



BSI Standards Publication

Intelligent transport systems — Dynamic data and map database specification for connected and automated driving system applications

Part 1: Architecture and logical data model for harmonization of static map data

National foreword

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Technical Specification

ISO/TS 22726-1

Intelligent transport systems — Dynamic data and map database specification for connected and automated driving system applications —

Part 1: Architecture and logical data model for harmonization of static map data

*Systèmes de transport intelligents — Spécification de
données dynamiques et de bases de données cartographiques
pour les applications de système de conduite connectées et
automatisées —*

*Partie 1: Architecture et modèle logique de données pour
l'harmonisation des données cartographiques statiques*

**Second edition
2025-11**



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This second edition cancels and replaces the first edition (ISO/TS 22726-1:2023), which has been technically revised.

The main changes are as follows:

- addition of a traffic regulation model consisting of traffic regulations, time conditions, and vehicle conditions;
- addition of traffic regulation attributes in the carriageway and lane data sets;
- addition of "carriageway manoeuvre path" and "lane manoeuvre path" classes in the carriageway and lane datasets;
- addition of the "crossfall" class as one of the physical characteristics for carriageways and lane data sets;
- integration of both major and minor road structures packages into the road structure sub-package;
- addition of an upper space feature attribute in the carriageway data set;
- addition of properties which define the features in the space under the vehicle bridge or the objects of the super- or sub-structures;
- addition of a parking lot marking class in the road marking sub-package;
- change of "island nose" to "shock absorption device" class name;
- change of "speed bump" to "traffic calming device" class name;
- change of "bus stop board" to "public transport stop point board" class name;
- change of "inaccessible sloped zone" to "inaccessible zone" class name;
- integration of both "bridge" and "viaduct" into the "vehicle bridge" class;

— additional technical and editorial revisions.

A list of all parts in the ISO 22726 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In response to emerging automated driving system (ADS) development, a new requirement for an intelligent transport system (ITS) map database standard has been raised to define a set of models for highly confident map data.

The data used in ADS are categorized into static data (i.e. map for highly automated driving (MHAD) and traditional map data) and dynamic data (e.g. traffic and travel information). These data are mutually related and linked to support ADS. The data model for ADS should have a structure specialized for automated driving and be presented in a manner useable for ADS.

In the case of static map data used by ITS, ISO 14296 specifies a logical data model applied to vehicle navigation systems and cooperative ITS (C-ITS). The data model of ISO 14296 is insufficient for ADS because of limitations to represent detailed or accurate carriageway and road-related features. In addition, new relationships between new map features and dynamic data are defined.

Even though GDF 5.1 (ISO 20524-2) defines map data used in ADS, such as road belts or lane belts, as detailed road map data, it focuses on a data model for exchanging and provisioning map data between map makers and data centres. The GDF model, which is based on three catalogues (Feature, Attribute, and Relationship), is inefficient not only for storing ITS map data in a database, but also for being able to access that data rapidly in vehicles. Therefore, this document defines a database standard to quickly and directly access detailed road map entities and their related information.

Implementation of this document can potentially lead to cost reductions in maintenance and expansion of map access libraries, as well as reductions in compilation and maintenance costs of map and map-related data for data providers for connected and automated driving, and vehicle control applications.

Intelligent transport systems — Dynamic data and map database specification for connected and automated driving system applications —

Part 1: Architecture and logical data model for harmonization of static map data

1 Scope

This document specifies the architecture and the logical data model of static map data for connected and automated driving system applications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 19501, *Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 belt

configuration concept for specifying an area bounded by side lines and terminal lines, characterized by directions and represented as one or more linear axes when skeletonized

Note 1 to entry: The number of skeletonized axes differs depending on the feature class. In the case of a belt applied to a one-way lane, the number is one. When applied to an intersection, the belt has axes corresponding to the number of unique allowable traffic directions.

[SOURCE: ISO 20524-2:2020, 3.2]

3.2 direction

signature of belt, determined by an allowed connection between a pair of terminal lines

[SOURCE: ISO 20524-2:2020, 3.3]

3.3

belt feature

two-dimensional Feature bounded by three or more Edges or four or more NET coordinate Tuple

[SOURCE: ISO 20524-2:2020, 3.1.]

3.4

feature

database representation of a real-world object

[SOURCE: ISO 20524-1:2020, 3.4.9]

3.5

link

directed topological connection between two nodes, composed of an ordered sequence of one or more segments and represented by an ordered sequence of zero or more shape points

[SOURCE: ISO/TS 20452:2007, 3.19]

3.6

node

data model entity for a topological junction of two or more links or end bounding a link

Note 1 to entry: A link stores the coordinate value of the corresponding GDF junction.

[SOURCE: ISO/TS 20452:2007, 3.23]

3.7

partition line

transversal line representing the boundary of a segment set to a road belt element and a lane belt element, and both terminations are set on the side line of road belt element or lane belt element

3.8

probe data

vehicle sensor information formatted as probe data elements and/or probe messages that are processed, formatted and transmitted to a land-based centre for processing to create a good understanding of the driving environment

[SOURCE: ISO 24100:2010, 3.14]

3.9

road feature

feature, specified by a belt, that represents an area for vehicle travel

EXAMPLE Carriageways, intersections and lanes are examples of road features.

Note 1 to entry: This is a general term for the roadway, carriageways, intersections and lanes, and does not contain the sidewalks and paths for pedestrians.

3.10

side line

type of boundary line constituting a belt feature other than a terminal line

[SOURCE: ISO 20524-2:2020, 3.4, modified — The admitted term "side line" has been used as the preferred term.]

3.11

terminal line

type of boundary line constituting a belt feature and designated for determining a direction of a belt feature in combination with another terminal line

[SOURCE: ISO 20524-2:2020, 3.5]

4 Abbreviated terms and symbols

ADS	automated driving system
C-ITS	cooperative ITS
CMS	changeable message sign
GNSS	Global Navigation Satellite System
IAP	IntersectionAnchorPosition
IB	IntersectionBelt
IBSd	IntersectionBeltSideLine
IBTr	IntersectionBeltTerminalLine
ICP	IntersectionConnectionPoint
ITS	intelligent transport system
LAP	lane anchor position
LBE	LaneBeltElement
LBJ	LaneBeltJoint
LBSd	LaneBeltSideLine
LBSg	LaneBeltSegment
LBSSg	LaneBeltSideLineSegment
LBTr	LaneBeltTerminalLine
LCP	LaneConnectionPoint
MHAD	map for highly automated driving
MLP	manoeuvre lane path
MP	manoeuvre path
POI	point of interest
RAP	RoadAnchorPosition
RBE	RoadBeltElement
RBS	RoadBeltSection
RBSg	RoadBeltSegment
RBSd	RoadBeltSideLine
RBSSg	RoadBeltSideLineSegment
RBTr	RoadBeltTerminalLine
RSE	RoadStructuresAndEquipment

RTK-GPS	real time kinematics - global positioning system
VMS	variable message sign

5 Document structure and conformance

5.1 Document structure

This document contains the following main clauses, subclauses and annexes:

- Conformance ([5.2](#))
- Architecture ([Clause 6](#))
- Logical data model of map data ([Clause 7](#))
- Overall data model of map data ([7.1](#))
- Transportation package ([7.2](#))
- MHAD package ([Clause 8](#))
- MHADCommonProperty package ([Clause 9](#))
- RoadBeltNetwork package ([Clause 10](#))
- LaneBeltNetwork package ([Clause 11](#))
- RoadBeltStructureAndEquipment package ([Clause 12](#))
- Relationship to dynamic information ([Clause 13](#))
- [Annex A](#) (normative) Abstract test suite
- [Annex B](#) (informative) Basic data types and stereotypes
- [Annex C](#) (informative) Resolution and accuracy of the MHAD
- [Annex D](#) (informative) Comparison of the road network models of MHAD and existing map models

5.2 Conformance

Data model structures shall be provided as specified in [Clause 7](#).

Any data structure claiming conformance with this document shall pass the requirements presented in the abstract test suite in [Annex A](#).

UML expressions for diagrams in this document shall conform to ISO/IEC 19501.

Throughout this document, the data types and stereotypes as defined in [Table B.1](#) apply.

6 Architecture

Automated driving systems (ADSs) and their applications can refer to both static map data and dynamic information data. In addition, ITS stations in automated driving vehicles, connected vehicles and road equipment can collect sensing data, such as contradictions between the static map and features of the real world, traffic data, and travel information, and distribute them as probe data.

[Figure 1](#) depicts the conceptual system architecture of map data in an ITS station for an ADS.

In ITS vehicle stations that correspond to ADSs, the application uses map data (MHAD) and additional dynamic data. The original data, along with updates of the MHAD data and dynamic data, are intended to be provided through external transmitted messages received from outside of the station. Automated driving applications also use data collected from both in-vehicle and roadside mounted sensors and can also use conventional map data which complements the applications to which the navigation system and/or C-ITS refer.

