Paper for Consideration by TSMAD27

Reconciling Geographic Markup Language (GML) with S-100

Submitted by:	US Navy (SPAWAR Atlantic)
Executive Summary:	Discussion of the issues encountered with the draft S-100 GML Profile, as well as the challenges of implementing GML Application Schemas based upon the S-100 GML Profile.
Related Documents:	IHO S-100 (Universal Hydrographic Data Model 1.0.0)
	ISO 19107:2003 (Geographic information – Spatial schema)
	OGC 07-036 (OpenGIS Geography Markup Language Encoding Standard 3.2.1)
	IHO S-101 (ENC Product Specification Draft February 2012)
Related Projects:	S-100 GML Profile

Introduction / Background

The NATO Warship ECDIS (WECDIS) Capabilities Assessment Team (CAT) is working on an interchange format called NATO User Defined Layer (NUDL) as part of the upcoming revised WECDIS standardization agreement (STANAG). As WECDIS will be required to operate with the S-100 standard, the decision was made to base the NUDL design on the S-100 Geography Markup Language (GML) Profile. This allowed the NUDL to be closely aligned with S-100, as well as use an open interchange format (GML). During the development of the NUDL schemas, it became apparent that the current S-100 GML Profile (as well as GML itself) presented some technical challenges. This report will discuss those challenges.

Analysis/Discussion

There are two general issues with the current S-100 GML Profile:

- No direct support for loxodromic interpolation (rhumb lines)
- Incongruous implementation of the ISO 19107 geometry schemas

Note, however, that these issues are with GML itself. The S-100 schema inherits these issues simply as a result of being based upon GML.

The first issue concerns the ability to represent loxodromes in the S-100 schema. GML enumerates several interpolation methods, but does not include one for loxodromes. Further, the current definition of GML (3.2.1) prevents extension or modification of the interpolation list, thereby preventing the S-100 Profile (or application schema) from introducing loxodromes. A change request (08-194) was submitted to the GML Technical Committee to address the current limitations of the *CurveInterpolationType* enumeration, which would effectively resolve this issue. However, this request is still marked as pending and there is no indication that the GML specification will be updated to reflect this change.

There is, however, one indirect approach to representing loxodromes with GML, which is to project all coordinates using a Mercator projection. Once projected and coded with the appropriate Coordinate Reference System (CRS), the "linear" interpolation method could be used since loxodromes are represented as straight lines in a Mercator projection. This would typically require a transformation in both directions (both *to* and *from* the projected form), and would not be easily enforceable with just the use of the XML schema(s). This method would also introduce potential errors due to the repeated coordinate transformations.

The second issue concerns the differing implementations of ISO 19107 by S-100 and GML. Primarily, this issue exists as a by-product of a limitation in the XML Schema Definition (XSD) language. XSD is not able to directly represent the concept of multiple-inheritance, which ISO 19107 (and S-100) makes use of for some of the key geometry definitions. GML, which uses XSD, gets around this limitation by defining an abstract base class (see OGC 07-036 section 11.2.2.1) that the rest of the geometries are based upon. While this does allow the necessary container relationships to be defined, it also allows relationships that are not supported by S-100.

For example, GML defines *LineStringType*, which is derived from the common base class *AbstractCurveType*. Because of this inheritance, the *CompositeCurveType* (GM_CompositeCurve in S-100) can contain objects of *LineStringType*. However, S-100 requires that GM_CompositeType contain only GM_OrientableCurve objects, which is not the case for *LineStringType*.

In general, it appears that the conversion from S-100 to GML would be possible. However, the ability to convert from GML to S-100 would not be guaranteed. While it would be possible to limit some of the discrepancies via the S-100 GML Profile (by excluding those geometries that S-100 will never use), there may still be some edge cases that would prevent a non-ambiguous, two-way mapping between S-100 and GML. Note that this issue would likely exist for *any* schema defined with XSD.

Conclusions

While GML may provide some benefit (e.g. visualizing S-100 data in a generic GML viewer), it may not be a good choice as an interchange format between S-100 systems. The lack of a loxodromic interpolation type and the inherent limitations of XSD make GML ill-suited for an S-100 interchange format. While the loxodrome issue can be overcome with some effort, the schema mapping issue can only be mitigated by implementing rules external to GML. In other words, it would not be sufficient for a compliant ECDIS to rely solely upon the S-100 GML Profile and applicable Application Schemas.

Recommendations

Assuming that S-100 features can be unambiguously mapped to and from GML features (which this paper does not evaluate), it is our recommendation that S-100 use only GML feature types. S-100 would, instead of using GML geometry types, define its own geometry types that have the same constraints as specified by S-101 (e.g. the implicit restriction of GM_CurveSegment interpolation to "loxodromic"). With this approach, we believe that the geometry types can be defined such that they can be unambiguously transferred between S-100 ECDIS platforms.

For use cases which require the additional encoding of geometries for which S-100 would not suffice, GML geometry types could still be used. This would result in a serialization that contains GML features, S-100 geometries, and GML geometries. Strict S-100 platforms would be able to process these serializations without ambiguity (they would simply ignore the GML geometries), while hybrid platforms (e.g. WECDIS) could read and/or generate both the S-100 portion of the serialization and the GML portion.

Justificat**ion and Impacts**

N/A

Action Required of SNPWG

The SNPWG is invited to:

        A.   Discuss the issue(s) – We do not believe this issue concerns the SNPWG.