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Information Technology – Geographic Information Framework Data Content Standard

Part 7c: Roads

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Foreword

Geographic information, also known as geospatial information, both underlies and is the subject of much of the political, economic, environmental, and security activities of the United States. In recognition of this, the United States Office of Management and Budget issued Circular A-16 (revised 2002), which established the Federal Geographic Data Committee (FGDC) as a coordinating organization.

Work on this standard started under the Geospatial One-Stop e-Government initiative. The standard was developed with the support of the member agencies and organizations of the FGDC and aids in fulfilling a primary objective of the National Spatial Data Infrastructure (NSDI), that is, creation of common geographic base data for seven critical data themes. The seven core data themes are considered framework data of critical importance to the spatial data infrastructure.

The increasing need to coordinate collection of new data, identify applicability of existing data, and exchange data at the national level led to the submission of this standard to the ANSI process to become an American National Standard. The national standard contained in this document and its parts was sponsored by Technical Committee L1, Geographic Information Systems, of the InterNational Committee for Information Technology Standards (INCITS), an ANSI-accredited standards development organization.

As the Geographic Information Framework Data Content Standard was developed using public funds, the U.S. Government will be free to publish and distribute its contents to the public, as provided through the Freedom of Information Act (FOIA), Part 5 United States Code, Section 552, as amended by Public Law No. 104-231, “Electronic Freedom of Information Act Amendments of 1996”.

Introduction

The primary purpose of the Geographic Information Framework Data Content Standard, Part 7c: Roads is to support the exchange of transportation data related to road networks. This part of the standard also seeks to establish a common baseline for the content of road transportation databases for public agencies and private enterprises. It seeks to decrease the costs of acquiring and exchanging road transportation data for Federal, State, Tribal, local, and other governmental agency users and creators of road transportation data. Benefits of adopting the part also include the long-term improvement of the geospatial transportation base data, improved integration of safety and enforcement data, and streamlined maintenance procedures.

This part of the Framework Data Content Standard was preceded in development by the National Spatial Data Infrastructure (NSDI) Framework Transportation Identification Standard and the National Cooperative Highway Research Program (NCHRP) 20-27(2). The Transportation Identification Standard served as the starting point for this part of the standard but surpasses it by adding support for linear events.

Framework Data Content Standard – Roads

1 Scope

The Geographic Information Framework Data Content Standard, Part 7c: Roads defines the components of a model for describing roads which, along with Air (Part 7a), Rail (Part 7b), Transit (Part 7d), and Inland Waterways (Part 7e), is one of five modes that compose the Transportation theme of the digital geospatial data framework. The primary purpose of this part of the standard is to support the exchange of transportation data related to road systems. It is the intent of the Roads part to develop a consensus around a set of common definitions for real world features in order to advance the goals of the NSDI. It is the intent of the part to set a common baseline that will foster the widest possible set of applications of road data for both user and producer. It is also intended to foster improvements in the common spatial data infrastructure through enhanced data sharing and the reduction of redundant data production.

There are a number of issues common to the transportation domain that are covered in the Transportation Base (Part 7) part of the standard because of their broader applications. Some of these issues and their relevance for the Road part are discussed in the informative annexes of the Transportation Base.

At a high level, the road model described in the standard is made up of features that can have geographic locations and characteristics. These features can be interconnected in various ways to represent road networks for path finding/routing applications. While the design team has considered the need for path finding applications, the level of data required by such applications is beyond the scope of many organizations. Specifically, many State and local government agencies do not have adequate data for routing purposes and they do not have the budget to create and maintain this data. It is expected that the content in the Roads part will support the development of specialized networks for routing applications, but this level of information is not a requirement.

This part of the Framework Data Content Standard can be implemented using a variety of software packages and is designed to accommodate data with or without geometry. While this document touches on implementation issues, it is not intended to serve as an implementation specification. It is designed to accommodate data associated with the complete road system at all levels of service and all functional classes that may be defined by a data-providing agency. It also accommodates assets associated with roads that are typically used for navigation, safety, and measurement.

To accommodate multi-modal transportation systems, TranPoints and TranPaths are instantiable, whereas TranSegs are not. This allows the linear segments of each mode to be mode-specific (for example, RoadSeg) but allows them to be connected to segments from other modes. A multi-modal node such as a passenger rail station could be used to connect RoadSegs and RailSegs. In this case, it would be represented as a TranPoint instead of a RoadPoint or RailPoint. Alternatively, it could be modeled as both a RoadPoint and a RailPoint, with the two being equivalent. A TranPath instance would be able to use RoadSegs and RailSegs to define a multi-modal route.

The Roads part of the standard applies to NSDI framework transportation data produced or disseminated by or for the Federal Government. According to Executive Order 12906, Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure, Federal agencies collecting or producing geospatial data, either directly or indirectly (for example, through grants, partnerships, or contracts with other entities), shall ensure, prior to obligating funds for such activities, that data will be collected in a manner that meets all relevant standards adopted through the Federal Geographic Data Committee (FGDC) process.

The Roads part relies extensively on ISO 19133 for linear referencing. Linear reference systems (LRS) are, in the strictest sense, not central to this part of the standard and also are complex enough to warrant separate treatment. Users should refer to Annex B of the Transportation Base (Part 7) part of the standard for information on linear reference systems. The use of LRS is not added simply to support the requirements of departments of transportation; LRS is used as a technique to transfer road information between systems in a simple, flexible data structure that does not impose a specific segmentation scheme on the data being exchanged. LRS is used in this part of the standard to support the exchange of asset information such as sign locations and pavement condition, as well as to support the placement of transportation statistics such as traffic counts or accident data along the roads, or the number of lanes, or speed limits.

A linkage between this part of the standard and appropriate ISO standards for representing spatial features using the Unified Modeling Language (UML) has been developed. These upper-level classes are not necessarily unique to roads, or even to transportation. A specific road profile of those standards has been assembled as the base classes for this model, primarily to take advantage of geometry, topology, and metadata standards. Additional work by ISO TC211 and TC204 to harmonize Geographic Data Files (GDF) and linear referencing standards is in progress in parallel with the development of this standard. Annex B in the Base Document (Part 0) contains a brief explanation of UML diagrams.

2 Conformance

This thematic part includes a data dictionary/model based on the conceptual schema presented below. To conform to this part, the user shall satisfy the requirements of the data dictionary/model. The user's conforming dataset shall include a value for each mandatory element and a value for each conditional element for which the condition is true. It may contain values for any optional element. The data type of each value shall be that specified for the element in the data dictionary/model and the value shall lie within the specified domain. This part only specifies the special requirements of conformance for a dataset containing information on the road system. Conformance to this part requires additional actions specified in the Base Document (Part 0) and Transportation Base (Part 7).

3 Normative references

Annex A of the Base Document (Part 0) lists normative references applicable to two or more parts of the standard, including those other than the transportation parts. Informative references applicable to two or more transportation parts only are listed in Annex C of the Transportation Base (Part 7). Annex D of the Base Document lists informative references applicable to two or more of the parts, including those other than the transportation parts.

4 Maintenance authority

4.1 Level of responsibility

The FGDC is the responsible organization for coordinating work on all parts of the Geographic Information Framework Data Content Standard. The United States Department of Transportation (USDOT), working with the FGDC, is the responsible organization for coordinating work on the Geographic Information Framework Data Content Standard, Part 7: Transportation Base and subparts (Parts 7a, 7b, 7c, and 7d, excluding 7e) and is directly responsible for development and maintenance of the transportation parts (excluding 7e) of the Framework Data Content Standard.

