American National Standard
for Information Technology—

Geographic Information Framework – Data Content Standards For Transportation Networks: Rail

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Geographic Information Framework Data Content Standards For Transportation Networks: Rail
(Part XXX)

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American National Standard

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Foreword

The primary purpose of the standard is to support the exchange of transportation data related to rail networks. This standard also seeks to establish a common baseline for the content of rail transportation databases for public agencies and private enterprises. It seeks to decrease the costs of acquiring and exchanging rail transportation data for local, tribal, state, federal, and North American users and creators of rail transportation data. Benefits of adopting the standard also include the long-term improvement of the geospatial transportation base data, improved integration of safety, emergency response, and enforcement data, and streamlined maintenance procedures.

This standard has been developed to fulfill one of the objectives of the NSDI, i.e., to create common geographic base data for seven critical data themes. These core themes are considered Framework data, reflecting their critical importance as geographic infrastructure. The Geospatial One Stop initiative is an e-government initiative of the federal government designed to expedite the creation of the seven Framework layers. This standard has been developed in response to the One Stop initiative to realize the goals and objectives of the NSDI.

Suggestions for improvements of this standard will be welcome. They should be sent to

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This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee – INCITS/L1. Committee approval of this Standard does not necessarily imply that all committee members voted for its approval.

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American National Standard for Information Technology
Geographic Information Framework
Data Content Standards
(ANSI X.X.X2002)

1 Scope of this Standard

This standard defines components of the railway system, which is one of at least five modes that compose the transportation theme of the digital geospatial data framework. The primary purpose of the standard is to support the exchange of transportation data related to the railway system. It is the intent of the standard to allow the widest utility of railway transportation data for the user and producer of transportation information by enhancing data sharing and reducing redundant data production.

At a high level, the rail system described in the standard is made up of rail features, which can have geographic locations and characteristics. These rail features can be interconnected in various ways to represent rail networks for routing applications. While the Rail MAT initially considered defining the content for detailed, engineering level datasets, this version of the standard focuses on a generalized view of the rail network that enables the broadest variety of operational uses. It is anticipated that the current version of the standard will be suitable for some engineering applications, however, the development team recognizes that all engineering needs will not be satisfied by this version of the standard. It is anticipated that future versions of this data standard will better define the content for rail engineering datasets in order to satisfy the data sharing needs of the entire rail community.

The standard can be implemented using a variety of software packages and is designed to accommodate data encoded without geometry as well as to support the exchange of data encoded in a variety of geographic information systems. It is designed to be able to depict the complete rail system at all levels of service and all functional classes that may be defined by a data-providing agency. It accommodates assets associated with the rail that are typically used for navigation, safety, and measurement.

The rail standard will initially apply to National Spatial Data Infrastructure (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 [1], federal agencies collecting or producing geospatial data, either directly or indirectly (e.g., 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.

Because of the North American scope of the railway network, this standard attempts to address the differences between Canadian and U.S. definitions of railway related concepts and terminology and harmonize the model to be applicable in both user communities. The rail development team is composed of representative stakeholders from both countries that address these issues as appropriate.

This standard is part of a set of transportation standards that are to be integrated into a comprehensive standard to support five primary modes of transportation systems: roads, rail, transit, air, and water. In the process of developing the rail standard, conflicts were identified that either impacted it or may be shared by the standard being developed for the transit mode. A separate sub-group has been established to address these issues and coordinate the efforts of both development teams. Recommendations will be incorporated into this standard where applicable.

A linkage between this 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 rail, or even to transportation. For the benefit of the user, Annex A contains a brief explanation of UML diagrams.

1.1 Railway Use Cases

In developing the standard, a series of general use cases were developed to assist in defining the requirements for a rail model. While these use cases focus on scenarios common to a broad segment of the rail industry, they are not comprehensive in defining all the potential uses of rail data. They were critical in providing focus for the development team. In future versions of the standard, more detailed and formalized use cases will be developed to facilitate expansion and refinement of the rail model.

1.1.1 Emergency Response Use Case

This use case details an emergency response scenario involving the following user groups.

- Locomotive Engineer
- Railroad Dispatcher

An event, such as a derailment, occurs that requires the railroad to involve outside agencies. The locomotive engineer needs to summon non-railroad emergency response agencies, such as fire departments to control fires, rescue squads to provide injury assistance, environmental agencies to contain hazardous material spills, or law enforcement to assist the population in vicinity of the incident.

During this type of scenario, the engineer contacts the railroad dispatcher and describes the event location by track and milepost. In response, the dispatcher contacts outside agencies to relate the railroad location to a location reference understood by the outside agency. By having the GIS data layers for tracks and mileposts as well as for streets, highways, municipal boundaries, waterways, and other pertinent geospatial layers, the dispatcher can describe the location relative to an intersection or provide a distance from a road crossing, city, or river for the outside agency to direct them to the derailment.

1.1.2 Emergency Stop Use Case

This use case details a scenario that requires the cessation of rail traffic along a specific section of track. This scenario involves the following user groups.

- Railroad Customer Service Center Representative
- Railroad Dispatcher
- Locomotive Engineer
- Local Law Enforcement Officer
- Local Law Enforcement Central Dispatching

An event occurs that requires the railroad to stop a train, such as a car stuck on a crossing. In response, a local law enforcement officer needs to contact the railroad to ensure on-coming rail traffic is stopped.

In this scenario, the law enforcement officer contacts the central dispatcher who then calls the railroad thought to be the owner of the track using a 1-800 number for the railroad. The railroad customer service center representative receives the call and the law enforcement officer relays information regarding the incident and the location of the road crossing. This could include the following types of location information:

- Street or highway name
- Municipality and/or county name
- State
- Closest intersection (highways or streets)
- Closest town or municipality to the event
- Proximity to other landmarks such as a bridge or river

The service representative will use GIS data for the rail network, such as track and milepost, overlaid with other GIS data layers for streets, highways, municipal boundaries, and waterways to correlate the location received from the law enforcement officer with a track and mile post. The service representative contacts the dispatcher in control of the identified track and sends notification of the situation. The dispatcher will then radio the locomotive engineers on approaching trains to have them stop at a safe distance from the crossing.

Additionally, if there are multiple tracks at the crossing and there is the possibility that another railroad could be operating through the crossing, the first railroad customer representative can contact the other railroad in order to stop their trains.