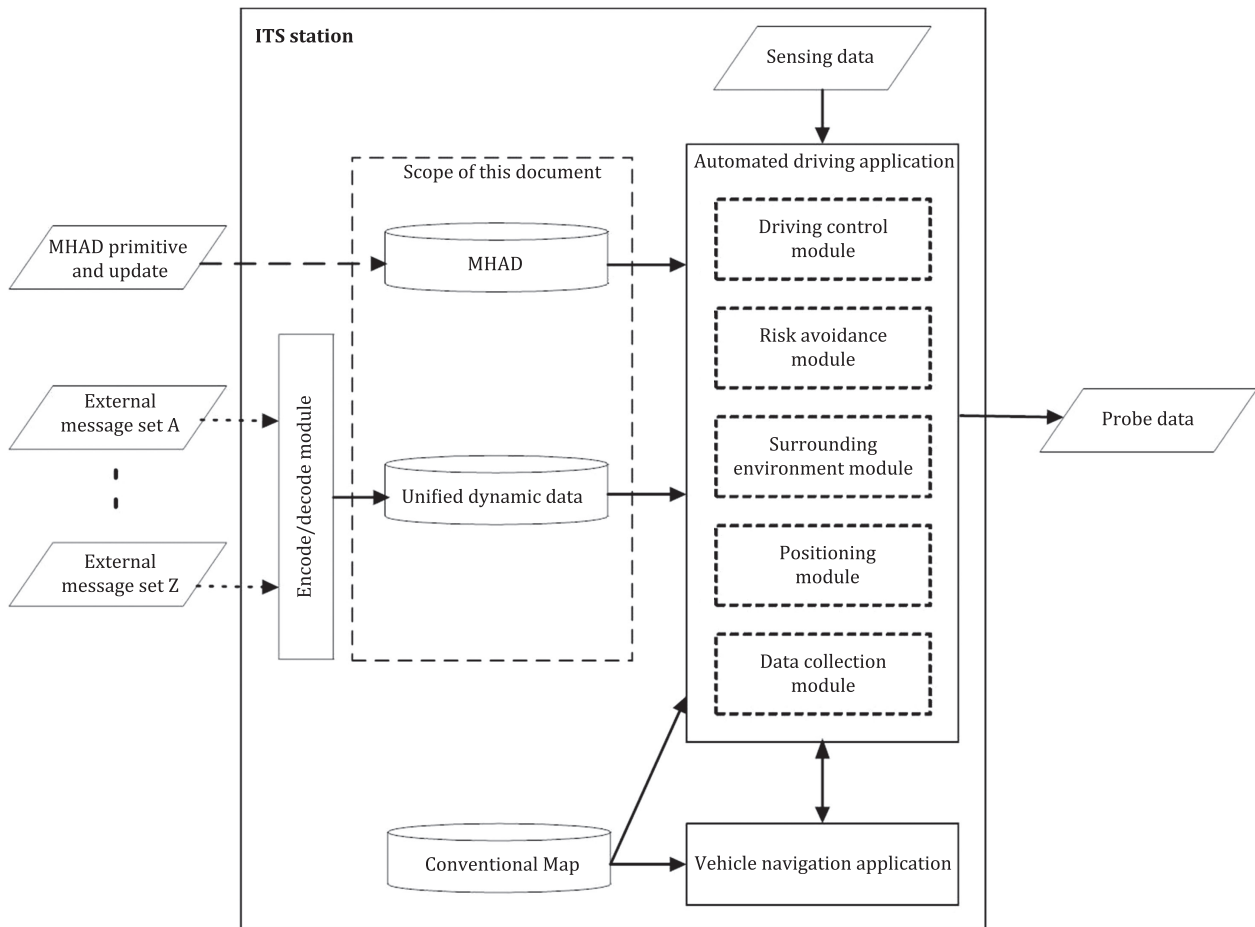


Figure 1 — Conceptual system architecture

7 Logical data model of map data

7.1 Overall data model of map data

The overall map data model for ITS is adopted from the model defined in ISO 14296 which consists of the following packages:

- AddressLocation: location information based on various types of information both on the Earth and in the map data;
- Cartographic: terrain map information for expressing a visual map;
- Service&POI: information of the services and POI that exist in a fixed location;
- Transportation: information concerning fixed features for transportation; and
- DynamicInformation: external information in association with transportation data for providing real-time conditions and/or status.

To support ADS, both the Transportation and DynamicInformation packages are expanded.

The DynamicInformation package is specified in ISO/TS 22726-2:2025.

The overall map data model is shown in [Figure 2](#).

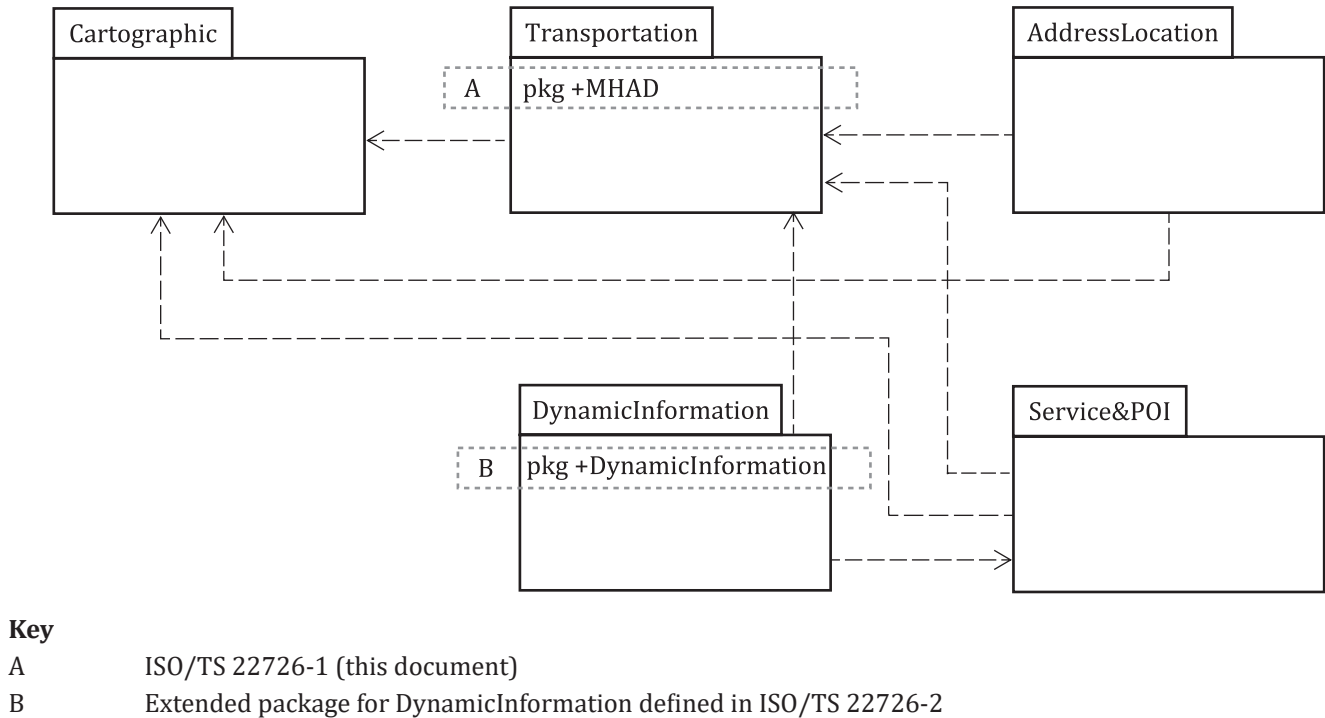


Figure 2 — Overall map data model

7.2 Transportation package

Following the addition of the MHAD package to the Transportation package, the updated package consists of the following:

- MHAD: data for road belt network, lane belt network, and road structures and equipment for connected and automated driving systems,
- TransferZoneNetwork: information concerning place and connected network for transferring with the transport network,
- RoadNetwork: static road data using linear network modelling,
- PublicTransportationNetwork: static network data for the public transportation system,
- BicyclePathNetwork: static path network data for bicycle movement, and
- PedestrianPathNetwork: static path network data for pedestrian movement.

The overview of the Transportation package is shown in [Figure 3](#).

The TransferZoneNetwork package and the RoadNetwork package are defined in ISO 14296. The RoadNetwork package contains features represented by links and nodes, in multiple levels corresponding to the concept of different map scales. The features in the MHAD package can be related to road features such as RoadElement, Intersection, IntersectionLink, IntersectionConnectionPoint and Lane in the RoadNetwork package and are described in [Clause D.2](#).

This document only defines the specifications of features in the MHAD package.

