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Testbed 10 Engineering Report: GML for Aviation Conformance Testing

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Abstract

This activity is part of OGC Testbed 10. The aviation thread was focused on developing and demonstrating the use of the Aeronautical Information Exchange Model (AIXM) and the Flight Information Exchange Model (FIXM), building on the work accomplished in prior testbeds to advance the applications of OGC Web Services standards in next generation air traffic management systems to support European and US aviation modernization programs

This document summarizes technical work relating to the enhancement of the GML 3.2.1 conformance test suite in accord with the requirements in the OWS-10 RFQ, Annex B[1], section 6.3.6: "*GML for Aviation Compliance Test Suite + GML for Aviation Conformance Testing ER"*. The essential aim is to advance compliance with respect to the use of GML geometry representations in aviation (AIXM) data.

Keywords

Ogcdoc, ogc document, ows10, aviation, aixm, gml, iso 19107

[1] http://www.opengeospatial.org/pub/www/ows10/rfq/annexb.html

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Contents

Page

Figures

Page

Testbed 10 Engineering Report: GML for Aviation Conformance Testing

1 Introduction

1.1 Scope

This document summarizes the work undertaken to extend the GML 3.2.1 conformance test suite in order to validate geometry representations that may appear in aviation (AIXM) data sets. Guidelines regarding the use of GML geometry elements in AIXM elements are presented in OGC 12-028, *Guidance and Profile of GML for use with Aviation Data*. These additional constraints are incorporated within the abstract test cases described in clause 6 and implemented in the GML validator.

1.2 Document contributor contact points

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

Name	Organization
R. Martell	Galdos Systems, Inc.

1.3 Revision history

Date	Release	Editor	Primary clauses modified	Description
2014-01-31	Initial Draft	R. Martell	All	Initial draft.
2014-04-15	Final Draft	R. Martell	5, 8	Final draft for review.
2014-04-30	Final	R. Martell	7	Added description of REST API.
2014-05-08	Final (corr.)	R. Martell	8.1	Deleted comment about invalid metadata property value.

1.4 Forward

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

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

2 References

The following documents are referenced in 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.

ISO 19107:2003, *Geographic information — Spatial schema*.

OGC 07-036, *OpenGIS® Geography Markup Language (GML) Encoding Standard* (also published as ISO 19136:2007).

OGC 12-028, *Guidance and Profile of GML for use with Aviation Data*.

3 Terms and definitions

For the purposes of this report, the definitions specified in Clause 4 of the GML Encoding Standard [OGC 07-036] and in ISO 19107 shall apply. In addition, the following terms and definitions apply.

3.1
abstract test case
generalized test for a particular requirement

[ISO 19105:2000, 4.1]

3.2
conformance
fulfilment of specified requirements

[ISO 19105:2000, 4.7]

3.3
executable test case
specific test of an implementation to meet particular requirements

[ISO 19105:2000, 4.13]

3.4
executable test suite
set of executable test cases

[ISO 19105:2000, 4.14]

4 Conventions

4.1 Abbreviated terms

AIXM	Aeronautical Information Exchange Model
ATS	Abstract Test Suite
ETS	Executable Test Suite
GML	Geography Markup Language
URI	Uniform Resource Identifier
URN	Uniform Resource Name

4.2 Document references

References to parts of documents may take the form of URN values. For OGC documents the syntax specified in OGC 09-047r3 is adopted. To reference parts of ISO standards the scheme specified in RFC 5141 is used.

EXAMPLE urn:iso:std:iso:19136:clause:9.10,10.1.3.2

5 Overview

The test development work focused on validating geometry representations commonly appearing in AIXM 5.1 data sets that adhere to the AIXM-GML profile (OGC 12-028). In particular, tests were developed for the following GML and AIXM geometry elements:

- gml:Point (aixm:Point, aixm:ElevatedPoint)
- gml:Curve (aixm:Curve, aixm:ElevatedCurve)
- gml:OrientableCurve
- gml:CompositeCurve
- gml:Surface (aixm:Surface, aixm:ElevatedSurface)

NOTE The following curve segments are included in the AIXM-GML profile: gml:ArcByCenterPoint, gml:CircleByCenterPoint, gml:Arc, gml;Circle, gml:GeodesicString, gml:Geodesic, gml: LineStringSegment.