The FGDC shall be the sole organization responsible for direct coordination with the InterNational Committee for Information Technology Standards (INCITS) concerning any maintenance or any other requirements mandated by INCITS or ANSI affecting any part of this standard.

4.2 Contact information

Address questions concerning this part of the standard to:

Federal Geographic Data Committee Secretariat
c/o U.S. Geological Survey
590 National Center
Reston, Virginia 20192 USA

Telephone: (703) 648-5514
Facsimile: (703) 648-5755
Internet (electronic mail): gdc@fgdc.gov
WWW Home Page: http://fgdc.gov

5 Terms and definitions

Definitions applicable to the Roads part are listed here. Other definitions, applicable to multiple transportation parts of the standard are defined in the Transportation Base (Part 7). More general terms can be found in the Base Document (Part 0) of the standard. Users are advised to consult these documents for a complete set of definitions.

5.1
anchor section

section of road between two anchor points

NOTE Anchor sections state the official surface length of a road segment [NCHRP 20-27(2)]

5.2
equivalence relationship (between road points)

correlation used to indicate that a road point in one dataset is equivalent to (that is to say, has the same physical location as) one or more road points in another dataset

5.3
equivalence relationship (between road segments)

correlation used to indicate that a road segment in one dataset is equivalent to (that is to say, represents the same part of the physical road system as) one or more, whole or partial, road segments in another dataset

5.4
road feature

entity that constitutes the road system

5.5
road path

ordered list of whole or partial sections of physical road (that is to say, road segments)

EXAMPLE An administrative route, such as Interstate 95, or a delivery route.

6 Symbols, abbreviated terms, and notations

Symbols, abbreviations, and notations common to two or more transportation parts are listed in the Transportation Base (Part 7). Symbols, abbreviations, and notations applicable to multiple parts, including the transportation parts, are listed in the Base Document (Part (0).

7 Road system model

7.1 Road system

The road system model describes the geographic locations, interconnectedness, and characteristics of the street and roads in the larger transportation system. The transportation system includes physical and non-physical components representing all modes of travel that allow the movement of goods, services, and people between locations.

The road infrastructure is a physical component of the entire transportation system, generally consisting of public ways with perhaps a number of carriageways that are possibly paved.

The focus of this part of the standard is to define a way to encode segments, their start and end points, and their attributes, which may have different values associated with different parts of a segment. The model has three main components:

- A road segmentation model, which defines the representation of the physical segments of the road network (road segments), their connectivity (road points), and their usage (road paths)
- An event model, which defines a method to model attributes that may have values that change from one part of a segment to another and to linearly locate features along road segments or paths
- A linear reference model, which defines how locations are specified along linear features. Strictly speaking, the linear reference model is not a part of this model, but is referenced because of the part it plays in handling the attribution for road features. The linear reference model is described in full in Annex B of the Transportation Base

7.2 Road segmentation model

7.2.1 Introduction

A road feature is any type of transportation feature that is part of the road system. It is a type of transportation feature.

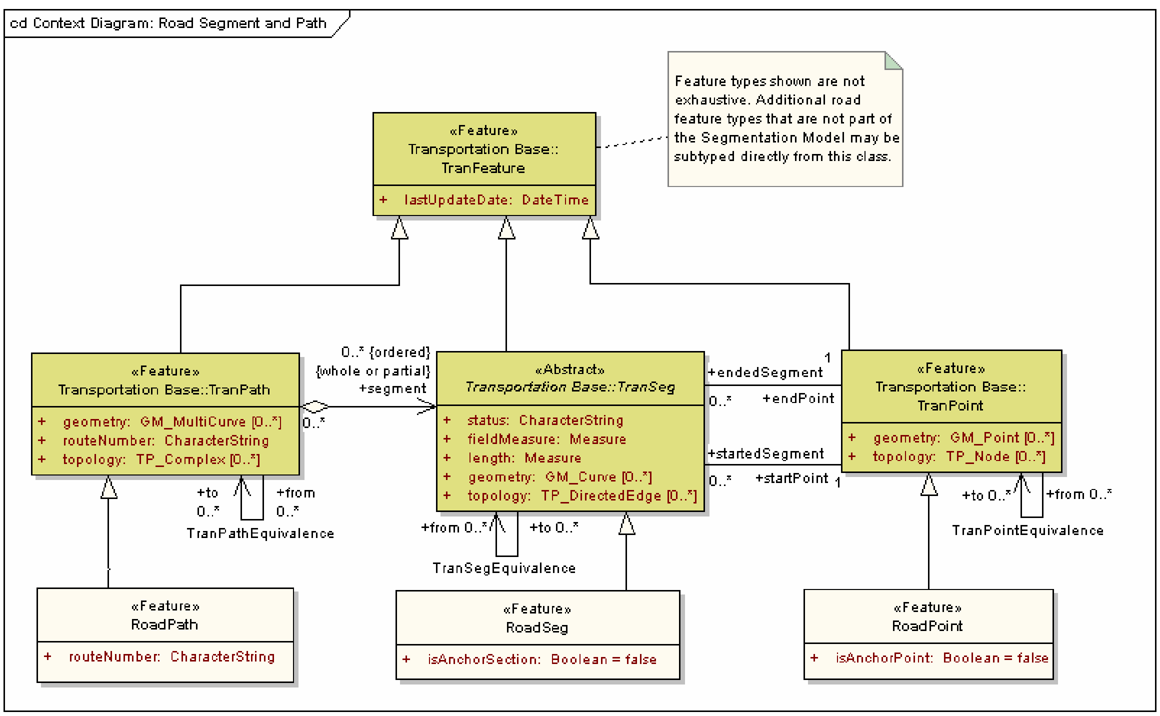

Figure 1 – Context diagram: Relationship of road features to Transportation Base (Part 7) model

To ensure maximum utility in a variety of contexts, this road model does not prescribe any specific business rules for the segmentation of the road system. The road network is the set of road features and their topological relationships which together define all possible movements through the road system. The road network can be broken up into segments called RoadSegs. RoadSegs represent individual pieces of the physical road network, such as that part of Main

Street which exists between First Avenue and Second Avenue. RoadSegs are topologically connected by RoadPoints. RoadPoints serve to connect two RoadSegs. RoadPaths prescribe a usage of part of the road network. They represent a path through a set of whole or partial RoadSegs, such as Route 66 or Washington Avenue. RoadSeg, RoadPoint, and RoadPath are specializations of the transportation feature classes TranSeg, TranPoint, and TranPath, respectively (see Figure 1). All other real world entities comprising the road system are represented as road features.

7.2.2 RoadPoint

RoadPoint is the specified location of an endpoint of a RoadSeg. This relationship is illustrated in Figure 2, where two RoadPoints, A and B, bound a RoadSeg. Point C represents the location of some real world entity such as an intersection or a bridge somewhere along the RoadSeg. Point D represents the location of another entity along the RoadSeg, but offset a lateral distance to one side. Because C and D do not terminate or represent the topological connection between RoadSegs, they shall not be represented as RoadPoints. Instead, if they represent real world entities (with attributes), they shall be represented as road features. FeatureEvents can be used to define their location along and optionally offset from a RoadSeg. Alternatively, Points C and D can be represented as AttributeEvents if they represent attributes instead of entities, such as the start of a bridge. This is explained further in the event model section below.

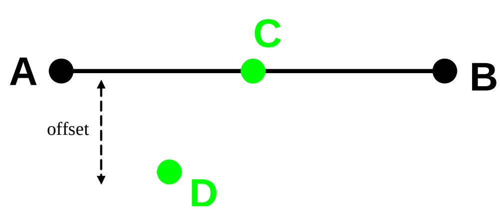

Figure 2 – RoadPoints bounding a RoadSeg (A, B) and non-RoadPoints (C, D)

RoadPoints can have geometry of type GM_Point and topology attribute of type TP_Node. Both GM_Point and TP_Node are inherited from TranPoint and defined in ISO 19107.

