Geo-Science GML Encoding Project

GXF Application Schema - GXF2GML Transformation

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GLOSSARY OF TERMS

XML	eXtensible Markup Language
GML	Geography Markup Language
GXF	Grid eXchange Format
GXF2GML	GXF to GML Conversion Stylesheet
GML2GXF	GML to GXF Conversion Stylesheet
XSLT	eXtensible Stylesheet Language Transformation
UML	Unified Modeling Language
USGS	United States Geological Survey
flat2XML	XSLT Extensions for Flat File to XML (FiveSight Technologies)

REVISION HISTORY

Version	Date	Pages	Description	Release
1/0	2002-03-30	All	First Issue	
1/1	2002-05-06	All	Updated for revised schemas	

TABLE OF CONTENTS

1 INTRODUCTION

This document outlines:

- the Grid Exchange Format (GXF) GML Application Schema developed for Canadian aeromagnetic and radiometric data.
- transforming GXF data to GML data (bi-directionally) using the provided XSLT transformation tools.

Note that an additional GXF Application Schema, based on GMLv3.0, is available on the distribution CD-ROM (*/geoscience/schemas/gml3GXFSchema*). However, as it is a supplemental schema, it is not documented.

1.1 Reference Documents

The following documents are referenced in this document:

R-1	TR2001-213-01	Geo-Science GML Encoding Project: Technical Specifications
R-2	TR2001-213-02	Geo-Science GML Encoding Project: Final Report
R-3	OGC 01-029	Geography Markup Language 2.0 Implementation Specification. http://www.opengis.net/gml/01-029/GML2.html, February 20, 2001. OGC
R-4		Grid eXchange File, revision 3. http://www.geosoft.com/support/technote/pdf/gxfr3d9_1.pdf, May 2, 2001. Society of Exploration Geophysicists (SEG) Gravity and Magnetic Committee

2 GXF APPLICATION SCHEMA

2.1 Introduction

Federal aeromagnetic and radiometric data is currently stored in proprietary GeoSoft™ binary format. To model and transfer such data in a non-proprietary, standardized format, a GXF GML application schema has been developed. The application schema is based on the GeoSoft™ Grid eXchange Format (GXF), as it provides an intermediary text-based data format that can be readily exported or imported from existing GeoSoft™software used by NRCAN.

2.2 Grid eXchange Format (GXF)

The GXF format is fully described in *Grid eXchange File, revision 3 [Document R-4]*. A GXF file is an ASCII file made up of labeled data objects and comments. Each labeled data object has a label line followed by one or more data lines. A label line is identified by a '#' character in the first column, followed immediately by an upper-case label. Any data associated with the label is found on one or more lines following the label. All lines in a GXF file must be less than or equal to 80 characters in length. Any line that is not part of a labeled data object is ignored.

The normative GXF objects are:

- #TITLE
- #POINTS
- #ROWS
- #SENSE
- #XORIGIN
- #YORIGIN
- #ROTATION
- #PTSEPARATION
- #RWSEPARATION
- #TRANSFORM
- #DUMMY

- #GRID

2.3 GXF Schema Model

The GXF model is logically represented using Unified Modeling Language (UML) notation as shown in Figure 2.3:

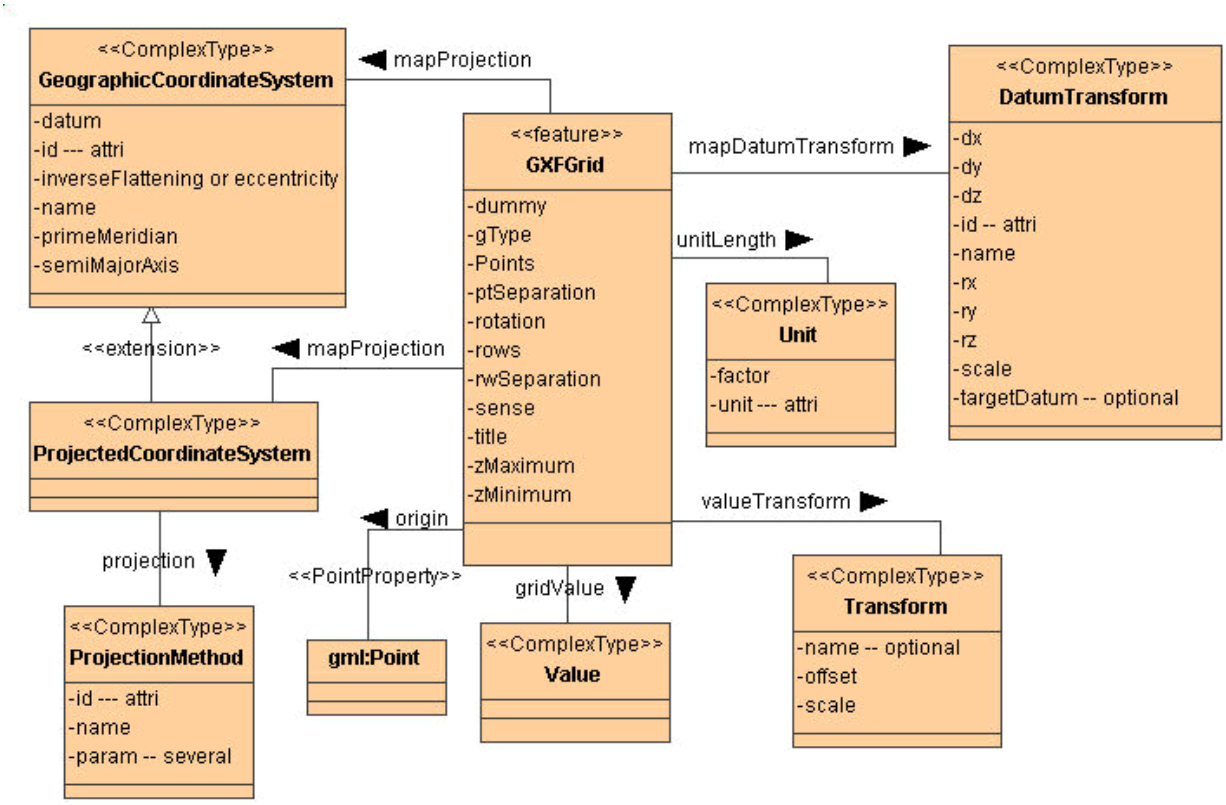

Figure 2.3 – GXF UML Model

This model is used as the basis to encode the GML GXF application schema. The GML encoding rules, syntax, and model are fully described in *Geography Markup Language 2.0 Implementation Specification [Document-R-3]*.

As indicated by the UML diagram above, the GXF Grid object is modeled as a GML feature that has simple properties (e.g. rotation), as well as association properties (e.g. origin) that contain or reference instances of other types (e.g. gml:Point).

The current GXF application schema models the parameters for the geographic coordinate system, projected coordinate system, and projection and datum

transformation methods as explicit properties. With the advent of GML3, it is expected that such information will be referenced as metadata.

The ProjectionMethodType provides a generalized type for capturing custom projection methods defined in a GXF file. Both the name and parameter(s) may be set to arbitrary values.

Note that GXF Comments are not modeled in the GML schema. This is because of the unpredictability of their location and/or format in GXF files.

The annotated GXF Schema is attached as Appendix A. It may be consulted for further documentation particular to individual elements and types. It is also found on the distribution CD-ROM in */geoscience /schemas/GXFSchema/gxf.xsd*.

2.4 Sample Instance Documents

The gxfExample.xml sample instance document is attached as Appendix B. It was created from the example given in *Grid eXchange File [Document R-4]*. This instance documents validates with the gxf.gsd schema referred to in section 2.3.