The geometry elements covered by the tests are shown in Figure 1. It is important to note that the tests are **not** tied to any particular application domain. The validator will check all instances of the standard GML geometry elements *plus* any application-defined geometries that can substitute for them; the application schemas are inspected to discover these additional geometry elements.

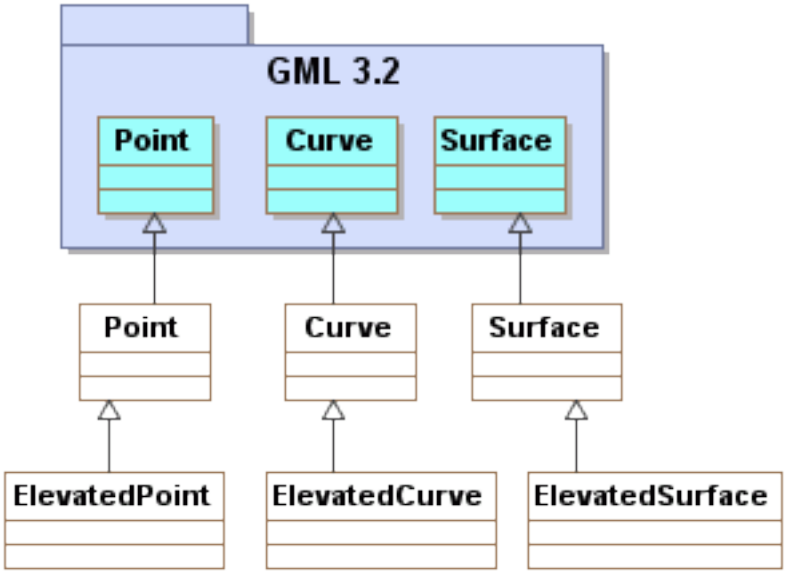

Figure 1: Geometry type coverage

The fundamental goal was to extend the existing GML 3.2.1 conformance test suite to perform more thorough checking that goes beyond schema validation. The test assertions were gleaned from the documents identified in Figure 2, where a dependency relationship is depicted as a dashed line with an open arrow.

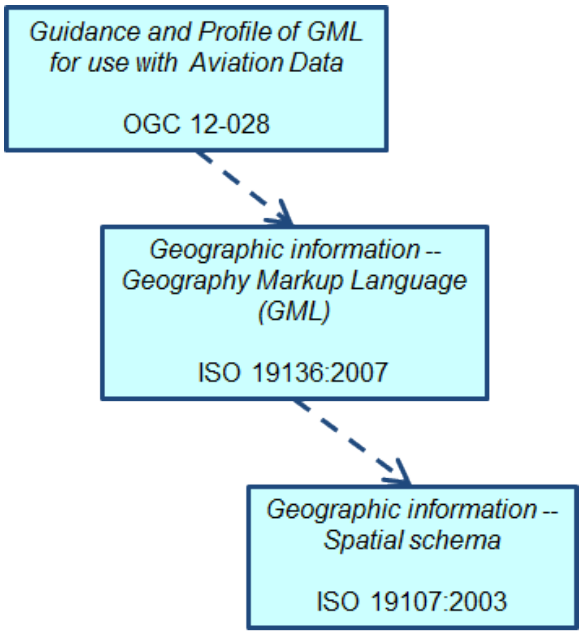

Figure 2: Sources of test assertions

The new tests were added to the `org.opengis.cite.iso19136.data.spatial` package, which contains the classes listed below[2].

- PointTests
- CurveTests
- CompositeCurveTests
- SurfaceTests
- EnvelopeTests
- GeometryAssert

6 Test assertions

6.1 Valid CRS reference

A geometry (or envelope) element must have a known CRS reference; the value of the srsName attribute is an absolute URI for which one of the following conditions is true:

1. it identifies a "well-known" CRS definition (Note 1), or
2. it refers to a CRS definition.

NOTE The 'urn' or 'http' URI schemes may be used to identify a CRS in accord with OGC 09-048r3 (e.g. "urn:ogc:def:crs:EPSG::4326").