7.2.3 Anchor point

An anchor point represents a physical location in the field that can be unambiguously described so that it can be clearly located in the real world using the point description. An anchor point is a link between the computer representation of the road system and the real world. An anchor point shall occur at the ends of an anchor section. There is no requirement to include anchor points in the dataset being transferred, so all RoadPoints are not necessarily anchor points. Figure 1 shows that RoadPoint has a Boolean attribute (isAnchorPoint) indicating whether the point is considered an anchor point.

7.2.4 RoadSeg

RoadSeg represents a continuous nonbranching linear section of a road, which means that RoadSeg represents a road segment. RoadSeg is a specified directed path between two RoadPoints along a physical road that identifies a unique segment of that system. Each segment has an identifier, with points used to start and end segments. It is important to note here that a RoadSeg does not necessarily have to be an entire road. It could be a single lane or a carriageway. Furthermore, a segment is not defined as a line on a map, but as a segment of physical road, of which the beginning, end, and length are determined by transportation agencies based on their business needs. The agencies determine where the junctions of segments are placed.

RoadSeg extends TranSeg and is depicted in Figure 1. Because it extends TranSeg, RoadSeg inherits all properties from TranSeg including optional geometry of type GM_Curve as defined in

ISO 19107. According to ISO 19107, GM_Curve extends GM_OrientableCurve and therefore has direction. RoadSeg also can have a topology of type TP_DirectedEdge, as defined in ISO 19107. The reason TP_DirectedEdge has been introduced is to facilitate the representation of feature topology through its combinatorial structures independent of its geometry. For example, in the implementation of this model, a data provider may choose to represent only the geometry of a RoadSeg, which implies a direction inherited from GM_OrientableCurve. Another data provider may choose not to supply road feature geometry and only provide the orientation of the RoadSeg using its topology attribute.

7.2.5 Road segment equivalence

Different transportation agencies may define their segments differently. In Figure 3, one agency has defined segment 1-1 extending from A to B. Another agency can represent the same section of road using two road segments, 2-1 and 2-2, with road points “A” and “B” and a new point “D.” The equivalence relationship on the RoadSeg class provides the ability to indicate that a segment is equivalent to one or more other segments. For example, segments 2-1 and 2-2 are equivalent to segment 1-1. The concepts of equivalency are described in detail in Annex A of the Transportation Base.

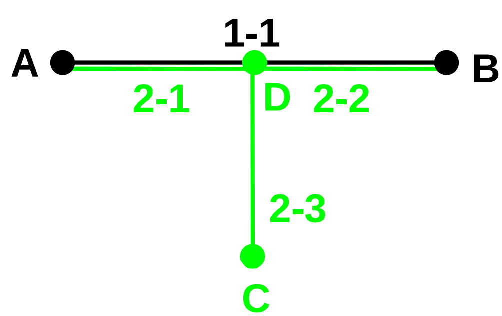

Figure 3 – Creating subsegments from main segments

7.2.6 Anchor section

An anchor section represents a section of road between two known and recoverable locations, that is to say, anchor points. RoadSeg has a Boolean attribute indicating whether the segment is an anchor section. Anchor sections state the official length of a road segment. Anchor points say where the anchor section starts and ends. The function of anchor sections is to support the collection of data by providing an "all distances measured on this piece of road shall add up to this length" checksum. Figure 1 shows that RoadSeg has an attribute to indicate whether it is an anchor section.

7.2.7 RoadPath

Because it is a path through the physical road network, RoadPath may be an ordered list of whole or partial RoadSegs it uses, which may or may not be contiguous. RoadPath extends TranPath as shown in Figure 1. An example of RoadPath is an Interstate highway such as Interstate 40. The geometry of RoadPath is GM_MultiCurve, to allow for discontinuities in the path. The topology of RoadPath is TP_Complex and routeNumber is a character string.

7.2.8 Attributes for road system

Listed below in Table 1 are the road system objects and their attributes.

Table 1 – Road system objects

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
1	RoadPath	Linear, possibly discontinuous portion of the road system that may be a collection of RoadSeg instances			<<Feature>>	Lines 2-11
2	Framework::Feature::identifier	Feature identifier for the RoadPath	M	1	<<DataType>> Framework::Identifier	Unrestricted
3	Framework::Feature::metadata	Structured or unstructured metadata as defined by the community of practice	O	1	CharacterString	May be text or structured metadata fragment
4	Framework::Feature::attribute	Producer-defined attribute for inclusion in transfer	O	*	<<DataType>> Framework::Extended Attributes	Unrestricted
5	Transportation Base:: TranFeature::lastUpdateDate	Timestamp indicating when the RoadPath object was last edited	M	1	DateTime	Valid historical or current date and time
6	Transportation Base:: TranPath::geometry	Geometric representation of the instantiated RoadPath entity	O	*	<<Type>> GM_MultiCurve	Defined in ISO 19107
7	Transportation Base:: TranPath::topology	Topological representation	O	*	<<Type>> TP_Complex	Defined in ISO 19107
8	routeNumber	Public RoadPath identifier	M	1	CharacterString	Unrestricted
9	Role name: segment	Road segment feature used by the RoadPath	O	*	<<Abstract>> TransportationBase:: TranSeg	Whole or partial RoadSeg
10	Role name: from	Source RoadPath in equivalency	C/Part of equivalency?	*	<<Feature>> TransportationBase::	Unrestricted

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
					TranPath	
11	Role name: to	Destination RoadPath in equivalency	C/Part of equivalency?	*	<<Feature>> TransportationBase:: TranPath	Unrestricted
12	RoadPoint	RoadSeg terminus (start, end)			<<Feature>>	Lines 13-23
13	Framework::Feature::identifier	Feature identifier for the RoadPoint	M	1	<<DataType>> Framework::Identifier	Unrestricted
14	Framework::Feature::metadata	Structured or unstructured metadata as defined by the community of practice	O	1	CharacterString	May be text or structured metadata fragment
15	Framework::Feature::attribute	Producer-defined attribute for inclusion in transfer	O	*	<<DataType>> Framework:: ExtendedAttributes	Unrestricted
16	Transportation Base:: TranFeature::lastUpdateDate	Timestamp indicating when the RoadPoint object was last edited.	M	1	DateTime	Valid historical or current date and time
17	Transportation Base:: TranFeature:geometry	Geometric representation of the instantiated road point entity	O	*	<<Type>> GM_Point	Defined in ISO 19107
18	Transportation Base:: TranFeature:topology	Topological representation	O	*	<<Type>> TP_Node	Defined in ISO 19107
19	isAnchorPoint	Indicates whether RoadPoint is an anchor point	M	1	Boolean	True/False, Yes/No, 1/0; default = False
20	Role name: startedSegment	Segment that starts at the road point	C/RoadSeg starts at RoadPoint?	*	<<Abstract>> TransportationBase:: TransSeg	Unrestricted
21	Role name: endedSegment	Segment that ends at the road point	C/RoadSeg ends at RoadPoint?	*	<<Abstract>> TransportationBase:: TransSeg	Unrestricted
22	Role name: from	Source RoadPoint in equivalency	C/Part of equivalency?	*	<<Feature>> TransportationBase::	Unrestricted

