
            <value uom="urn:ogc:def:uom:OGC:1.0:unity">0.999601272</value>
            <valueOfParameter xlink:href="#EPSG8805" xlink:title="Scale
factor at natural origin"/>
        </usesValue>
        <usesValue>
            <value uom="urn:ogc:def:uom:OGC:1.0:metre">400000</value>
            <valueOfParameter xlink:href="#EPSG8806" xlink:title="False
Easting"/>

```

```

    </usesValue>
    <usesValue>
      <value uom="urn:ogc:def:uom:OGC:1.0:metre">-100000</value>
      <valueOfParameter xlink:href="#EPSG8807" xlink:title="False
Northing"/>
    </usesValue>
  </Conversion>

```

9.3 XML document simple example

The above example XML document can be simplified by referencing coordinate operation components that are defined by the EPSG and are used for multiple Conversions, becoming:

```

<?xml version="1.0" encoding="UTF-8"?>
<Conversion xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG19916">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06-->
  <!-- SourceCRS: EPSG:4277 OSGB 1936 -->
  <!-- TargetCRS: EPSG:27700 OSGB 1936 / British National Grid -->
  <coordinateOperationName>Transverse
Mercator</coordinateOperationName>
  <coordinateOperationID>
    <name
codeSpace="urn:ogc:def:coordinateOperation:EPSG:6.3:">19916</name>
  </coordinateOperationID>
  <usesMethod xlink:href="urn:ogc:def:method:EPSG:6.3:9807"
xlink:title="Transverse Mercator"/>
  <usesValue>
    <value uom="urn:ogc:def:uom:OGC:1.0:degree">49</value>
    <valueOfParameter xlink:href="#EPSG8801" xlink:title="Latitude of
natural origin"/>
  </usesValue>
  <usesValue>
    <value uom="urn:ogc:def:uom:OGC:1.0:degree">-2</value>
    <valueOfParameter xlink:href="#EPSG8802" xlink:title="Longitude
of natural origin"/>
  </usesValue>
  <usesValue>
    <value uom="urn:ogc:def:uom:OGC:1.0:unity">0.999601272</value>
    <valueOfParameter xlink:href="#EPSG8805" xlink:title="Scale
factor at natural origin"/>
  </usesValue>
  <usesValue>
    <value uom="urn:ogc:def:uom:OGC:1.0:metre">400000</value>
    <valueOfParameter xlink:href="#EPSG8806" xlink:title="False
Easting"/>
  </usesValue>
  <usesValue>
    <value uom="urn:ogc:def:uom:OGC:1.0:metre">-100000</value>
    <valueOfParameter xlink:href="#EPSG8807" xlink:title="False
Northing"/>
  </usesValue>

```

```

    </usesValue>
  </Conversion>

```

10 Vertical CRS XML encoding

10.1 Summary

When using this GML 3.1.1 profile, the definition of each Vertical coordinate reference system (CRS) shall be XML encoded using the VerticalCRS element, defined in the attached normative XML Schema Document named coordinateReferenceSystems.xsd. The GML objects contained or referenced in this VerticalCRS are indicated in this XML document skeleton:

```

<VerticalCRS>
  <usesVerticalCS>
    <VerticalCS>
      <usesAxis>
        <CoordinateSystemAxis></CoordinateSystemAxis>
      </usesAxis>
    </VerticalCS>
  </usesVerticalCS>
  <usesVerticalDatum>
    <VerticalDatum></VerticalDatum>
  </usesVerticalDatum>
</VerticalCRS>

```

NOTE The UML class diagrams contained in Subclause C.5 provide graphical views of the contents of the VerticalCRS XML element.

This skeleton XML document indicates that:

- a) A VerticalCRS element shall contain one usesVerticalCS and one usesVerticalDatum elements (in addition to other mandatory and optional information).
- b) That usesVerticalCS element shall reference or contain the definition of one VerticalCS.
- c) That VerticalCS definition element shall contain one usesAxis element.
- d) That usesAxis element shall reference or contain the definition of one CoordinateSystemAxis.
- e) That usesVerticalDatum element shall reference or contain the definition of one VerticalDatum.

10.2 XML document full example

An example XML document completely defining a VerticalCRS is:

```

<?xml version="1.0" encoding="UTF-8"?>
<VerticalCRS xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG5701">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-05-->
  <srsName>Newlyn</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.0:">5701</name>
  </srsID>
  <usesVerticalCS>
    <VerticalCS gml:id="EPSG6499">
      <csName>Height up in metres</csName>
      <csID>
        <name codeSpace="urn:ogc:def:cs:EPSG:6.0:">6499</name>
      </csID>
      <usesAxis>
        <CoordinateSystemAxis gml:id="EPSG9904"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
          <name>Gravity-related height in up direction with metre
units</name>
          <axisID>
            <name
codeSpace="urn:ogc:def:axis:EPSG:6.0:">9904</name>
          </axisID>
          <axisAbbrev>H</axisAbbrev>
          <axisDirection>up</axisDirection>
        </CoordinateSystemAxis>
      </usesAxis>
    </VerticalCS>
  </usesVerticalCS>
  <usesVerticalDatum>
    <VerticalDatum gml:id="EPSG5101">
      <datumName>Ordnance Datum Newlyn</datumName>
      <datumID>
        <name codeSpace="urn:ogc:def:datum:EPSG:6.0:">5101</name>
      </datumID>
      <verticalDatumType
codeSpace="urn:ogc:def:verticalDatumType:OGC:1.0:">geoidal</verticalDat
umType>
      </VerticalDatum>
    </usesVerticalDatum>
  </VerticalCRS>

```

10.3 XML document simple example

The above example XML document can be simplified by referencing CRS components that are defined by the EPSG and are used for multiple geographic CRSs, becoming:

```

<?xml version="1.0" encoding="UTF-8"?>
<VerticalCRS xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

```



```

xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSSProfile.xsd" gml:id="EPSG5701">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06-->
  <srsName>Newlyn</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.0:">5701</name>
  </srsID>
  <usesVerticalCS xlink:href="urn:ogc:def:cs:EPSG:6.0:6499"
xlink:title="Height up in metres"/>
  <usesVerticalDatum>
    <VerticalDatum gml:id="EPSG5101">
      <datumName>Ordnance Datum Newlyn</datumName>
      <datumID>
        <name codeSpace="urn:ogc:def:datum:EPSG:6.0:">5101</name>
      </datumID>
      <verticalDatumType
codeSpace="urn:ogc:def:verticalDatumType:OGC:1.0:">geoidal</verticalDat
umType>
      </VerticalDatum>
    </usesVerticalDatum>
  </VerticalCRS>

```

11 Compound CRS XML encoding

11.1 Summary

When using this GML 3.1.1 profile, the definition of each Compound coordinate reference system (CRS) shall be XML encoded using the CompoundCRS element, defined in the attached normative XML Schema Document named coordinateReferenceSystems.xsd. The GML objects contained or referenced in this CompoundCRS are indicated in this XML document skeleton:

```

<CompoundCRS>
  <includesCRS>
    <ProjectedCRS></ProjectedCRS> or <GeographicCRS></GeographicCRS>
  </includesCRS>
  <includesCRS>
    <VerticalCRS></VerticalCRS>
  </includesCRS>
</CompoundCRS>

```

NOTE The UML class diagrams contained in Subclause C.6 provide graphical views of the contents of the CompoundCRS XML element.

This skeleton XML document indicates that:

- a) Each CompoundCRS element shall contain an ordered sequence of two includesCRS elements (in addition to other mandatory and optional information).
- b) The first includesCRS element shall reference or contain the definition of one ProjectedCRS or 2D GeographicCRS, as specified in Clause 7 or 8.

- c) The second includesCRS element shall reference or contain the definition of one VerticalCRS, as specified in Clause 10.

11.2 XML document example

An example XML document defining a CompoundCRS is:

```
<?xml version="1.0" encoding="UTF-8"?>
<CompoundCRS xmlns="http://www.opengis.net/gml"
  xmlns:gml="http://www.opengis.net/gml"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.opengis.net/gml
    ../commonCRSsProfile.xsd" gml:id="EPSG7405">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-05-->
  <srsName>OSGB36 /British National Grid + ODN</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.3:">7405</name>
  </srsID>
  <validArea>
    <description>United Kingdom (UK) - Great Britain - England
    Scotland Wales - onshore; Isle of Man.
  </description>
  </validArea>
  <includesCRS xlink:href="urn:ogc:def:crs:EPSG:6.3:27700"
  xlink:title="OSGB 1936 / British National Grid"/>
  <includesCRS xlink:href="urn:ogc:def:cs:EPSG:6.3:6499"
  xlink:title="Newlyn"/>
</CompoundCRS>
```

This example uses URNs referencing the two included CRSs. Alternately, the complete definitions of those CRSs could be XML encoded (as shown in previous examples) within the two includesCRS elements.

Annex A
(normative)

Abstract test suite

An abstract test suite is not provided in this version of this Profile Implementation Specification.

Annex B (informative)

UML model

B.1 Introduction

This annex provides UML models of the primary XML elements included in this GML 3.1.1 Common CRSs profile, using the OGC/ISO profile of UML summarized in Subclause 5.3 of [OGC 05-008]. These UML models are all extracted from OGC Abstract Specification Topic 2 [OGC 05-046r3]. The capitalization of attribute names uses the OGC/ISO profile of UML.

NOTE GML 3.1.1 is not yet fully harmonized with Abstract Specification Topic 2, so the XML document examples in Clauses 7-11 are not fully consistent with the following UML class diagrams.

B.2 Geographic CRSs

B.2.1 Simple UML model

Figure B.1 is a simplified UML class diagram extracted from Topic 2 that shows all the concrete (non-abstract) object classes and associations related to the SC_GeographicCRS class. To keep this diagram simple, none of the class attributes is displayed. This diagram shows that the SC_GeographicCRS uses a CS_GeodeticCS, which has either two or three usesAxis associations to CS_CoordinateSystemAxis.

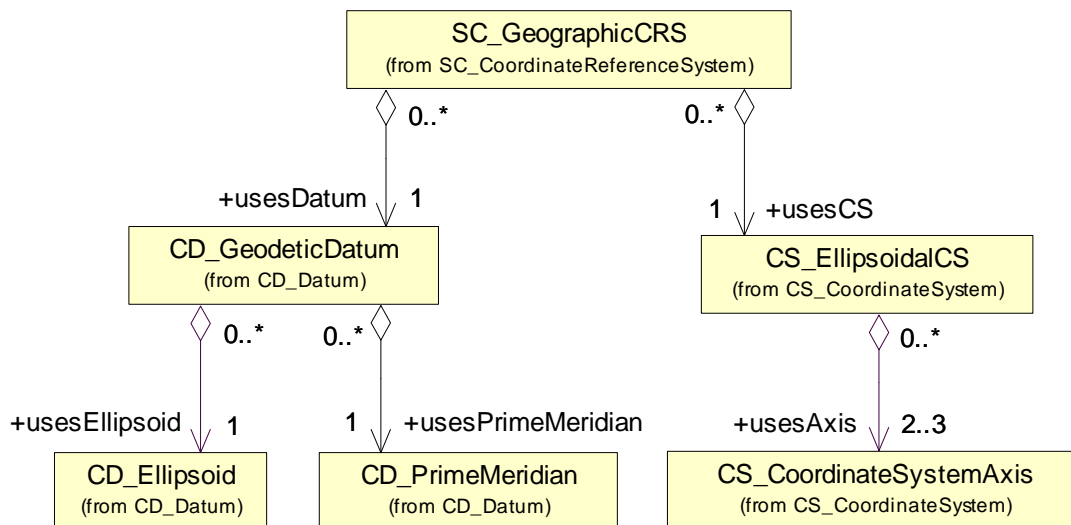


Figure B.1 — GeographicCRS simple UML class diagram

Notice that the GeographicCRS class does NOT include or reference any coordinate operations, which can be used to transform or convert geographic coordinates into any other coordinate reference system.

B.2.2 Full UML model

Figure B.2 is a more complete UML class diagram extracted from Topic 2 that shows essentially all the classes and associations related to the SC_GeographicCRS class. This diagram again shows that the SC_GeographicCRS uses a CS_GeodeticCS, which has either two or three usesAxis associations to CS_CoordinateSystemAxis.

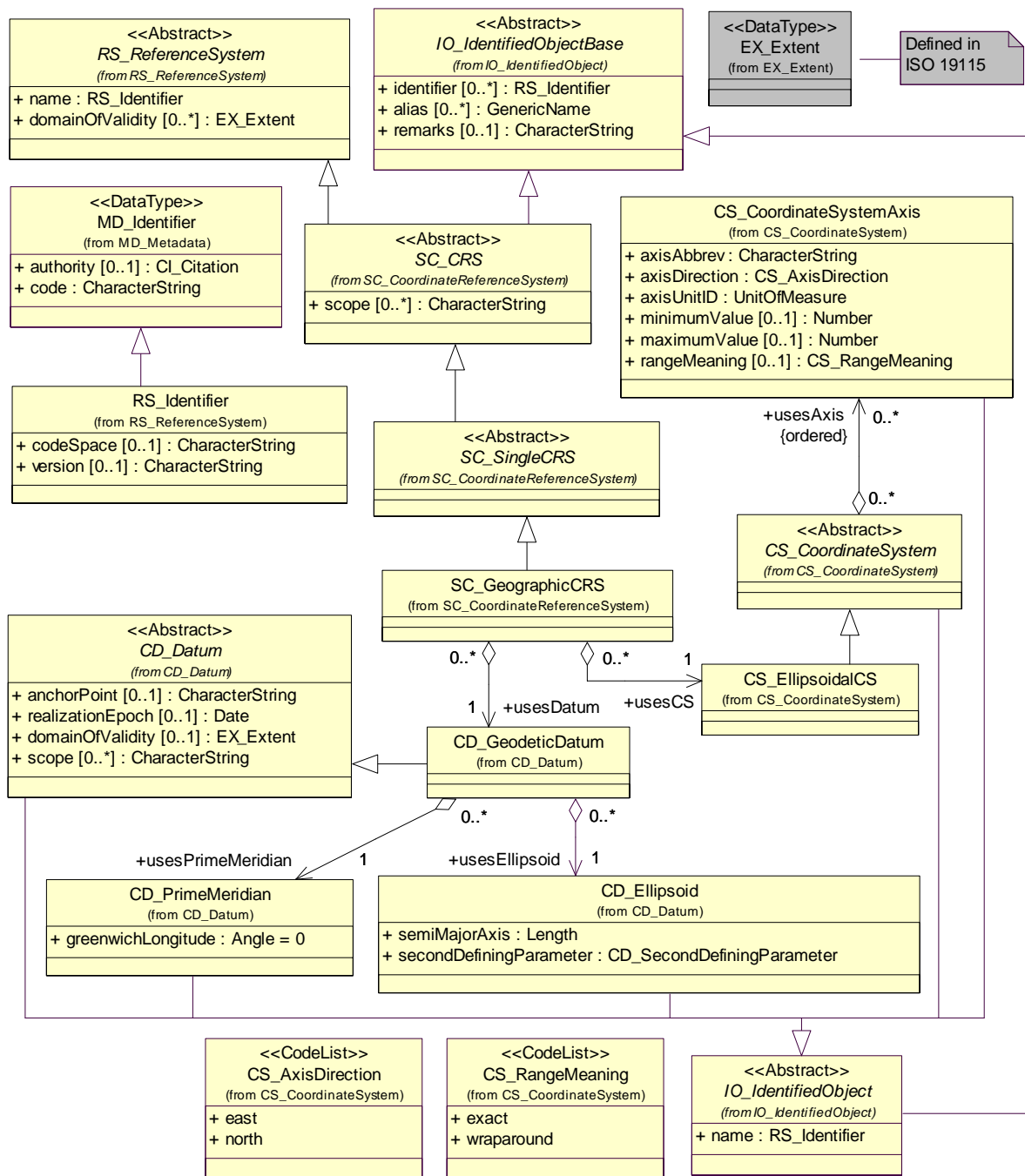


Figure B.2 — GeographicCRS full UML class diagram

B.3 Projected CRSs

B.3.1 Simple UML model

Figure B.3 is a simplified UML class diagram for projected CRSs extracted from Topic 2. This diagram shows the concrete (non-abstract) object classes and associations related to the SC_ProjectedCRS class, except for the classes and associations for the CC_Conversion class (discussed in Subclause B.4) used as the definedByConversion and the SC_GeographicCRS class (discussed in Subclause B.2) that serves as the baseCRS.

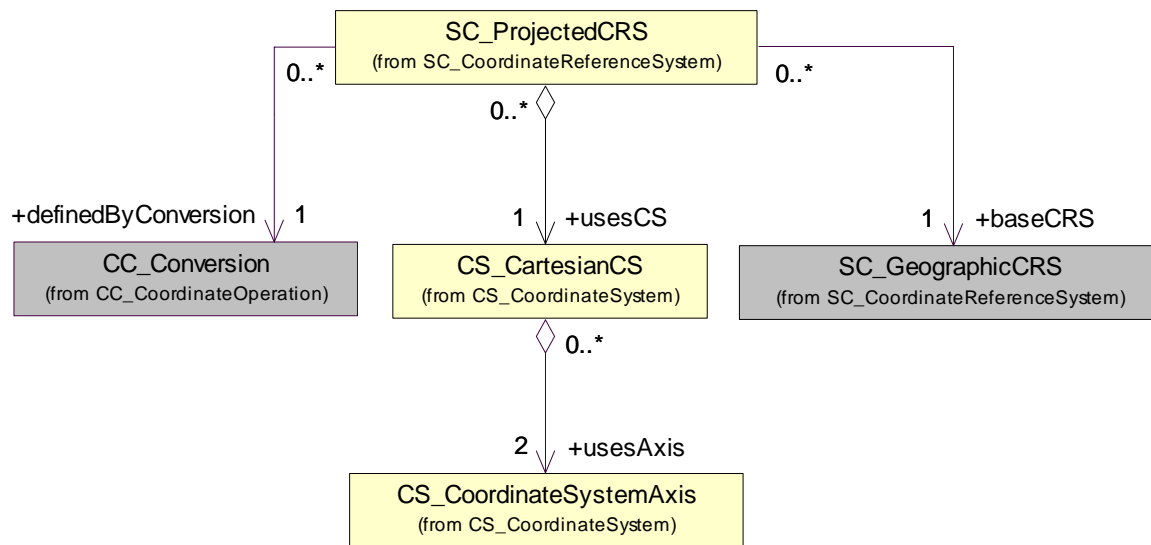


Figure B.3 — ProjectedCRS simple UML class diagram

B.3.2 Full UML model

Figure B.4 is a more complete UML class diagram for projected CRSs extracted from Topic 2. This diagram shows the classes and associations related to the SC_ProjectedCRS class, except for the classes and associations for the CC_Conversion class (discussed in Subclause B.4) used as the definedByConversion and the SC_GeographicCRS class (discussed in Subclause B.2) that serves as the baseCRS.

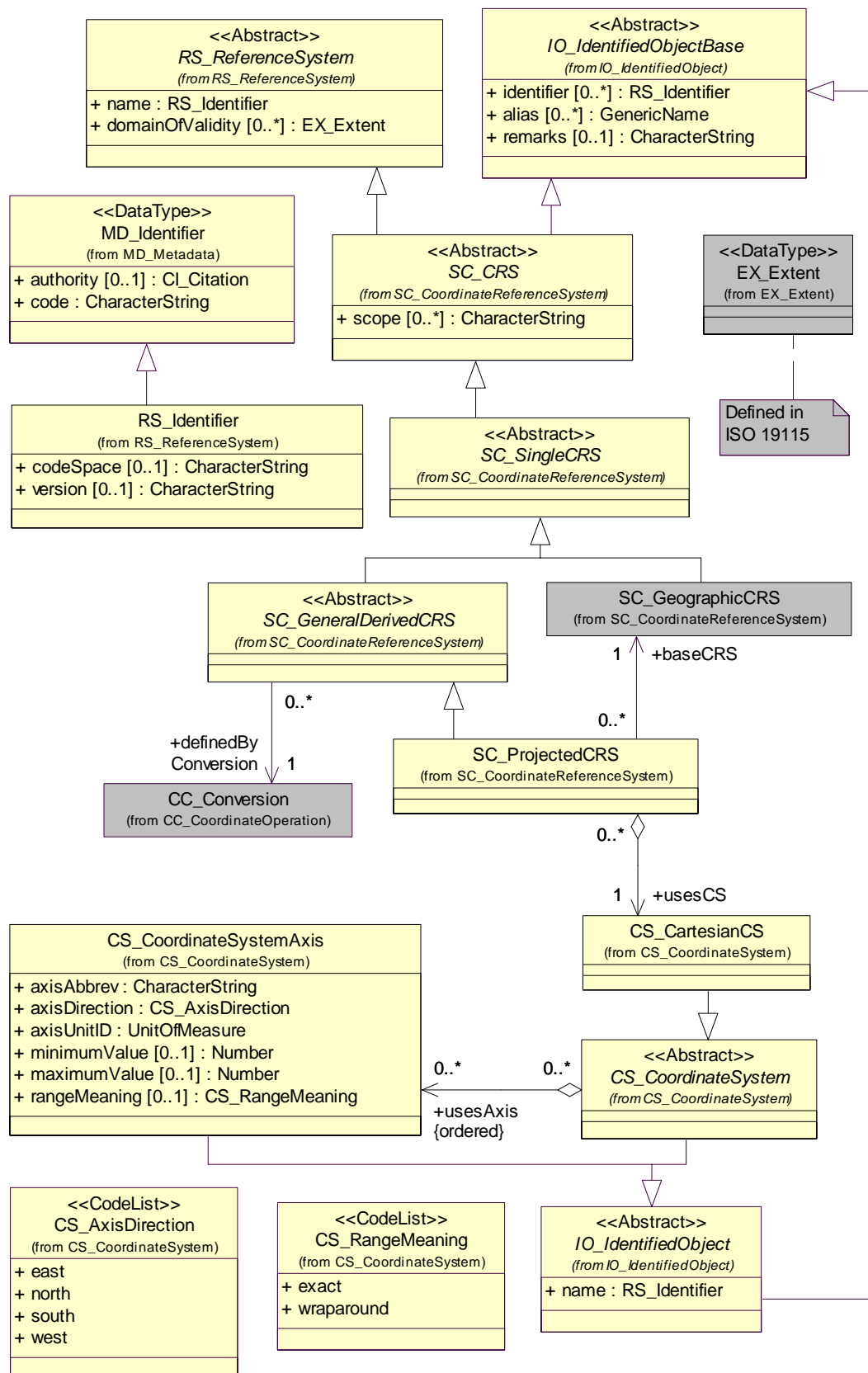


Figure B.4 — ProjectedCRS full UML class diagram

B.4 Coordinate conversions

B.4.1 Simple UML model

A SC_ProjectedCRS is defined by a CC_Conversion, which is a concrete subtype of the CC_CoordinateOperation class. Figure B.5 is a simplified UML class diagram for a CC_Conversion used for a projected CRS. This diagram shows the concrete (non-abstract) objects classes and associations related to the CC_Conversion class when used to define a SC_ProjectedCRS, except for the CC_ParameterValueGroup and CC_OperationParameterGroup classes, which are not normally useful in defining a projected CRS.

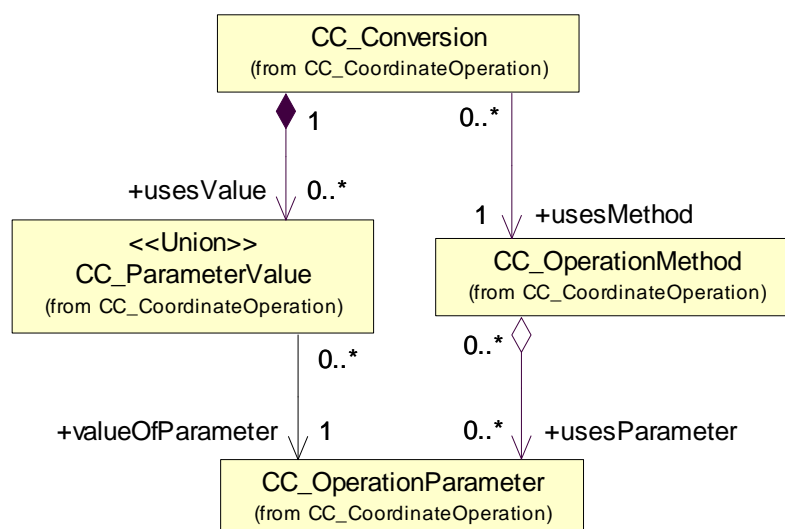


Figure B.5 — Conversion UML simple UML class diagram

To keep this diagram simple, none of the class attributes are displayed. The `definedByConversion` association from the `SC_ProjectedCRS` class (inherited from the abstract `SC_GeneralDerivedCRS` class) is also not shown. For a projected CRS, this Conversion is usually defined by about five instances of the `CC_OperationParameter` and `CC_ParameterValue` classes, as needed.

B.4.2 Full UML model

Figure B.6 is a more complete UML class diagram for a CC_Conversion used for a projected CRS. This diagram shows the classes and associations related to the CC_Conversion class when used to define a SC_ProjectedCRS, except for the:

- Contents of the `DQ_PositionalAccuracy` and `EX_Extent` classes, defined in ISO 19115
- `CC_ParameterValueGroup` and `CC_OperationParameterGroup` classes, which are not normally useful in defining a projected CRS
- Details of the `SC_GeneralDerivedCRS` class, because they are shown on the diagram in Figure B.4.

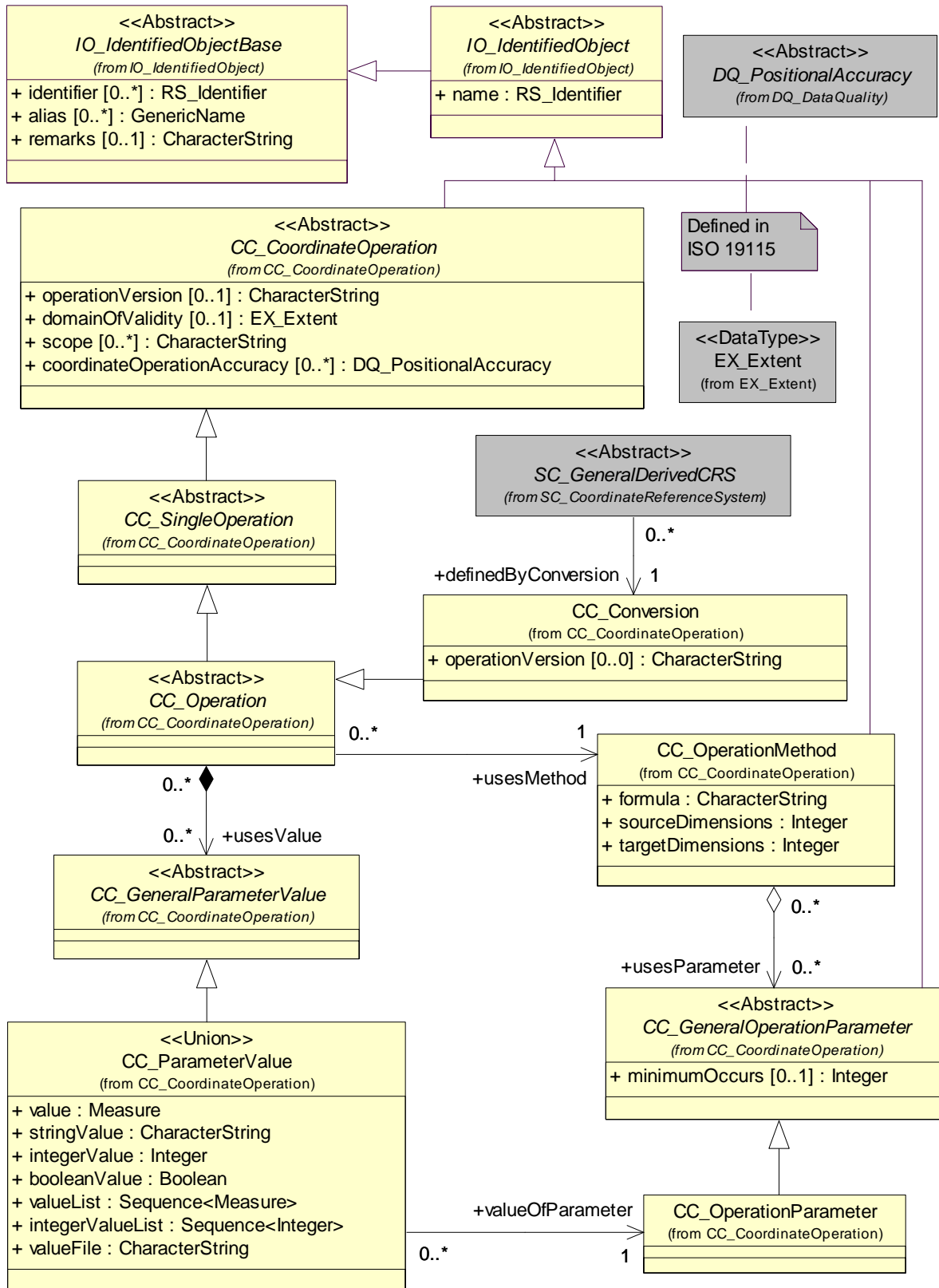


Figure B.6 — Conversion full UML class diagram

B.5 Vertical CRSs

B.5.1 Simple UML model

Figure B.7 is a simplified UML class diagram for Vertical CRSs extracted from Topic 2. This diagram shows the concrete (non-abstract) object classes and associations related to the SC_VerticalCRS class.

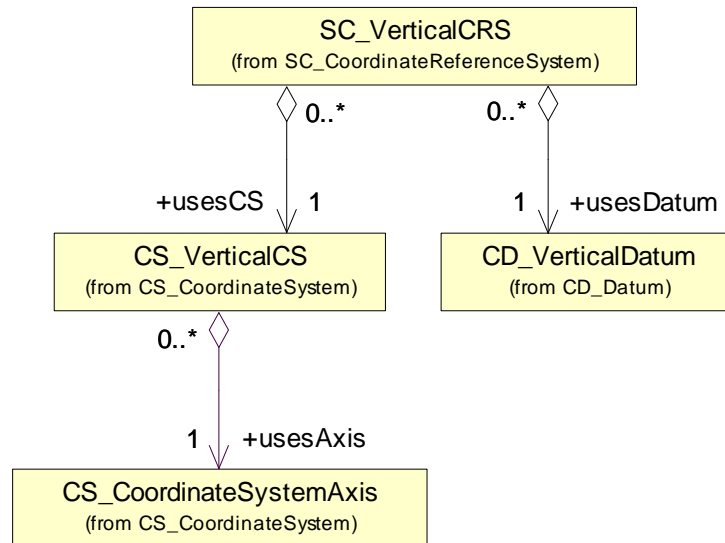


Figure B.7 — VerticalCRS simple UML class diagram

B.5.2 Full UML model

Figure B.8 is a more complete UML class diagram extracted from Topic 2 that shows more of the classes and associations related to the SC_VerticalCRS class.

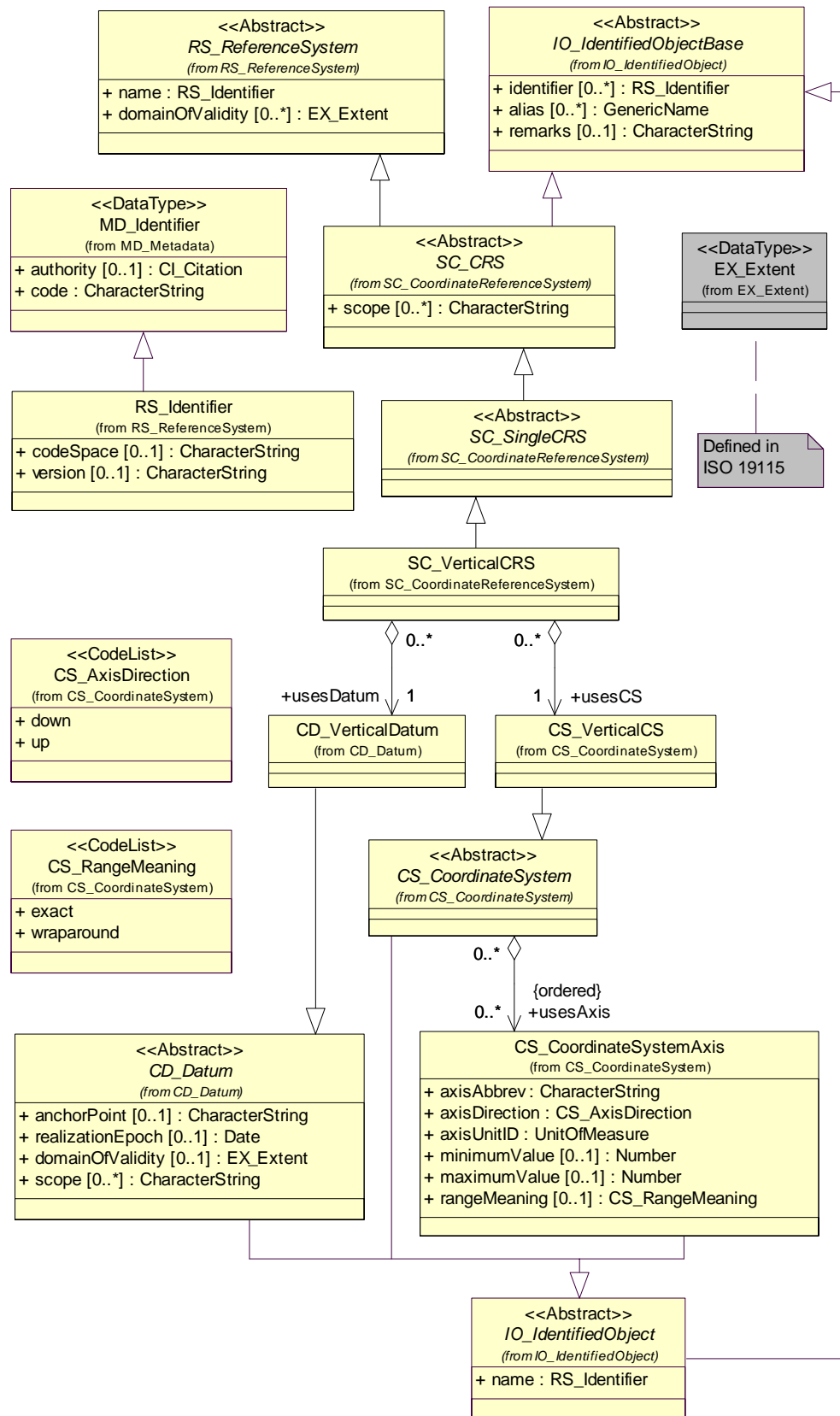


Figure B.8 — VerticalCRS full UML class diagram

B.6 Compound CRSs

B.6.1 Simple UML model

Figure B.9 is a simplified UML class diagram for Compound CRSs extracted from Topic 2. This diagram shows the concrete (non-abstract) object classes and associations related to the SC_CompoundCRS class, when it combines a SC_ProjectedCRS and a SC_VerticalCRS. Similarly, a 2D SC_GeographicCRS could be combined with a SC_VerticalCRS. This figure does not detail the SC_ProjectedCRS class which is discussed in Subclause B.3, or the SC_VerticalCRS class which is discussed in Subclause B.5.

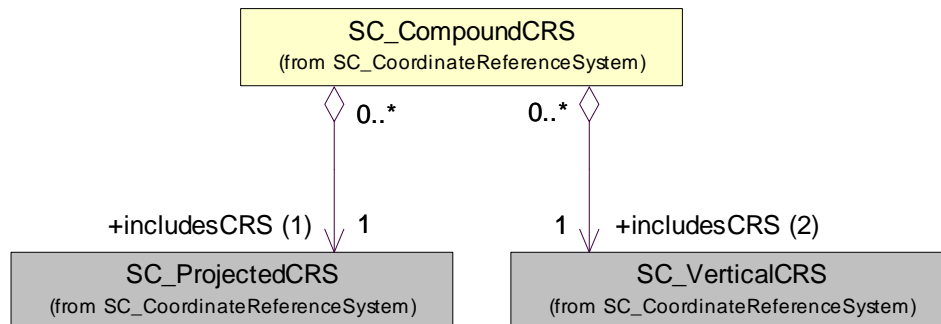


Figure B.9 — CompoundCRS simple UML class diagram

B.6.2 Full UML model

Figure B.10 is a more complete UML class diagram extracted from Topic 2 that shows more of the classes and associations related to the SC_CompoundCRS class, when it combines a Projected CRS and a VerticalCRS. Again, this figure does not detail the SC_ProjectedCRS class which is discussed in Subclause B.3, or the SC_VerticalCRS class which is discussed in Subclause B.5.