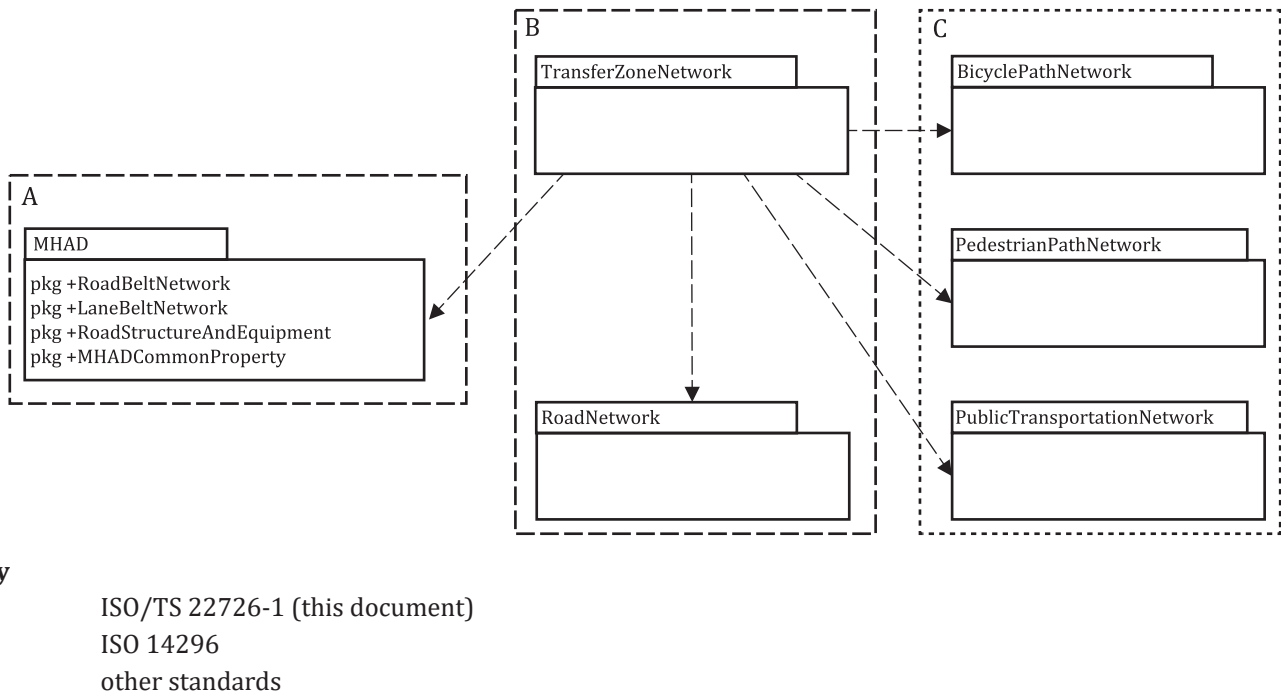


Figure 3 — Overview of the Transportation package

8 MHAD package

8.1 Configuration of MHAD package

A connected and/or automated driving system requires the road belt network data, the lane belt network data and the road structures and equipment data related to road features. The MHAD represents the data model for a static map of the road and consists of the following packages:

- RoadBeltNetwork package — defines belt features and relevant features which compose road-level networks,
- LaneBeltNetwork package — defines belt features and relevant features which compose lane-level networks,
- RoadStructureAndEquipment package — defines road structures and road equipment which are related to road-level and/or lane-level networks, and
- CommonPropertyClasses package — defines the data classes commonly used in multiple sub-packages belonging to the MHAD package.

[Figure 4](#) shows the package diagram of the MHAD package.

The MHAD package contains an MHAD class which is defined as the root class for the entire package.

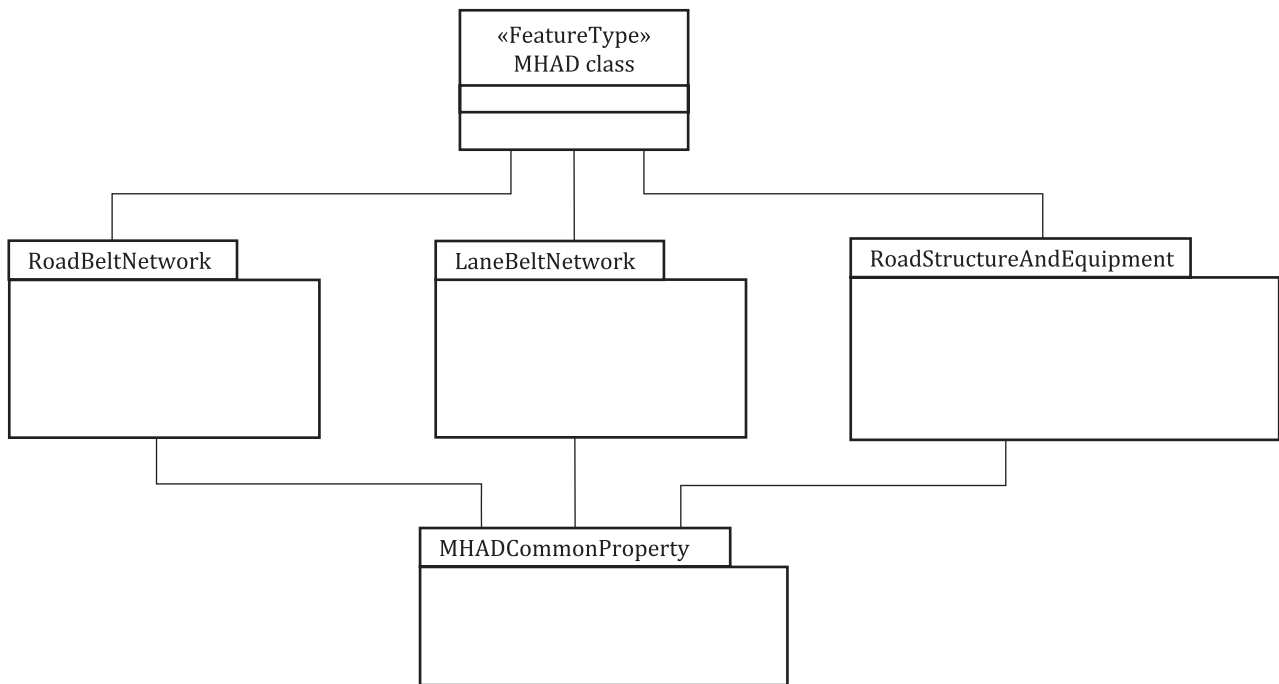


Figure 4 — MHAD package diagram

[Figure 5](#) shows the classes and relationships for expressing the hierarchical model of the MHAD package.