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
					TranPoint	
23	Role name: to	Destination RoadPoint in equivalency	C/Part of equivalency?	*	<<Feature>> TransportationBase:: TranPoint	Unrestricted
24	RoadSeg	Linear, continuous, non-branching portion of the road system			<<Feature>>	Lines 25-38
25	Framework::Feature::identifier	Feature identifier for the RoadSeg	M	1	<<DataType>> Framework::Identifier	Unrestricted
26	Framework::Feature::metadata	Structured or unstructured metadata as defined by the community of practice	O	1	CharacterString	May be text or structured metadata fragment
27	Framework::Feature::attribute	Producer-defined attribute for inclusion in transfer	O	*	<<DataType>> Framework:: ExtendedAttributes	Unrestricted
28	Transportation Base:: TranFeature::lastUpdateDate	Timestamp indicating when the RoadSeg object was last edited	M	1	DateTime	Valid historical or current date and time
29	Transportation Base:: TranSeg::status	Status of segment entity; for example, proposed, under construction, open to traffic, abandoned, and so on	M	1	CharacterString	Unrestricted
30	Transportation Base:: TranSeg::fieldMeasure	Length of segment, as determined in the field; if isAnchorSection = True, then this is the official length of the segment for the LRS	M	1	Measure	Defined in ISO 19103
31	Transportation Base:: TranSeg::length	length of the RoadSeg feature, which may differ from the field measured length due to differences in calculation	M	1	Measure	Unrestricted
32	Transportation Base:: TranSeg::geometry	Geometric representation of the instantiated segment entity	O	*	<<Type>> GM_Curve	Defined in ISO 19107

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
33	Transportation Base:: TranSeg::topology	Topological representation	O	*	<<Type>> TP_DirectedEdge	Defined in ISO 19107
34	isAnchorSection	Indicates whether road segment is an anchor section	M	1	Boolean	True/False, Yes/No, 1/0; default = False
35	Role name: startPoint	RoadPoint corresponding to segment start	M	1	<<Feature>> TransportationBase:: TranPoint	Unrestricted
36	Role name: endPoint	RoadPoint corresponding to segment end	M	1	<<Feature>> TransportationBase:: TranPoint	Unrestricted
37	Role name: from	Source RoadSeg in equivalence	C/Part of equivalency?	*	<<Abstract>> TransportationBase:: TranSeg	Unrestricted
38	Role name: to	Destination RoadSeg in equivalence	C/Part of equivalency?	*	<<Abstract>> TransportationBase:: TranSeg	Unrestricted

7.3 The event model

7.3.1 Introduction

Transportation events are the mechanism by which attributes or entities can be linearly located along either a TranSeg or a TranPath linear feature. Refer to the transportation event model in the Transportation Base for a more detailed overview of the transportation event model. Transportation events can be either attribute events or feature events. Within the Roads part, events specific to the road system are supported as specializations of transportation attribute and feature events.

7.3.2 RoadAttributeEvent

If an attribute value of a linear feature has a single, constant value along the entire length of the feature (for example, status and fieldMeasure), the attribute exists at the feature (RoadSeg or RoadPath) level and it is sufficient to store this single value with the feature. If the value of the attribute can change along the length of the linear feature (for example, speed limit, number of lanes); the location where each change occurs must also be specified. To accomplish this, RoadAttributeEvents are used.

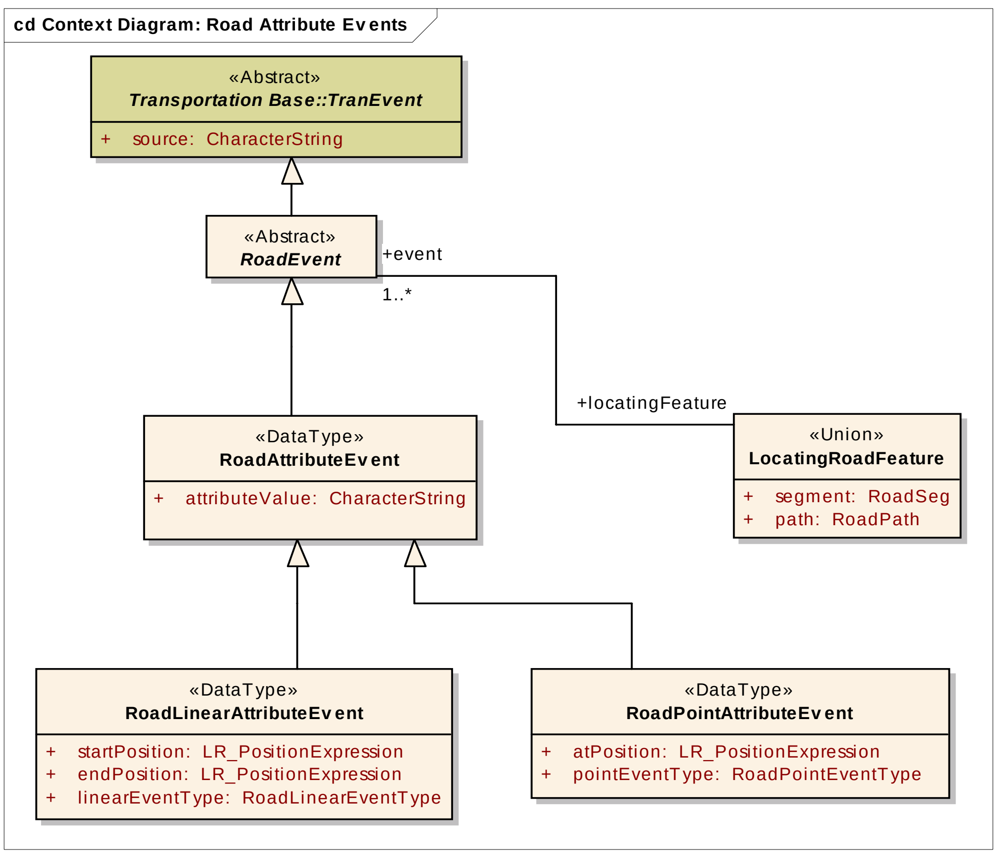

Figure 4 – RoadAttributeEvent model

Each RoadAttributeEvent specifies a particular value for an attribute of a linear feature along with the location along that feature for which the value applies. RoadAttributeEvents are subtyped into point and linear events. A RoadPointAttributeEvent event occurs at a single position along a RoadSeg or RoadPath. This position is called an “at” position. RoadLinearAttributeEvents apply to a length of the RoadSeg or RoadPath. This interval is defined by a “start” and an “end” position on the RoadSeg or RoadPath. The “at”, “start”, and “end” positions used to locate an event are specified using a linearly referenced position expression. This expression specifies the linear reference method used to perform the measurement, the linear feature (RoadSeg or RoadPath) being measured, the measurement along the feature, and optionally the measurement laterally offset to either side. See Annex B of the Transportation Base for more details.

7.3.2.1 RoadLinearAttributeEvent

RoadLinearAttributeEvents provide the means of specifying the value and location of a single segment or path attribute that may apply only to part of the segment or path. The value of the segment or path attribute is specified as the attributeValue, inherited from RoadAttributeEvent. The location interval along which the value applies is specified by a “start” and “end” position along the segment or path, using linearly referenced position expressions explained in Annex B of the Transportation Base. The name of the attribute is specified by the linearEvent attribute of RoadLinearAttributeEvent. A non-exhaustive code list of RoadLinearEventType values is supplied (see Figure 6). An example of a RoadLinearAttributeEvent is the speed limit of a road. The RoadLinearEventType value is “speedRestriction”. An attributeValue of 55 MPH might apply for only part of the road segment, delineated by “start” and “end” positions along the road segment. RoadLinearAttributeEvents have no geometry of their own but instead inherit any geometry which may have been defined for the segment or path to which they apply.