1.1.3 Incident Reporting Use Case

This use case details a scenario in which a member of the public contacts an “authority” to report an incident. This scenario involves the following user groups.

- The Railroad's Rail Traffic Control Center
- The Railroads' Law Enforcement Personnel
- Non Railroad Emergency Response Agencies (911, Fire Departments, Ambulance
- Services, Contractors, Population in vicinity of incident)

A member of the general public witnesses an incident on a railroad and needs to contact the appropriate "authorities" to describe the incident and the location. The citizen may not know the railroad track owner, subdivision name, and mileage sign location. Other location information that may be provided is:

- Street or highway name
- Municipality and/or county name
- State
- Closest intersection (highways or streets)
- Closest town or municipality
- GPS location
- Information found on the back of crossbucks
- Proximity to other landmarks such as a bridge or river
- Track configuration at incident (single track, multiple tracks)
- Whether incident is at a crossing

The "public" Emergency Responder would then dispatch appropriate services and would also try to identify and then contact the appropriate rail company. The "public" responder would also need to convey the location description to the railroad (as described in Section 1.1.1).

2 Normative References

The standards referenced in the Base Transportation Standard contain provisions, which through reference in this text constitute provisions of this American National Standard. Other standards applicable to this document are referenced in the ANSI Base Transportation Standard [2]. Users are advised to refer to that document for a complete list of normative references that apply to this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in the Base Transportation Standard.

[1] Executive Order 12906

[2] American National Standards Institute, 2003, *Geospatial One Stop Base Transportation Standard.* ANSI X.X.X2002, Part XXXX.

[3] ISO 19109 *Geographic Information - Rules for Application Schemas Standard*

[4] ISO 19110 *Geographic Information - Feature Catalogs Standard*

[5] ISO 19115 *Geographic Information – Metadata*

[6] ISO 19107, *Geographic Information—Spatial Schema*.

[7] ISO 19103, *Geographic information - Conceptual schema language*

3 Definitions

Definitions applicable to the rail standard are listed here. Other, more general transportation terms are defined in the Base Transportation Standard. Users are advised to consult that document for a complete set of transportation definitions.

Amalgamated Stations - A station (or station point) is a named location where railroad or non-railroad revenue and operating business occurs (a station point does not necessarily have a station building). An amalgamated station represents a geographic area that may contain one or more station points. An amalgamated station is also named – this name often corresponds to a known geopolitical place name.

Non-Operating Property - An operating property is a property required for the operation of the rolling stock – whether it is in movement or at a standstill. An example is a rail right-of-way. A non-operating property is a property that is not dedicated to the direct operation of the railway. A non-operating property can have buildings on it, but will not have active tracks on it.

Railroad Administrative Region - A geographic region where a railroad operates and that is managed by a supervisor, superintendent, manager, vice-president, or other designated person of responsibility. Such a geographic region is not necessarily limited to the boundaries of the real property owned by the railroad.

Route – An ordered list of RRX_Segments or an ordered list of sub-routes.

4 Symbols (and abbreviations)

Symbols and associated abbreviations applicable to this standard are listed in the Base Transportation Standard.

GOS – Geospatial One Stop initiative

RRX – Three letter mnemonic designating the Rail mode of the Transportation theme

TRN – Three-letter mnemonic designating the Transportation theme

5 The GOS Feature Meta Model

5.1 Semantics

A feature is an abstraction of a real world phenomenon that is of interest to the application. Instances of features that share common characteristics are organized in classes. Classes are object realizations of the Metaclasses defined in the ISO Rules for Application Schemas Standard (ISO 19109) [3], and instances of the types described in the ISO Feature Catalogs Standard (ISO 19110) [4]. Rail segments and Intersections are examples of Feature Types.

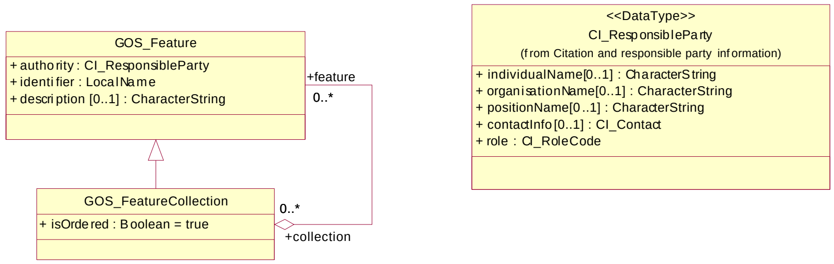

Figure 1–The GOS Metafeature Model

Figure 1 shows GOS_FeatureType, which is an object realization of the metaclasses defined in the ISO feature model. Features have names, "LocalName" that are unique within the namespace of the feature collection or the database in which they exist. GOS_Feature has a mandatory attribute called "source".

GOS_FeatureCollection is a collection of features. Feature collection is an aggregate of zero or more features. Feature collections are also features and therefore can have their own attributes and feature names. Feature collections can be, but not in all cases, defined as ordered lists.

The source attribute has type CI_ResponsibleParty that is defined in ISO 19115 [5]. It provides a standardized method for citing a resource as well as information about the source agency or party responsible (CI_ResponsibleParty) for a resource. The CI_ResponsibleParty data type contains the identity of person(s), and/or position, and/or organization(s) associated with the resource. OwnerInformation is a subtype of CI_ResponsibleParty. It provides contact information in case of emergency at this Rail Feature. It also provides information about the ownership type of the rail feature, such as, private or public.

6 Rail System

6.1 Semantics

The rail transportation standard attempts to accommodate the principal aspects of the rail transportation including geographic locations, interconnectedness, and characteristics of the transportation system. The rail transportation system includes physical and non-physical components representing all modes of travel that allow the movement of goods and people between locations. It also includes the supporting infrastructure necessary for rail operations and maintenance.

The transportation infrastructure is the physical component of the entire transportation system. Thus, the transportation theme includes many modes, or sub themes. Geospatial data depicting road, rail, transit, waterway systems, and airport facilities represent the transportation infrastructure that make up this version of the GOS standard. Each sub theme has developed a standard that accommodates the uniqueness of that mode. This document is a companion document to the GOS Base Transportation standard and deals only with railways.

