Extensions to S-100 Spatial Types

S-100 WG3

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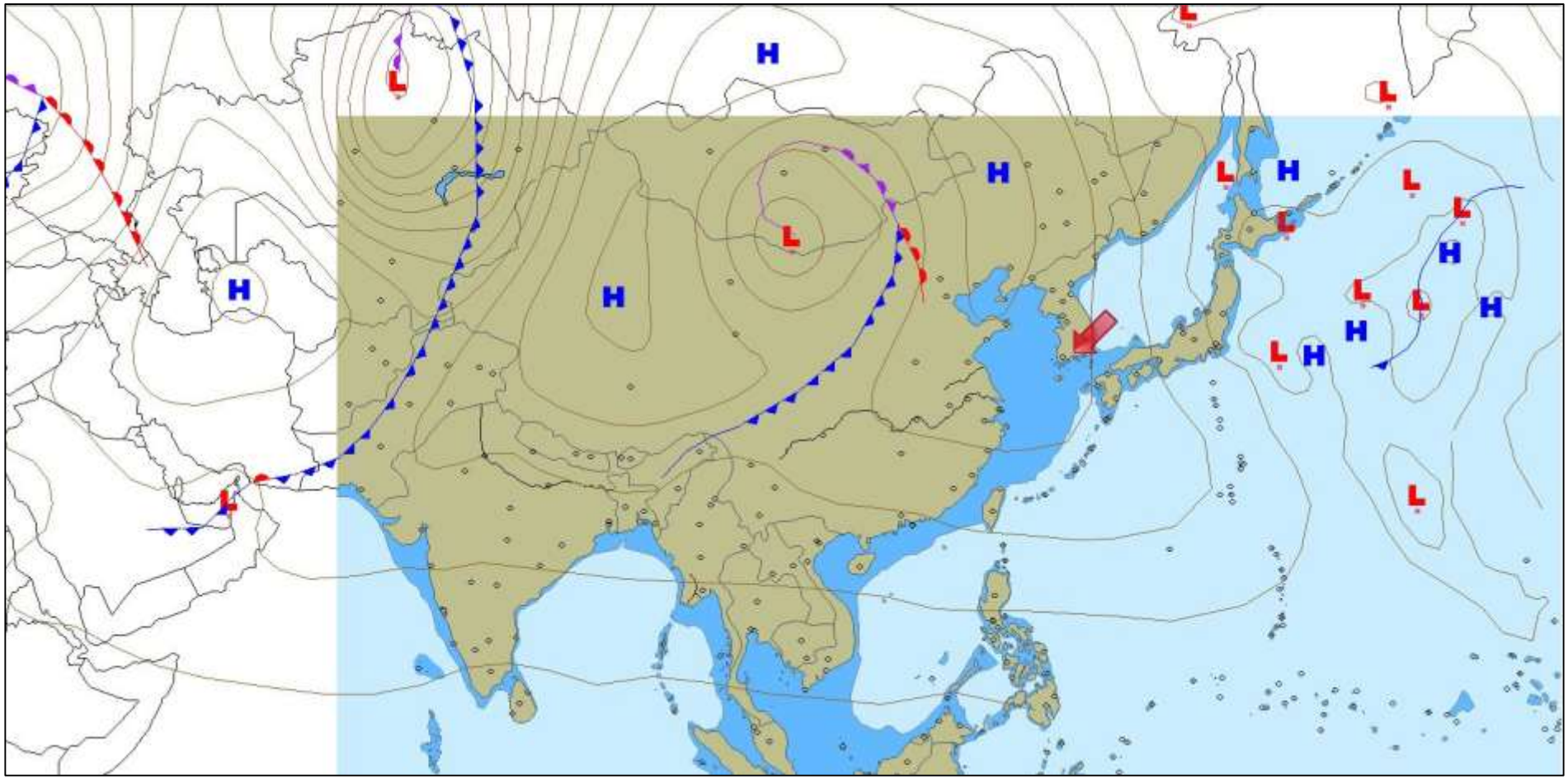
Part I – The Problem