Along with gxfExample.xml, two other sample instance documents are provided on the distribution CD-ROM in *geoscience/schemas/gxfSchema/*:

- *a_grd.xml* (transformed from *a_grd.gxf* sample data supplied by NRCAN)
- *bellingham.xml* (transformed from USGS *bellingham.gxf* data, available at http://geopubs.wr.usgs.gov/open-file/of99-514/grids.html)

The GML instance documents may include compressed data within the <Value> element. This occurs wherever the native file GXF file format stores the grid data in compressed format. The nature of the compression and decompression mechanism is described in *Grid eXchange File, revision 3 [Document R-4]*.

3 GXF2GML TRANSFORMATION TOOL

3.1 Introduction

The GXF2GML tool transforms a GXF file, based on GXF revision 3, to a GML instance document that validates with the GXF schema. The tool uses the open-source Xalan XSLT engine and a custom XSLT stylesheet (*/stylesheets/GXF2GML/GXF2GML.xsl)*. In order to work with the GXF flat-file format, GXF2GML additionally uses open-source "flat2XML" XSLT extension functions provided by FiveSight Technologies (http://www.fivesight.com/downloads/xsltflatfile.asp).

A successful transformation is predicated on the following conditions:

- The original GXF file is valid.
- XORIGIN is always followed by YORIGIN.
- The line delimiter is LF (i.e. ASCII 10 or '&#10').

Note that all input comments are ignored during the transformation process.

3.2 Software Requirements

In order to run the GXF2GML tool, the following software must be installed on a client machine running Windows 98/NT4.0/2000:

- Java 2 Runtime Environment, v1.3.1 (http://java.sun.com/j2se/);

The GXF2GML tool also uses:

- the open-source Xalan-J 2.1.0 XSLT processor (http://xml.apache.org/dist/xalan-j/). It is found in */geoscience/lib/xalan.jar.*
- FiveSight Technologies flat2xml-2.0 XSLT extension functions (http://www.fivesight.com/downloads/xsltflatfile.asp). It is found in */geoscience /lib/xalan.jar*

3.3 Installation and Running

The Java 2 Runtime Environment, v1.3.1, must be installed on the host machine. It is available from http://java.sun.com/j2se/.

The contents of the distribution CD should be copied to the client machine such that the existing directory structure (e.g. */geoscience/lib, /geoscience/schemas*, etc.) is maintained. This will copy the necessary .jar files, and maintain the relative addressing between files.

To run the GXF2GML tool:

1. Open a Command Prompt window
2. Change the DOS directory to */geoscience /stylesheets/gxf2gml*
3. Run the gxf2gml.bat file as follows:

   gxf2gml <input.gxf> gxf2gml.xsl <output.xml>,

   where:

   input.gxf = an input GXF (*.gxf) file;

   gxf2gml.xsl = the XSLT stylesheet;

   output.xml = the name of an output GML (*.xml) file.

The output GML files are set to validate with the gml.xsd schema located in the */stylesheets/gxf2gml* directory. If the GML instance is moved to another location, the relative path for the validating gml.xsd schema file must be reset in the <GXFGrid xsi:schemaLocation="..."> attribute.

3.4 Test Results

Several tests were performed to assess the performance of the transformation tool. The following input GXF files (found in */geochem/stylesheets/gxf2gml/*) transformed successfully to GML:

- *a_grd.gxf* (input); *a_grdOut.xml* (output)
- *example.gxf* (input); *exampleOut.xml* (output)
- *example2.gxf* (input); *example2Out.xml* (output)

- *bellingham.gxf* (input); *bellinghamOut.xml* (output)
- *georgia_305m.gxf* (input); *georgia_305mOut.xml* (output)

These files are found in the */tools/GXF2GML* directory for convenience.

A successful transformation was determined by transforming the resulting GML output back to GXF using the GML2GXF tool (see section 4 below). These were then inspected visually to ensure that all data elements were maintained through the bi-directional transformation processes.

4 GML2GXF TRANSFORMATION TOOL

4.1 Introduction

The GML2GXF transformation tool works in a similar fashion as the GXF2GML tool. It uses an XSLT engine (Saxon) and XSLT stylesheet (*/stylesheet/GML2GXF/gxf2gml.xsl*) to transform a GXF GML instance document to a GXF file.