7.3.2.2 RoadPointAttributeEvent

RoadPointAttributeEvent provides the means of specifying the value and location of a single segment or path attribute that has a particular value only at a single point along the segment or path. The value of the segment or path attribute is specified as the attributeValue, inherited from RoadAttributeEvent. The point location is specified by an “at” position along the segment or path, using a linearly referenced position expression explained in Annex B of the Transportation Base. The name of the attribute is specified by the pointEvent attribute of RoadPointAttributeEvent. A non-exhaustive code list of RoadPointEventType values is supplied (see Figure 6). An example of a RoadPointAttributeEvent is a stop sign along a road. The RoadPointEventType value is “sign”. An attributeValue of “stop” specifies the type of sign. The sign is located at a position along the road segment. The position expression allows the sign to be located at a position laterally offset from the center of the road. If more information is needed about the sign, the sign shall instead be represented as a feature and then linearly located with a RoadPointFeatureEvent. RoadPointAttributeEvents can also be used to specify where something like a pedestrian cross walk crosses the segment or path. RoadPointAttributeEvents have a linear location along a segment or path but have no explicit geospatial coordinate location of their own. This can be obtained from any geometry which may have been defined for the segment or path to which the RoadPointAttributeEvent applies.

7.3.3 RoadFeatureEvent

Features can have attributes, each with a single, constant value. One of these attributes can be the geometry of the feature. For example, a street sign road feature can have a height attribute and a point geometry. This feature can also be linearly located along one or more RoadSegs or RoadPaths. Each such linear location is specified by a RoadFeatureEvent. The RoadFeatureEvent linearly locates any feature along a RoadSeg or RoadPath. RoadFeatureEvents are subtyped into RoadPointFeatureEvents and RoadLinearFeatureEvents. A RoadPointFeatureEvent occurs at a single position along a RoadSeg or RoadPath. This position is called an “at” position. RoadLinearFeatureEvents apply to a length of the RoadSeg or RoadPath. This interval is defined by a “start” and an “end” position on the RoadSeg or RoadPath. The “at”, “start”, and “end” positions used to locate an event are specified using a linearly referenced position expression. This expression specifies the linear reference method used to perform the measurement, the linear feature (RoadSeg or RoadPath) being measured, the measurement along the feature, and optionally the measurement laterally offset to either side. See Annex B of the Transportation Base for more details.

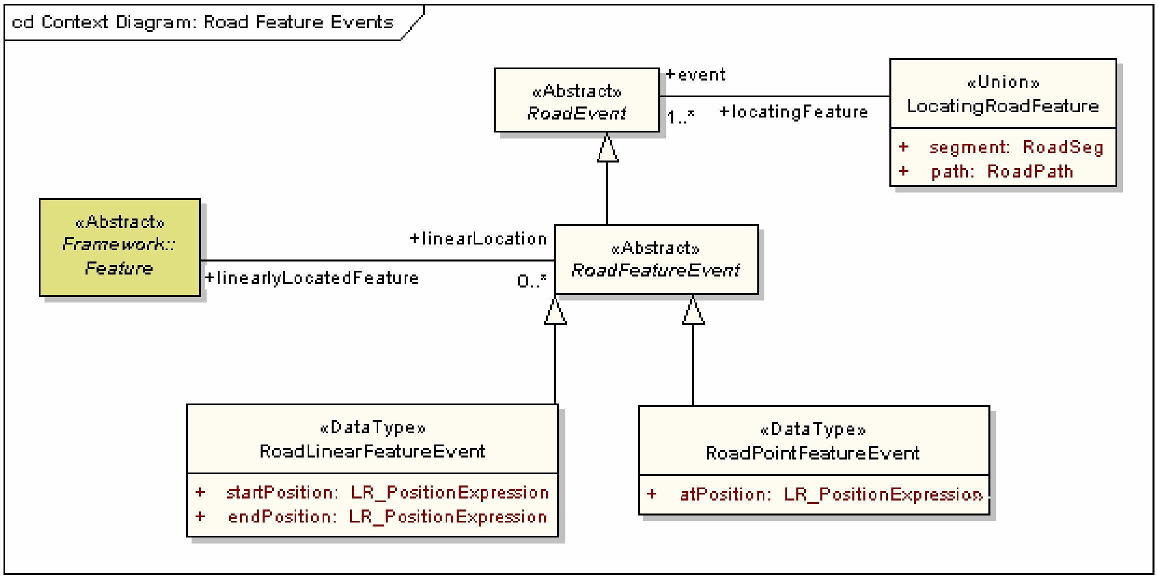

Figure 5 – RoadFeatureEvent model

7.3.3.1 RoadLinearFeatureEvent

A RoadLinearFeatureEvent provides the means of specifying a linear location for a feature as a length along a segment or path. All of the feature's attributes, including optional geometry, are included with the feature. The RoadLinearFeatureEvent is only attributed with the linear location. There are no restrictions on the type of feature being located. The feature can be linear, like guardrail. Guardrail attributes, like date installed or manufacturer, are kept with the guardrail feature. The location where the guardrail begins along the roadway is kept with the RoadLinearFeatureEvent, specified as the "start" position; the location where the guardrail ends is specified by the "end" position. The "start" and "end" positions each use a linearly referenced position expression explained in Annex B of the Transportation Base. The guardrail feature may not have geometry of its own, but instead rely on the geometry of the locating segment or path. Features with area geometries, like a county, are also supported. In this case, the RoadLinearFeatureEvent depicts what part of the segment or path is in the county.

7.3.3.2 RoadPointFeatureEvent

A RoadPointFeatureEvent provides the means of specifying a linear location for a feature as a single point location along a segment or path. All of the feature's attributes, including optional geometry, are included with the feature. The RoadPointFeatureEvent is only attributed with the linear location of the feature along a segment or path, specified by a single "at" position along the segment or path using a linearly referenced position expression explained in Annex B of the Transportation Base. There are no restrictions on the type of feature being located. The feature can have a point footprint, like a stop sign. Sign attributes, like date installed or height, are kept with the sign feature. The sign feature may not have geometry of its own, but instead rely on the geometry of the locating segment or path. Features with linear geometries, like a county boundary, are also supported. In this case, the RoadPointFeatureEvent depicts where the segment or path crosses the county boundary (that is to say, the county changes).

Figure 6 – RoadPointEvent and RoadLinearEvent code lists

7.3.4 RoadAttributeEvent data dictionary

Listed below in Table 2 are the RoadAttributeEvent objects and their associated attributes.

Table 2 – RoadAttributeEvent data dictionary

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
39	RoadEvent	Mechanism for locating an attribute value or feature along a road			<<Abstract>>	Lines 40-41
40	Transportation Base:: TranEvent::source	Supplier of the event object	M	1	CharacterString	Unrestricted
41	Role name: locatingFeature	Road feature to which event is referenced	M	1	<<Union>> LocatingRoadFeature	RoadSeg or RoadPath
42	RoadAttributeEvent	Mechanism for locating an attribute value along a road			<<DataType>>	Line 43
43	attributeValue	Value of the attribute at the specified location	M	1	CharacterString	Unrestricted
44	RoadLinearAttributeEvent	Mechanism for locating an attribute value for an interval along a road			<<DataType>>	Lines 45-47
45	startPosition	Starting location along the road for the attribute value	M	1	<<Type>> LR_PositionExpression	Defined in ISO 19133
46	endPosition	Ending location along the road for the attribute value	M	1	<<Type>> LR_PositionExpression	Defined in ISO 19133
47	linearEventType	Name of the attribute	M	1	<<CodeList>> RoadLinearEventType	Restricted to values in the code list RoadLinearEventType (see Figure 6)
48	RoadPointAttributeEvent	Mechanism for locating an attribute value at a single point along a road			<<DataType>>	Lines 49-50
49	atPosition	Point location along the road at	M	1	<<Type>>	Defined in ISO 19133