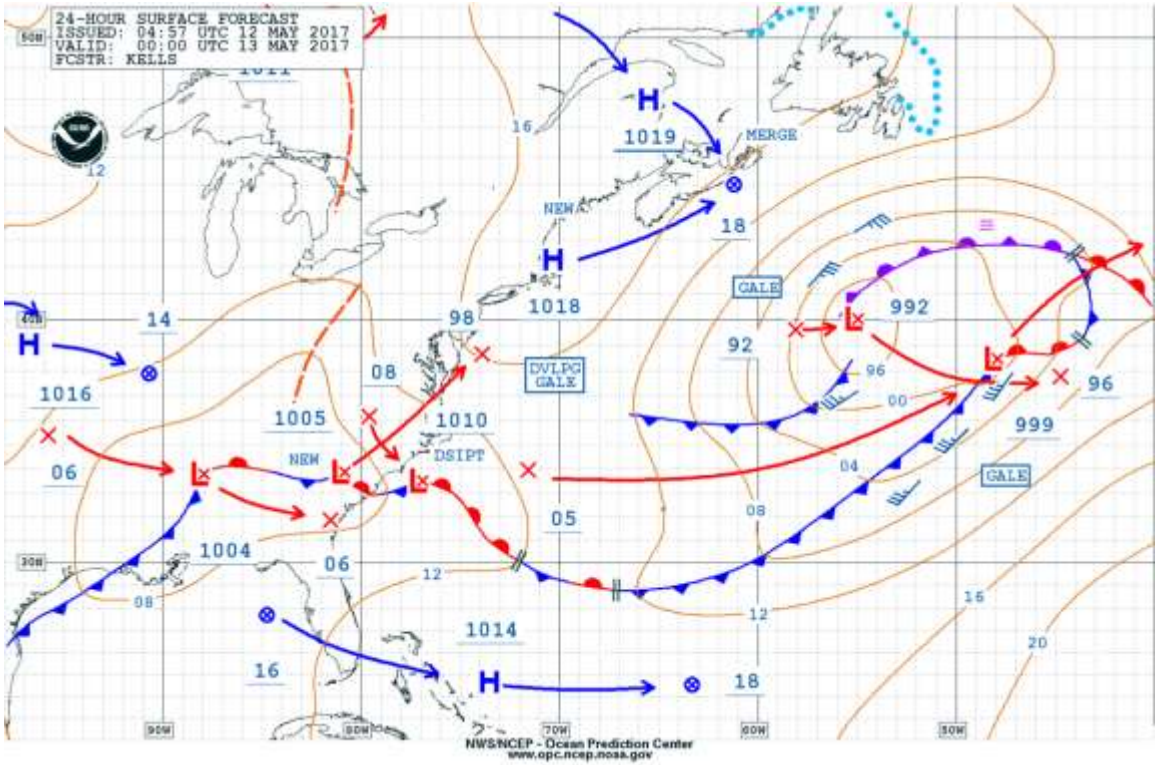
S-412 Weather Overlay: Testing



S-412 Weather Overlay: Portrayal Challenges

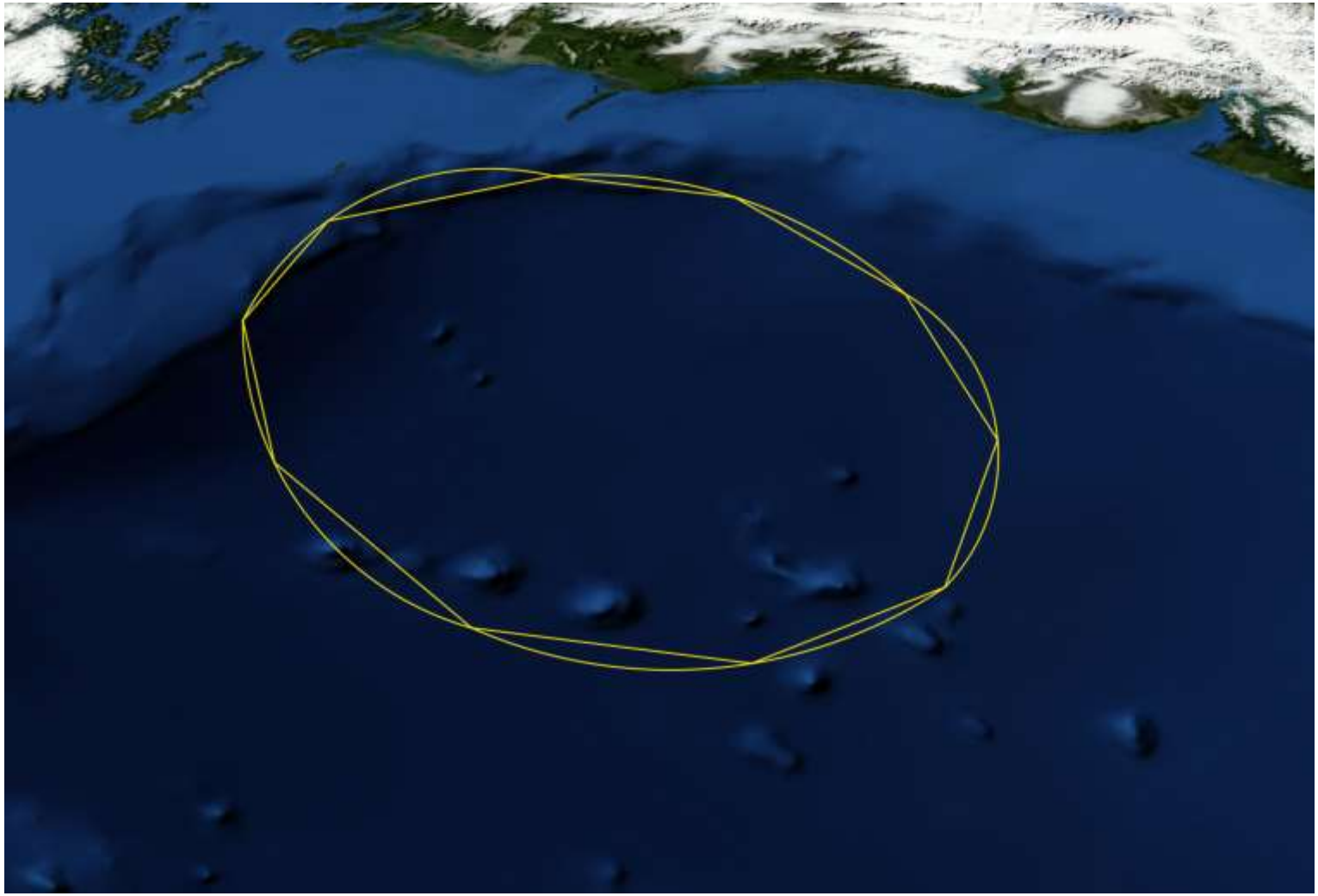
The need to preserve smoothed geometries in S-412:

- Isobar spacing and direction changes represent higher/lower wind speed and wind direction changes.
- Kinks in isobars represent airmass changes.
- Thousands of points for one line raises file size concerns



S-412 Weather Overlay: Portrayal Challenges

Preserving smoothed geometries in S-412.



