Ed Wells – 3 November 2021 -- Draft

ASMS White Paper #1: Adding Address Geometry Elements to the FGDC Address Standard

A. SUMMARY

This paper proposes adding a basic set of address map geometry elements and related attributes to the FGDC address standard, to provide for the data and data relationships needed to:

- 1. Represent addresses in map displays (geometry elements); and,
- 2. Connect addresses to transportation networks (as defined in the FGDC transportation standard).

B. CURRENT FGDC ADDRESS STANDARD

The FGDC address standard was created to fulfill several purposes, among them:

- "Provide a systematic, consistent basis for recording all addresses in the United States."
- "Define the elements needed to compose addresses and store them within relational databases and geographic information systems."
- "Define the attributes needed for address documentation, mapping, and quality testing, including address ID's, coordinates, and linear reference locations." (FGDC 1.2, p2)

The FGDC address standard, as endorsed in 2011, includes no geometric attributes for representing an address in a map. The address standard includes numeric elements for address coordinates, from which an address point can be constructed, but no address point element is specified. Point construction is left as a task to be done locally.

C. REASONS FOR RECOMMENDING REVISION

Since 2011, two developments have highlighted the need for a set of address geometry elements and attributes:

- 1. The Census Bureau's proposal for a MapPosition element, and
- 2. The growing importance of GIS-based routing and navigation services, particularly in NG9-1-1 systems.

C.1 Address Points, Address Placement, and Multi-point Addresses. In 2015, the Census Bureau proposed adding a MapPosition element, so that:

1. An address could be mapped to one or more geometric points, and

2. Each point had an "address placement" attribute to give its point of placement, that is, how the point was placed within the address (at the parcel centroid, building centroid, driveway, front door, etc.).

Multi-point addresses are useful, for example, when address contains multiple features, or when the main structure is distant from the road access point, and each point is useful for different operations, but all should carry the same Address ID. There are also cases where an address spans a jurisdictional boundary, and for QC and other point-in-polygon operations it is useful for the address to have points in each jurisdiction.

The proposal was approved by subject matter reviewers, but not formally endorsed by the FGDC. The address placement attribute was incorporated into the NAD Pilot Project schema. Providing for multiple address points was noted as a desirable future enhancement (NAD Pilot Project Report, pp. 46-48, 51).

C.2 Addresses, Address Ranges, Road Segments, and the Transportation Standard Road Network Model. The ubiquity of GIS-based routing and navigation services, and in particular the growing incorporation of GIS-based address data into NG-9-1-1 call routing and dispatch systems, highlight the importance of relating address locations to road centerlines. This relationship requires two datasets:

- 1. A road network, mapping the roads as a topological network of nodes and segments, with each segment is attributed by, at minimum, a Segment ID, Complete Street Name and TIGER-style range of four Complete Address Numbers.
- 2. An mapped address file, mapped (almost always mapped as points).

The address standard includes no road network geometry elements or topology rules, but none is needed. The FGDC Transportation Standard includes all the data items and structures need to construct a topological road network. Most importantly, it defines and relates **RoadPoint**, **RoadSeg**, and **RoadPath** elements, road events, topology attributes, and segmentation rules.

The FGDC road network model, in turn, is grounded in an abstract, general transportation network that is defined in the Transportation Base part of the standard. That same general model also underpins models for rail, inland waterway, and transit transportation networks. This is useful for the infrequent occasions when rail lines or waterways are treated as thoroughfares within an addressing system, and address numbers are assigned along them.

The address standard need not replicate or reinvent what is already in the transportation standard. It already incorporates the transportation network model by reference (see Section 2.3.4, especially 2.3.4.1 and 2.3.4.3; Appendix H; and Appendix I.2.8). In particular, two road network features are the geometric equivalents of two address classes:

- RoadPoints are (in most cases) the geometric equivalent of Intersection Addresses.
- RoadSegs (and, as needed, RailSegs and waterway segments) are the geometric equivalents for Four-number Address Ranges and some Two-number Address Ranges.

The remaining thoroughfare and landmark classes (Numbered Thoroughfare, Unnumbered Thoroughfare, Landmark, Community, and some Two-number Range addresses) are typically mapped to Address Points, which must be connected to the transportation network.

C.3 Connecting the Address Point to its Corresponding RoadSeg. The address standard includes all the tabular elements needed to relate addresses to road segments. It has none of the geometric elements. As a result, the address standard elements do not provide for map connectivity from address to road segment.

Each address point is, by definition, related to a centerline segment whose name and range contain the address. Valid relationships must pass tabular and map tests:

- **Tabular tests:** Same Complete Street Name; proper parity; in sequence.
- **Map test:** An imaginary "fishbone" line, drawn from the address point to the segment, should not cross any other road segment.

The elements in the address standard support the tabular tests, but not the map tests.

C.4 Complete Street Names and Road Segments. One of the first tasks in creating an address repository is to compile a complete, accurate list of Complete Street Names. The address standard includes all the elements needed to parse and construct Complete Street Names, but it does not include the Street Name ID needed to compile and manage them as a table in a relational database.

If created, a Street Name Identifier would serve the same purpose for Complete Street Names that Address Identifier serves for complete addresses. It would identify the Complete Street Names for database table operations such as query, selection, and update; and it would serve as a foreign key to relate Complete Street Names to other database objects, most importantly RoadSegs.

C.5 Resolving Inconsistencies Between the Transportation Standard and the Address

Standard. The transportation standard, having been written before the address standard was endorsed, includes some data items that overlap and conflict with the address standard. The Address Standard Maintenance Subgroup could provide recommendations for revising the transportation standard to resolve the inconsistencies, if it were deemed useful by the transportation maintenance authority, but there is no necessity to do so. The changes proposed for the address standard can be effected by simply incorporating the transportation network model exclusive of the conflicting data items, and stating which address standard items should be used in their places.