A geometry element (but **not** an envelope) may inherit its CRS reference from a broader spatial context. If a geometry element does not explicitly carry the srsName attribute, then it shall be effectively inherited from either:

a. the nearest ancestor geometry (aggregate) that has the srsName attribute, or
b. the gml:boundedBy/gml:Envelope element in the containing feature instance.

The source documents are listed below.

- urn:ogc:doc:dp:12-028:clause:3.2
- urn:iso:std:iso:19136:clause:9.10,10.1.3.2
- urn:iso:std:iso:19107:clause:6.2.2.17

6.2 Valid coordinates

A geometry (or envelope) element must satisfy all of the following conditions:

1. length of coordinate tuple = CRS dimension
2. it lies within (is covered by) the valid area of the associated CRS

NOTE The last constraint will serve to detect obvious cases where the axis order is incorrect (for example, a position expressed in EPSG 4326 as -122.22, 50.55).

---

[2] The source code may be obtained from the OGC CITE repository.

The source documents are listed below.

– urn:iso:std:iso:19107:clause:6.2.2.10

6.3 Valid envelope positions

The coordinates of the lower corner must be less than the coordinates of the upper corner, where the coordinate tuples are compared item by item: lowerCorner < upperCorner.

The source documents are listed below.

– urn:iso:std:iso:19136:clause:10.1.4.6
– urn:iso:std:iso:19107:clause:6.4.3.2,6.4.3.3

6.4 Curve segments

A curve must satisfy all of the following conditions:

1. the curve has one or more segments;
2. the segments are contiguous (end point of each segment except the last being the start point of the next).

The source documents are listed below.

– urn:iso:std:iso:19136:clause:10.4.5
– urn:iso:std:iso:19107:clause:6.3.16.1

6.5 Surface boundary (components)

Each ring composing the boundary of a surface must be:

1. simple (does not self-intersect);
2. closed (forms a cycle such that the ends are identical).

The source documents are listed below.

– urn:iso:std:iso:19136:clause:10.5.11.1
– urn:iso:std:iso:19107:clause:6.3.6

6.6 Surface boundary (topology)

Each interior ring must be covered by the surface delimited by the exterior boundary (if it exists). The rings may touch at a tangent point.

The source documents are listed below.

– urn:iso:std:iso:19136:clause:10.5.5

– urn:iso:std:iso:19107:clause:6.3.7.2

6.7 Surface orientation

A surface has an "up" direction in terms of the upward (positive) normal, which is the side of the surface from which the exterior boundary appears counterclockwise and interior boundaries are traversed in a clockwise manner. In essence, the interior is always to the left of a boundary curve (Figure 3).

The source documents are listed below:

– urn:iso:std:iso:19136:clause:10.5.5
– urn:iso:std:iso:19107:clause:6.3.17.1,6.4.33.2

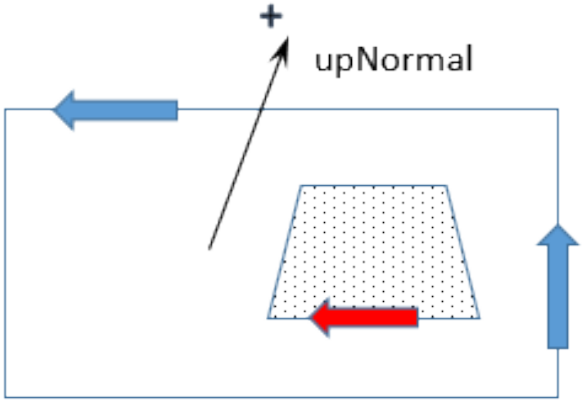

Figure 3: Surface upNormal

7 Test execution

7.1 Web interface

The geometry tests were implemented as extensions of the GML 3.2.1 conformance test suite. The suite may be run using the official OGC test harness, TEAM-Engine 4.0. The OGC maintains a testing facility that provides access to the latest test suites at this location: <http://cite.opengeospatial.org/te2/>.

The interface provided by the TEAM-Engine web application presents a form wherein the location of the instance document to be validated is specified by an absolute URI value. Alternatively, the GML document may be uploaded for validation (Figure 4).