S-412 Weather Overlay: Portrayal Challenges

S-100 allows for a limited number of curved geometry options

S100_gmlProfile.xsd	S100_GM_CurveInterpolation	S100 approved element using	GML 3.2.1 element using
linear	Y	LineStringSegment	LineStringSegment
geodesic	Y	GeodesicString	Geodesic
circularArcCenterPointWithRadius	Y	S100_CircleByCenterPoint S100_ArcByCenterPoint	ArcByCenterPoint
circularArc3Points	Y	(not used- S100_ArcByCenterPoint used instead)	ArcString
elliptical	Y	N/A	N/A
conic	Y	N/A	N/A
loxodromic	Y	N/A	N/A
circularArc2PointWithBulge	N	N/A	ArcByBulge
clothoid	N	N/A	Clothoid
polynomialSpline	N	N/A	BSpline, Bezier
cubicSpline	N	N/A	CubicSpline
rationalSpline	N	N/A	Bspline

S-412 Weather Overlay: Portrayal Challenges

Difficulties finding solutions using linear line segments

S100_gmlProfile.xsd	S100_GM_CurveInterpolation	S100 element using	GML 3.2.1 element using	GDAL Support (can plot in QGIS)?	PGEN Array Issue? (memory issue -no point filtering)
linear	Y	LineStringSegment	LineStringSegment	Y	y
geodesic	Y	GeodesicString	Geodesic	Y	y