Line	Name/Role Name	Definition	Obligation/ Condition	Maximum Occurrence	Data Type	Domain
		which the attribute value applies			LR_PositionExpression	
50	pointEvent	Name of the attribute	M	1	<<CodeList>> RoadPointEventType	Restricted to the values in the code list RoadPointEventType (see Figure 6)
51	RoadFeatureEvent	Mechanism for locating a feature along a road			<<Abstract>>	Line 52
52	Role name: linearlyLocatedFeature	Feature that is located along the road	M	1	<<Feature>> Framework:: Feature	Unrestricted
53	RoadLinearFeatureEvent	Mechanism for locating a feature along an interval along a road			<<DataType>>	Lines 54-55
54	startPosition	Starting location along the road for the feature	M	1	<<Type>> LR_PositionExpression	Defined in ISO 19133
55	endPosition	Ending location along the road for the feature	M	1	<<Type>> LR_PositionExpression	Defined in ISO 19133
56	RoadPointFeatureEvent	Mechanism for locating a feature at a single point along a road			<<DataType>>	Line 57
57	atPosition	Point location along the road at which the feature is located	M	1	<<Type>> LR_PositionExpression	Defined in ISO 19133
58	LocatingRoadFeature	Road feature used to locate a road event			<<Union>>	Lines 59-61
59	segment	The RoadSeg used to locate a road event	C/If path is notspecified	1	RoadSeg	Unrestricted
60	path	The RoadPath used to locate a road event	C/If segment is not specified	1	RoadPath	Unrestricted
61	Role name: event	Road event located by the feature	M	*	<<Abstract>> RoadEvent	Unrestricted

7.4 Code lists

7.4.1 RoadLinearEventType code list

RoadLinearEventType is a non-exhaustive CodeList of values for the attribute linearEvent.

Table 3 – CodeList for RoadLinearEventType

Name	Definition
operationalStatus	
length	
routeNumber	
directionalPrefix	
directionalSuffix	
ownership	
addressInformation	
alternateName	
alternateNameBody	
alternateNameText	
alternateStreetName	
alternateStreetNameBody	
alternateStreetNameText	
averageVehicleSpeed	
directionOfTrafficFlow	
dividedRoadElement	
divider	
dividerType	
dividerWidth	
emergencyVehicleLane	
externalIdentifier	
firstHouseNumber	
formOfWay	
frequencyOfATrafficConnection	
functionalRoadClass	
houseNumberRange	
houseNumberStructure	

Name	Definition
intermediateHouseNumber	
laneDependentValidity	
lastHouseNumber	
lateralOffset	
maxHeightAllowed	
maxLengthAllowed	
maxWeightAllowed	
maxNumberOfLanes	
maxTotalWeightAllowed	
maxWeightPerAxleAllowed	
maxWidthAllowed	
minNumberOfLanes	
minNumberOfOccupents	
mountainPass	
multiMediaAction	
multiMediaDescription	
multiMediaFileAttachment	
multiMediaFileAttachmentContext	
multiMediaFileAttachmentName	
multiMediaFileAttachmentType	
multiMediaTimeDomain	
nameComponent	
nameComponentLength	
nameComponentOffset	
nameComponentType	
namePrefix	
numberOfLanes	
openingPeriod	
pavedRoadSurfaceType	
pavementStatus	
postalCode	
removableBlockage	

Name	Definition
roadGradient	
roadInclination	
scenicValue	
slipRoadType	
specialRestriction	
speedRestriction	
trafficFlow	
trafficFlowMeasure	
trafficFlowMeasurementType	
trafficFlowMeasurementUnit	
trafficJamSensitivity	
travelTime	
validityDirection	
validityPeriod	
vehicleType	
width	

7.4.2 RoadPointEventType code list

RoadPointEventType is a non-exhaustive CodeList of values for the attribute pointEvent.

Table 4 – CodeList for RoadPointEventType

Name	Definition
pass	
tollbooth	
tollCharge	
maxElevation	
sign	

Annex A
(informative)
Road example

The map in Figure A.1 depicts a set of roads which are to be exchanged using this part of the standard.

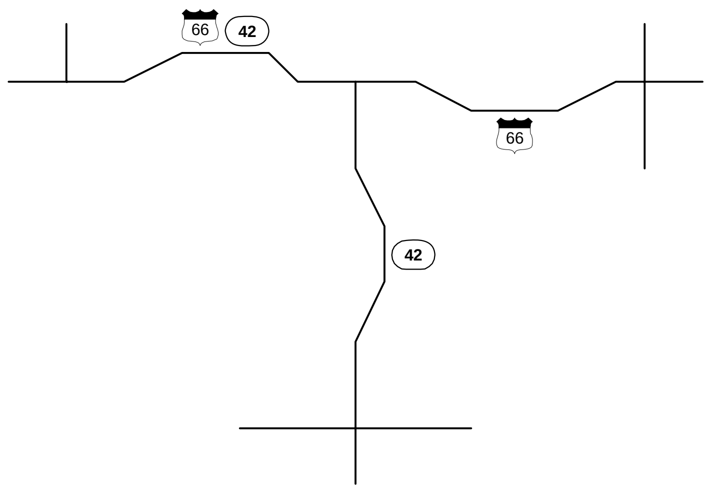

Figure A.1 – Road example

The data supplier chooses to create a segmentation model based on splitting the physical roads at all intersection locations. Road points are defined at these intersection locations. These are represented by road points 1, 2, 3, and 4 in Figure A.2. Road segments represent the physical roads between these road points. Road segment 101 starts at road point 1 and ends at road point 2; 102 from 2 to 3; and 103 from 2 to 4.

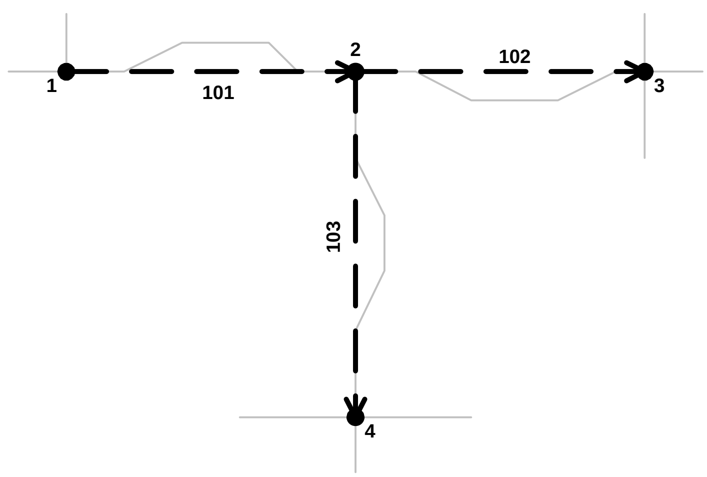

Figure A.2 – Road points and road segments

The road segments are depicted as straight lines in Figure A.2 to highlight the fact that they are not geometric shapes; they merely represent the physical roadway. Any number of geometric shapes can be associated with each road segment to represent its physical shape and location at varying levels of precision. Figure A.3 shows an approximate, linestring geometry for the road segments which may be sufficient for GIS applications. Figure A.4 shows a more precise, curve geometry which might be used for engineering design and construction.