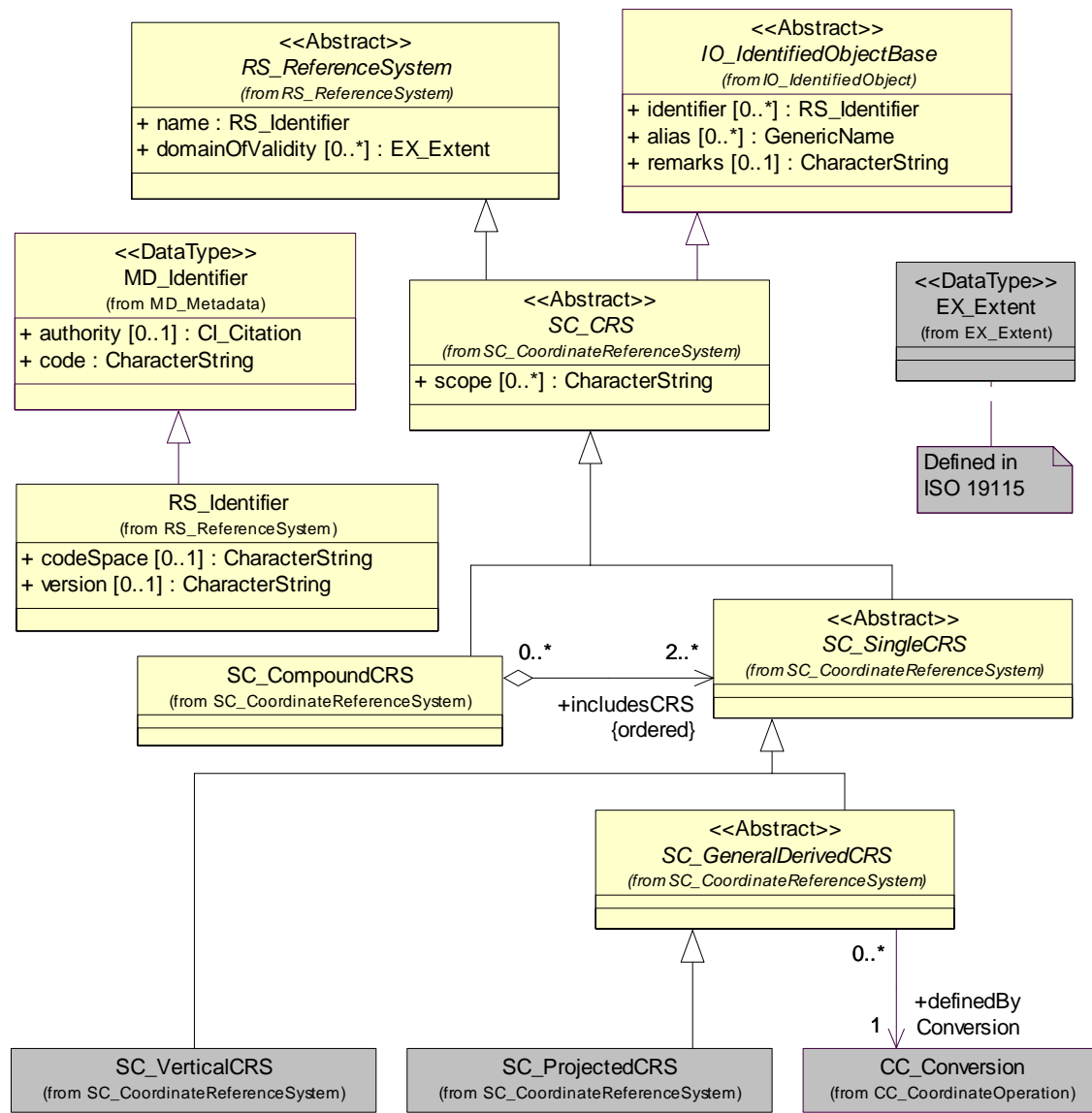


Figure B.10 — CompoundCRS full UML class diagram

Annex C (informative)

Expected uses of CRS definition data

C.1 Introduction

The expected OGC uses (or use cases) for transferring CRS and coordinate operation definition data produce requirements to be satisfied by the XML encoding of that data. Three broad uses of such definition data transfer have been identified:

- a) Use to transfer definition of a Coordinate Reference System (CRS), used by other geospatial data
- b) Use to transfer definition of a Coordinate Transformation (CT), that can be performed by a coordinate transformation service
- c) Use to transfer lineage or history of other geospatial data

Additional OGC uses of the proposed CRS and coordinate operation definition data might be identified in the future. These expected OGC uses assume the OGC is standardizing software-to-software interfaces (or Application Programming Interfaces, APIs) and associated data transfer formats, but is not (currently) trying to standardize human-computer interfaces.

Each OGC standard interface must allow both server and client software to be written that implements that interface. Simplicity of the interfaces is highly desirable, to simplify client software. Simplicity of server implementation software is somewhat important, but not as important as interface simplicity.

The following subclauses first discuss the multiple uses of definition data, the alternate ways in which definition data can be transferred, and then the three data transfer uses listed above.

C.2 Multiple uses of definition data

CRS and CT definition data can be used in at least three broad overlapping ways, to:

- a) Describe a specific CRS or CT to a human user. Note that different human users need different degrees of definition detail.
- b) Uniquely identify a specific CRS or CT to software. For a CRS, such identification can be used by software to check if different geospatial datasets are recorded using the same CRS, or to find additional data about a CRS that is stored elsewhere.
- c) Provide data for performing coordinate transformations and conversions, useful to transformation software. For a CT, such data might be used to perform that

transformation. For a CRS, such data might be used in transforming point positions to or from that CRS.

C.3 Alternative ways to transfer definition data

CRS and CT definition data can be transferred in three alternative ways:

- a) Transfer only identifier and perhaps name, of each CRS or CT
- b) Transfer complete definition, of each CRS or CT
- c) Transfer partial definition with identifiers (and perhaps names) for remaining parts, of each CRS or CT

Only an identifier needs to be transferred for a complete CRS or CT, or for any part thereof, for any part that is well-known to the receiving software. Well-known usually means that some recognized authority has produced and published a complete specification of that part. Server software could have those well-known definitions coded into the software. Alternately, server software could be coded to access those definitions when needed from a separate service known to the server. Such a separate service may be maintained by the authority or by a third party.

In general, there will be several CRS and CT specification authorities that one server or client might use, separately and together. Of course, some software implementations may use no such authority, or only one such authority. One widely-used, publicly-available authority is the European Petroleum Survey Group (EPSG) database, and use of this authority is specified in several OGC Implementation Specifications. However, other and more private authorities exist and must be supported by some OGC standard interfaces, including military affiliated authorities (e.g., DIGEST). Somewhat private authorities are expected to be used for many engineering and image coordinate reference systems.

A complete CRS or CT specification must be transferred for a CRS or CT, or for any part thereof, for any part that is not well-known to the receiving software. Some server or client implementations could support no well-known CRS and/or CT definitions. More likely, some applications are expected to use some non-well-known CRS or CT definitions. For example, a grid coverage will often use a CRS specific to that coverage. Also, an image coordinate transformation is likely to be specific to one image, and may not be supported by any authority that makes that CT well-known.

C.4 Use to transfer coordinate reference system definition

XML encoding can be used to transfer the definition of a Coordinate Reference System (CRS) used by other geospatial data. In most cases, one geospatial dataset will use only one CRS. The definition of a CRS for a geospatial dataset can be transferred (usually through an OGC interface) for several different purposes, including:

- a) Coordinate Transformation (CT) interface. The current Coordinate Transformation (CT) server interface allows use of XML to transfer definitions of CRSs. That is, a client can send the definition of one CRS that the client is requesting access, to server

software. Similarly, the server software can send to a client the definition of one CRS that the client currently has access to.

- b) Geography Markup Language (GML). The encoding of features in XML, now specified in the GML Implementation Specification, would use this CRS XML to define the CRS of a feature collection or feature.
- c) Web Map Server (WMS) interface. A future version of the WMS interface might use XML to define the CRS that the client is requesting “map” data in. (The WMS interface does not currently use XML for this purpose.) In the current WMS interface, only well-known CRSs are supported, so only the identifier of that well-known CRS is transferred in a Get Map request.
- d) Grid Coverage (GC) interface. A future version of the GC (access) interface might use XML to define the CRS used by a coverage, when requested by a client. (The current GC interface does not use XML for this purpose.) In the current draft GC interface, the CRS can be defined for one specific grid coverage, requiring transfer of a more complete specification of that CRS. That grid CRS is usually specified as a custom affine coordinate conversion or transformation from another CRS.
- e) Web Coverage Service (WCS) interface. The WCS (access) interface uses XML to reference the CRS used by a coverage or requested by a client.

C.4.1 Current CRS transfer by low-level CT interface

The current low-level Coordinate Transformation (CT) Implementation Specification [OGC 01-009] supports XML transfer of a CRS definition in one operation and in one attribute.

The `createFromXML` operation of the `CS_CoordinateSystemFactory` <<Interface>> class creates a `CS_CoordinateSystem` object from a XML character string. One server will implement one `CS_CoordinateSystemFactory` object. The signature of this UML operation is:

```
createFromXML (xml:CharacterString) : CS_CoordinateSystem
```

The “XML” read-only UML attribute of the `CS_Info` class allows a client to get an XML character string representation of an object, which can be either a `CS_CoordinateSystem` or a `CS_Unit` UML object. Objects of both the `CS_CoordinateSystem` and `CS_Unit` UML classes can be instantiated by multiple other objects visible to one client. Note that a `CS_CoordinateSystem` object can be created in several ways other than use of the `createFromXML` operation. The signature of this UML attribute is:

```
XML : CharacterString
```

In the `createFromXML` operation, and when the UML attribute is used to get XML for a `CS_CoordinateSystem` object, the XML DTD for `CS_CoordinateSystem` provided in Section 15.1.1 (pages 113 through 115) of 00-007r4 is used. Example XML using that XML DTD is provided in Section 15.1.2 (pages 116 and 117) of 01-009. (Because that XML DTD and example XML are each more than one page, they are not copied here.)

NOTE A future version of the Coordinate Transformation (CT) Implementation Specification could use XML in additional places, especially where use of WKT is now supported but use of XML is not now supported.

C.4.2 Current CRS transfer by ICT and high-level CT interfaces

A draft high-level Coordinate Transformation (CT) Implementation Specification [OGC 01-013r1] supports XML transfer of a CRS definition by two operations. The same two operations are supported by the draft Image Coordinate Transformation (ICT) interface [OGC 00-045r1]. These two operations are provided to clients by the one Ground Coordinate Transformation Service <<Interface>> object. The UML operation signatures of these two operations are:

```
addTransformation (metadata : TransformationMetadata,
                  format : TextFormat) : TransformationID
transformationMetadata (transformation : TransformationID, format :
                       TextFormat) : TransformationMetadata
```

XML is one possible format used by the Transformation Metadata <<DataType>> class that is used by these two operations. The Transformation Metadata class contains three UML attributes, with the signatures:

```
sourceCS : CoordinateSystemDefinition
targetCS : CoordinateSystemDefinition
transformation [0..1]: TransformationDefinition
```

The CoordinateReferenceSystem XML element, with all its contents, specified in this document could to be used for each Coordinate System Definition instance in the Transformation Metadata. (However, the Transformation XML element specified in GML 3.1.1, with all their contents, alternately could be used for complete Transformation Metadata, including both the source and target CoordinateReferenceSystems.)

C.5 Use to transfer coordinate transformation (CT) definition

XML can be used to transfer the definition of a Coordinate Transformation (CT) in the interfaces to Coordinate Transformation (CT) services. These interfaces include the accepted (low level) CT Implementation Specification, OGC document 01-009. These interfaces also include a high-level CT interface now proposed in document 01-013, plus draft Image Coordinate Transformation interfaces documented in 00-045r1. These CT interfaces use XML to transfer CT definitions with and without associated source and target CRSs.

C.5.1 Current CT transfer by low-level CT Interface

The current low-level Coordinate Transformation (CT) Implementation Specification [OGC 01-009] supports XML transfer of a CT definition in one operation and one attribute.

The createFromXML operation of the CT_MathTransformFactory <<Interface>> class creates a CT_MathTransform object from a XML character string. One server will

implement one CT_MathTransformFactory object. The UML signature of this operation is:

```
createFromXML (xml:CharacterString) : CT_MathTransform
```

The “XML” read-only UML attribute of the CT_MathTransform class allows a client to get an XML character string representation of this UML object. Objects of the CT_MathTransform class can be instantiated by multiple UML objects visible to one client. Note that a CT_MathTransform object can be created in several ways other than use of the createFromXML operation. The signature of this UML attribute is:

```
XML : CharacterString
```

For both of these XML uses, the XML DTD for CT_MathTransform provided in Section 15.1.1 (page 113) of 01-009 is used. Example XML using that XML DTD is not provided in 01-009. The XML DTD for CT_MathTransform now in Section 15.1.1 is:

```
<!DOCTYPE CT_MathTransform [
<!ELEMENT CT_MathTransform (
  CT_ConcatenatedTransform |
  CT_InverseTransform |
  CT_ParameterizedMathTransform |
  CT_PassThroughTransform) >

<!ELEMENT CT_ParameterizedMathTransform (CT_Parameter*)>
<!ATTLIST CT_ParameterizedMathTransform
  ClassName          CDATA      #REQUIRED
>

<!ELEMENT CT_PassThroughTransform (CT_MathTransform)>
<!ATTLIST CT_PassThroughTransform
  FirstAffectedOrdinate CDATA      #REQUIRED
>

<!ELEMENT CT_ConcatenatedTransform (CT_MathTransform*)>
<!ELEMENT CT_InverseTransform (CT_MathTransform)>

<!ELEMENT CT_Parameter EMPTY>
<!ATTLIST CT_Parameter
  Name          CDATA      #REQUIRED
  Value         CDATA      #REQUIRED
>
]>
```

NOTE This CT_MathTransform does not include any information on the source and target coordinate systems. Also, a future version of the low-level Coordinate Transformation (CT) Implementation Specification could use XML in additional places, especially where use of WKT is now supported but use of XML is not now supported.)

C.5.2 Current CT transfer by ICT and high-level CT interfaces

A draft high-level Coordinate Transformation (CT) interface specification [OGC 01-013] supports XML transfer of a CT definition by two operations. The same two operations are supported by the draft Image Coordinate Transformation (ICT) interface [OGC 00-

045r1]. These two operations are provided to clients by the one Ground Coordinate Transformation Service <<Interface>> object. The signatures of these two UML operations are:

```
addTransformation (metadata : TransformationMetadata,
    format : TextFormat) : TransformationID
transformationMetadata (transformation : TransformationID, format :
    TextFormat) : TransformationMetadata
```

XML is one possible format used by the Transformation Metadata <<DataType>> class that is used by these two operations. The Transformation Metadata class contains three UML attributes, with the signatures:

```
sourceCS : CoordinateSystemDefinition
targetCS : CoordinateSystemDefinition
transformation [0..1]: TransformationDefinition
```

The Transformation XML element specified in GML 3.1.1, with all their contents, could be used for a complete Transformation Metadata instance, including both the source and target CoordinateReferenceSystems. The Conversion XML element, with all its' contents probably can also be used for each Transformation Metadata instance.

C.6 Use to transfer dataset lineage or history

XML can be used to transfer the lineage or history of geospatial data, especially data encoded using XML. Such lineage information is specified by ISO 19115: Geographic information – Metadata to be part of the useful metadata about a dataset, and that metadata could be recorded in XML. (The OGC encourages use of ISO 19115 Metadata, but there are no uses of XML to transfer dataset lineage or history in current accepted OGC Implementation Specifications.)

The lineage of a dataset, or of a part of a larger dataset, is likely to include the original CRS of the positions in that data, plus the sequence of coordinate transformations used to change these positions into the CRS in which the data is now recorded. Alternately, one concatenated coordinate transformation could be recorded that includes the original CRS and the sequence of coordinate transformations used. Similar metadata might be recorded for data still in the original CRS, but planned to be converted into a different CRS.

Annex D (informative)

More XML document examples

D.1 Introduction

This annex provides additional example XML documents using this GML 3.1.1 Common CRSs profile. These XML examples omit some optional XML elements and attributes that might be included, and include some optional elements and attributes that might be omitted. This omission or inclusion was partially based on whether reasonable values were known for optional elements and attributes. The optional elements that are omitted in these XML examples include:

- a) The "remarks" element in all IdentifierType and object elements.
- b) The "scope" element in all elements that could include it.

These XML examples use patterns that are not specified in this document for values of the "gml:id" and "xlink:title" XML attributes.

NOTE For interoperability, the patterns or formats used for the values of these attributes must be specified somewhere, perhaps in or with an Application Schema.

D.2 Extended example XML for compound coordinate reference system

This subclause provides a more complete example XML document using the CompoundCRS XML element, with its contained elements, applied to a 3D compound coordinate reference system that combines a Projected and a Vertical CRS. Note that this Compound CRS Definition contains three other CRS definitions, for a Vertical CRS, a Geographic 2D CRS, and a Projected CRS.

```
<?xml version="1.0" encoding="UTF-8"?>
<CompoundCRS xmlns="http://www.opengis.net/gml"
  xmlns:gml="http://www.opengis.net/gml"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xsi:schemaLocation="http://www.opengis.net/gml
    ../commonCRSsProfile.xsd" gml:id="EPSG7405">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06 -->
  <srsName>OSGB36 /British National Grid + ODN</srsName>
  <srsID>
    <name codeSpace="urn:ogc:def:crs:EPSG:6.3:">7405</name>
  </srsID>
  <validArea>
    <description>United Kingdom (UK) - Great Britain - England
    Scotland Wales - onshore; Isle of Man. </description>
  </validArea>
  <includesCRS>
```

```

    <ProjectedCRS gml:id="EPSG27700">
      <srsName>OSGB 1936 / British National Grid</srsName>
      <srsID>
        <name codeSpace="urn:ogc:def:crs:EPSG:6.3:">27700</name>
      </srsID>
      <validArea>
        <description>United Kingdom (UK) - Great Britain - England
Scotland Wales - onshore; Isle of Man. </description>
      </validArea>
      <baseCRS>
        <GeographicCRS gml:id="EPSG4277">
          <srsName>OSGB 1936</srsName>
          <srsID>
            <name
codeSpace="urn:ogc:def:crs:EPSG:6.3:">4277</name>
          </srsID>
          <validArea>
            <description>United Kingdom (UK) - Great Britain -
England Scotland Wales - onshore; Isle of Man. </description>
          </validArea>
          <usesEllipsoidalCS>
            <EllipsoidalCS gml:id="EPSG6402">
              <csName>ellipsoidal</csName>
              <csID>
                <name
codeSpace="urn:ogc:def:cs:EPSG:6.3:">6402</name>
              </csID>
              <usesAxis>
                <CoordinateSystemAxis gml:id="EPSG9901"
gml:uom="urn:ogc:def:uom:OGC:1.0:degree">
                  <name>Geodetic latitude in north direction
with degree units</name>
                  <axisID>
                    <name
codeSpace="urn:ogc:def:axis:EPSG:6.3:">9901</name>
                  </axisID>
                  <axisAbbrev>Lat</axisAbbrev>
                  <axisDirection>north</axisDirection>
                </CoordinateSystemAxis>
              </usesAxis>
              <usesAxis>
                <CoordinateSystemAxis gml:id="EPSG9902"
gml:uom="urn:ogc:def:uom:OGC:1.0:degree">
                  <name>Geodetic longitude in east direction
with degree units</name>
                  <axisID>
                    <name
codeSpace="urn:ogc:def:axis:EPSG:6.3:">9902</name>
                  </axisID>
                  <axisAbbrev>Lon</axisAbbrev>
                  <axisDirection>east</axisDirection>
                </CoordinateSystemAxis>
              </usesAxis>
            </EllipsoidalCS>
          </usesEllipsoidalCS>
          <usesGeodeticDatum>
            <GeodeticDatum gml:id="EPSG6277">

```

```

        <datumName>OSGB 1936</datumName>
        <datumID>
            <name
codeSpace="urn:ogc:def:datum:EPSG:6.3:">6277</name>
            </datumID>
            <usesPrimeMeridian>
                <PrimeMeridian gml:id="EPSG8901">
                    <meridianName>Greenwich</meridianName>
                    <meridianID>
                        <name
codeSpace="urn:ogc:def:meridian:EPSG:6.3:">8901</name>
                        </meridianID>
                        <greenwichLongitude>
                            <angle
uom="urn:ogc:def:uom:OGC:1.0:degree">0</angle>
                            </greenwichLongitude>
                        </PrimeMeridian>
                    </usesPrimeMeridian>
                    <usesEllipsoid>
                        <Ellipsoid gml:id="EPSG7001">
                            <ellipsoidName>Airy 1830</ellipsoidName>
                            <ellipsoidID>
                                <name
codeSpace="urn:ogc:def:ellipsoid:EPSG:6.3:">7001</name>
                                </ellipsoidID>
                                <semiMajorAxis
uom="urn:ogc:def:uom:OGC:1.0:metre">6377563.396</semiMajorAxis>
                                <secondDefiningParameter>
                                    <inverseFlattening
uom="urn:ogc:def:uom:OGC:1.0:unity">299.3249646</inverseFlattening>
                                    </secondDefiningParameter>
                                </Ellipsoid>
                            </usesEllipsoid>
                        </GeodeticDatum>
                    </usesGeodeticDatum>
                </GeographicCRS>
            </baseCRS>
            <definedByConversion>
                <Conversion gml:id="EPSG19916">
                    <coordinateOperationName>Transverse
Mercator</coordinateOperationName>
                    <coordinateOperationID>
                        <name
codeSpace="urn:ogc:def:coordinateOperation:EPSG:6.3:">19916</name>
                        </coordinateOperationID>
                    <usesMethod>
                        <OperationMethod gml:id="EPSG9807">
                            <methodName>Transverse Mercator</methodName>
                            <methodID>
                                <name
codeSpace="urn:ogc:def:method:EPSG:6.3:">9807</name>
                                </methodID>
                                <methodFormula>See Section 1.4.6 "Transverse
Mercator" of EPSG Guidance Note 7, December 2000. </methodFormula>
                                <sourceDimensions>2</sourceDimensions>
                                <targetDimensions>2</targetDimensions>
                                <usesParameter>

```

```

        <OperationParameter gml:id="EPSG8801">
          <parameterName>Latitude of natural
origin</parameterName>
          <parameterID>
            <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8801</name>
            </parameterID>
          </OperationParameter>
        </usesParameter>
        <usesParameter>
          <OperationParameter gml:id="EPSG8802">
            <parameterName>Longitude of natural
origin</parameterName>
            <parameterID>
              <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8802</name>
              </parameterID>
            </OperationParameter>
          </usesParameter>
        </usesParameter>
        <usesParameter>
          <OperationParameter gml:id="EPSG8805">
            <parameterName>Scale factor at natural
origin</parameterName>
            <parameterID>
              <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8805</name>
              </parameterID>
            </OperationParameter>
          </usesParameter>
        </usesParameter>
        <usesParameter>
          <OperationParameter gml:id="EPSG8806">
            <parameterName>False Easting</parameterName>
            <parameterID>
              <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8806</name>
              </parameterID>
            </OperationParameter>
          </usesParameter>
        </usesParameter>
        <usesParameter>
          <OperationParameter gml:id="EPSG8807">
            <parameterName>False Northing</parameterName>
            <parameterID>
              <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8807</name>
              </parameterID>
            </OperationParameter>
          </usesParameter>
        </OperationMethod>
      </usesMethod>
    <usesValue>
      <value
uom="urn:ogc:def:uom:OGC:1.0:degree">49</value>
      <valueOfParameter xlink:href="#EPSG8801"
xlink:title="Latitude of natural origin"/>
    </usesValue>
  </usesValue>

```



```

                <value uom="urn:ogc:def:uom:OGC:1.0:degree">-
2</value>
                <valueOfParameter xlink:href="#EPSG8802"
xlink:title="Longitude of natural origin"/>
                </usesValue>
                <usesValue>
                <value
uom="urn:ogc:def:uom:OGC:1.0:unity">0.999601272</value>
                <valueOfParameter xlink:href="#EPSG8805"
xlink:title="Scale factor at natural origin"/>
                </usesValue>
                <usesValue>
                <value
uom="urn:ogc:def:uom:OGC:1.0:metre">400000</value>
                <valueOfParameter xlink:href="#EPSG8806"
xlink:title="False Easting"/>
                </usesValue>
                <usesValue>
                <value uom="urn:ogc:def:uom:OGC:1.0:metre">-
100000</value>
                <valueOfParameter xlink:href="#EPSG8807"
xlink:title="False Northing"/>
                </usesValue>
            </Conversion>
        </definedByConversion>
        <usesCartesianCS>
            <CartesianCS gml:id="EPSG4400">
                <csName>Easting and Northing in metres</csName>
                <csID>
                    <name
codeSpace="urn:ogc:def:cs:EPSG:6.3:">4400</name>
                </csID>
                <usesAxis>
                    <CoordinateSystemAxis gml:id="EPSG9906"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
                        <name>Easting in east direction with metre
units</name>
                        <axisID>
                            <name
codeSpace="urn:ogc:def:axis:EPSG:6.3:">9906</name>
                        </axisID>
                        <axisAbbrev>E</axisAbbrev>
                        <axisDirection>east</axisDirection>
                    </CoordinateSystemAxis>
                </usesAxis>
                <usesAxis>
                    <CoordinateSystemAxis gml:id="EPSG9907"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
                        <name>Northing in north direction with metre
units</name>
                        <axisID>
                            <name
codeSpace="urn:ogc:def:axis:EPSG:6.3:">9907</name>
                        </axisID>
                        <axisAbbrev>N</axisAbbrev>
                        <axisDirection>north</axisDirection>
                    </CoordinateSystemAxis>

```