circularArcCenterPointWithRadius	Y	S100_CircleByCenterPoint S100_ArcByCenterPoint	ArcByCenterPoint	Y	n
circularArc3Points	Y	(not used- S100_ArcByCenterPoint used instead)	ArcString	Y	n
elliptical	Y	N/A	N/A	N	n
conic	Y	N/A	N/A	N	n
loxodromic	Y	N/A	N/A	N	n
circularArc2PointWithBulge	N	N/A	ArcByBulge	Y	n
clothoid	N	N/A	Clothoid	N	n
polynomialSpline	N	N/A	BSpline, Bezier	N	n
cubicSpline	N	N/A	CubicSpline	N	n
rationalSpline	N	N/A	Bspline	N	n

Part II – Proposed Solution

Considerations in defining the solution

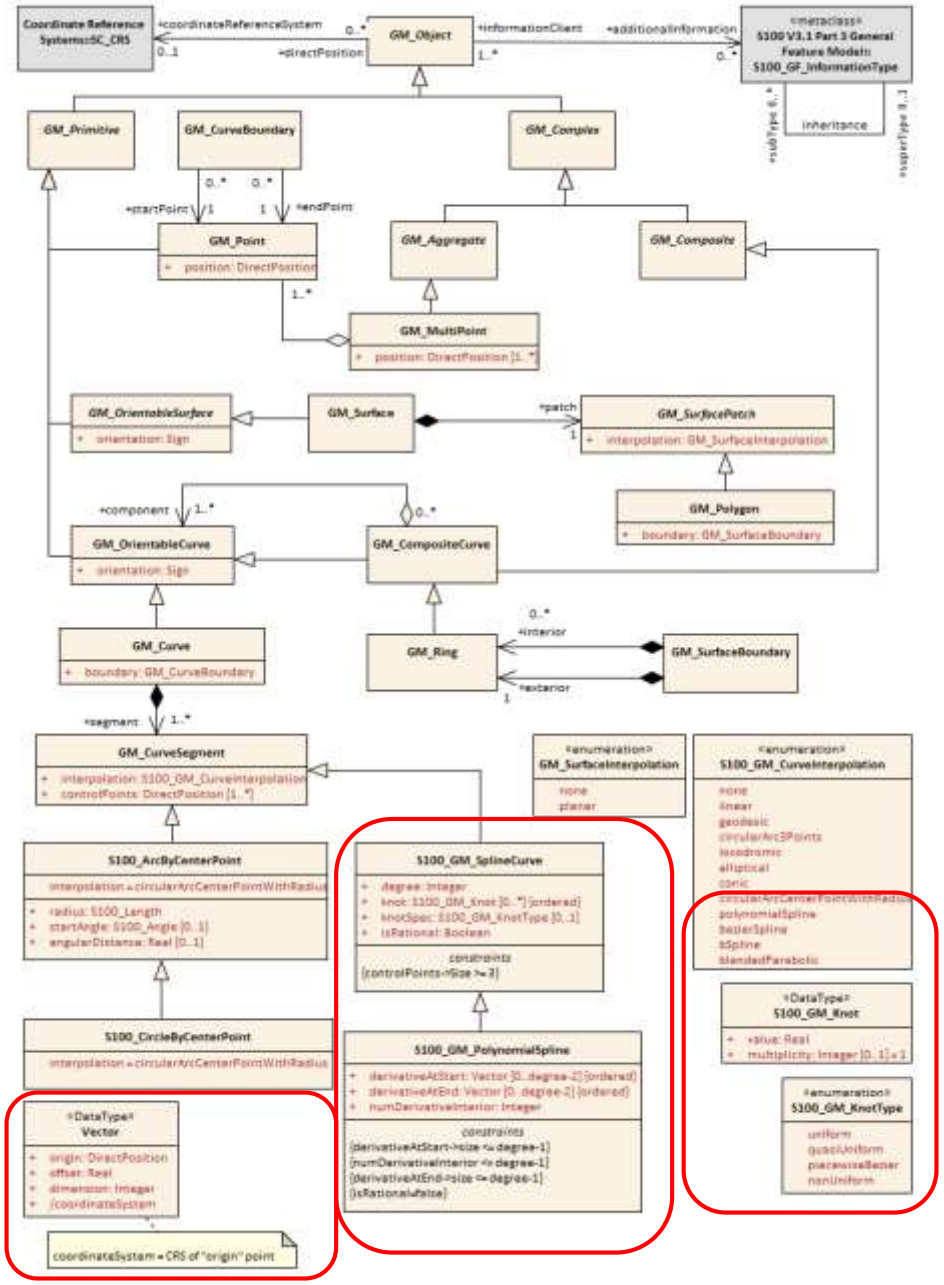
- Approach to spatial model changes between ISO 19107:2003 and new draft of ISO 19107.
- Small errors in spline model of ISO 19107:2003 (propagated to GML 3.2.1)
- New ISO draft simplifies and generalizes spline modeling
- So the approach to 3.x(?) splines is: splice the new ISO model of splines into the current S-100 3.0.0 model
  - Curve segments retained (new ISO 19107 does away with ‘segments’, uses curves instead).
  - S-100 3.X: Spline segments are just another kind of curve segment