This standard considers the engineering and operational requirements of the Rail Network. As shown in Figure 3, from the operational point of view applications are not necessarily required to capture each track individually. Instead, a collection of adjacent tracks is represented as a centerline. For rail engineering applications it is required to capture each rail track from point-of- switch to point-of-switch. This standard uses a variety of ways to describe the rail system for both operational and engineering applications. However, all aspects of the model hinge on three main components: segments, points and events. Segments represent portions of the physical rail system that are defined by the application domain using business rules that may vary between operational and engineering applications. Therefore, in this standard, RRX_Segment represents two somewhat different semantics:

1. Each RRX_Segment may represent a track, which extends between two point-of switches. This is depicted in the "Engineering" view in Figure 2.
2. Each RRX_Segment represents the centerline of one or more adjacent tracks. In this case RRX_Segment has an attribute, which indicates the number of tracks it represents. This is depicted in the "Operational" view in Figure 2, where Seg 2 is the representative of Track 1 and Track 2.

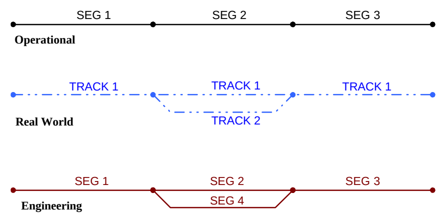

Figure 2 - Different representation of the rail network

Points represent discrete locations of interest along or near the rail system. These can be a segment termini or the location of an intersection. Events represent attributes that occur along or near the rail system. To encourage a maximum of utility in a variety of contexts, this rail standard accommodates two different views of rail system. However, it does not prescribe any specific business rules for segmentation, or locating points and attributes along the rail system. The focus of this standard is to define a way to encode rail segments, their start and end points, and their attributes, which may have varying values along each segment. The rail standard contains four packages that follow the logical grouping of its components:

1) A Segmentation model, derived from the Base Transportation model that defines segments and their associated geometries and topology.

2) A Linear Reference Model (LRM), which defines a measurement method used apply attributes to segments by locating their endpoints and define their extent. Strictly speaking, the LRM is not a part of this model, but is referenced because of the central part it plays in handling the attribution for rail features. The LRM is described in full in the Base Transportation Standard, Annex A.

3) A Facilities and Administrative Areas package defining the important features in a Rail System.

4) A Tracks and Segments Package defining the representation of rail where each segment is the centreline of the rail or an individual track.

6.2 Segmentation Model

6.2.1 Semantics

A Rail Feature is any type of feature that constitutes or is associated with the rail system. As shown in Figure 3, TRN_Feature has three subtypes: TRN_Seg, TRN_Point, and TRN_Path. TRN_Seg, TRN_Point, and TRN_Path are three realizations of the abstract TRN_Feature object metaclasses found in the Base Transportation Standard.

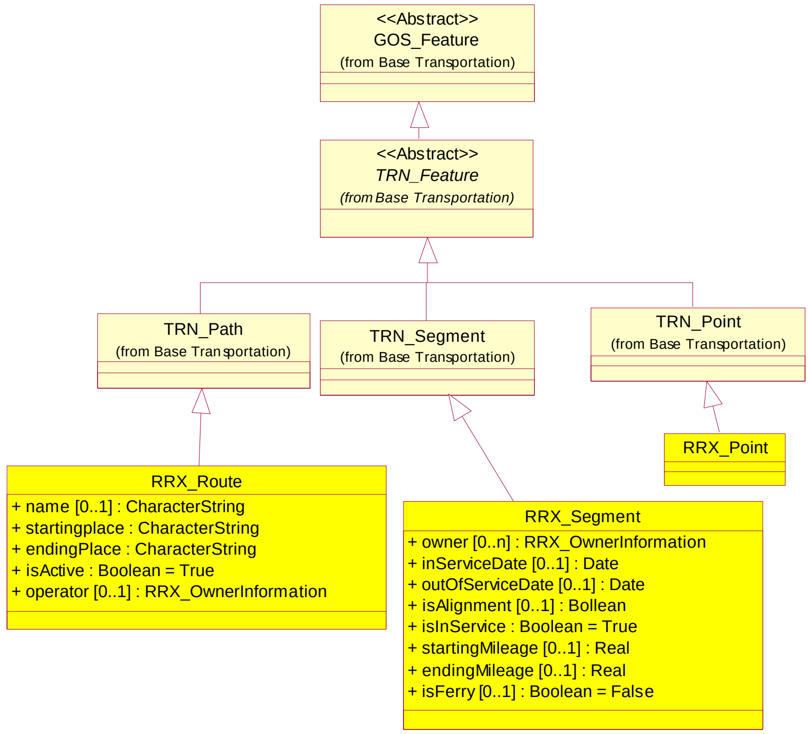

Figure 3 – Context Diagram: Relationship of Rail Features to Base Transportation Model

Figure 3 also shows that RRX_Path, RRX_Segment, and RRX_Point are special subclasses of TRN_Path, TRN_Segment, and TRN_Point respectively, and inherit the properties associated with these high level classes. RRX_Path, RRX_Segment, and RRX_Point are the three central features in this model. For a fuller discussion of the general transportation segmentation model, users are advised to consult the GOS Base Transportation Standard.

6.3 RRX_Point

6.3.1 Semantics

RRX_Point is shown in Figure 4 to be a special subtype of TRN_Feature. RRX_Points therefore, inherit all the geometric and topological properties associated with TRN_Feature. Geometry is restricted to be of type GM_Point and topology to be of type TP_Node. Both GM_Point and TP_Node are defined in ISO 19107 [6].

RRX_Point is a point along the rail system, which has special significance either for starting or ending a rail segment, such as a RRX_SwitchPoint, or representing a significant position along the rail system such as a Fueling Station. The Association Role “isTheEndOf” and “isTheStartOf” identify RRX_Segments that have the respective RRX_Point as starting or ending points.