```

        </usesAxis>
      </CartesianCS>
    </usesCartesianCS>
  </ProjectedCRS>
</includesCRS>
<includesCRS>
  <VerticalCRS gml:id="EPSG5701">
    <srsName>Newlyn</srsName>
    <srsID>
      <name codeSpace="urn:ogc:def:crs:EPSG:6.3:">5701</name>
    </srsID>
    <usesVerticalCS>
      <VerticalCS gml:id="EPSG6499">
        <csName>Gravity-related height up in metres</csName>
        <csID>
          <name
codeSpace="urn:ogc:def:cs:EPSG:6.3:">6499</name>
        </csID>
        <usesAxis>
          <CoordinateSystemAxis gml:id="EPSG9904"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
            <name>Gravity-related height in up direction with
metre units</name>
            <axisID>
              <name
codeSpace="urn:ogc:def:axis:EPSG:6.3:">9904</name>
            </axisID>
            <axisAbbrev>H</axisAbbrev>
            <axisDirection>up</axisDirection>
          </CoordinateSystemAxis>
        </usesAxis>
      </VerticalCS>
    </usesVerticalCS>
    <usesVerticalDatum>
      <VerticalDatum gml:id="EPSG5101">
        <datumName>Ordnance Datum Newlyn</datumName>
        <datumID>
          <name
codeSpace="urn:ogc:def:datum:EPSG:6.3:">5101</name>
        </datumID>
        <verticalDatumType codeSpace="
urn:ogc:def:verticalDatumType:OGC:1.0:">geoidal</verticalDatumType>
      </VerticalDatum>
    </usesVerticalDatum>
  </VerticalCRS>
</includesCRS>
</CompoundCRS>

```

D.3 Simplified example XML for conversion

The coordinate Conversion example in Subclause 9.2 contains most details within the usesMethod element. If the details of that Transverse Mercator operation method are sufficiently available elsewhere, a much shorter example XML document can be used:

```

<?xml version="1.0" encoding="UTF-8"?>
<Conversion xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG19916">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06-->
  <!-- SourceCRS: EPSG:4277 OSGB 1936 -->
  <!-- TargetCRS: EPSG:27700 OSGB 1936 / British National Grid -->
  <coordinateOperationName>Transverse
Mercator</coordinateOperationName>
  <coordinateOperationID>
    <name
codeSpace="urn:ogc:def:coordinateOperation:EPSG:6.3:">19916</name>
    <version>6.0</version>
  </coordinateOperationID>
  <usesMethod xlink:href="urn:ogc:def:method:EPSG:6.3:9807"
xlink:title="Transverse Mercator"/>
    <usesValue>
      <value uom="urn:ogc:def:uom:OGC:1.0:degree">49</value>
      <valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8801" xlink:title="Latitude
of natural origin"/>
    </usesValue>
    <usesValue>
      <value uom="urn:ogc:def:uom:OGC:1.0:degree">-2</value>
      <valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8802" xlink:title="Longitude
of natural origin"/>
    </usesValue>
    <usesValue>
      <value uom="urn:ogc:def:uom:OGC:1.0:unity">0.999601272</value>
      <valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8805" xlink:title="Scale
factor at natural origin"/>
    </usesValue>
    <usesValue>
      <value uom="urn:ogc:def:uom:OGC:1.0:metre">400000</value>
      <valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8806" xlink:title="False
Easting"/>
    </usesValue>
    <usesValue>
      <value uom="urn:ogc:def:uom:OGC:1.0:metre">-100000</value>
      <valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8807" xlink:title="False
Northing"/>
    </usesValue>
  </Conversion>

```

This example assumes that information for the Transverse Mercator OperationMethod is available elsewhere. Example XML for this method is given in the following subclause.

D.4 Example XML for operation method

This subclause provides an example XML document using the `OperationMethod` element, with data for the Transverse Mercator conversion method.

```
<?xml version="1.0" encoding="UTF-8"?>
<OperationMethod xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="EPSG9807">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06 -->
  <methodName>Transverse Mercator</methodName>
  <methodID>
    <name codeSpace="urn:ogc:def:method:EPSG:6.3:">9807</name>
    <version>6.0</version>
  </methodID>
  <methodFormula>See Section 1.4.6 "Transverse Mercator" of EPSG
Guidance Note 7, December 2000. </methodFormula>
  <sourceDimensions>2</sourceDimensions>
  <targetDimensions>2</targetDimensions>
  <usesParameter>
    <OperationParameter gml:id="EPSG8801">
      <parameterName>Latitude of natural origin</parameterName>
      <parameterID>
        <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8801</name>
        </parameterID>
      </OperationParameter>
    </usesParameter>
    <usesParameter>
      <OperationParameter gml:id="EPSG8802">
        <parameterName>Longitude of natural origin</parameterName>
        <parameterID>
          <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8802</name>
          </parameterID>
        </OperationParameter>
      </usesParameter>
    <usesParameter>
      <OperationParameter gml:id="EPSG8805">
        <parameterName>Scale factor at natural origin</parameterName>
        <parameterID>
          <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8805</name>
          </parameterID>
        </OperationParameter>
      </usesParameter>
    <usesParameter>
      <OperationParameter gml:id="EPSG8806">
        <parameterName>False Easting</parameterName>
        <parameterID>
          <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8806</name>
          </parameterID>
```

```

    </OperationParameter>
  </usesParameter>
</usesParameter>
  <OperationParameter gml:id="EPSG8807">
    <parameterName>False Northing</parameterName>
    <parameterID>
      <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8807</name>
    </parameterID>
  </OperationParameter>
</usesParameter>
</OperationMethod>

```

D.5 Example XML for CRS dictionary

This subclause provides an example XML document using the Dictionary element from the dictionary.xsd schema of GML 3.1, with its' contained elements, applied to the example CompoundCRS used in Subclause D.2 with all of its components separated in the dictionary.

```

<?xml version="1.0" encoding="UTF-8"?>
<Dictionary xmlns="http://www.opengis.net/gml"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xlink="http://www.w3.org/1999/xlink"
xsi:schemaLocation="http://www.opengis.net/gml
../commonCRSsProfile.xsd" gml:id="CrsDictionary">
  <!-- Primary editor: Arliss Whiteside. Last updated 2005-10-06-->
  <description>Example GML Dictionary of some coordinate reference
systems and components. </description>
  <name>CRS Dictionary</name>
  <dictionaryEntry>
    <CompoundCRS gml:id="EPSG7405">
      <srsName>OSGB36 /British National Grid + ODN</srsName>
      <srsID>
        <name codeSpace="urn:ogc:def:crs:EPSG:6.3:">7405</name>
      </srsID>
      <validArea>
        <description>United Kingdom (UK) - Great Britain - England
Scotland Wales - onshore; Isle of Man. </description>
      </validArea>
      <includesCRS xlink:href="#EPSG27700" xlink:title="OSGB 1936 /
British National Grid"/>
      <includesCRS xlink:href="#EPSG5701" xlink:title="Newlyn"/>
    </CompoundCRS>
  </dictionaryEntry>
  <dictionaryEntry>
    <ProjectedCRS gml:id="EPSG27700">
      <srsName>OSGB 1936 / British National Grid</srsName>
      <srsID>
        <name codeSpace="urn:ogc:def:crs:EPSG:6.3:">27700</name>
      </srsID>
      <validArea>
        <description>United Kingdom (UK) - Great Britain - England
Scotland Wales - onshore; Isle of Man. </description>

```

```

        </validArea>
        <baseCRS xlink:href="#EPSG4277" xlink:title="OSGB 1936"/>
        <definedByConversion xlink:href="#EPSG19916"
xlink:title="Transverse Mercator"/>
        <usesCartesianCS xlink:href="#EPSG4400"
xlink:title="Cartesian"/>
    </ProjectedCRS>
</dictionaryEntry>
<dictionaryEntry>
    <GeographicCRS gml:id="EPSG4277">
        <srsName>OSGB 1936</srsName>
        <srsID>
            <name codeSpace="urn:ogc:def:crs:EPSG:6.3:">4277</name>
        </srsID>
        <validArea>
            <description>United Kingdom (UK) - Great Britain - England
Scotland Wales - onshore; Isle of Man. </description>
        </validArea>
        <usesEllipsoidalCS xlink:href="#EPSG6402"
xlink:title="ellipsoidal"/>
        <usesGeodeticDatum xlink:href="#EPSG6277" xlink:title="OSGB
1936"/>
    </GeographicCRS>
</dictionaryEntry>
<dictionaryEntry>
    <EllipsoidalCS gml:id="EPSG6402">
        <csName>ellipsoidal</csName>
        <csID>
            <name codeSpace="urn:ogc:def:cs:EPSG:6.3:">6402</name>
        </csID>
        <usesAxis xlink:href="#EPSG9901northDegreeEPSG9901"
xlink:title="Geodetic latitude in north direction with degree
unitsGeodetic latitude"/>
        <usesAxis xlink:href="#EPSG9902eastDegreeEPSG9902"
xlink:title="Geodetic longitude in east direction with degree
unitsGeodetic longitude"/>
    </EllipsoidalCS>
</dictionaryEntry>
<dictionaryEntry>
    <CoordinateSystemAxis gml:id="EPSG9901"
gml:uom="urn:ogc:def:uom:OGC:1.0:degree">
        <name>Geodetic latitude in north direction with degree
units</name>
        <axisID>
            <name codeSpace="urn:ogc:def:axis:EPSG:6.3:">9901</name>
        </axisID>
        <axisAbbrev>Lat</axisAbbrev>
        <axisDirection>north</axisDirection>
    </CoordinateSystemAxis>
</dictionaryEntry>
<dictionaryEntry>
    <CoordinateSystemAxis gml:id="EPSG9902"
gml:uom="urn:ogc:def:uom:OGC:1.0:degree">
        <name>Geodetic longitude in east direction with degree
units</name>
        <axisID>
            <name codeSpace="urn:ogc:def:axis:EPSG:6.3:">9902</name>

```

```

        </axisID>
        <axisAbbrev>Lon</axisAbbrev>
        <axisDirection>east</axisDirection>
    </CoordinateSystemAxis>
</dictionaryEntry>
<dictionaryEntry>
    <GeodeticDatum gml:id="EPSG6277">
        <datumName>OSGB 1936</datumName>
        <datumID>
            <name codeSpace="urn:ogc:def:datum:EPSG:6.3:">6277</name>
        </datumID>
        <usesPrimeMeridian xlink:href="#EPSG8901"
xlink:title="Greenwich"/>
        <usesEllipsoid xlink:href="#EPSG7001" xlink:title="Airy
1830"/>
    </GeodeticDatum>
</dictionaryEntry>
<dictionaryEntry>
    <PrimeMeridian gml:id="EPSG8901">
        <meridianName>Greenwich</meridianName>
        <meridianID>
            <name
codeSpace="urn:ogc:def:meridian:EPSG:6.3:">8901</name>
        </meridianID>
        <greenwichLongitude>
            <angle uom="urn:ogc:def:uom:OGC:1.0:degree">0</angle>
        </greenwichLongitude>
    </PrimeMeridian>
</dictionaryEntry>
<dictionaryEntry>
    <Ellipsoid gml:id="EPSG7001">
        <ellipsoidName>Airy 1830</ellipsoidName>
        <ellipsoidID>
            <name
codeSpace="urn:ogc:def:ellipsoid:EPSG:6.3:">7001</name>
        </ellipsoidID>
        <semiMajorAxis
uom="urn:ogc:def:uom:OGC:1.0:metre">6377563.396</semiMajorAxis>
        <secondDefiningParameter>
            <inverseFlattening
uom="urn:ogc:def:uom:OGC:1.0:unity">299.3249646</inverseFlattening>
        </secondDefiningParameter>
    </Ellipsoid>
</dictionaryEntry>
<dictionaryEntry>
    <Conversion gml:id="EPSG19916">
        <coordinateOperationName>Transverse
Mercator</coordinateOperationName>
        <coordinateOperationID>
            <name
codeSpace="urn:ogc:def:coordinateOperation:EPSG:6.3:">19916</name>
        </coordinateOperationID>
        <usesMethod xlink:href="#EPSG9807" xlink:title="Transverse
Mercator"/>
        <usesValue>
            <value uom="urn:ogc:def:uom:OGC:1.0:degree">49</value>

```