Summary of proposed changes

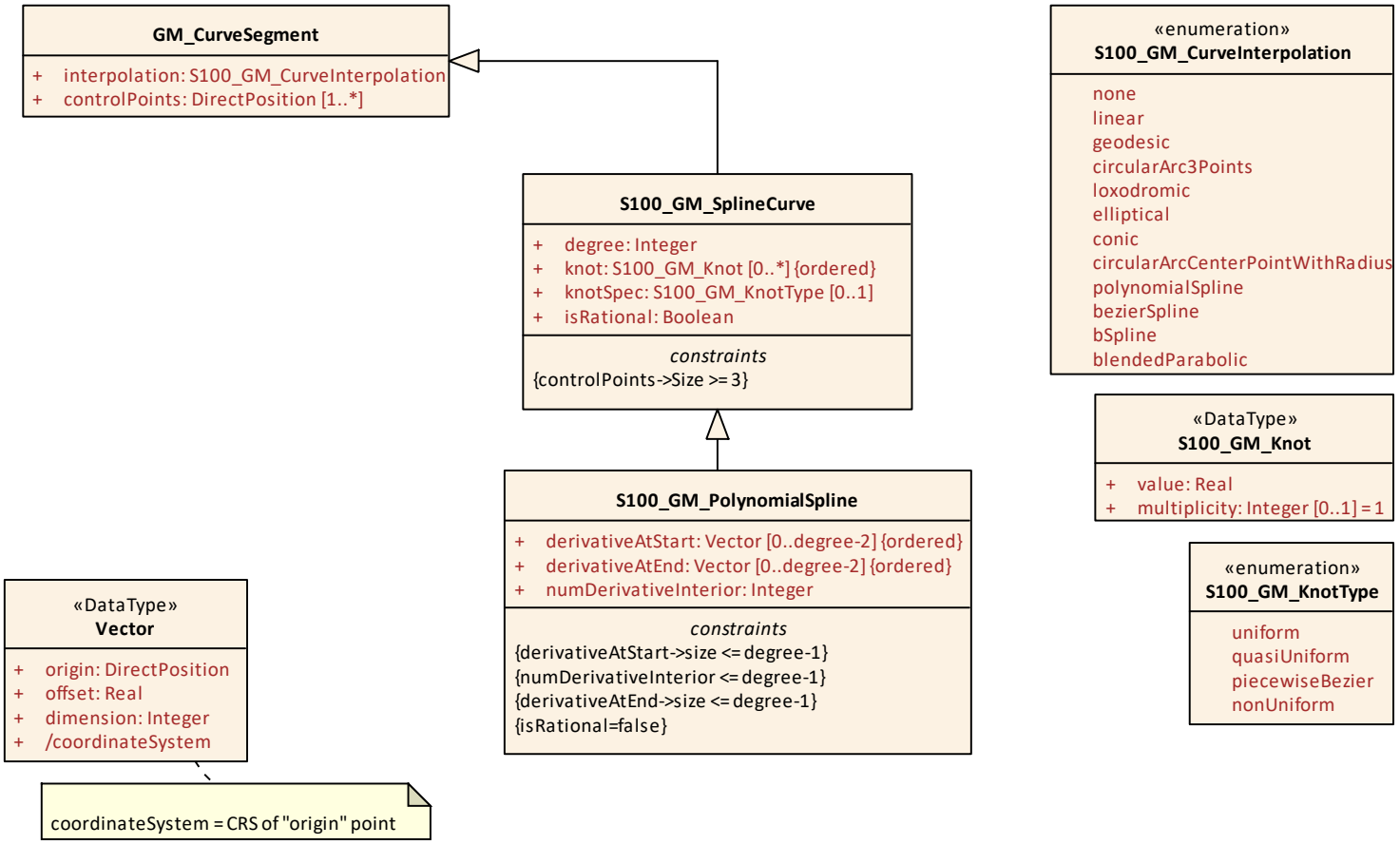
- Part 7:
  - No change to existing spatial types in S-100 Part 7.
  - The enumeration S100_CurveInterpolationType is extended
  - New classes for splines (as curve segments)
  - Explanation of splines model and relation to 19107:2003 and 19107:2018(?) draft – §7.4.1.1.1
  - Explanation of blended parabolic interpolation – §7.4.2.2.2
  - Miscellaneous minor changes to integrate spline types and new draft of ISO 19107 in clauses of general applicability.
- Part 10a:
  - Curve record extended with spline fields and segment parameters (10a-5
  - Knot and derivative types added (10a-5.4.10 & 10a-5.4.11)
  - Additional interpolations in enumeration for curve interpolation (10a-5.7.2.4)
- GML profile:
  - Curve interpolation types
  - Types for S100_GM_SplineCurve, S100_GM_PolynomialSpline and types used by them (knot, vector, and knotType).
  - Added a generic S100_GM_Curve type for other interpolations, specifically blended or fitted curves.
- Redlines of Part 7 and 10a, and XSDs for GML profile are all on the S-100 page.