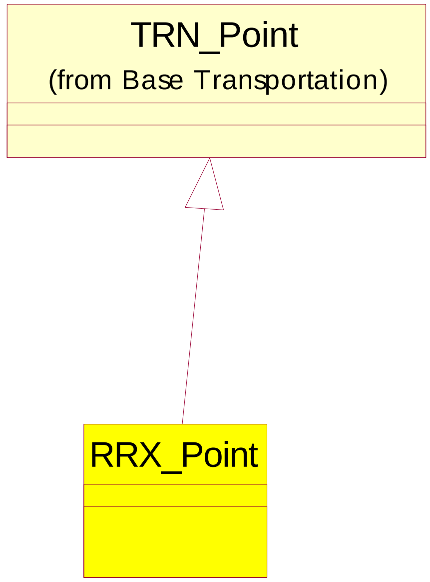

Figure 4-Context Diagram: RRX_Point

RRX_Point can also be located along an RRX_Segment. Examples of these locations might be a rail signal at an intersection. The association role “referenceTo” allows RRX_Points to be located along RRX_Segment. The attribute “alongLocation” linearly locates the point along the segment. No requirements are specified on where to place RRX_Points, except to satisfy the requirements for start and endpoints for RRX_Segment, and that whatever segmentation method is employed, it is applied consistently throughout the dataset.

6.4 RRX_Segment

6.4.1 Semantics

An RRX_Segment represents a linear section of the physical rail system designed for the movement of trains. RRX_Segment extends TRN_Feature and is depicted in Figure 5. Within this standard, RRX_Segment may be defined in a variety of ways for a given stretch of rail tracks. For example, a single RRX_Segment can represent the entire identified area of tracks (e.g., a section that have more than one track) between two points. Or, a separate RRX_Segment can be defined for each track. RRX_Segment can have geometry of type GM_Curve as defined in ISO 19107. RRX_Segment can also have a topology of type TP_DirectedEdge as defined in ISO 19107. According to ISO 19107, GM_Curve extends GM_OrientableCurve and therefore has direction. The direction of an RRX_Segment is determined by the "from" and "to" RRX_Point.

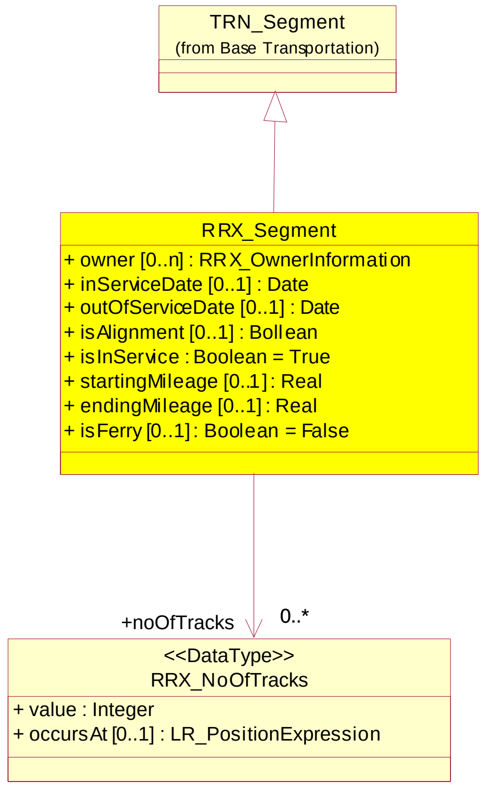

Figure 5-Context Diagram: RRX_Segment

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 standard, a data provider may choose to represent only the geometry of a RRX_Segment, which implies a direction inherited from GM_OrientableCurve. Another data provider may choose not to supply rail feature geometry and only provide the orientation of the RRX_Segment using its topology attribute.

RRX_Segment is associated with a data type that identifies the number of tracks, RRX_NoOfTracks. RRX_NoOfTracks is expressed as an integer and has an associated LR_PositionExpression expressed within the LRM schema. An RRX_Segment has a unique identifier and must be bounded by two RRX_Points. No mandates are provided on how to segment the rail system except that the data provider is consistent in segmentation methodology.

The defining agency can add attributes that are related to physical characteristics of the rail to the RRX_Segment. If they are added as attributes of the RRX_Segment, as shown in Figure 5, the value of the attribute applies to the entire length of the RRX_Segment. In other words, attributes should only be assigned directly to an RRX_Segment if the intent is to force segmentation at changes in the specified attribute value. In these cases, the RRX_Segment terminates and a new one is started at the point where the attribute value changes. If it is necessary to allow the value of the attribute to change as the RRX_Segments are traversed, then that attribute should instead be assigned indirectly to the RRX_Segment as an RRX_LinearAttributeEvent (see below).

Specific rail agencies may define segments differently. In Figure 6, Case A, an agency, which operates the rail system, defines segments as the track centerline that connects two stations. Another agency might instead have segments span between switches along each track, as detailed in Figure 6, Case B.

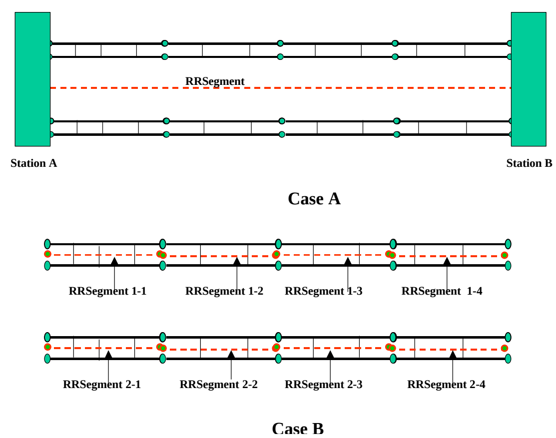

Figure 6 - Different representations of the rail system

Figure 6 models the cases for representing a segment per track and a segment per a collection of tracks. The association role “noOfTracks” is used in cases where RRX_Segment represents a collection of tracks. Usually, a new segment is created when the number of tracks changes. The association role "theTrack" is used where RRX_Segments represent each track in a rail system. The XOR indicates that an RRX_Segment can either represent a collection of tracks or a single track, but not both at the same time.

6.5 RRX_Route

6.5.1 Semantics

RRX_Route is a collection of one or more, whole or partial, RRX_Segments. An RRX_Segment is used to represent the physical railway itself and so can contain attributes about the physical railway. An RRX_Route represents an ordered sequence of segments that defines the route followed to connect two destinations. An example of this is an Amtrak Route between Washington DC Union Station and New York Penn Station.