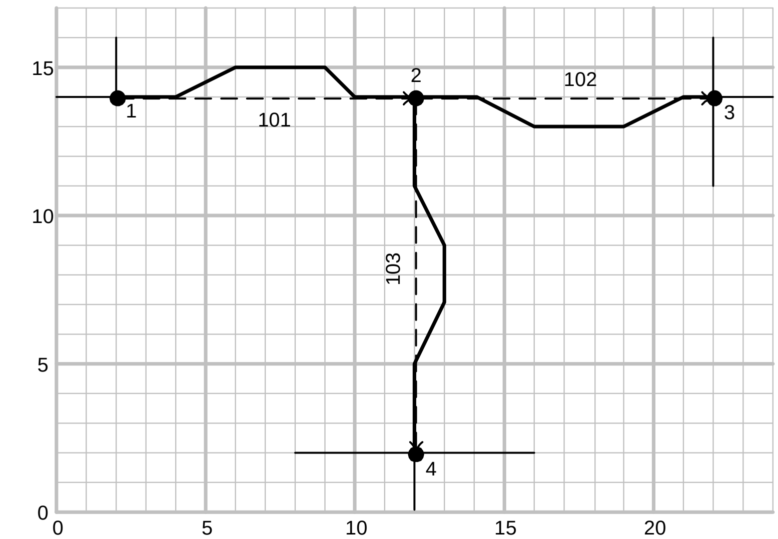

Figure A.3 – Approximate GIS linestring geometry

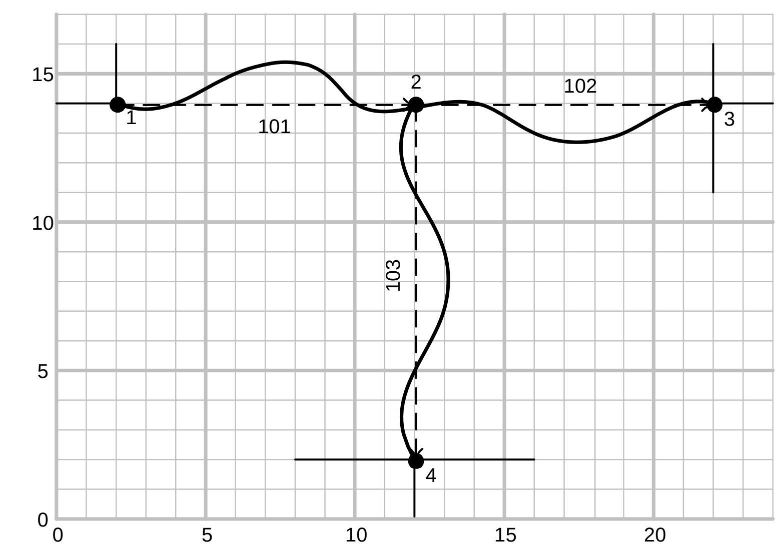

Figure A.4 – More precise engineering curve geometry

Regardless of the associated geometry, each road segment is attributed with a length value for use in linearly referenced calculations. Additionally, each road segment has a field measure value equal to the actual length of the physical road in the field.

The rationale for segmentation is up to the data provider. It would have been acceptable to have alternatively defined a single road segment, 100, between road points 1 and 3 in a different dataset. Road segment 100 could then be equivalenced to segments 101 and 102. Alternative road points could have been defined at locations other than intersections, if the segmentation strategy was something other than intersection to intersection.

Road paths are used to represent a usage of the road segments, such as for administrative routes. In Figure A.5, U.S. Route 66 follows the physical road represented by road segments 101 and 102. State Highway 42 also uses 101 but then makes a right turn and follows road segment 103.

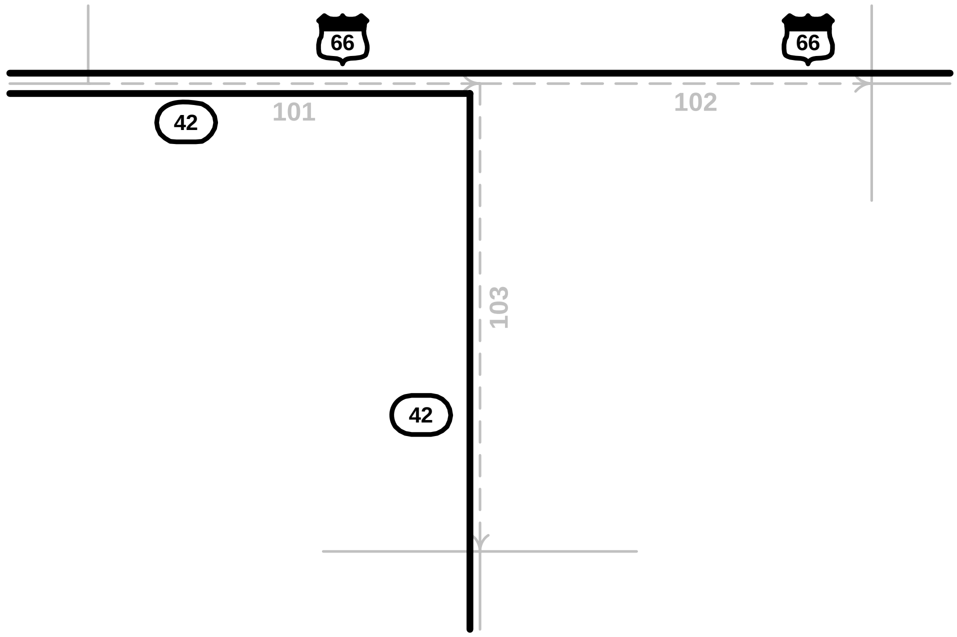

Figure A.5 – Road paths

Because Route 66 uses the entire road segments and because its direction of increasing mileage matches the direction of the underlying road segments, it is sufficient to define the association between Route 66 and road segments 101 and 102 as a simple list.

Because a road path can use partial as well as whole road segments, a more sophisticated mapping may be used. One way to achieve this is to use linear referencing to define matching locations on the path and the participating segments. Table A.1 shows the road segment mappings for paths 66 and 42. Positions along the paths are expressed using a milepoint linear reference method, where locations are measured in miles from the start of the path (see Figure A.6). Positions along road segments are defined using a percentage linear reference method, where locations are expressed as a percentage of the length attribute of the road segment, in the direction from its start to end road points.

Table A.1 – Road path to road segment mappings

Road Path	Milepoint	Road Segment	Percentage
Route 66	52.0	101	0
	64.6	101	100
	64.6	102	0
	75.0	102	100
Highway 42	10.0	101	0
	22.6	101	100
	22.6	103	0
	35.0	103	100

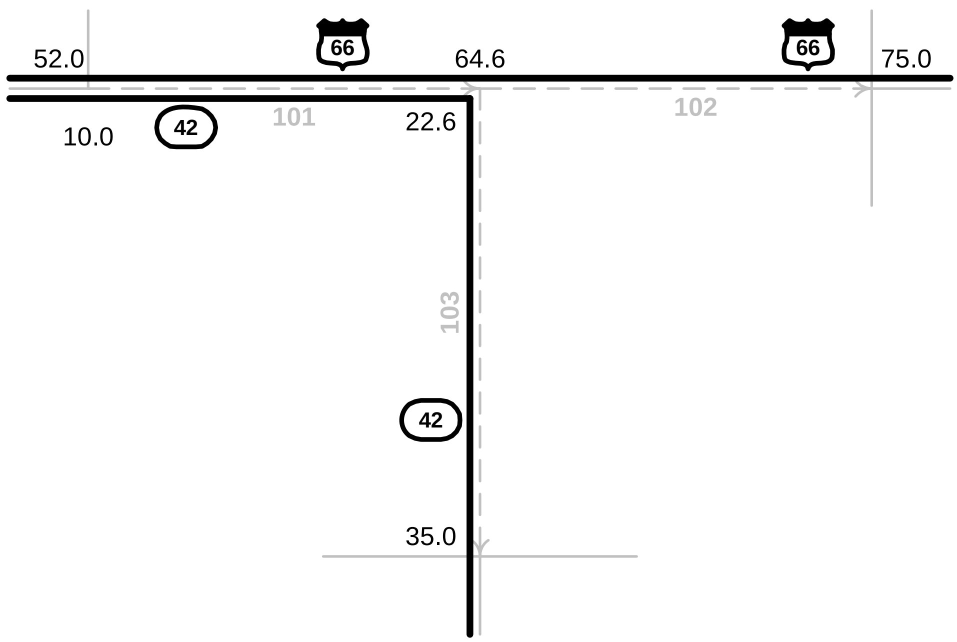

Figure A.6 – Routes with milepoint values

Attributes can be defined directly for segments and paths if they apply to the entire segment or path, respectively. Examples of these are road segment length and road path route number. Often, attributes can change value along the length of the segment or path. This is encoded as road attribute events.