Mod

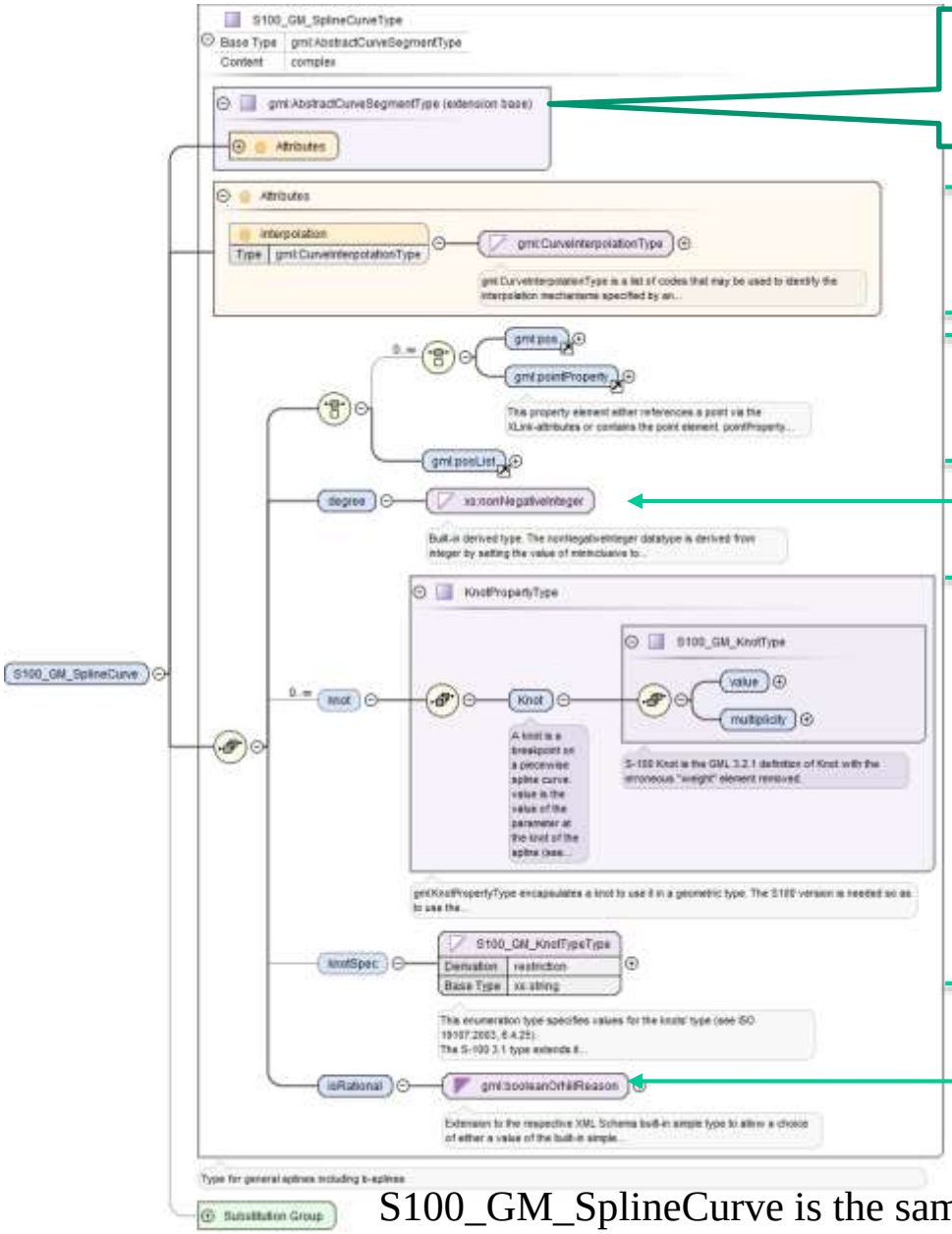
- Principle: Extend S-100 3.0.0 spatial model with splines model of new draft of 19107.
- Adds another subtype of curve segment for splines
- Parabolic blended curves to be a curve segment with interpolation type='blendedParabolic'
- Adds interpolation types for splines and blended parabolic interpolations
- Classes used by splines
  - Vector
  - Knot type
  - Knot value



Model - detail



Splines in the GML profile XSDs - 1



Extension of GML curve type

Additional interpolation types for splines and blended curve

Control points (references or coordinates)