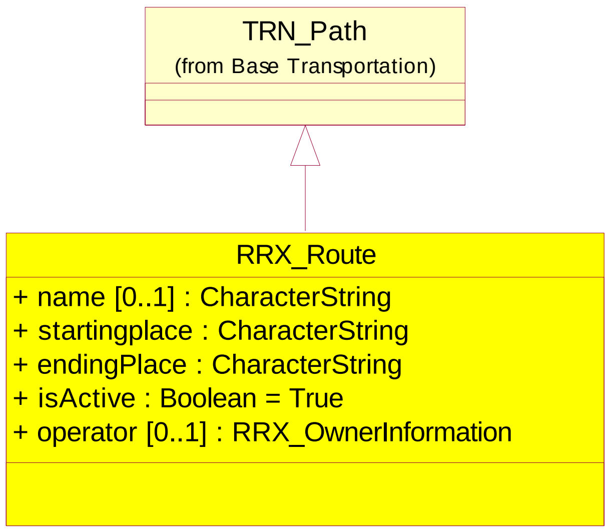

Figure 7-Context Diagram: RRX_Route

RRX_Route extends TRN_Feature and is shown in Figure 7. It is an instance of the feature collection meta-model shown in Figure 1. In practice this means that members of the feature collection can be all or parts of rail segments, and must be contiguous. The geometry of RRX_Route can be explicitly defined by a GM_CompositeCurve or implicitly defined by the sum of the geometries defined for its component RRX_Segment, as defined by "the RRX_Segment". It is also possible to use both geometry approaches. For example, the RRX_Segment geometries may be a more precise representation of the rail system, whereas the RRX_Route geometry may be a more generalized representation.

6.6 RRX_Track

6.6.1 Semantics

Class RRX_Track represents the centerline of each pair of rails. This standard does not prescribe specific business rules on how tracks are segmented. However, in most engineering applications, tracks are segmented between Point of Switches. The association role "attributeEvent" is used to represent varying attributes along a track, as illustrated in Figure 8. For example the same stretch of track may have different "clearance" values. In this case, "clearance" can be a TRN_LinearFeatureEvent and linear referencing methods can be used to indicate the portion of the track where this attribute value applies, independent of the rail segmentation.

The association role "theServiceType" indicates what services this track supports. The CodeList ServiceTypeList, shown in Figure 8, enumerates types of services that may exist on a track.

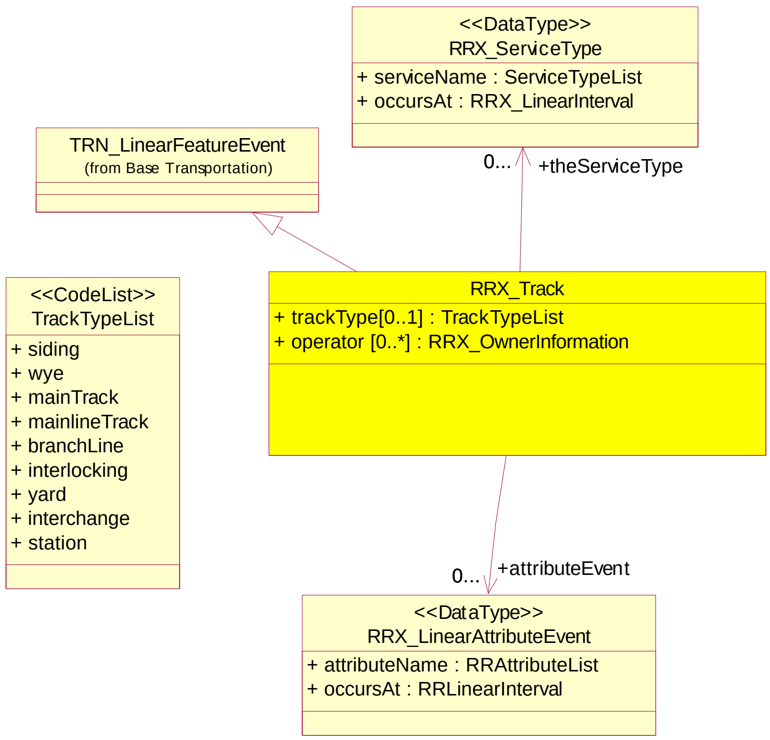

Figure 8 – Context Diagram: RRX_Track Class

6.7 Administrative Areas and Facilities

6.7.1 Semantics

This section deals with the supporting infrastructure that is used by the rail industry to conduct ongoing rail operations. These include designated areas for aggregating rail stock, shipping facilities, regulatory signage and signals, and other facilities necessary for the safe and efficient operation of the rail industry.

6.7. RRX_Station

6.7.1 Semantics

The RRX_Station is shown in Figure 9. RRX_Station is a special subclass of the TRN_PointFeatureEvent class of features. RRX_Stations have zero or one type expressed as a character string. Attributes owner, name, SPLC, and FSAC are all expressed as character strings.

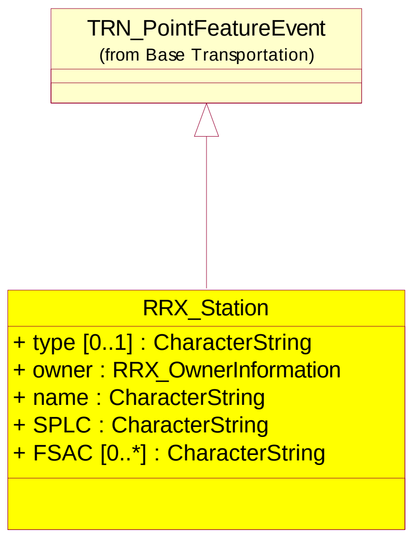

Figure 9-Context Diagram: RRX_Station

6.8 RRX_CommunicationTower

6.8.1 Semantics

Figure 10 describes the context for RRX_CommunicationTower. RRX_CommunicationTower is a special subclass of TRN_PointFeatureEvent and inherits a geometry of type GM_Point from ISO 19107. RRX_CommunicationTower has two attributes, towerType, expressed as a character string, and owner, which is derived from list RRX_OwnerInformation.