If the grid data contained in the <Value> element is compressed, it must follow the GXF base-90 compression format. See *Grid eXchange File, revision 3 [Document R-4]* for details on the GXF compression syntax.

4.2 Software Requirements

The Java 2 Runtime Environment, v1.3.1, must be installed on the host machine running Windows 98/NT/Win2k. It is available from http://java.sun.com/j2se/.

The contents of the distribution CD should be copied to the client machine such that the existing directory structure (e.g. */geoscience/lib, /geoscience/schemas*, etc.) is maintained.

To run the GXF2GML tool:

1. Open a Command Prompt window.
2. Change the DOS directory to */geoscience /stylesheets/gml2gxf*

4. Run the gxf2gml.bat file as follows:

   gml2gxf <input.xml> gxf2gml.xsl <output.gxf>,

   where:

   input.xml = an input GML (*.xml) file;

   gxf2gml.xsl = the XSLT stylesheet;

   output.gxf = the name of an output GXF (*.gxf) file.

The output GML files are set to validate with the gml.xsd schema located in the */stylesheets/gml2gxf* directory. If the GML instance is moved to another location, the relative path for the validating gml.xsd schema file must be reset in the <GXFGrid xsi:schemaLocation="..."> attribute.

4.3 Test Results

The GML2GXF tool was tested in conjunction with the testing of the GXF2GML tool. See section 3.4 for details.

The following input GML files (found in */geochem/stylesheets/gxf2gml/*) transformed successfully to GXF:

- *a_grdOut.xml* (input); a_*grdGxfOut.gxf* (output)
- *bellingham.xml* (input); *gxfExampleOut.gxf* (output)
- *gxfExample.xml* (input); *gxfExampleOut.gxf* (output)
- *gxfExample2.xml* (input); *gxfExample2Out.gxf* (output)

A: ANNOTATED GXF SCHEMA

File: */geoscience/schemas/GXFSchema/gxf.xsd*

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="urn:usgs:gxf-v3.0:schemas:gxf:v1.0" xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:gml="http://www.opengis.net/gml" xmlns:gxf="urn:usgs:gxf-
v3.0:schemas:gxf:v1.0" elementFormDefault="qualified" attributeFormDefault="unqualified">
    <annotation>
        <appinfo source="urn:usgs:gxf-v3.0:schemas:gxf:v1.0"/>
        <documentation>Schema for Grid Exchange File (GXF) format, revision 3.  Based on GML2.1.1</documentation>
    </annotation>
    <!-- =========imports the GML schema================================== -->
    <import namespace="http://www.opengis.net/gml" schemaLocation="../gml-2.1.1/feature.xsd"/>
    <import namespace="http://www.w3.org/1999/xlink" schemaLocation="../gml-2.1.1/xlinks.xsd"/>
    <!--======================global elements declarations=======================-->
    <element name="GXFGrid" type="gxf:GXFGridType">
        <annotation>
            <documentation>A GXFGrid element represents the root for a GXF grid.</documentation>
        </annotation>
    </element>
    <!--=== ================Complex Type Definitions==========-->
    <complexType name="GXFGridType">
        <annotation>
            <documentation>Captures the simple and complex properties (e.g. associations) of a GXF grid.  As GXF data
may store objects in any order, the GXFGrid properties are contained within an xsd:all group.</documentation>
        </annotation>
        <all>
            <element ref="gml:description" minOccurs="0"/>
            <element ref="gml:name" minOccurs="0"/>
            <element ref="gml:boundedBy" minOccurs="0"/>
            <element name="title" type="string" minOccurs="0">
                <annotation>
                    <documentation>Title of the grid.  This corresponds to the #TITLE object in GXF3.</documentation>
                </annotation>
            </element>
            <element name="points" type="decimal">
                <annotation>
                    <documentation>Number of points in a grid row.  This corresponds to the #POINTS object in
GXF3.</documentation>
                </annotation>
            </element>
            <element name="rows" type="decimal">
                <annotation>
                    <documentation>Number of rows in the grid.  This corresponds to the #ROWS object in
GXF3.</documentation>
                </annotation>
            </element>
            <element name="sense" type="gxf:SenseType" minOccurs="0">
                <annotation>
                    <documentation>Sense of the grid.  This corresponds to the #SENSE object in GXF3.</documentation>
                </annotation>
            </element>
            <element name="origin" type="gml:PointPropertyType" minOccurs="0">
                <annotation>
                    <documentation>Origin of the grid.  The coordinates of the point correspond to #XORIGIN and
#YORIGIN objects in GXF3.</documentation>
                </annotation>
```