Speed limit is an example of the linear type of road attribute event; the speed limit can have different values at different locations along a road segment or road path (see Figure A.7). The speed limit attribute events can be defined against road paths using a milepoint linear reference method as in Table A.2.

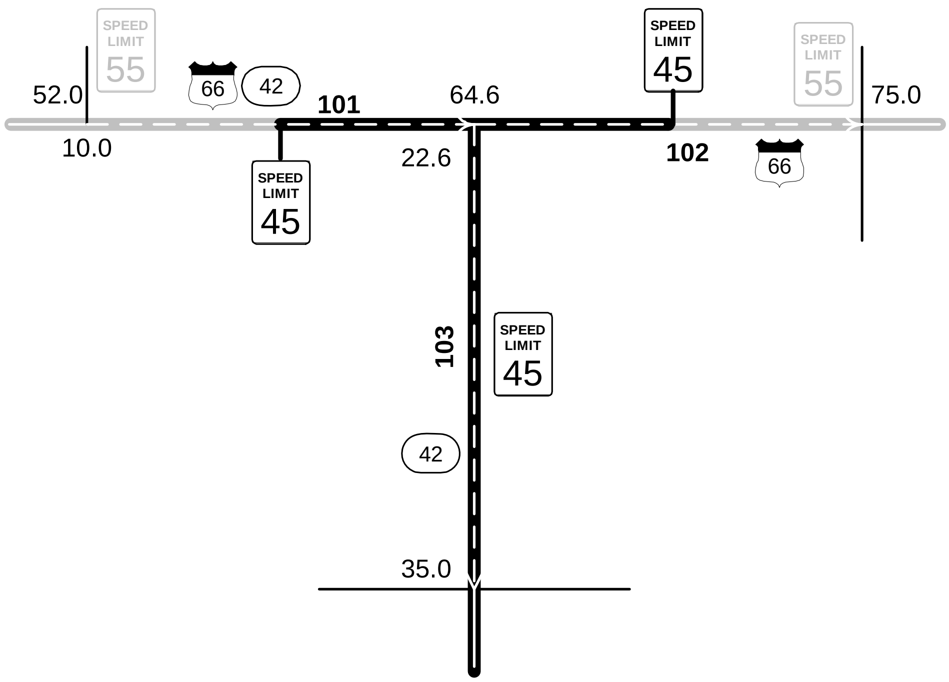

Figure A.7 – Speed limit road linear attribute events

Table A.2 – Road path speed limit linear attribute events

Road Path	Speed Limit Value	From Position Milepoint	To Position Milepoint
Route 66	55	52.0	58.3
	45	58.3	69.8
	55	69.8	75.0
Highway 42	55	10.0	16.3
	45	16.3	35.0

Alternatively, since speed limit is functionally dependent upon the road segment rather than the routes that use it, speed limit road attribute events could be defined against the underlying road segments as in Table A.3. This way, a speed limit value is defined once but then usable by all routes using the road segment. This normalized approach facilitates edits to speed limit values – there is only one occurrence to be edited. It also makes it possible to give roads without route designations a speed limit value(s).

Table A.3 – Road segment speed limit linear attribute events

Road Segment	Speed Limit Value	From Position Percentage	To Position Percentage
101	55	0	50
	45	50	100
102	45	0	50
	55	50	100
103	45	0	100

Road attribute events may occur at a single point along the road. An example of this point type of road attribute event is “sign”. This event is characterized by the value of the attribute, in this case the type of sign, and an “at” position defining its linearly referenced location. For the stop sign in Figure A.8, the value is “stop” and the “at” position is {road segment 103, percentage/feet, 0.1, left curb, -5.0}. The position expression shown within the curly braces is, in accordance with ISO 19133, comprised of the linear element being measured (road segment 103), the linear referencing method (percentage with offsets measured in feet), a distance of 0.1% along the length of road segment 103 in the direction from road point 2 to 4, an offset referent equal to “left curb”, and an offset distance of 5.0 feet to the left of, that is, from the back of the curb.

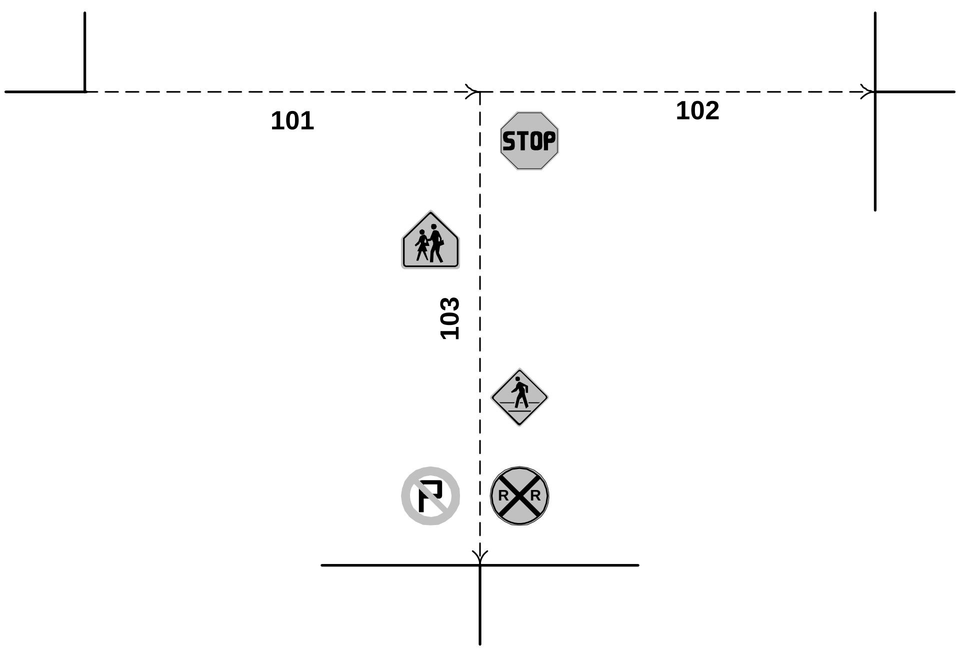

Figure A.8 – Road segment point events

If more information needs to be exchanged about the stop sign, then it can be encoded with a point feature (rather than attribute) event. This event has the same at position as defined above. Instead of an attribute value, it has an association to a sign feature. This feature can have whatever attributes are appropriate, for example authority = “DOT”, identifier = 1073625, description = “stop sign”, last update date = 1992-1-9, installed date = 1991-7-11, height = 5’6”, and GM_Point = (12.01, 13.99). Notice that, as a feature, the stop sign can have its own geometry, independent of its linearly referenced location along road segment 103.

Figure A.8 has additional point attribute or feature events, such as a pedestrian crosswalk or a railroad crossing. School zones and no parking areas would more likely be encoded as linear attribute or feature events.