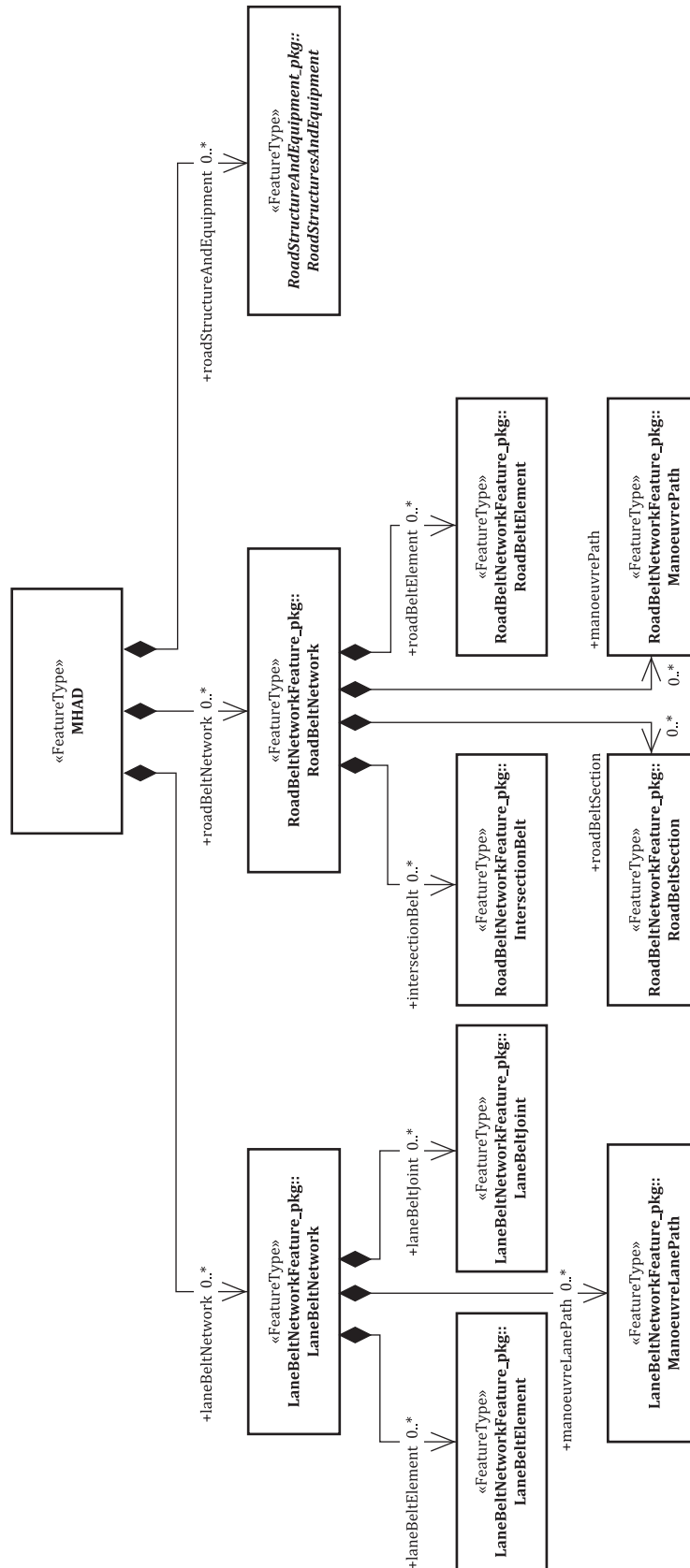


Figure 5 — Class diagram of the MHAD package

8.2 Belt concept for roadway, intersection and lane

Roadways and intersections are expressed by lines and points in conventional road network data models. However, emerging ITS applications (e.g. lane keeping for C-ITS and automated driving systems) require highly defined information that enables the vehicle to identify where it is driving in a lane, and in which lane it is allowed to drive in order to overtake other vehicles.

To provide such information, road features, such as the roadway, intersections and lanes need to be expressed by specific area features which have characteristics implying directions and/or trajectories of moving vehicles. An instance of this specific area feature is transformed into a directed line that corresponds to a possible directed trajectory of regular vehicle movement when it is degenerated by means of a mathematical morphology transformation.

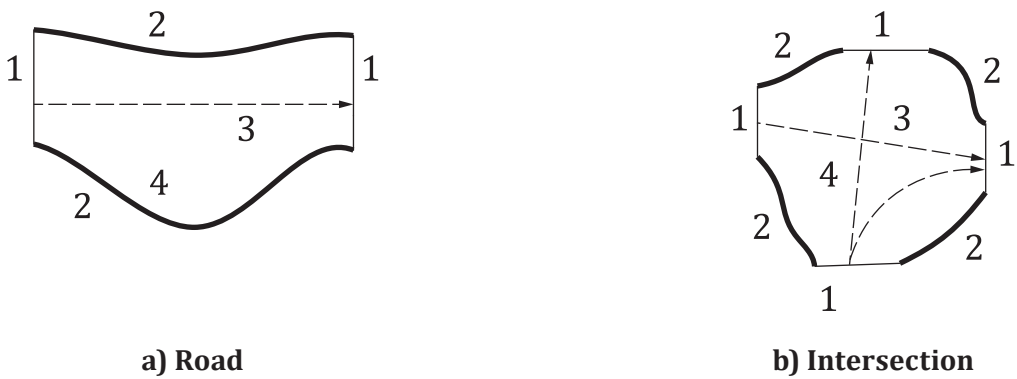
A conventional data model enables a vehicle to identify in which road and/or lane it is driving. However, an area feature in the conventional data model merely expresses a space for free motion and does not imply any specific directions. Thus, the area feature in the conventional data model does not meet the requirements of emerging ITS applications.

The "belt concept" and belt features specified in ISO 20524-2 meet the recommendation that roads, intersections and lanes should be represented by a specific area feature with the directions defined as their characteristics. As illustrated in [Figure 6](#), a belt feature is a specific area feature which is bounded by a combination of side lines and terminal lines.

In the case of a road [[Figure 6 a\)](#)], a belt has at least one directional characteristic, the "direction". Additionally, the belt can have other characteristics which include the widths of the belt that are calculated as the distance between a pair of side lines for that belt. The value width should be associated with a measure on the degenerated line representing the belt feature.

The terminal lines define the characteristics of the belt direction. In the case of an intersection [[Figure 6 b\)](#)], a belt has at least two directional characteristics. Widths of a belt are calculated as the distance between a pair of side lines which determine both sides of the belt except in an intersection.

In the belt data model, terminal lines are conceptually represented and assumed to function as "directional control valves" at both ends of a flow. Side lines are also conceptually represented and can refer to real road-related objects (e.g. lane markings, flow-markings, kerbs, guardrails, etc.).



Key	
1	terminal line
2	side line
3	direction
4	belt

Figure 6 — Example of belt structure

In the MHAD package, road features are instantiated as features in the RoadBeltNetwork package and the LaneBeltNetwork package.

8.3 Relationship between road feature and road structures and equipment feature

In the real world, there are various features located at or along roads such as road markings, traffic signals, kerbs, manholes, fences, walls, guardrails and poles. These features are referred to as road structures or road equipment and are defined as features in the RoadStructureAndEquipment package in MHAD.

As road structures and road equipment are located at or along a road, they can have relationships with road features such as those defined by the RoadBeltNetwork package and the LaneBeltNetwork package. When road structures and road equipment are interrelated, it is necessary to define the specific location on the road feature that relates to the corresponding part of the road structures and road equipment.

EXAMPLE The outline of a kerb represents the boundary of the kerb itself and at the same time represents a part of a side line of the road feature where that kerb is located.

In the MHAD data model, road features have anchor positions that are used to associate road structures or pieces of road equipment to the road and indicate the position where the road structures and/or road equipment is anchored to the road feature.

A projection point is a point positioned on the geometry of the road structures and road equipment and associated to the anchor position. A projection line is part of the outline of the road structures or road equipment, specified by a pair of projection points. Both the projection point, and project line of road structures and road equipment are designed to indicate traffic limitations due to the physical characteristics of the road structures and road equipment, and they can be used as reference positions for positioning functions.

Anchor positions are defined as RoadAnchorPosition, IntersectionAnchorPosition and LaneAnchorPosition in either a RoadBeltNetwork or LaneBeltNetwork package.

If a road structure and equipment feature crosses or are set up along continuous roads, the road structure and equipment feature have intermediate projection points at continuous road boundaries to identify an anchor position of each road feature.

[Figure 7](#) shows examples of the positional relationships of anchor positions, projection lines, and projection points between a RoadBeltElement and a bridge and a guardrail.

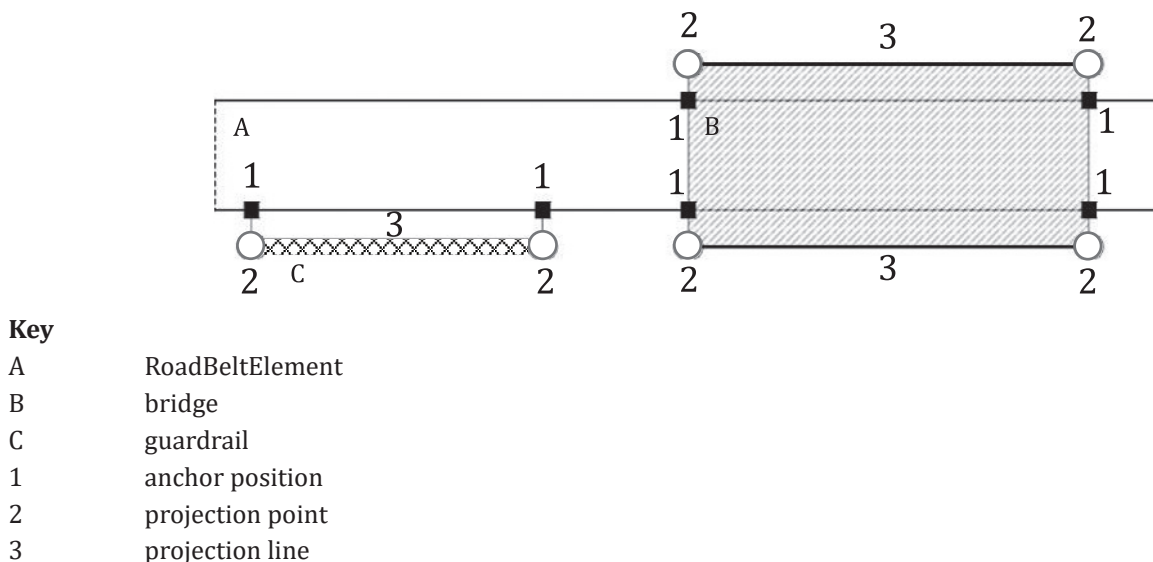


Figure 7 — Example of relationship between a road belt element, a bridge, and a guardrail

8.4 MHAD class

The MHAD class is the root class of the MHAD data model and has three composition relationships to the contained classes.

[Table 1](#) defines the details of the MHAD class.