```
            </element>
            <element name="rotation" type="decimal" default="0.0" minOccurs="0">
                <annotation>
                    <documentation>Rotation of the grid.  This corresponds to the #ROTATION object in
GXF3.</documentation>
                </annotation>
            </element>
            <element name="ptSeparation" type="decimal" default="1.0" minOccurs="0">
                <annotation>
                    <documentation>Separation between points in the grid.  This corresponds to the #PTSEPARATION
object in GXF3.</documentation>
                </annotation>
            </element>
            <element name="rwSeparation" type="decimal" default="1.0" minOccurs="0">
                <annotation>
                    <documentation>Separation between rows in the grid.  This corresponds to the #RWSEPARATION
object in GXF3.</documentation>
                </annotation>
            </element>
            <element name="valueTransform" type="gxf:ValueTransformType" minOccurs="0"/>
            <element name="unitLength" type="gxf:UnitLengthReferenceType" minOccurs="0"/>
            <element name="mapProjection" type="gxf:MapProjectionReferenceType" minOccurs="0"/>
            <element name="mapDatumTransform" type="gxf:MapDatumTransformReferenceType" minOccurs="0"/>
            <element name="zMinimum" type="decimal" minOccurs="0">
                <annotation>
                    <documentation>zMinimum of the grid.  This corresponds to the #ZMINIMUM object in
GXF3.</documentation>
                </annotation>
            </element>
            <element name="zMaximum" type="decimal" minOccurs="0">
                <annotation>
                    <documentation>zMaximum of the grid.  This corresponds to the #ZMAXIMUM object in
GXF3.</documentation>
                </annotation>
            </element>
            <element name="dummy" type="string" minOccurs="0">
                <annotation>
                    <documentation>A specified 'dummy' value in the grid.  This corresponds to the #DUMMY object in
GXF3.</documentation>
                </annotation>
            </element>
            <element name="gType" type="decimal" minOccurs="0">
                <annotation>
                    <documentation>gType for the grid.  This corresponds to the #GTYPE object in GXF3.  The gType is
used to specify the number of digits to use for base-90 compression of the grid data.</documentation>
                </annotation>
            </element>
            <element name="gridValue" type="gxf:GridValueType"/>
        </all>
        <attribute name="fid" type="ID" use="optional"/>
    </complexType>
    <!-- ========================================================== -->
    <complexType name="ReferenceType">
        <annotation>
            <documentation>This type acts as like an association class, such that it may contain or point to a remote object.
It is a base type for other specialized association types (e.g. UnitLengthReferenceType). The  value of the
gml:remoteSchema attribute can be used to locate a schema fragment that constrains the target instance.</documentation>
        </annotation>
        <attributeGroup ref="xlink:simpleLink"/>
        <attribute ref="gml:remoteSchema" use="optional"/>
    </complexType>
    <!-- ========================================================== -->
    <complexType name="ValueTransformType">
        <annotation>
            <documentation>An association property that contains a Transform object.</documentation>
        </annotation>
```