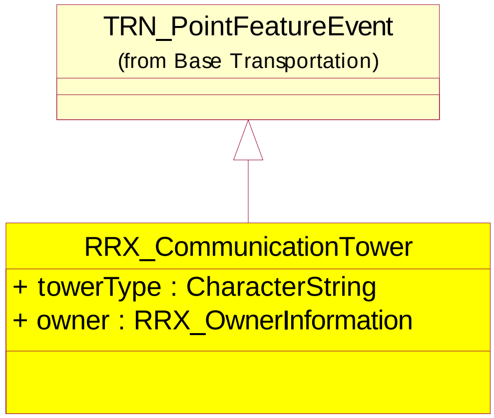

Figure 10-Context Diagram: RRX_CommunicationTower

6.9 RRX_Platform

6.9.1 Semantics

The feature, RRX_Platform is shown in Figure 11. RRX_Platform is a special subclass of TRN_PointFeautureEvent and therefore inherits a geometry of GM_Point. The code list, PlatformTypeList in Figure 10 provides the values for platformType. The other code list, PlatformHeightList gives values for the height of the platform. Other attributes include stationServiced, measuredLength, owner, and platformName.

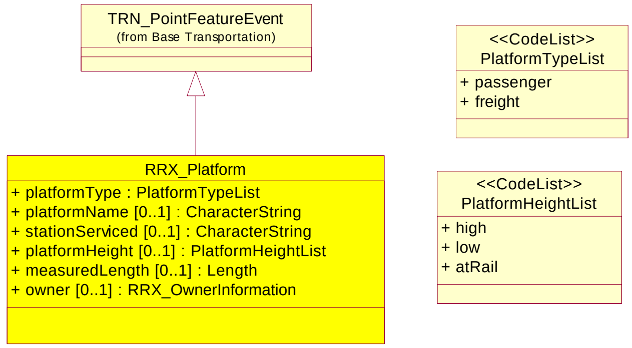

Figure 11-Context Diagram: RRX_Platform

6.10 RRX_WaysideDetectionDevice

6.10.1 Semantics

The RRX_WaysideDetectionDevice is depicted in Figure 12, and is shown to be a special subtype of TRN_PointFeatureEvent. It has a geometry of GM_Point and has four attributes: owner, deviceType, name, and alarmType, all expressed as character strings. The values for attribute ‘owner’ are given by list RRX_OwnerInformation.

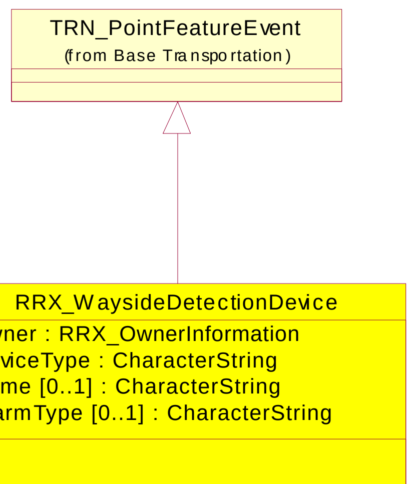

Figure 12-Context Diagram: RRX_WaysideDetectionDevice

6.11 RRX_Yard

6.11.1 Semantics

Figure 13 shows the feature class RRX_Yard and its relationship as a special subtype of GOS_Feature, which does not specify a geometry type. Code list, YardTypeList gives the values for attribute ‘type’.

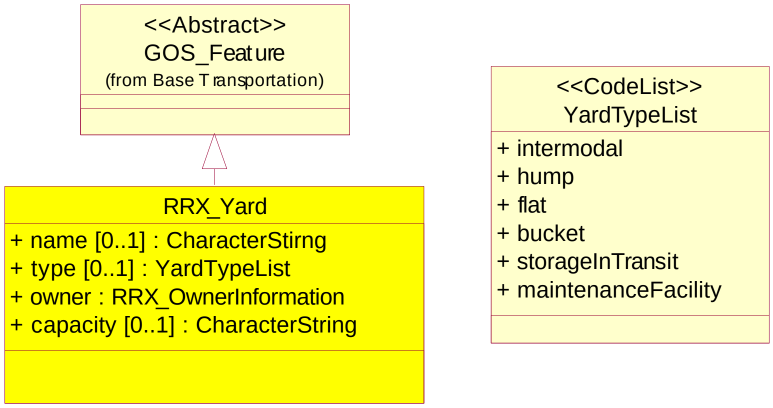

Figure 13-Context Diagram: RRX_Yard

6.12 RRX_Bridge

6.12.1 Semantics

Figure 14 shows RRX_Bridge to also be a special subtype of GOS_Feature, which leaves it to users to specify the geometric representation and topological rules. Certain RRX_Bridge attributes, -bridgeName, bridgeType, isBallasted, and utilitiesCarried, are expressed as character strings. The values for bridgeOwner and externalIdentifier attributes are supplied by list RRX_OwnerInformation.

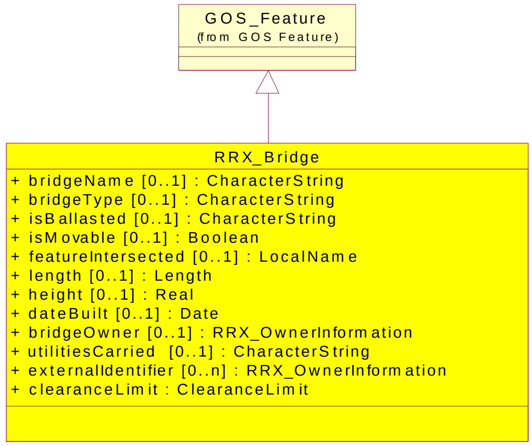

Figure 14-Context Diagram: RRX_Bridge

6.13 RRX_ControlPoint

6.13.1 Semantics

RRX_ControlPoint is depicted in Figure 15, which shows that RRX_ControlPoint is a special subtype of TRN_PointFeatureEvent. Code list ControlPointTypeList gives the values for attribute pointType. Attribute name is expressed as a character string and attribute owner is supplied by list RRX_OwnerInformation.

