TSMAD27-4.3.12A

Paper for consideration by TSMAD

More Spatial Types for S-100 Edition 2.0.0

Submitted by:	SNPWG / Jeppesen
Executive Summary:	This paper describes possible spatial types for ellipses and annular sectors in S-100 Edition 2.0.0.
Related Documents:	(1) S-100 Ed. 1.0.0; (2) TSMAD27-4.3.11B Spatial Types for S-100
Related Projects:	(1) S-100

1 Introduction

Discussions with SNPWG identified two additional candidate spatial types for inclusion in S-100. This paper describes them as additional candidates for new spatial types in S-100 Edition 2.0.0.

2 Terms and abbreviations

MSI Marine Safety Information

3 References

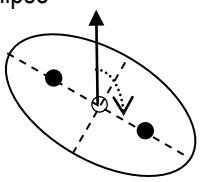
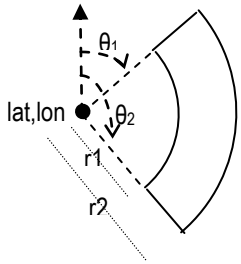
ISO 19107: Geographic Information – Spatial Schema

4 Discussion

4.1 Candidate Spatial Types

The types are listed in Table 1.

Table 1. Additional spatial types

Item	Type	Justification / Examples
Ellipse 	Coordinate Geometry	Used for marine safety information in Japan.
AnnularSector 	Coordinate Geometry	Used for defining practice areas in Australian waters and NGA publications.

4.1.1 Ellipses

Neither ISO 19107 nor ISO 19136 define a distinct spatial type for ellipses. ISO 19136 has an example showing how an ellipse can be defined as a new spatial type.

Within ISO 19107 we can model ellipses using GM_Conic or GM_BSplineCurve. These use representations based on analytic geometry. It is unlikely that the formats for conics given by ISO 19107 are used in maritime information. Spatial data would therefore have to be converted from the format actually used.

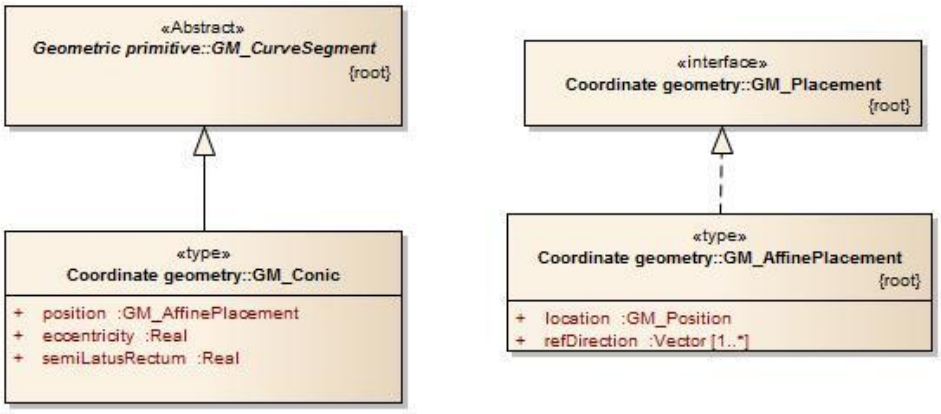


Figure 1. Ellipse as Conic - extract from ISO 19107 model of Conic section

ISO 19107 also has the value “elliptical” as one of the allowed values of GM_CurveInterpolation. Curves with this interpolation type require four control points on the curve (ISO 19107 § 6.4.8).

Alternatively, an ellipse can be defined using other parameters, for example:

1. Ellipse with vector axes
    a. Center coordinates
    b. Semi-major axis vector
    c. Semi-minor axis vector
2. Ellipse with azimuth
    a. Center coordinates
    b. Major axis length
    c. Minor axis length
    d. Azimuth of major axis.