```
        <sequence>
            <element name="Transform" type="gxf:TransformType"/>
        </sequence>
    </complexType>
    <!--================================-->
    <complexType name="TransformType">
        <annotation>
            <documentation>Transformation parameters.  This type corresponds to the #TRANSFORM object in
GXF3.</documentation>
        </annotation>
        <sequence>
            <element name="scale" type="decimal" default="1.0"/>
            <element name="offset" type="decimal" default="0.0"/>
            <element name="name" type="string" minOccurs="0"/>
        </sequence>
    </complexType>
    <!--============================================================-->
    <complexType name="UnitLengthReferenceType">
        <annotation>
            <documentation>Association property that contains or points to a Unit object.</documentation>
        </annotation>
        <complexContent>
            <extension base="gxf:ReferenceType">
                <sequence minOccurs="0">
                    <element name="Unit" type="gxf:UnitType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!--===========================-->
    <complexType name="UnitType">
        <annotation>
            <documentation>Describes the grid units.  This type corresponds to the #UNIT_LENGTH object in
GXF3.</documentation>
        </annotation>
        <sequence>
            <element name="factor" type="decimal"/>
        </sequence>
        <attribute name="unit" type="string" use="required"/>
    </complexType>
    <!--================================================-->
    <complexType name="MapProjectionReferenceType">
        <annotation>
            <documentation>Association property that contains or points to a GeographicCoordinateSystem or
ProjectedCoordinateSystem object.</documentation>
        </annotation>
        <complexContent>
            <extension base="gxf:ReferenceType">
                <choice minOccurs="0">
                    <element name="GeographicCoordinateSystem" type="gxf:GeographicCoordinateSystemType"/>
                    <element name="ProjectedCoordinateSystem" type="gxf:ProjectedCoordinateSystemType"/>
                </choice>
            </extension>
        </complexContent>
    </complexType>
    <!--================================-->
    <complexType name="GeographicCoordinateSystemType">
        <annotation>
            <documentation>Models the geographic coordinate system.  This type corresponds to the #MAP_PROJECTION
object in GXF3.</documentation>
        </annotation>
        <sequence>
            <element name="name" type="string"/>
            <element name="datum" type="string"/>
            <element name="semiMajorAxis" type="decimal"/>
            <element name="inverseFlatteningOrEccentricity" type="decimal"/>
```



```
            <element name="primeMeridian" type="decimal"/>
        </sequence>
        <attribute name="id" type="string" use="optional"/>
    </complexType>
    <!--================================-->
    <complexType name="ProjectedCoordinateSystemType">
        <annotation>
            <documentation>Models the projected coordinate system.  This type corresponds to the #MAP_PROJECTION
object in GXF3.</documentation>
        </annotation>
        <complexContent>
            <extension base="gxf:GeographicCoordinateSystemType">
                <sequence>
                    <element name="projection" type="gxf:ProjectionReferenceType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!--================================-->
    <complexType name="ProjectionReferenceType">
        <annotation>
            <documentation>Association property that contains or points to a ProjectionMethod object.</documentation>
        </annotation>
        <complexContent>
            <extension base="gxf:ReferenceType">
                <sequence minOccurs="0">
                    <element name="ProjectionMethod" type="gxf:ProjectionMethodType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!--================================-->
    <complexType name="ProjectionMethodType">
        <annotation>
            <documentation>Models a generic projection method.</documentation>
        </annotation>
        <sequence>
            <element name="name" type="string"/>
            <element name="param" type="decimal" maxOccurs="unbounded"/>
        </sequence>
        <attribute name="id" type="string" use="optional"/>
    </complexType>
    <!--================================================-->
    <complexType name="MapDatumTransformReferenceType">
        <annotation>
            <documentation>Association property that contains or points to a DatumTransform object.</documentation>
        </annotation>
        <complexContent>
            <extension base="gxf:ReferenceType">
                <sequence minOccurs="0">
                    <element name="DatumTransform" type="gxf:DatumTransformType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!--======================-->
    <complexType name="DatumTransformType">
        <annotation>
            <documentation>Models the datum transformation.  This corresponds to the #MAP_DATUM_TRANSFORM
object in GXF3.</documentation>
        </annotation>
        <sequence>
            <element name="name" type="string"/>
            <element name="dx" type="decimal"/>
            <element name="dy" type="decimal"/>
            <element name="dz" type="decimal"/>
```