Table 1 — MHAD class

Class: MHAD		
Definition: Dataset representing the static road network map which consists of the datasets of the road belt network, the lane belt network, and the road structures and equipment.		
Abstract:		
Subtype of:		
Stereotypes: «FeatureType»		
Relationship role name: laneBeltNetwork		
	Definition:	Specifies lane belt network data sets.
	Relationship type:	Composition
	Value type:	LaneBeltNetwork
	Multiplicity:	0..*
	Stereotypes:	«FeatureType»
Relationship role name: roadStructureAndEquipment		
	Definition:	Specifies road structures and equipment data sets.
	Relationship type:	Composition
	Value type:	RoadStructuresAndEquipment
	Multiplicity:	0..*
	Stereotypes:	«FeatureType»
Relationship role name: roadBeltNetwork		
	Definition:	Specifies road belt network data sets.
	Relationship type:	Composition
	Value type:	RoadBeltNetwork
	Multiplicity:	0..*
	Stereotypes:	«FeatureType»

9 MHADCommonProperty package

9.1 General

The MHADCommonProperty package represents the data packages commonly used in the MHAD data model, and consists of the following sub-packages:

- GeneralCommonProperty sub-package — defines data classes and their relationships used as general common data,
- CommonPhysicalCharacteristics sub-package — defines common data classes and their relationships used as belt segment common data, and
- TrafficRegulation sub-package — defines data classes and their relationships for the traffic regulation model used as commonly in MHAD.

[Figure 8](#) shows the package diagram of the MHAD CommonProperty package.

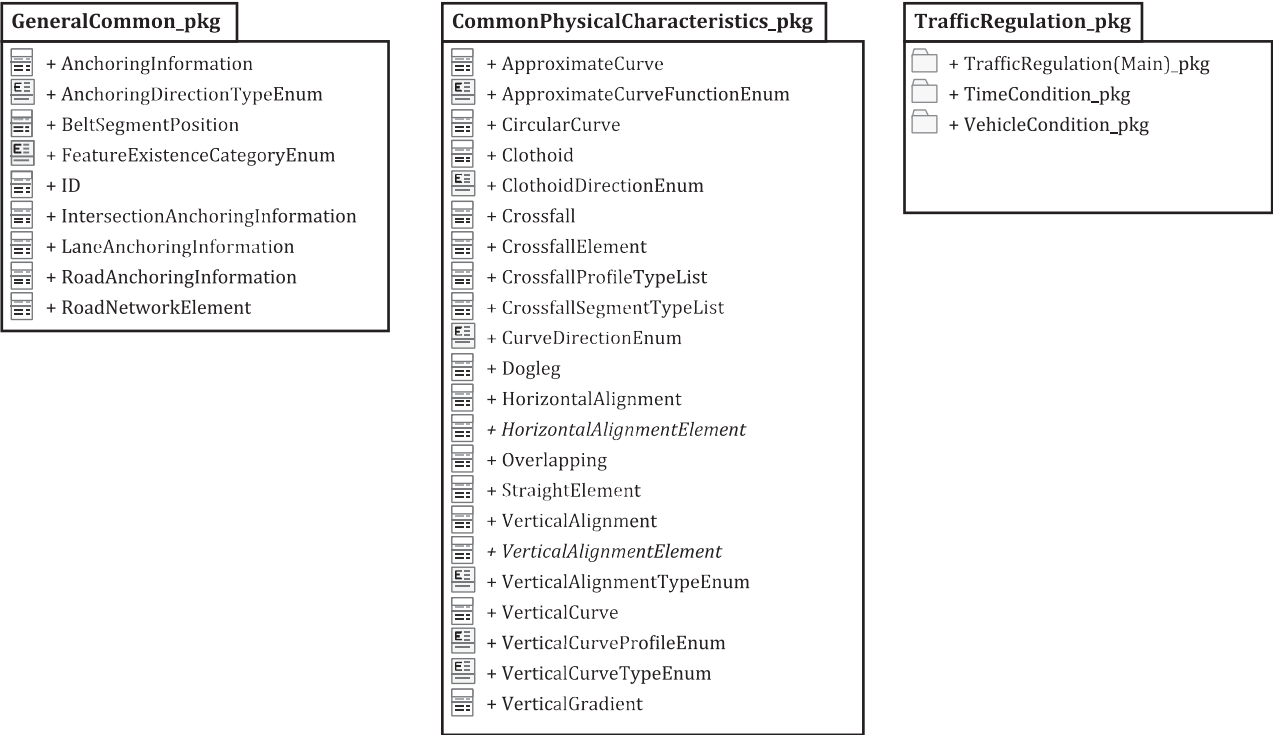


Figure 8 — MHAD CommonProperty package

9.2 GeneralCommonProperty package

9.2.1 General

The GeneralCommonProperty package defines common data classes and relationships other than the RoadPhysicalCharacteristics and TrafficRegulation packages.

[Figure 9](#) shows the class diagram of the GeneralCommonProperty package.

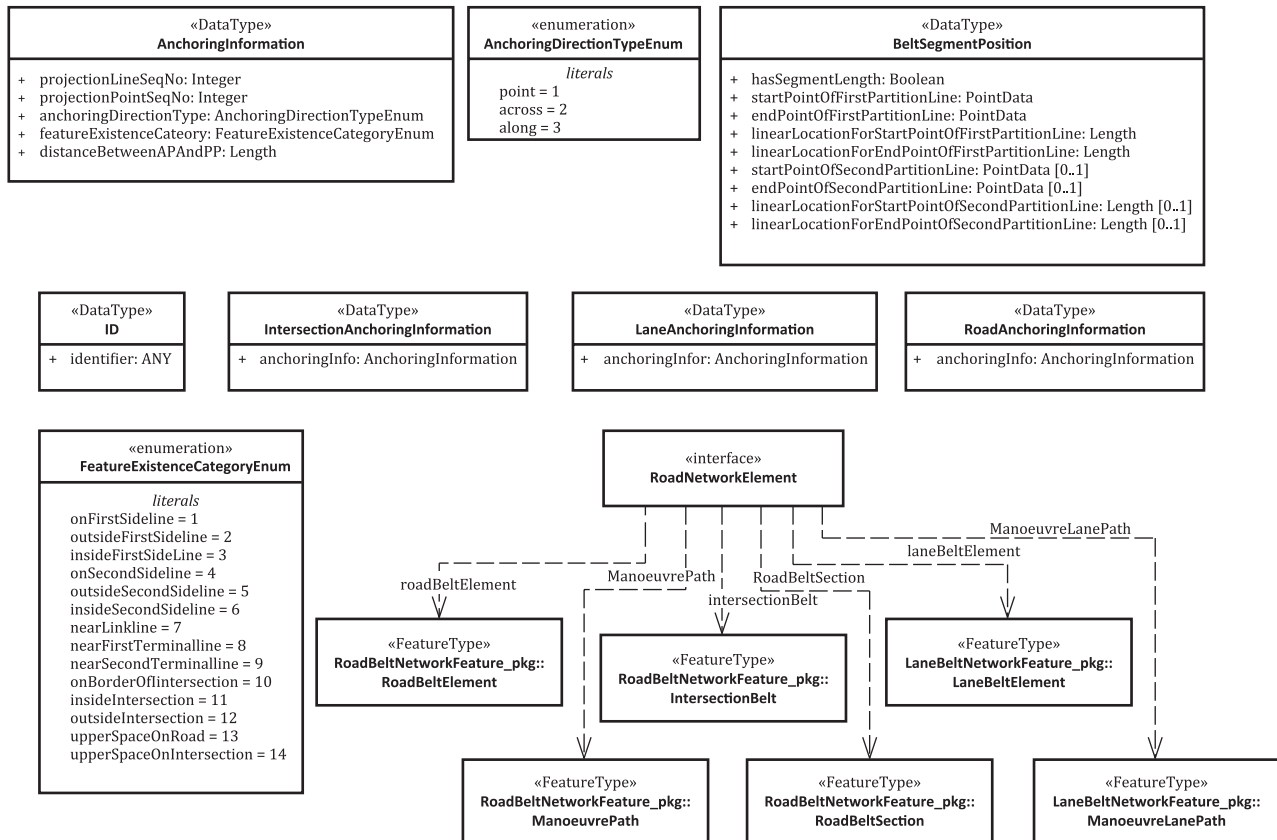


Figure 9 — Class diagram of the GeneralCommonProperty package

9.2.2 Class definitions

9.2.2.1 General

The GeneralCommonProperty package consists of the following classes.

9.2.2.2 AnchoringInformation class

The AnchoringInformation class represents a common property used in an association class between anchor positions of roads, intersection, or lanes and a roadside feature. Since a related roadside feature may have some projection points and projection lines, it needs an identifier to specify projection line and point corresponding to the anchor position.

[Table 2](#) defines the details of AnchoringInformation class.