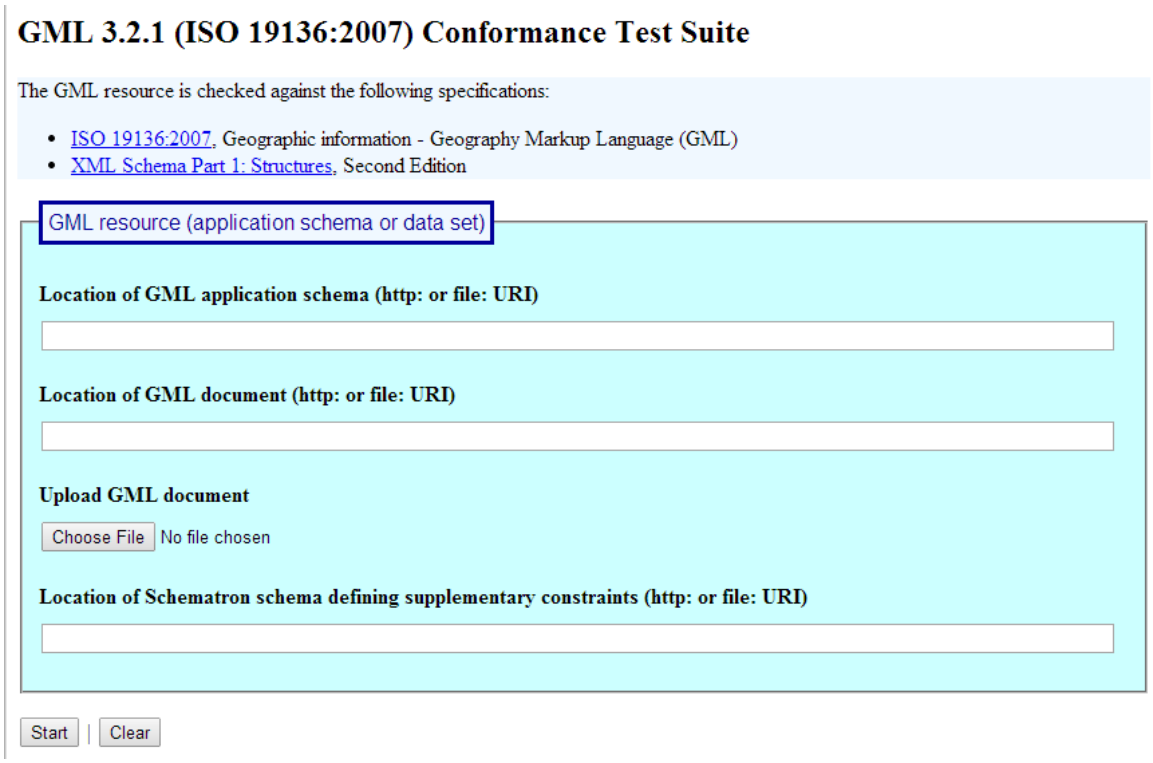

Figure 4: Test execution (web interface)

7.2 REST API

A REST API provides an alternative means of executing the test suite by submitting a GET request to the test controller endpoint. The test run arguments are summarized in Table 1. The *Obligation* descriptor can have the following values: M (mandatory), O (optional), or C (conditional).

Table 1 — Test run arguments

Name	Type	Obligation	Description
xsd	URI	C (required if 'gml' is not supplied)	Refers to a GML application schema[a]
gml	URI	C (required if 'xsd' is not supplied)	Refers to a representation of a GML data instance[a]
sch	URI	O	Refers to a Schematron schema[b]

a. Ampersand ('&') characters appearing within a query parameter value must be percent-encoded as %26.
b. A Schematron schema that defines supplementary data constraints. See ISO 19757-3:2006.

The request URI has the following form (substitute the appropriate host name and port number for the actual test harness):

`http://host:port/teamengine/rest/suites/gml/3.2.1-r15/run?gml=uri`

where *uri* is an absolute URI that refers to the instance document to be validated; the 'http' and 'file' URI schemes are acceptable. The result entity is an XML document with <testng-results> as the document element.