```
            <element name="rx" type="decimal"/>
            <element name="ry" type="decimal"/>
            <element name="rz" type="decimal"/>
            <element name="scale" type="decimal"/>
            <element name="targetDatum" type="string" minOccurs="0"/>
        </sequence>
        <attribute name="id" type="string" use="optional"/>
    </complexType>
    <!--=================================================-->
    <complexType name="GridValueType">
        <annotation>
            <documentation>Type for the gridValue property</documentation>
        </annotation>
        <sequence>
            <element name="Value" type="gxf:ValueListType">
                <annotation>
                    <documentation>The value for the grid.  This corresponds to the #GRID object in
GXF3.</documentation>
                </annotation>
            </element>
        </sequence>
    </complexType>
    <!--=== ================Simple Type Definitions==========-->
    <simpleType name="ValueListType">
        <annotation>
            <documentation>Captures the grid data. It is simply a string list.</documentation>
        </annotation>
        <list itemType="string"/>
    </simpleType>
    <!--=== =========================-->
    <simpleType name="SenseType">
        <annotation>
            <documentation>Enumerated list of possible values for the Sense property.</documentation>
        </annotation>
        <restriction base="integer">
            <enumeration value="-1"/>
            <enumeration value="1"/>
            <enumeration value="-2"/>
            <enumeration value="2"/>
            <enumeration value="-3"/>
            <enumeration value="3"/>
            <enumeration value="-4"/>
            <enumeration value="4"/>
        </restriction>
    </simpleType>
</schema>
```


B: SAMPLE GXF GML INSTANCE DOCUMENT

File: */geoscience/schemas/GXFSchema/gmlExample.xml*

```
<?xml version="1.0" encoding="UTF-8"?>
<GXFGrid xmlns="urn:usgs:gxf-v3.0:schemas:gxf:v1.0" 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="urn:usgs:gxf-v3.0:schemas:gxf:v1.0 gxf.xsd">
    <points>6</points>
    <rows>4</rows>
    <origin>
        <gml:Point>
            <gml:coordinates>1750000.0,4250.0</gml:coordinates>
        </gml:Point>
    </origin>
    <rotation>0.0</rotation>
    <ptSeparation>12.5</ptSeparation>
    <rwSeparation>12.5</rwSeparation>
    <unitLength>
        <Unit unit="ftUS">
            <factor>0.3048006096012</factor>
        </Unit>
    </unitLength>
    <mapProjection>
        <ProjectedCoordinateSystem>
            <name>NAD27 / Ohio North</name>
            <datum>NAD27</datum>
            <semiMajorAxis>6378206.4</semiMajorAxis>
            <inverseFlatteningOrEccentricity>0.082271854</inverseFlatteningOrEccentricity>
            <primeMeridian>0</primeMeridian>
            <projection>
                <ProjectionMethod>
                    <name>Lambert Conic Conformal (2SP)</name>
                    <param>40.4333333333</param>
                    <param>41.7</param>
                    <param>39.6666666667</param>
                    <param>82.5</param>
                    <param>609601.22</param>
                    <param>0</param>
                </ProjectionMethod>
            </projection>
        </ProjectedCoordinateSystem>
    </mapProjection>
    <mapDatumTransform>
        <DatumTransform>
            <name>NAD27 to WGS 84 (6)</name>
            <dx>-8</dx>
            <dy>159</dy>
            <dz>175</dz>
            <rx>0</rx>
            <ry>0</ry>
            <rz>0</rz>
            <scale>1</scale>
        </DatumTransform>
    </mapDatumTransform>
    <gridValue>
        <Value>
    0 1 2 3 4 5
    10 11 12 13 14 15
    20 21 22 23 24 25
```



```
    30 31 32 33 34 35
    </Value>
    </gridValue>
</GXFGrid>
```