Table 2 — AnchoringInformation class

Class: AnchoringInformation
Definition: Information about projection point and/or projection line of a roadside feature that is attached to an association from an anchor position class to a roadside feature class.
Subtype of:
Stereotypes: «DataType»
Attribute: projectionLineSeqNo

Table 2 (continued)

	Definition:	A unique sequence number within the road structure or equipment to specify the corresponding projection line.
	Value type:	Integer
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Attribute: projectionPointSeqNo		
	Definition:	A unique sequence number within the road structure or equipment to specify the corresponding projection point.
	Value type:	Integer
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Attribute: anchoringDirectionType		
	Definition:	Type of the anchoring direction of the road feature.
	Value type:	AnchoringDirectionTypeEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Attribute: featureExistenceCategory		
	Definition:	Category defining where a projection point of the road structure or a piece of road equipment exists.
	Value type:	FeatureExistenceCategoryEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Attribute: distanceBetweenAPAndRP		
	Definition:	Distance between the road anchor position and a projection point of the road structure or a piece of road equipment.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»

9.2.2.3 AnchoringDirectionTypeEnum class

The AnchoringDirectionTypeEnum class is an enumeration type item for specifying a type of the positional relationship between an anchor position and a road structure and equipment feature.

[Table 3](#) defines the details of AnchoringDirectionTypeEnum class.

Table 3 — AnchoringDirectionTypeEnum class

Class: AnchoringDirectionTypeEnum		
Definition: List of available enumerations for the types of the positional relationship between an anchor position and a projection point/ projection line.		
Subtype of: AnchoringInformation		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	Point	Roadside feature represented by a projection point is placed at the anchor position on a road feature.
2	across	Roadside feature represented by a projection line is placed across a road feature at its anchor position.
3	along	Roadside feature represented by a projection line is placed along a road feature at its anchor position.

9.2.2.4 BeltSegmentPosition class

The BeltSegmentPosition class specifies a position of the (road/lane) belt segment.

Since the (road/lane) belt segment is bounded by two sidelines and two partition lines, the position of the (road/lane) belt segment is specified by four points. i.e., the start points and end points of the first and second partition lines.

The first partition line is located toward of the first (road/lane) belt terminal line and the second partition line is located toward of the second belt terminal line.

[Table 4](#) defines the details of BeltSegmentPosition class.

Table 4 — BeltSegmentPosition class

Class: BeltSegmentPosition		
Definition: The position configuration of the (road/lane) belt segment feature.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: hasSegmentLength		
	Definition:	Distinction that the belt segment has a length (true) or is zero-length (false). If the value is false, the properties about the second partition line are omitted.
	Value type:	Boolean
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: startPointOfFirstPartitionLine		
	Definition:	Coordinates of the start point of the first partition line that is located on the first (road/lane) belt sideline.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: endPointOfFirstPartitionLine		
	Definition:	Coordinates of the end point of the first partition line that is located on the second (road/lane) belt sideline.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: linearLocationForStartPointOfFirstPartitionLine		
	Definition:	Distance along the first (road/lane) belt sideline from the first point of that the first (road/lane) belt sideline to the start point of the first partition line.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: linearLocationForEndPointOfFirstPartitionLine		
	Definition:	Distance along the second (road/lane) belt sideline from the first point of the second (road/lane) belt sideline to the end point of the first partition line.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: startPointOfSecondPartitionLine		

Table 4 (continued)

	Definition:	Coordinates of the start point of the second partition line that is located on the first (road/lane) belt sideline.
	Value type:	PointData
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Attribute: endPointOfSecondPartitionLine		
	Definition:	Coordinates of the end point of the second partition line that is located on the second (road/lane) belt sideline.
	Value type:	PointData
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Attribute: linearLocationForStartPointOfSecondPartitionLine		
	Definition:	Distance along the first (road/lane) belt sideline from the first point of that the (road/lane) belt sideline to the start point of the second partition line.
	Value type:	Length
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Attribute: linearLocationForEndPointOfSecondPartitionLine		
	Definition:	Distance along the second (road/lane) belt sideline from the first point of that the (road/lane) belt sideline to the end point of the second partition line.
	Value type:	Length
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»

9.2.2.5 FeatureExistenceCategoryEnum class

The FeatureExistenceCategoryEnum class is an enumeration type item for specifying the type of the position of the projection point of the road structure and equipment feature.

[Table 5](#) defines the details of FeatureExistenceCategoryEnum class.

Table 5 — FeatureExistenceCategoryEnum class

Class: FeatureExistenceCategoryEnum		
Definition: List of available enumerations for a position where a projection point of a road structure, or a piece of road equipment exists.		
Subtype of: AnchoringInformation		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	onFirstSideline	The road structure or the road equipment is located on the first sideline.
2	outsideFirstSideline	The road structure or the road equipment is located outside the first sideline.
3	insideFirstSideLine	The road structure or the road equipment is located inside the first sideline.
4	onSecondSideline	The road structure or the road equipment is located on the second sideline.
5	outsideSecondSideline	The road structure or the road equipment is located outside the second sideline.
6	insideSecondSideline	The road structure or the road equipment is located inside the second sideline.
7	nearLinkline	The road structure or the road equipment is located near the link line.

Table 5 (continued)

8	nearFirstTerminalline	The road structure or the road equipment is located near the first terminal line.
9	nearSecondTerminalline	The road structure or the road equipment is located near the second terminal line.
10	onBorderOfIntersection	The road structure or the road equipment is located on the border of the intersection.
11	insideIntersection	The road structure or the road equipment is located outside the intersection.
12	outsideIntersection	The road structure or the road equipment is located inside the intersection.

9.2.2.6 ID class

The ID class represents the identifier for identifying an instance of a datatype class. A «FeatureType» class has an implicit ID.

[Table 6](#) defines the details of ID class.

Table 6 — ID class

Class: ID		
Definition: A primitive data type which is used to identify a class instance defined by a number, character string, etc.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: identifier		
	Definition:	Identifier of the feature type.
	Value type:	ANY
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»

9.2.2.7 IntersectionAnchoringInformation class

The IntersectionAnchoringInformation class specifies anchoring information for the relationship between the intersection anchor position and roadside features.

[Table 7](#) defines the details of IntersectionAnchoringInformation class.

Table 7 — IntersectionAnchoringInformation class

Class: IntersectionAnchoringInformation		
Definition: Association class which represents the information for the relationship between the intersection anchor position and roadside features.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: anchoringInfo		
	Definition:	Represents the information for the relationship between an intersection anchor position and roadside features.
	Value type:	AnchoringInfomation
	Multiplicity:	1
	Stereotypes:	«DataType»

9.2.2.8 LaneAnchoringInformation class

The LaneAnchoringInformation class It specifies anchoring information for the relationship between the lane anchor position and roadside features.

[Table 8](#) defines the details of LaneAnchoringInformation class.

Table 8 — LaneAnchoringInformation class

Class: LaneAnchoringInformation		
Definition: Association class which represents the information for the relationship between the lane anchor position and roadside features.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: anchoringInfo		
	Definition:	Represents the information for the relationship between a lane anchor position and the roadside feature.
	Value type:	AnchoringInformation
	Multiplicity:	1
	Stereotypes:	«DataType»

9.2.2.9 RoadAnchoringInformation class

The RoadAnchoringInformation class specifies anchoring information for the relationship between the road anchor position and roadside features.

[Table 9](#) defines the details of RoadAnchoringInformation class.

Table 9 — RoadAnchoringInformation class

Class: RoadAnchoringInformation		
Definition: Association class which represents the information for the relationship between the road anchor position and roadside features.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: anchoringInfo		
	Definition:	Represents the information for the relationship between a lane anchor position and the roadside feature.
	Value type:	AnchoringInformation
	Multiplicity:	1
	Stereotypes:	«DataType»

9.2.2.10 RoadNetworkElement class

The road network element class is a feature level interface that represents the road features linked with the dynamic information, and associates with the road belt element, lane belt element, and intersection belt classes.

Through this interface class, the road belt features specified in this document (ISO/TS 22726-1) can be associated or linked with the dynamic data provided by different information services, specified in ISO/TS 22726-2.

[Table 10](#) defines the details of the RoadNetworkElement class.