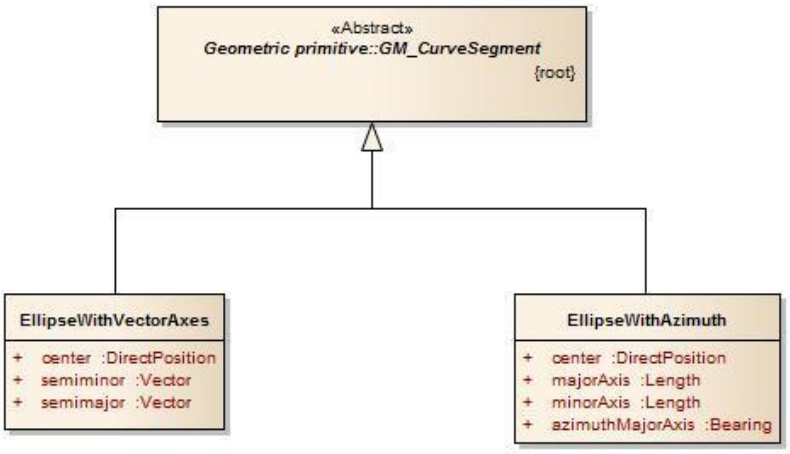


Figure 2. Other models for the ellipse type

EllipseWithVectorAxes is the example from ISO 19136. The ISO 19136 (GML) example uses semi-major and semi-minor axes in Vector form, which includes axis directions, and means that azimuth does is not encoded as a separate attribute. EllipseWithAzimuth conforms to the Japan MSI example which uses the description:

> *in ellipse shaped area center 24-23N 161-46E; Large Axis 216 miles and small axis 59.4 miles; Azimuth of large axis 134 degrees.*

Representations in terms of other parameters are also possible, the best format between efficient implementation and data producer convenience is to be determined.

If a spatial type for ellipses is to be added then it is more convenient from the producer's point of view to define a novel spatial type since the ISO 19107 alternatives almost certainly require data conversion. A parametric representation may be more efficient from the computer graphics point of view, but projections add a complicating factor which needs to be investigated.

4.1.2 Annular sectors

Annular sector areas are sometimes seen in nautical publications, e.g., for military exercise areas. Examples of annular sectors are in the figures below. SNPWG requested a data format for this spatial type. The proposal for spatial types envisages encoding it using a composite curve with arc segments for the inner and outer arcs and linear segments for the radial segments.

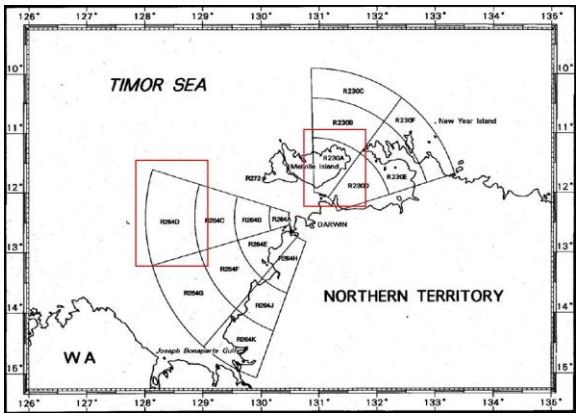


Figure 3. Areas to be avoided - AU. From NGA Pub. 160

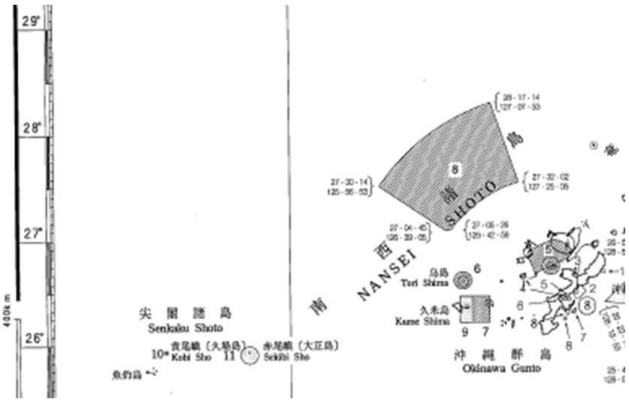


Figure 4. Exercise area example - Japan

NGA publications define such areas using the coordinates of the corners, and the center and radii of the inner and outer arcs. E.g.:

> ***R264B—****12°38'16"S, 130°10'16"E; then the minor arc of a circle 45 NM in radius centered on Darwin DME (12°25'24"S, 130°54'23"E) to 12°12'26"S, 130°10'20"E; 12°02'16"S, 129°36'08"E; then the minor arc of a circle 80 NM in radius centered on Darwin DME to 12°48'09"S, 129°35'45"E.*

At present there are two options to encode such objects:

A. S-100 Edition 1.0.0 follows S-57 and requires the use of polygons, i.e., the boundaries are sequences of line segments small enough to approximate the object at the data scale.

B. The ArcByCenterPoint type proposed earlier for S-100 Edition 2.0.0 allows the two arcs to be encoded as curves using center, radius, and bearings of the end points. Using this, the boundary would be a composite curve consisting of the inner and outer arcs and radial segments joining their corresponding end points.

Neither option can be recognized as an annular sector by software without additional computation (which might require testing many polygons, and therefore be inefficient).

We are considering a new spatial type "annular sector" (this is called "wedge" or "arcband" in some COTS tools). This is similar to the "sector by center point" proposed earlier but has an additional parameter "inner radius". It would probably be a super-type of the SectorByCenterPoint spatial type (following the GML paradigm for modeling hierarchies). The parameters would be:

a) Center coordinates

b) Inner radius

c) Outer radius

d) Start bearing relative to center

e) End bearing relative to center

4.2 Data formats

GML: XML types for both spatial types can be added to either the S-100 profile or root application schemas for S-100 Edition 2.0.0. Since these are not standard GML types the implications for compatibility with off-the-shelf GML software need to be carefully considered.

ISO 8211: The options are the same as for the types proposed in the earlier TSMAD 27 paper:

1) No change to the ISO 8211 encoding of S-100 Edition 1.0.0. Convert all instances of the additional spatial types to use only spatial types defined in S-100 Edition 1.0.0.

2) Use only the formats allowed by S-101,

3) Define new encodings for the additional spatial types. This means extending Part 10a of S-100 with new spatial record types, field names, etc.

4) Define “enhanced” encodings for the new types, which conform to S-100 Edition 1.0.0 for format (i.e., use the existing spatial record types, field names, etc.) but add information pertaining to the new types (e.g., centre and radius for circles).

4.3 Justification, advantages, and disadvantages

Recent discussions in SNPWG identified additional spatial types as potentially useful for nautical information . The arguments in TSMAD27-4.3.11B about simplifying data generation by non-cartographers using less-capable software, conversion effort, data verification, effort, accuracy, and data volume. Other advantages are:

- Explicit semantics might allow more efficient spatial operations, e.g., IN/OUT computations using the bearing and distance of a query point relative to the center and/or other object parameters.
- Reduced scale-dependence, because the number of control points needed is not dependent on data scale. This should also simplify production.

The disadvantages of added complexity for implementations, additional processing for map projections and portrayal, and implementation of spatial operations also apply. Compatibility with off-the-shelf software also remains a consideration, since these types are either specified in ISO standards using analytic geometry (i.e., conic sections) or not specified (though they may be implemented in some off-the-shelf software). Also, the absence of explicit curve segments for some boundary curves such as radial segments means they cannot be referenced by adjacent objects.

As with the other spatial types, addition of a type to S-100 does not require that all product specifications use it. Specifications are free to restrict types to a subset of those defined in S-100.

5 Actions Requested

TSMAD is requested to:

- note this paper
- comment on the costs and benefits of adding these new spatial types to the S-100 spatial schema
- comment on suitable data formats for these types.