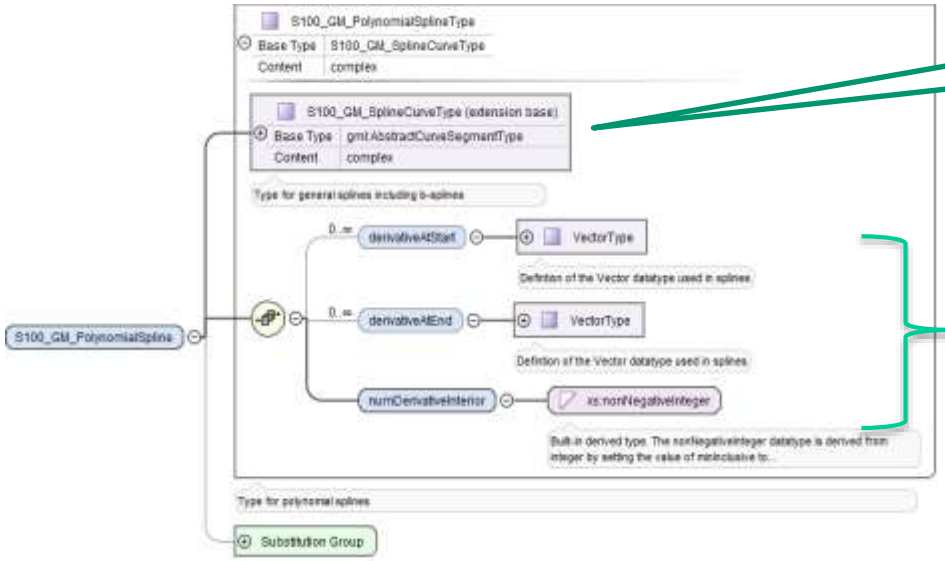
Degree

Knots - values and type

Whether spline is a ‘rational spline’

S100_GM_SplineCurve is the same as the interface SplineCurve in the ISO/DIS 29107 20170628 (Figure 19) except for omitting curveForm.

Splines in the GML profile XSDs - 2



Extension of spline curve type

Information about smoothness and direction/curvature at ends in the form of curve tangents (derivatives).
(controls how well pieces of a larger curve ‘fit’ preceding and following pieces)

An "nth degree" polynomial spline shall be defined piecewise as an n-degree polynomial, with up to C^{n-1} continuity at the control points where the defining polynomial changes. This level of continuity is controlled by the attribute *numDerivativesInterior*. Parameters shall include directions for as many as *degree - 2* derivatives of the polynomial at the start and end point of the segment. GM_Linestring is equivalent to a 1st degree polynomial spline. It has simple continuity at the controlPoints (C^0), but does not require derivative information (degree - 2 = -1).

More information about proposed changes

- Extends the spatial primitives in Part 7 with types to allow encoding of BSpline, cubic spline, polynomial spline, and/or Bezier curve segments.
- Adds blended parabolic interpolation as an additional interpolation type, since this is also being used for weather information.
- Considering the anomalies in ISO 19107:2003 and consequently in GML 3.2.1, this proposal takes into account the most recent draft update to ISO 19107 and adapts the GML 3.2.1 model to resolve anomalies in ISO 19107:2003 and bridge the gap between the 2003 publication and current draft of ISO 19107.
- Corresponding updates to the S-100 ISO 8211 and GML encoding formats to allow encoding of spline curve segments are included.
- The updated GML profile includes only the segment types for SplineCurve and PolynomialSpline. It should be possible to encode the more specialized types of splines using only these types. For example cubic splines (i.e., curve segments that are cubic splines) can be encoded using polynomial splines with degree = 3.
- The updated GML profile also adds a generic S100_GM_Curve type in the S100 namespace to allow encoding of curve segments with interpolations other than those fixed in GML 3.2.1. The PolynomialArc interface from the new draft of 19107 is not used because it is modeled as being accompanied by a specified polynomial function which is not (yet?) needed in S-100.

Summary

- Solution bridges ISO 19107:2003 with changes in the pending revision
- Coefficients and methods for computing piecewise cubic and other splines are well-known in computer graphics, mathematics, and computer-aided geometric design, and are therefore not reproduced in Part 7.
- Spline implementations on marine systems should be available today (mainly for surfaces) – e.g., for applications that display bathymetric data as a sea floor surface or “3D” visualizations.