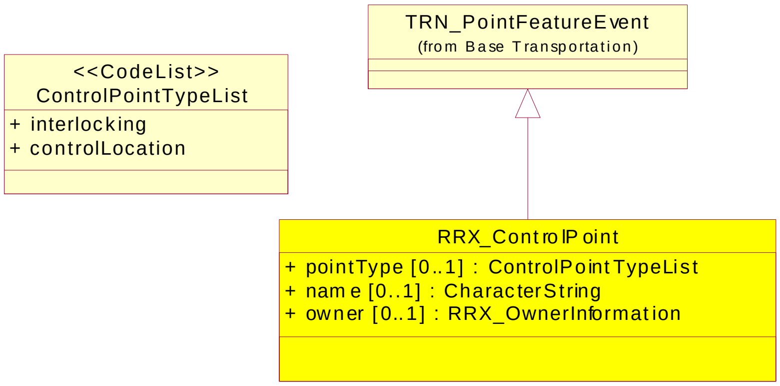

Figure 15-Context Diagram: RRX_ControlPoint

6.14 RRX_FuelingFacility

6.14.1 Semantics

The feature class RRX_FuelingFacility is depicted in Figure 16, and shown to be a special subtype of TRN_PointFeatureEvent. RRX_FuelingFacility geometry is GM_Point as defined in ISO 19107. The value for attribute owner is supplied by list RRX_OwnerInformation. Attribute name is given as a character string and attributes isDTL and isPipelineDelivery are Boolean expressions. Attribute capacity is given as a volume expression.

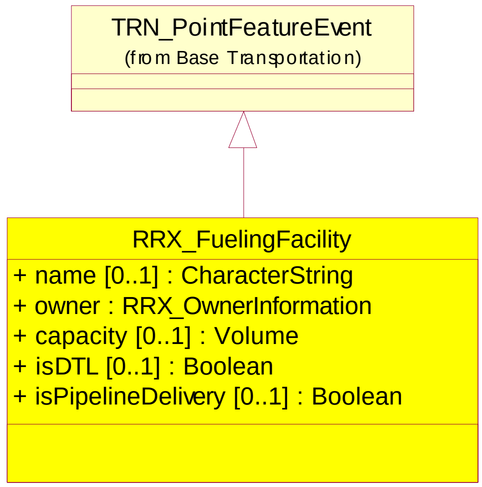

Figure 16-Context Diagram: RRX_FuelingFacility

6.15 RRX_LinearOccupancy

6.15.1 Semantics

Figure 17 shows the RRX_LinearOccupancy feature class, which is shown to be a special subclass of TRN_LinearFeatureEvent. RRX_LinearOccupancy has geometry of type GM_Curve as defined in ISO 19107 and can also have a topology of type TP_DirectedEdge. According to ISO 19107, GM_Curve extends GM_OrientableCurve and therefore has direction. The value for attributes owner and utilityOwner are supplied list RRX_OwnerInformation. Values for attribute levelOfGrade are supplied by list CrossingLevelList. The attribute occupancyType is given as a character string.

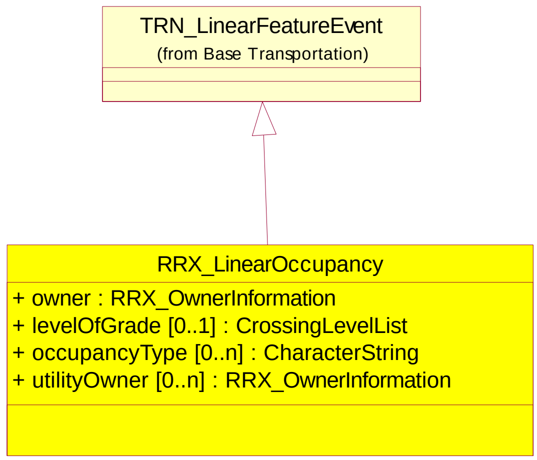

Figure 17-Context Diagram: RRX_LinearOccupancy

6.16 RRX_Signal

6.16.1 Semantics

Figure 18 shows the RRX_Signal feature class. RRX_Signal feature class is a special subtype of TRN_PointFeatureEvent and therefore its geometry is given as GM_Point. The attribute numberOfTracksServed is given as an integer and attribute description is given as a character string. The code list TravelDirectionList supplies the values for attribute travelDirection and the code list SignalTypeList supplies values for attribute signalType.

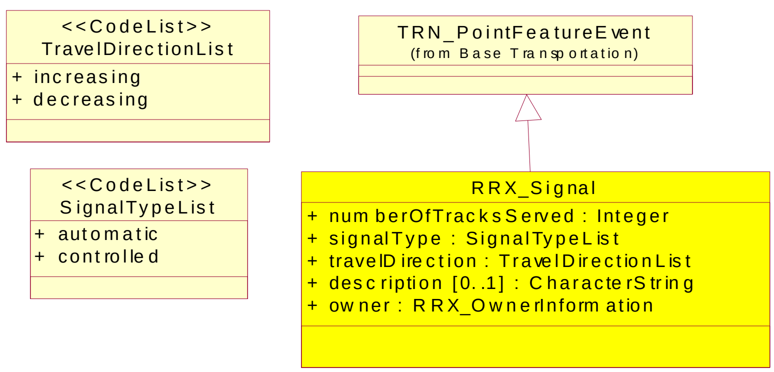

Figure 18-Context Diagram: RRX_Signal

6.17 RRX_Switch

6.17.1 Semantics

The feature class RRX_Switch is depicted in Figure 19, and also shown to be a special subtype of TRN_PointFeatureEvent. The value for attribute owner is supplied by list RRX_OwnerInformation and the value for switchAngle is given by code list switchAngleList. The attribute isManual is a Boolean value.

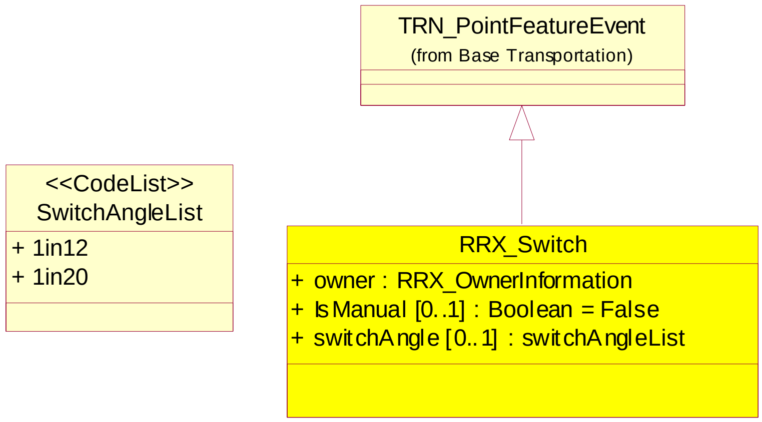

Figure 19-Context Diagram: RRX_Switch

6.18 RRX_TransportationCrossing

6.18.1 Semantics

Figure 20 depicts the feature class RRX_TransportationCrossing. It is a special subtype of TRN_PointFeatureEvent and has a geometry of GM_Point. Code list TransportationCrossingList supplies values for attribute crossingType. Code list CrossingLevelList supplies values for attribute levelOfCrossing. The value for attribute owner is supplied by list RRX_OwnerInformation. Attributes name, nearestRoad, and nearestAddress are expressed as character strings.