8 Test results (Donlon data set)

The test suite was run against the latest "Donlon" data set (updated on 2014-03-19). Several assertion errors were reported; these are summarized below along with suggestions for resolving the errors.

8.1 validateMetadataProperties test

```
Property value has minOccurs = 0. Property type definition must
contain the @xlink:href attribute:
{http://www.aixm.aero/schema/5.1}FeatureMetadataPropertyType
```

The type definition is listed below (the particle cardinality constraint is **highlighted**).

```
<complexType name="FeatureMetadataPropertyType">
  <complexContent>
    <extension base="gml:AbstractMetadataPropertyType">
      <sequence minOccurs="0">
        <element ref="gmd:MD_Metadata"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

Since the xs:sequence model group has minOccurs="0", the @xlink:href attribute declaration is expected so as to allow for a remote value; it is an error if a non-nillable property has no value. If the intent is to permit only in-line content (i.e. a child element), then this minOccurs constraint should be removed, since the property declaration itself already has minOccurs="0".

```
<complexType name="AbstractAIXMFeatureType" abstract="true">
  <complexContent>
    <extension base="aixm:AbstractAIXMFeatureBaseType">
      <sequence>
        <element name="featureMetadata"
         type="aixm:FeatureMetadataPropertyType" minOccurs="0"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

This issue applies to all of the base metadata property types defined in the AIXM namespace (see schema `AIXM_AbstractGML_ObjectTypesFeatures.xsd`):

- FeatureMetadataPropertyType
- FeatureTimeSliceMetadataPropertyType
- MessageMetadataPropertyType

8.2 verifyFeatureMemberProperties

`Expected` sequence compositor in non-empty property type {http://www.aixm.aero/schema/5.1/message}BasicMessageMemberAIXMPropertyType

This property type definition uses the xs:choice compositor:

```
<complexType name="BasicMessageMemberAIXMPropertyType">
  <complexContent>
    <extension base="gml:AbstractFeatureMemberType">
      <choice>
        <element ref="aixm:AbstractAIXMFeature"/>
      </choice>
      <attributeGroup ref="gml:AssociationAttributeGroup"/>
    </extension>
  </complexContent>
</complexType>
```

However, there is really no choice here and the GML property type patterns that must be adhered to (see ISO 19136, cl. 7.2.3) all use the xs:sequence compositor.

8.3 validSurfaceBoundary test

`In GML ring: Failed to unmarshal GML geometry from resource at urn:uuid:6118ba76-0d46-4ba7-af63-17f29755e890`

There is no standard mechanism for resolving a URN (Uniform Resource Name). The URN value occurs in a gml:curveMember property that refers to a boundary component of the geometry element aixm:Surface[@gml:id="ID_11364"]:

<gml:curveMember xlink:href="**urn:uuid:6118ba76-0d46-4ba7-af63-17f29755e890**" xlink:title="along the State border"/>

Inserting the referenced curve geometry would be the simplest means of fixing the error. Note that as stated in ISO 19136, cl. 8.1 it is an error if a GML property value cannot be dereferenced:

"The appearance of an xlink:href on a GML property indicates that the value of the property shall be found by traversing the link, that is the value is pointed to by the value of the xlink:href attribute."

8.4 validSurfaceOrientation test

Exterior boundary of surface with @gml:id='SFIRAMSWELL' is not oriented CCW with respect to the up-normal.

The fix here is to just reverse the orientation of the constituent curve member, gml:Curve[@gml:id="CFIRAMSWELL"]. The coordinate list (gml:posList) indicates a clockwise ordering.

```
<gml:Curve gml:id="CFIRAMSWELL">
  <gml:segments>
    <gml:GeodesicString>
      <gml:posList>57.0833333333333 -40.0
56.6666666666667 -21.1333333333333
43.5166666666667 -21.1333333333333
41.4 -30.05 40.7333333333333 -37.1833333333333 42.6
-37.0 44.0333333333333 -40.0 48.4666666666667
-41.3333333333333 52.85 -41.7833333333333
57.0833333333333 -40.0</gml:posList>
    </gml:GeodesicString>
  </gml:segments>
</gml:Curve>
```