D. TOWARD A SOLUTION: PROPOSED DATA ITEMS AND DATA RELATIONSHIPS

D.1 Elements and Attributes. The limitations described above can be met by adding four geometry elements and six related tabular attributes. These items would complement the road network elements in the transportation standard, and, within the address standard, they would require no changes to any other elements, attributes, or classes.

- Address Point. A map point representing an address, defined to allow for many-to-many relation between addresses and address points. Requires XY or XYZ coordinate set, and two attributes:
 - Address Point ID
 - Address Placement (driveway, parcel centroid, etc.)
- Address Fishbone. An imaginary line connecting an address point to the RoadSeg whose range contains the address. Requires XY or XYZ coordinates for each endpoint, and one attribute, Address Fishbone ID.

- Address Polyline. A polyline representing an address. Example: the transportation segment representing a TIGER-style (Four-number Range) address. Requires XY or XYZ coordinates for each endpoint and intermediate vertex, and one attribute, Address Polyline ID.
- Address Polygon. A polygon representing an address. Example: a polygon containing multiple points that represent the same address. Requires XY or XYZ coordinates for each endpoint and intermediate vertex, such that the first coordinate set equals the last coordinate set, plus one attribute, Address Polygon ID.
- Street Name Identifier. A unique ID given to a Complete Street Name.

D.2 Data Relationships. The address standard, augmented by these new data items, in combination with the transportation standard, would support the following data relationships:

- Address to Address Point (many to many)
 Note: One address can have multiple points. One point can represent multiple addresses (e..g., alias addresses; one primary addresses and all of its subaddresses)
- Address Point to RoadSeg (map)(many to one)
 Numbered Thoroughfare Address to Four-number Address Range (tabular)(many to one)
 Note: An address should be contained within one address range/RoadSeg. An address range/RoadSeg might contain zero, one, or many addresses. Similar relations would be supported for the other thoroughfare and landmark address classes.
- Intersection Address to RoadPoint(One to one) Note: Most RoadPoints represent intersections. Each intersection is represented by one RoadPoint.

Exceptions: Some RoadPoints do not represent an intersection. Examples: RoadPoints that represent a cul-de-sac, or a point where a jurisdictional boundary marks a change or street name or address numbering..

- Complete Street Name to Road Segment (Many to Many) Note: A complete Street Name can apply to multiple RoadSegs. A RoadSeg can have multiple Complete Street Names (e.g., alias names, historic names)
- Four-number Address Range to RoadSeg (Many to One) Note: A RoadSeg with multiple Complete Street Names will also, by definition, be related to multiple Four Number Address Ranges (one for each Complete Street Name).

E. PROSPECTIVE BENEFITS

The proposed data items, if added to the address standard, would yield several fundamental benefits to the address user community. The proposed changes would strengthen complementarity and consistency between the address standard and the transportation standard. The address standard, in conjunction with the road network standard, would include all the elements and attributes needed to:

- 1. Display address locations on maps, as points, lines, or polygons.
- 2. Connect address points to the transportation network, using the Address Fishbone.
- 3. Relate Intersection Addresses and address ranges to their corresponding RoadPoints and RoadSegs.
- 4. Relate multiple Complete Street Names to a RoadSeg, and vice versa.

- 5. Run geometry QC tests to complement tabular QC tests for addresses, their component elements, and their relation to the transportation network.
- 6. Provide, in addition to address mapping and a broader array of data quality tests, better support for computing transportation routes between addresses.

By augmenting a public set of standard data items, the proposed changes would promote a common basis for data organization, and they would simplify data exchange among systems serving these purposes. The proposed changes to the address standard are not dependent on any changes to the transportation standard.

F. STEPS TO COMPLETION

- 1. Draft item descriptions, review, and approve, for:
 - a. Address Point (with Address Point ID and Address Placement attributes)
 - b. Address Fishbone (with Address Fishbone ID attribute)
 - c. Address Polyline (with Address Polyline ID attribute)
 - d. Address Polygon (with Address Polygon ID attribute)
 - e. Street Name Identifier
- 2. Optional: In drafting the descriptions, request input from a representative of the transportation standard maintenance authority, to ensure maximum compatibility with both the Roads and Base parts of the transportation standard.
- 3. Optional: Draft a list of recommended revisions of the transportation standard, for transmittal to the transportation standard maintenance authority, if such would be deemed useful by that authority. (Note: The proposed changes to the address standard can proceed whether or not the transportation standard is revised.)

G. SOURCES AND BACKGROUND INFORMATION

Relation of FGDC Address Standard to FGDC Transportation Standard

1. FGDC address standard, Appendix H (pp. 498-502) and Appendix I, Sec. 2.8 (pp. 510-511)

Address Point

- Census Bureau. "Map Position Proposal for 2015 Revision of the United States Thoroughfare, Landmark, and Postal Address Data Standard". v1.8 (11/16/2015). 12 pp.
- 2. Address Content Subgroup of the Address Theme Subcommittee. *Recommended Content for the National Address Database*. June 8, 2020. "Address Coordinates, Address Placement, and Address Point". Pp71-75.

Road Network Elements

- 1. FGDC. *Geographic Information Framework Data Content Standard Part 7: Transportation Base.* FGDC-STD-014.7-2008. May 2008. 35pp.
- 2. FGDC. Geographic Information Framework Data Content Standard Part 7c: Transportation Roads. FGDC-STD-014.7c-2008. May 2008. 35pp.