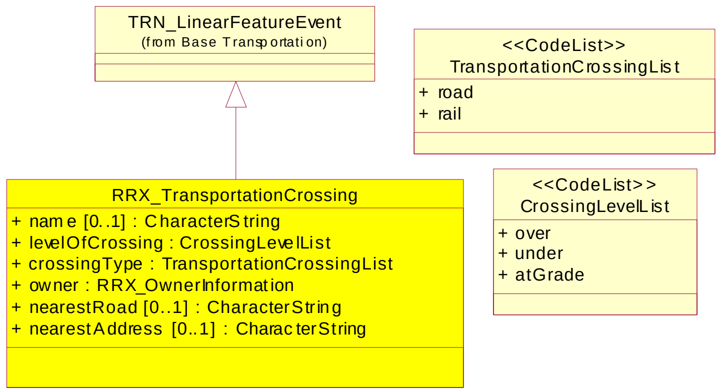

Figure 20-Context Diagram: RRX_TransportationCrossing

Annex A UML notations

The material in this annex is drawn from ISO/TS 19103 [7] and ISO 19115. The diagrams that appear in this Standard are presented using the Unified Modeling Language (UML) static structure diagram with the ISO Interface Definition Language (IDL) basic type definitions and the UML Object Constraint Language (OCL) as the conceptual schema language. The UML notations used in this standard are described in Figures 21 and 22.

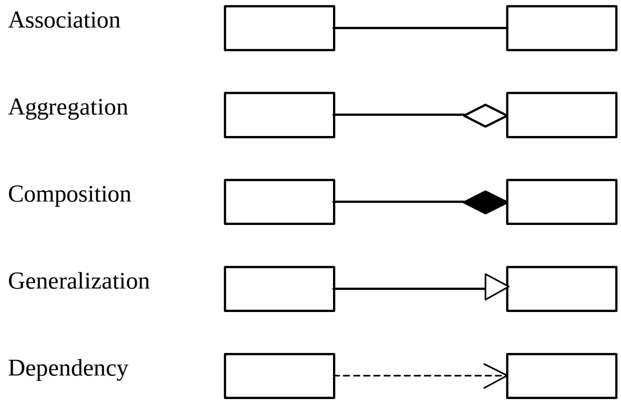

Figure 21–UML notation

UML model relationships

Associations

An association is used to describe a relationship between two or more classes. UML defines three different types of relationships, called association, aggregation and composition. The three types have different semantics. An ordinary association shall be used to represent a general relationship between two classes. The aggregation and composition associations shall be used to create part-whole relationships between two classes. The direction of an association must be specified. If the direction is not specified, it is assumed to be a two-way association. If one-way associations are intended, the direction of the association can be marked by an arrow at the end of the line.

An aggregation association is a relationship between two classes in which one of the classes plays the role of container and the other plays the role of the contained. A composition association is a strong aggregation. In a composition association, if a container object is deleted, then all of its contained objects are deleted as well. The composition association shall be used when the objects representing the parts of a container object cannot exist without the container object.

Generalization

A generalization is a relationship between a superclass and the subclasses that may be substituted for it. The super-class is the generalized class, while the subclasses are specified classes.

Instantiation / Dependency

A dependency relationship shows that the client class depends on the supplier class/interface to provide certain services, such as:

- Client class accesses a value (constant or variable) defined in the supplier class/interface;
- Operations of the client class invoke operations of the supplier class/interface;
- Operations of the client class have signatures whose return class or arguments are instances of the supplier class/interface.

An instantiated relationship represents the act of substituting actual values for the parameters of a parameterized class or parameterized class utility to create a specialized version of the more general item.

Roles

If an association is navigable in a particular direction, the model shall supply a "role name" that is appropriate for the role of the target object in relation to the source object. Thus in a two-way association, two role names will be supplied.

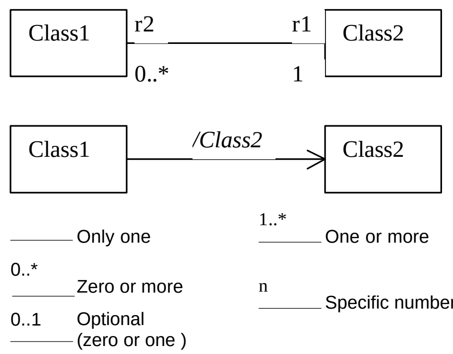

Figure 22–UML roles

Figure 22 represents how role names and cardinalities are expressed in UML diagrams. The role name "r1"' is Class1's relationship to Class2. The role name "r2" is Class2's relationship to Class1. The cardinalities show that "zero or many" Class1s are related to "exactly one" Class2. Figure 2 also shows how derived classes will be expressed. The diagram indicates that Class1 is a derived class of Class2. Any attributes and aggregates of Class1 are also derived from Class2.

UML model stereotypes

A UML stereotype is an extension mechanism for existing UML concepts. It is a model element that is used to classify (or mark) other UML elements so that they in some respect behave as if they were instances of new virtual or pseudo metamodel classes whose form is based on existing base metamodel classes. Stereotypes augment the classification mechanisms on the basis of the built-in UML metamodel class hierarchy. Below are brief descriptions of the stereotypes used in this Standard:

a) <<DataType>> descriptor of a set of values that lack identity (independent existence and the possibility of side effects). Data types include primitive predefined types and user-definable types. A DataType is thus a class with few or no operations whose primary purpose is to hold the abstract state of another class.
b) <<CodeList>> used to describe a more open enumeration. <<CodeList>> is a flexible enumeration. Code lists are useful for expressing a long list of potential values. If the elements of the list are completely known, an enumeration should be used; if the only likely values of the elements are known, a code list should be used.
c) <<Abstract>> class (or other classifier) that cannot be directly instantiated. UML notation for this to show the name in italics.
d) <<Package>> cluster of logically related components, containing sub-packages.
e) <<Leaf>> package that contains definitions, without any sub-packages.