Table 10 — RoadNetworkElement class

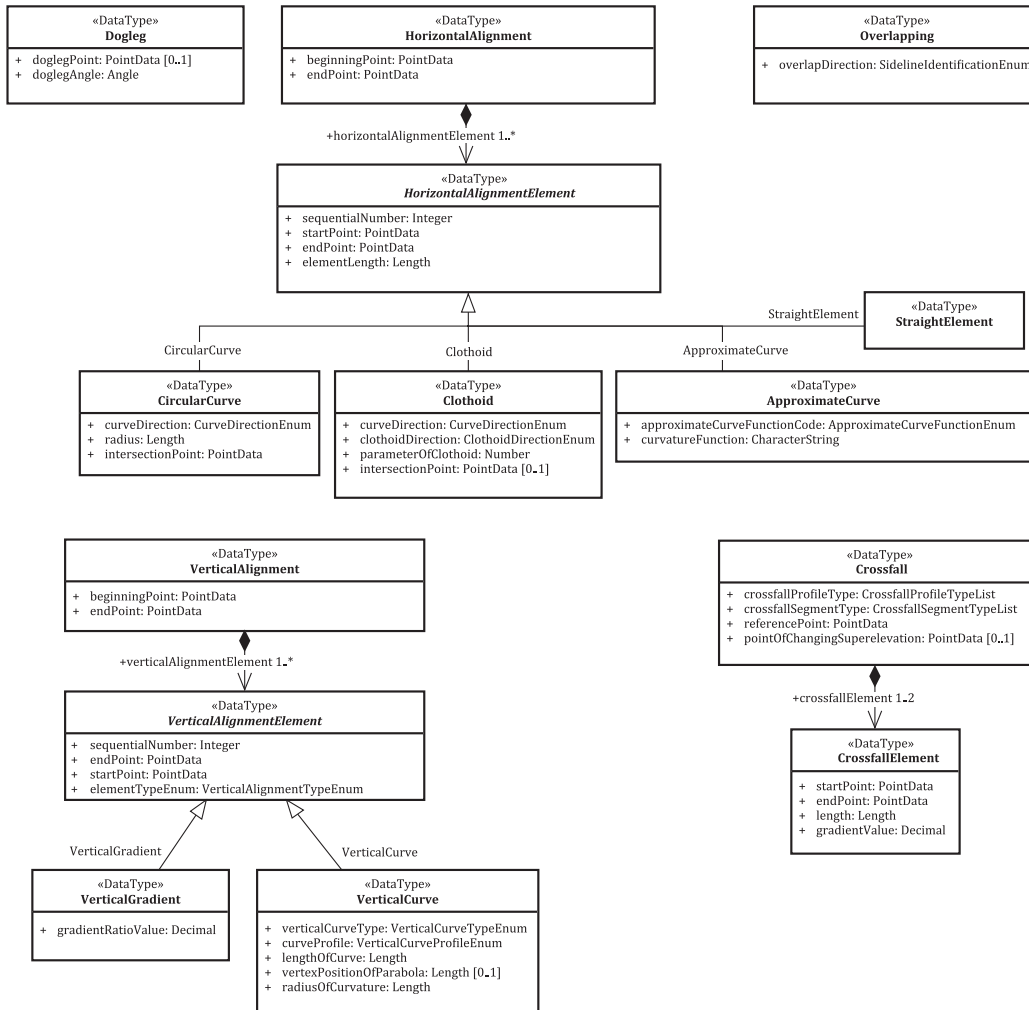
Class: RoadNetworkElement		
Definition: A feature level interface that represents the road features linked with the dynamic information defined in 22726-2.		
Abstract:		
Subtype of:		
Stereotypes: «interface»		
Relationship name: IntersectionBelt		
	Definition:	Specifies an intersection belt as a dependency relationship to the interface.
	Relationship type:	Dependency
	Value type:	IntersectionBelt
	Stereotypes:	«FeatureType»
Relationship name: LaneBeltElement		
	Definition:	Specifies a lane belt element as a dependency relationship to the interface.
	Relationship type:	Dependency
	Value type:	LaneBeltElement
	Stereotypes:	«FeatureType»
Relationship name: ManoeuvreLanePath		
	Definition:	Specifies a manoeuvre lane path as a dependency relationship to the interface.
	Relationship type:	Dependency
	Value type:	ManoeuvreLanePath
	Stereotypes:	«FeatureType»
Relationship name: ManoeuvrePath		
	Definition:	Specifies a manoeuvre path as a dependency relationship to the interface.
	Relationship type:	Dependency
	Value type:	ManoeuvrePath
	Stereotypes:	«FeatureType»
Relationship name: RoadBeltElement		
	Definition:	Specifies a road belt element as a dependency relationship to the interface.
	Relationship type:	Dependency
	Value type:	RoadBeltElement
	Stereotypes:	«FeatureType»
Relationship name: RoadBeltSection		
	Definition:	Specifies a road belt section as a dependency relationship to the interface.
	Relationship type:	Dependency
	Value type:	RoadBeltSection
	Stereotypes:	«FeatureType»

9.3 CommonPhysicalCharacteristics package

9.3.1 General

The CommonPhysicalCharacteristics subpackage defines data classes and their relationships for physical characteristics common to roadways and lanes and they are used in belt segment features.

[Figure 10](#) a) shows the class diagram of the CommonPhysicalCharacteristics package. [Figure 10](#) a) shows enumerations from the CommonPhysicalCharacteristics package.



a) Class diagram of the CommonPhysicalCharacteristics package

«enumeration» ApproximateCurveFunctionEnum <i>literals</i> polygonalLine = 1 NsplineExpression = 2 BsplineExpression = 3 polynomialExpression = 4	«enumeration» ClothoidDirectionEnum <i>literals</i> forwardDirection = 1 backwardDirection = 2
«CodeList» CrossfallProfileTypeList + onlyOne = 1 + roof = 2 + superelevation = 3	«CodeList» CrossfallSegmentTypeList + straight = 1 + circularCurve = 2 + clothoid = 3
«enumeration» CurveDirectionEnum <i>literals</i> clockwise = 1 counterclockwise = 2	«enumeration» VerticalAlignmentTypeEnum <i>literals</i> verticalGradient = 1 circularArc = 2 parabolicArc = 3
«enumeration» VerticalCurveProfileEnum <i>literals</i> crest = 1 sag = 2	«enumeration» VerticalCurveTypeEnum <i>literals</i> circularArc = 1 parabolicArc = 2

b) Enumerations of the CommonPhysicalCharacteristics package

Figure 10 — CommonPhysicalCharacteristics package

9.3.2 Class definitions

9.3.2.1 General

The CommonPhysicalCharacteristics package consists of the following classes.

9.3.2.2 ApproximateCurve class

The ApproximateCurve class is a basic element for a horizontal alignment which represents a shape by an approximate curvature function.

[Table 11](#) defines the details of ApproximateCurve class.

Table 11 — ApproximateCurve class

Class: ApproximateCurve		
Definition: A one of the basic items of a horizontal alignment element defined by means of a user-defined horizontal curve function such as polygonal curves, N-spline, B-spline, or a polynomial expression.		
Subtype of: HorizontalAlignmentElement		
Stereotypes: «DataType»		
Attribute: approximateCurveFunctionCode		
	Definition:	Method of approximation.
	Value type:	ApproximateCurveFunctionEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Attribute: curvatureFunction		
	Definition:	Formula to calculate the approximated curve.
	Value type:	CharacterString
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
NOTE This class inherits the attributes sequenceNumber, startPoint, endPoint, and elementLength from the horizontal alignment element superclass.		

9.3.2.3 ApproximateCurveFunctionEnum class

The ApproximateCurveFunctionEnum class is an enumeration type item for specifying the method of curve approximation for ApproximateCurve class.

[Table 12](#) defines the details of ApproximateCurveFunctionEnum class.

Table 12 — ApproximateCurveFunctionEnum class

Class: ApproximateCurveFunctionEnum		
Definition: List of available enumerations for the method of curve approximation.		
Subtype of: ApproximateCurve		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	polygonalLine	The curvature function is a polygonal line approximation,
2	nSplineExpression	The curvature function is an N-spline approximation.
3	bSplineExpression	The curvature function is a B-spline approximation,
4	polynomialExpression	The curvature function is specified by means of a polynomial expression.

9.3.2.4 CircularCurve class

The CircularCurve class is a basic element for a horizontal alignment which represents a shape by a circular arc.

[Table 13](#) defines the details of CircularCurve class.

Table 13 — CircularCurve class

Class: CircularCurve		
Definition: A one of the basic items of a horizontal alignment element defined by a circular arc curvature function.		
Subtype of: HorizontalAlignmentElement		
Stereotypes: «DataType»		
Attribute: curveDirection		
	Definition:	The direction from the start point to the end point of circular curve defined with reference to the intersection point.
	Value type:	CurveDirectionEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Attribute: radius		
	Definition:	Radius of the arc.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: intersectionPoint		
	Definition:	Coordinates of a point where the tangents of the start and end points of the arc intersect.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
NOTE This class inherits the attributes sequenceNumber, startPoint, endPoint, and elementLength from the horizontal alignment element superclass.		

9.3.2.5 Clothoid class

The Clothoid class is a basic element for a horizontal alignment which represents a shape by a clothoid arc.

[Table 14](#) defines the details of Clothoid class.

Table 14 — Clothoid class

Class: Clothoid		
Definition: A one of the basic items of a horizontal alignment element defined by a clothoid arc curvature function.		
Subtype of: HorizontalAlignmentElement		
Stereotypes: «DataType»		
Attribute: curveDirection		
	Definition:	Curve direction (from the start point to the end point) of the clothoid curve based on the Intersection Point of the clothoid curve.
	Value type:	CurveDirectionEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Attribute: clothoidDirection		
	Definition:	Transition direction of the clothoid arc.
	Value type:	ClothoidDirectionEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
NOTE This class inherits the attributes sequenceNumber, startPoint, endPoint, and elementLength from the horizontal alignment element superclass.		