```

        <valueOfParameter xlink:href="#EPSG8801"
xlink:title="Latitude of natural origin"/>
        </usesValue>
        <usesValue>
            <value uom="urn:ogc:def:uom:OGC:1.0:degree">-2</value>
            <valueOfParameter xlink:href="#EPSG8802"
xlink:title="Longitude of natural origin"/>
            </usesValue>
            <usesValue>
                <value
uom="urn:ogc:def:uom:OGC:1.0:unity">0.999601272</value>
                <valueOfParameter xlink:href="#EPSG8805" xlink:title="Scale
factor at natural origin"/>
                </usesValue>
                <usesValue>
                    <value uom="urn:ogc:def:uom:OGC:1.0:metre">400000</value>
                    <valueOfParameter xlink:href="#EPSG8806" xlink:title="False
Easting"/>
                    </usesValue>
                    <usesValue>
                        <value uom="urn:ogc:def:uom:OGC:1.0:metre">-100000</value>
                        <valueOfParameter xlink:href="#EPSG8807" xlink:title="False
Northing"/>
                        </usesValue>
                    </Conversion>
                </dictionaryEntry>
            <dictionaryEntry>
                <OperationMethod gml:id="EPSG9807">
                    <methodName>Transverse Mercator</methodName>
                    <methodID>
                        <name codeSpace="urn:ogc:def:method:EPSG:6.3:">9807</name>
                    </methodID>
                    <methodFormula>See Section 1.4.6 "Transverse Mercator" of EPSG
Guidance Note 7, December 2000. </methodFormula>
                    <sourceDimensions>2</sourceDimensions>
                    <targetDimensions>2</targetDimensions>
                    <usesParameter xlink:href="#EPSG8801" xlink:title="Latitude of
natural origin"/>
                    <usesParameter xlink:href="#EPSG8802" xlink:title="Longitude
of natural origin"/>
                    <usesParameter xlink:href="#EPSG8805" xlink:title="Scale
factor at natural origin"/>
                    <usesParameter xlink:href="#EPSG8806" xlink:title="False
Easting"/>
                    <usesParameter xlink:href="#EPSG8807" xlink:title="False
Northing"/>
                </OperationMethod>
            </dictionaryEntry>
        <dictionaryEntry>
            <OperationParameter gml:id="EPSG8801">
                <parameterName>Latitude of natural origin</parameterName>
                <parameterID>
                    <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8801</name>
                </parameterID>
            </OperationParameter>
        </dictionaryEntry>

```



```

<dictionaryEntry>
  <OperationParameter gml:id="EPSG8802">
    <parameterName>Longitude of natural origin</parameterName>
    <parameterID>
      <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8802</name>
    </parameterID>
  </OperationParameter>
</dictionaryEntry>
<dictionaryEntry>
  <OperationParameter gml:id="EPSG8805">
    <parameterName>Scale factor at natural origin</parameterName>
    <parameterID>
      <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8805</name>
    </parameterID>
  </OperationParameter>
</dictionaryEntry>
<dictionaryEntry>
  <OperationParameter gml:id="EPSG8806">
    <parameterName>False Easting</parameterName>
    <parameterID>
      <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8806</name>
    </parameterID>
  </OperationParameter>
</dictionaryEntry>
<dictionaryEntry>
  <OperationParameter gml:id="EPSG8807">
    <parameterName>False Northing</parameterName>
    <parameterID>
      <name
codeSpace="urn:ogc:def:parameter:EPSG:6.3:">8807</name>
    </parameterID>
  </OperationParameter>
</dictionaryEntry>
<dictionaryEntry>
  <CartesianCS gml:id="EPSG4400">
    <csName>Easting and Northing in metres</csName>
    <csID>
      <name codeSpace="urn:ogc:def:cs:EPSG:6.3:">4400</name>
    </csID>
    <usesAxis xlink:href="#EPSG9906eastMetreEPSG9906"
xlink:title="Easting in east direction with metre unitsEasting"/>
    <usesAxis xlink:href="#EPSG9907northMetreEPSG9907"
xlink:title="Northing in north direction with metre unitsNorthing"/>
  </CartesianCS>
</dictionaryEntry>
<dictionaryEntry>
  <CoordinateSystemAxis gml:id="EPSG9906"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
    <name>Easting in east direction with metre units</name>
    <axisID>
      <name codeSpace="urn:ogc:def:axis:EPSG:6.3:">9906</name>
    </axisID>
    <axisAbbrev>E</axisAbbrev>
    <axisDirection>east</axisDirection>

```

```

    </CoordinateSystemAxis>
  </dictionaryEntry>
  <dictionaryEntry>
    <CoordinateSystemAxis gml:id="EPSG9907"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
      <name>Northing in north direction with metre units</name>
      <axisID>
        <name codeSpace="urn:ogc:def:axis:EPSG:6.3:">9907</name>
      </axisID>
      <axisAbbrev>N</axisAbbrev>
      <axisDirection>north</axisDirection>
    </CoordinateSystemAxis>
  </dictionaryEntry>
  <dictionaryEntry>
    <VerticalCS gml:id="EPSG6499">
      <csName>Height up in metres</csName>
      <csID>
        <name codeSpace="urn:ogc:def:cs:EPSG:6.0:">6499</name>
      </csID>
      <usesAxis xlink:href="urn:ogc:def:axis:EPSG:6.0:9904"/>
    </VerticalCS>
  </dictionaryEntry>
  <dictionaryEntry>
    <CoordinateSystemAxis gml:id="EPSG9904"
gml:uom="urn:ogc:def:uom:OGC:1.0:metre">
      <name>Gravity-related height in up direction with metre
units</name>
      <axisID>
        <name codeSpace="urn:ogc:def:axis:EPSG:6.0:">9904</name>
      </axisID>
      <axisAbbrev>H</axisAbbrev>
      <axisDirection>up</axisDirection>
    </CoordinateSystemAxis>
  </dictionaryEntry>
  <dictionaryEntry>
    <VerticalDatum gml:id="EPSG5101">
      <datumName>Ordnance Datum Newlyn</datumName>
      <datumID>
        <name codeSpace="urn:ogc:def:datum:EPSG:6.0:">5101</name>
      </datumID>
      <verticalDatumType
codeSpace="urn:ogc:def:verticalDatumType:OGC:1.0:">geoidal</verticalDat
umType>
    </VerticalDatum>
  </dictionaryEntry>
</Dictionary>

```

Annex E (informative)

Application schema example

E.1 Introduction

This annex provides an example Application Schema based on this GML 3.1.1 Common CRSs Profile. This example includes a corresponding example XML document using that Application Schema plus the example UML model from which that Application Schemas was converted.

These XML examples use URNs to reference known objects by "xlink:href" and "gml:uom" XML attributes, based on “URNs of definitions in ogc namespace” [OGC 05-010].

E.2 Transverse Mercator conversion

E.2.1 Introduction

Standardized XML encoding is desirable for a number of commonly-used types of coordinate conversions and transformations. This subclause provides an example of one such encoding, applied to one commonly-used conversion type, namely the Transverse Mercator map projection. The following subclauses contain:

- a) A draft class diagram of a UML package for the Transverse Mercator type of map projection, which builds on the UML model in OGC Abstract Specification Topic 2.
- b) A draft XML Schema for encoding a Transverse Mercator projection, produced by converting this UML package.
- c) An example XML document based on this draft XML Schema for encoding an example Transverse Mercator map projection

E.2.2 UML package

Figure E.1 is a draft class diagram of a UML package for Transverse Mercator map projections. This class diagram is incomplete in that many of the needed association role names and multiplicities are not shown due to lack of space. This UML package builds on the UML model in OGC Abstract Specification Topic 2 [04-046r3].

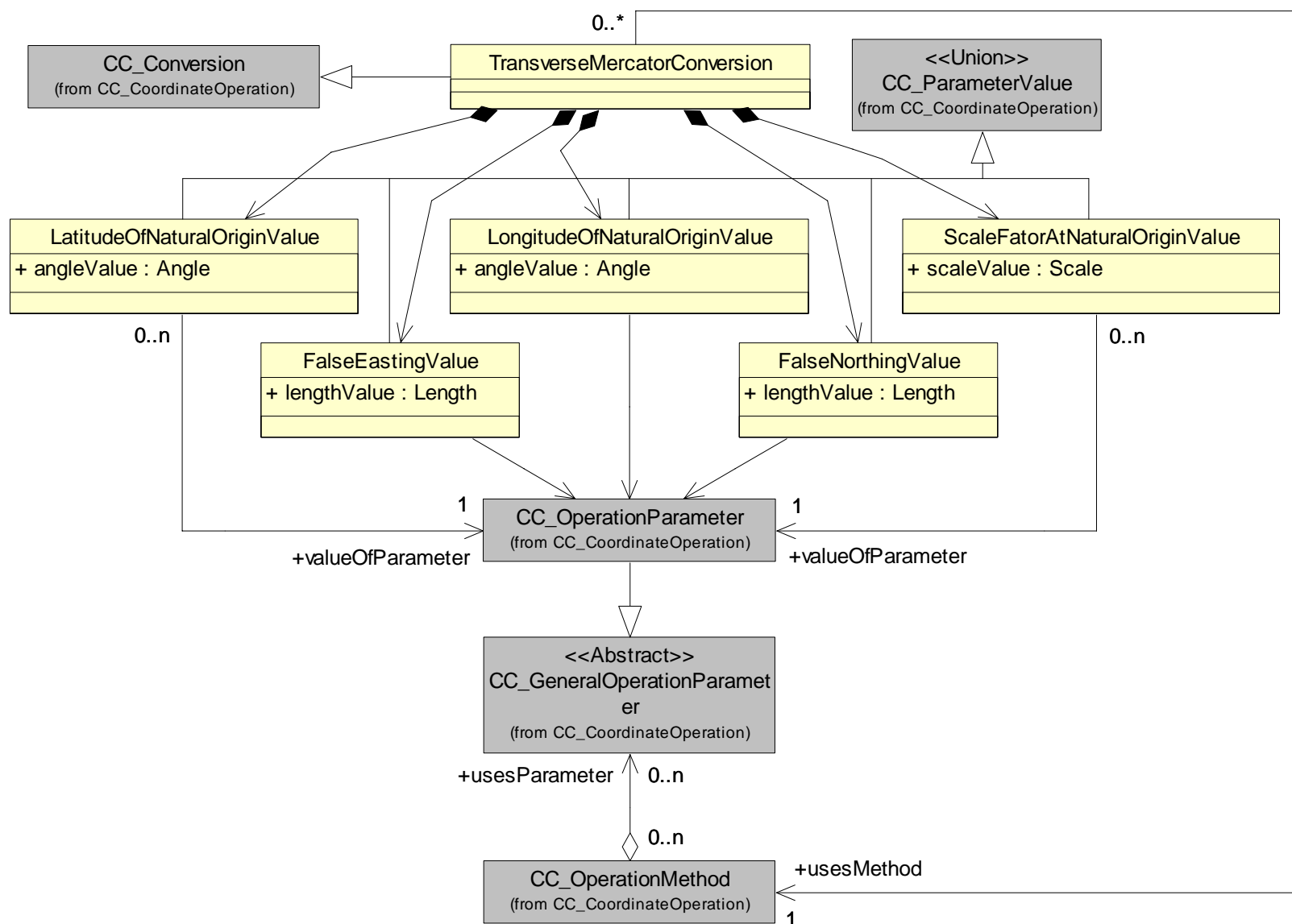


Figure E.1 — UML package for Transverse Mercator projection

E.2.3 Application schema

This subclause contains an example GML 3.1.1 Common CRSs profile for encoding a Transverse Mercator projection, produced by converting the above UML package. This XML Schema builds on the coordinateOperations.xsd in this profile. This draft Application Schema is written following the same GML 3 patterns and ISO 19118 XML encoding rules as used in the CRS Schemas in GML 3.1.1. As required, this draft Application Schema is written in a different namespace.

This draft Application Schema is:

```
<?xml version="1.0" encoding="UTF-8"?>
<schema xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:ex="http://www.opengis.net/examples"
targetNamespace="http://www.opengis.net/examples"
elementFormDefault="qualified" xml:lang="en">
  <annotation>
    <appinfo>transverseMercator.xsd</appinfo>
    <documentation>How to encode definition of specific Transverse
Mercator conversion. Example Application Schema to encode the data
needed to define a specific Transverse Mercator type of map projection,
which is a coordinate conversion. Written in the "ex" namespace.
    This schema encodes a draft Transverse Mercator package that
builds on the Coordinate Operation (CC_) package of the extended UML
Model for OGC Abstract Specification Topic 2: Spatial Referencing by
Coordinates. That draft package defines restricted subtypes of the
CC_Conversion and CC_ParameterValue classes as needed for the
Transverse Mercator map projection conversion.
    Reference: Guidance Note Number 7 "Coordinate Conversions and
Transformations including Formulas" (available through
http://www.epsg.org/), especially Section 1.4.6 "Transverse Mercator".
    Primary editor: Arliss Whiteside. Last updated 2005-10-06
    Copyright (c) Open Geospatial Consortium, Inc. (2005)
  </documentation>
</annotation>
<!-- =====
includes and imports
===== -->
<import namespace="http://www.opengis.net/gml"
schemaLocation="../../../commonCRSsProfile.xsd"/>
<import namespace="http://www.w3.org/1999/xlink"
schemaLocation="../../../xlink/1.0.1/xlinks.xsd"/>
<!-- =====
elements and types
===== -->
<element name="TransverseMercatorConversion"
type="ex:TransverseMercatorConversionType"
substitutionGroup="gml:_GeneralConversion"/>
<!-- ===== -->
<complexType name="TransverseMercatorConversionType">
  <annotation>
    <documentation>Specific Transverse Mercator map projection.
Uses the AbstractGeneralConversionType with restricted values for
included elements, including elements in the coordinateOperationID
```

element with the IdentifierType. If appropriate, the "codeSpace" element should have the string value "EPSG", and the "code" element should then have the appropriate EPSG code value. The other elements in the IdentifierType can be omitted. The "coordinateOperationName" element shall have a string value that names a specific Transverse Mercator map projection. The "_PositionalAccuracy" and "metaDataProperty" elements can be omitted. </documentation>

```

    </annotation>
    <complexContent>
      <extension base="gml:AbstractGeneralConversionType">
        <sequence>
          <element ref="ex:usesTransverseMercatorMethod"/>
          <element ref="ex:usesLatitudeOfNaturalOriginValue"/>
          <element ref="ex:usesLongitudeOfNaturalOriginValue"/>
          <element ref="ex:usesScaleFactorAtNaturalOriginValue"/>
          <element ref="ex:usesFalseEastingValue"/>
          <element ref="ex:usesFalseNorthingValue"/>
        </sequence>
      </extension>
    </complexContent>
  </complexType>
  <!-- ===== -->
  <!-- ===== -->
  <element name="usesTransverseMercatorMethod">
    <annotation>
      <documentation>Reference to Transverse Mercator operation
method. </documentation>
    </annotation>
    <complexType>
      <sequence/>
      <attribute ref="xlink:href" use="required"
fixed="urn:ogc:def:method:EPSG:6.3:9807"/>
    </complexType>
  </element>
  <!-- ===== -->
  <element name="usesLatitudeOfNaturalOriginValue"
type="ex:AngleValueType"
substitutionGroup="gml:_generalParameterValue">
    <annotation>
      <documentation>Value of the Latitude of the natural origin
parameter for a specific coordinate conversion. </documentation>
    </annotation>
  </element>
  <!-- ===== -->
  <element name="usesLongitudeOfNaturalOriginValue"
type="ex:AngleValueType"
substitutionGroup="gml:_generalParameterValue">
    <annotation>
      <documentation>Value of the Longitude of the natural origin
(or central meridian) parameter for a specific coordinate conversion.
</documentation>
    </annotation>
  </element>
  <!-- ===== -->
  <element name="usesScaleFactorAtNaturalOriginValue"
type="ex:ScaleValueType"
substitutionGroup="gml:_generalParameterValue">
    <annotation>

```

```

        <documentation>Value of the scale factor at the natural origin
(on the central meridian) parameter for a specific coordinate
conversion. </documentation>
    </annotation>
</element>
<!-- ===== -->
    <element name="usesFalseEastingValue" type="ex:LengthValueType"
substitutionGroup="gml:_generalParameterValue">
    <annotation>
        <documentation>Value of the false Easting coordinate of the
origin parameter for a specific coordinate conversion. </documentation>
    </annotation>
</element>
<!-- ===== -->
    <element name="usesFalseNorthingValue" type="ex:LengthValueType"
substitutionGroup="gml:_generalParameterValue">
    <annotation>
        <documentation>Value of the false Northing coordinate of the
origin parameter for a specific coordinate conversion. </documentation>
    </annotation>
</element>
<!-- ===== -->
<!-- ===== -->
    <complexType name="AngleValueType">
        <annotation>
            <documentation>Angle measure operation parameter value.
</documentation>
        </annotation>
        <complexContent>
            <extension base="gml:AbstractGeneralParameterValue">
                <sequence>
                    <choice>
                        <element ref="ex:angleValue"/>
                    </choice>
                    <element ref="gml:valueOfParameter"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
<!-- ===== -->
    <complexType name="ScaleValueType">
        <annotation>
            <documentation>Scale measure operation parameter value.
</documentation>
        </annotation>
        <complexContent>
            <extension base="gml:AbstractGeneralParameterValue">
                <sequence>
                    <element ref="ex:scaleValue"/>
                    <element ref="gml:valueOfParameter"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
<!-- ===== -->
    <complexType name="LengthValueType">
        <annotation>

```

```

        <documentation>Length measure operation parameter value.
</documentation>
    </annotation>
    <complexContent>
        <extension base="gml:AbstractGeneralParameterValue" type="gml:AbstractGeneralParameterValue" >
            <sequence>
                <element ref="ex:lengthValue"/>
                <element ref="gml:valueOfParameter"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
<!-- ===== -->
<!-- ===== -->
    <element name="angleValue" type="gml:AngleType"
substitutionGroup="gml:value">
        <annotation>
            <documentation>Angle value of an operation parameter, recorded
as a single number, with a unit of measure suitable for an angle, such
as degrees or radians. </documentation>
        </annotation>
    </element>
    <!-- ===== -->
    <element name="scaleValue" type="gml:ScaleType"
substitutionGroup="gml:value">
        <annotation>
            <documentation>Scale factor value of an operation parameter,
with a unit of measure suitable for a scale factor, such as percent,
permil, or parts-per-million. </documentation>
        </annotation>
    </element>
    <!-- ===== -->
    <element name="lengthValue" type="gml:LengthType"
substitutionGroup="gml:value">
        <annotation>
            <documentation>Length value of an operation parameter, with a
unit of measure suitable for a length, such as metres or feet.
</documentation>
        </annotation>
    </element>
    <!-- ===== -->
</schema>

```

E.2.4 Example XML document

An example XML document based on this example XML Schema for encoding an example Transverse Mercator map projection is:

```

<?xml version="1.0" encoding="UTF-8"?>
<TransverseMercatorConversion xmlns="http://www.opengis.net/examples"
xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengis.net/examples
transverseMercator.xsd" gml:id="EPSG19916">
    <!-- Example XML document. Primary editor: Arliss Whiteside. Last
updated 2005-01-28-->

```



```

<!-- SourceCRS: EPSG:4277 OSGB 1936 -->
<!-- TargetCRS: EPSG:27700 OSGB 1936 / British National Grid -->
<gml:coordinateOperationName>Transverse
Mercator</gml:coordinateOperationName>
<gml:validArea>
  <gml:description>United Kingdom (UK) - Great Britain - England
  Scotland Wales - onshore; Isle of Man. </gml:description>
</gml:validArea>
<usesTransverseMercatorMethod
xlink:href="urn:ogc:def:method:EPSG:6.3:9807"/>
  <usesLatitudeOfNaturalOriginValue>
    <angleValue uom="urn:ogc:def:uom:degree">49</angleValue>
    <gml:valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8801"/>
    </usesLatitudeOfNaturalOriginValue>
    <usesLongitudeOfNaturalOriginValue>
      <angleValue uom="urn:ogc:def:uom:OGC:1.0:degree">-2</angleValue>
      <gml:valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8802"/>
      </usesLongitudeOfNaturalOriginValue>
      <usesScaleFactorAtNaturalOriginValue>
        <scaleValue
uom="urn:ogc:def:uom:OGC:1.0:unity">0.999601272</scaleValue>
        <gml:valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8805"/>
        </usesScaleFactorAtNaturalOriginValue>
        <usesFalseEastingValue>
          <lengthValue
uom="urn:ogc:def:uom:OGC:1.0:metre">400000</lengthValue>
          <gml:valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8806"/>
          </usesFalseEastingValue>
          <usesFalseNorthingValue>
            <lengthValue uom="urn:ogc:def:uom:OGC:1.0:metre">-
100000</lengthValue>
            <gml:valueOfParameter
xlink:href="urn:ogc:def:parameter:EPSG:6.3:8807"/>
            </usesFalseNorthingValue>
          </TransverseMercatorConversion>

```

Annex F (informative)

Operation methods

F.1 Introduction

This annex contains brief descriptions of some conversion and transformation operation methods. It references the methods defined in the EPSG v 6.8 database, and lists some methods applicable to the transformation of coordinates.

Each operation method should uniquely specify the algorithm to be used for a coordinate transformation. This specification may comprise two algorithms, forward and inverse, as is sometimes used for map projection algorithms. Each conversion and transformation, and each operation method, should use a well-known data set in referencing such algorithms.

NOTE Of course, referencing a well-known algorithm does not imply that software which implements this algorithm has correctly implemented it, or has implemented all referenced algorithms. Similarly, referencing a well-known set of parameter values does not imply that software which implements these values uses the correct values.

F.2 EPSG defined operation methods

The well-known database from EPSG (version 6.8) specifies a number of operation methods. Please note that the EPSG data set is neither prescriptive, nor exhaustive. This document mentions a small subset of the methods in the EPSG data set. Methods not listed in this document, but listed in the EPSG data set, can easily be implemented using the OperationMethod and OperationParameter elements, making use of the method name and parameter names specified in the EPSG data set.

These operation methods are defined making use of well-defined operation parameters. When a coordinate operation is specified referencing an EPSG defined operation method, the detailed specification in an XML document should adhere to the EPSG definitions of the operation parameters.

The detailed definition of these operation method algorithms, with their formulas and a worked example is included in the EPSG data set, available on the Web, through the reflector: <http://www.epsg.org/>.

These and other information on coordinate operation methods is available on: http://www.remotesensing.org/geotiff/proj_list/. See also http://www.posc.org/Epicentre.2_2/DataModel/ExamplesofUsage/eu_cs.html.

F.3. Other operation methods

F.3.1 Introduction

The following operation methods are not specified in any well-known data set but are implied in the specification of Coordinate Systems and Coordinate Reference Systems.

Polar / Cartesian (2D) conversion

Spherical / Cartesian (3D) conversion

Cylindrical / Cartesian conversion

Geographic3D to Geographic2D/GravityRelatedHeight conversion

F.3.2 Polar / Cartesian (2D) conversion

This method converts two-dimensional polar coordinates to plane Cartesian coordinates and vice versa (the inverse algorithm is implied in this transformation method).

F.3.3 Spherical / Cartesian (3D) conversion

This method converts spherical coordinates (sometimes referred to as polar 3D coordinates) to 3D Cartesian coordinates and vice versa (the inverse algorithm is again implied in this transformation method). Please bear in mind that when the spherical coordinate system is used in a local context (e.g., in an EngineeringCRS); the converted Cartesian coordinate system can only be used in the same context: there is no datum change involved. Transformation to a Geocentric Cartesian system is possible only when the spherical coordinate system is also geocentric.

F.3.4 Cylindrical / Cartesian conversion

This method converts (3D) cylindrical coordinates to 3D Cartesian coordinates and vice versa. The area of use of the cylindrical coordinate system is unlikely to be other than local. The Cartesian coordinate system will therefore also be associated with an EngineeringCRS. A further (or indeed a one-step) transformation to a Geocentric system will be incorrect, although it may seem mathematically correct.

Bibliography

- [1] OGC 00-045r1, Draft RFC on Image Coordinate Transformations
- [2] OGC 01-009, Implementation Specification: Coordinate Transformation Services
- [3] OGC 04-046r3, OGC Abstract Specification Topic 2 – Spatial referencing by coordinates
- [4] OGC 05-011, Recommended XML/GML 3.1.1 encoding of common CRS definitions
- [5] OGC 05-013, Web Coordinate Transformation Service (WCTS) draft Implementation Specification
- [6] OGC 05-027r1, Recommended XML/GML 3.1.1 encoding of image CRS definitions