Table 14 (continued)

Attribute: parameterOfClothoid		
	Definition:	Homothetic parameter specified as A in the clothoid expression, $R \cdot R = AL$. Where, R : is the radius at the end of transition curve L : is the transition curve length
	Value type:	Number
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: intersectionPoint		
	Definition:	Coordinates of the point where the tangents of the start and end points of the curve section intersect.
	Value type:	PointData
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
NOTE This class inherits the attributes sequenceNumber, startPoint, endPoint, and elementLength from the horizontal alignment element superclass.		

9.3.2.6 ClothoidDirectionEnum class

The ClothoidDirectionEnum class is an enumeration type item for specifying a type of a clothoid direction for Clothoid class.

[Table 15](#) defines the details of ClothoidDirectionEnum.

Table 15 — ClothoidDirectionEnum class

Class: ClothoidDirectionEnum		
Definition: List of available enumerations for the clothoid direction		
Subtype of: Clothoid		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	forwardDirection	The transition curve direction is specified from the beginning point to the end point of the clothoid.
2	backwardDirection	The transition curve direction is specified from the end point to the beginning point of the clothoid.

9.3.2.7 Crossfall class

The Crossfall class represents a slope of a transverse straight line located at a single partition line. A crossfall is classified into a roof type, single slope type, and superelevation type, and a roof type crossfall have serial two crossfall elements. In the case of a lane crossfall, some attributes have constraints.

NOTE Even if the actual road cross section (i.e., crossfall) is curved, the crossfall is represented as a straight line.

[Table 16](#) defines the details of Crossfall class.

Table 16 — Crossfall class

Class: Crossfall		
Definition: A slope of a straight transverse shape of the road that is located at either a point of changing superelevation or a partition line of a segment which represents straight part, transition (clothoid) part, or circular curve part of a road.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: crossfallProfileType		
	Definition:	A profile type of a crossfall.
	Value type:	CrossfallProfileTypeList
	Multiplicity:	1
	Stereotypes:	«CodeList»
Attribute: crossfallSegmentType		
	Definition:	A road segment type where a crossfall is set.
	Value type:	CrossfallSegmentTypeList
	Multiplicity:	1
	Stereotypes:	«CodeList»
Attribute: referencePoint		
	Definition:	A representative point at for expressing a gradient value that is located at the intersection of the centre line and the partition line.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: pointOfChangingSuperelevation		
	Definition:	A position of a point of changing superelevation, if profile type is superelevation.
	Value type:	PointData
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Relationship role name: crossfallElement		
	Definition:	Represents details of the crossfall element.
	Relationship type:	Composition
	Value type:	CrossfallElement
	Multiplicity:	1..2
	Stereotypes:	«DataType»

9.3.2.8 CrossfallElement class

The CrossfallElement class represents a primitive element of a crossfall for physical characteristic of segmented roads.

[Table 17](#) defines the details of CrossfallElement class.

Table 17 — CrossfallElement class

Class: CrossfallElement	
Definition: The specification of an element for crossfall expressed by a straight shape.	
Subtype of: Crossfall	
Stereotypes: «DataType»	
Attribute: startPoint	

Table 17 (continued)

	Definition:	The start element point is either the first point of a partition line or a reference point.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: endPoint		
	Definition:	The end element point is either a reference point or the second point of a partition line.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: length		
	Definition:	The length of the element.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: gradientValue		
	Definition:	The rate of the slope which is calculated by the length and the difference elevation between the start and end points and expressed as a percentage such as +2,000 %. It is positive in the case of an ascending gradient and negative in the case of a descending gradient. The definition of ascending and descending gradient follows the actual setting technique.
	Value type:	Decimal
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»

9.3.2.9 CrossfallProfileTypeList class

The CrossfallProfileTypeList class is a code type item for specifying a type of a crossfall profile.

[Table 18](#) defines the details of CrossfallProfileTypeList class.

Table 18 — CrossfallProfileTypeList class

Class: CrossfallProfileTypeList		
Definition: List of available enumerations for profile type of the crossfall.		
Subtype of: Crossfall		
Stereotypes: «CodeList»		
Code	Value	Definition
1	singleSlope	A profile is represented by single straight line.
2	roof	A profile is represented by serial two straight lines like a roof slope.
3	superelevation	A profile is represented by single straight line or serial two straight lines passing through the point of changing superelevation

9.3.2.10 CrossfallSegmentTypeList class

The CrossfallSegmentTypeList class is a code type item for specifying a type of a crossfall segment.

[Table 19](#) defines the details of CrossfallSegmentTypeList class.

Table 19 — CrossfallSegmentTypeList class

Class: CrossfallSegmentTypeList		
Definition: List of available enumerations for category of road feature segment located the crossfall.		
Subtype of: Crossfall		
Stereotypes: «CodeList»		
Code	Value	Definition
1	straight	The crossfall is located in a straight segment of a road.
2	circularCurve	The crossfall is located in a circular curve segment of a road.
3	clothoid	The crossfall is located in a clothoid curve (transition) segment of a road.

9.3.2.11 CurveDirectionEnum class

The CurveDirectionEnum class is an enumeration type item for specifying a type of a curve direction for Circular Curve and Clothoid.

[Table 20](#) defines the details of CurveDirectionEnum class.

Table 20 — CurveDirectionEnum class

Class: CurveDirectionEnum		
Definition: List of available enumerations for the horizontal curve direction.		
Subtype of:		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	clockwise	The curve direction is clockwise.
2	counterclockwise	The curve direction is counterclockwise.

9.3.2.12 Dogleg class

The Dogleg class represents characteristics of a bend in a road or lane. A dogleg position is specified by a road belt segment or a lane belt segment which specifies single partition line. A dogleg angle is represented by an intersection angle “IA” of a centre line shape of a road belt element or a lane belt element at a dogleg point on a partition line.

[Table 21](#) defines the details of Dogleg class.

Table 21 — Dogleg class

Class: Dogleg		
Definition: A dogleg is a bend in a roadway or lane without transition curves and circular curve sections.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: doglegPoint		
	Definition:	Point that represents a position of the dogleg where, on a centre line of carriageway or lane, it intersects a partition line.
	Value type:	PointData
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Attribute: doglegAngle		

Table 21 (continued)

Definition:	Clockwise angle of the centre line exiting the dogleg point with reference to the centre line entering the dogleg point in the belt direction.
Value type:	Angle
Multiplicity:	1
Stereotypes:	«PrimitiveType»

9.3.2.13 HorizontalAlignment class

The HorizontalAlignment class represented by a single or serial alignment element defined mathematical function, is specified at a road or lane belt segment. If a horizontal alignment for an entire road belt element, the road belt segment specifies the entire road belt element.

[Table 22](#) defines the details of HorizontalAlignment class.

Table 22 — HorizontalAlignment class

Class: HorizontalAlignment	
Definition: Projection onto a horizontal plane of the centre line of carriageway (or lane) that consists of either a single element or a combination of elements sequentially ordered.	
Subtype of:	
Stereotypes: «DataType»	
Attribute: beginningPoint	
Definition:	Beginning point of the horizontal alignment located on the first partition line of a belt segment.
Value type:	PointData
Multiplicity:	1
Stereotypes:	«PrimitiveType»
Attribute: endPoint	
Definition:	End point of the horizontal alignment located on the second partition line of a belt segment.
Value type:	PointData
Multiplicity:	1
Stereotypes:	«PrimitiveType»
Relationship role name: horizontalAlignmentElement	
Definition:	Specifies component elements of HorizontalAlignment.
Relationship type:	Composition
Value type:	HorizontalAlignmentElement
Multiplicity:	1..*
Stereotypes:	«DataType»

9.3.2.14 HorizontalAlignmentElement class

The HorizontalAlignmentElement class is classified by either an approximate curve, a circular curve, a clothoid, or a straight element that are represented mathematical function.

[Table 23](#) defines the details of HorizontalAlignmentElement class.

Table 23 — HorizontalAlignmentElement class

Class: HorizontalAlignmentElement		
Definition: A single element consisting of a horizontal alignment.		
Subtype of: HorizontalAlignment		
Stereotypes: «DataType»		
Attribute: sequentialNumber		
	Definition:	A sequential number beginning with 1, specifying the order of the horizontal alignment element.
	Value type:	Integer
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: startPoint		
	Definition:	Coordinates of the start point of the horizontal alignment element.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: endPoint		
	Definition:	Coordinates of the end point of the horizontal alignment element.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: elementLength		
	Definition:	Horizontal length of the centre line specified from the start point to the end point.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Relationship name: ApproximateCurve		
	Definition:	This specialization relationship represents that ApproximateCurve class is one of the horizontal alignments for road physical characteristics.
	Relationship type:	Inheritance
	Value type:	ApproximateCurve
	Stereotypes:	«DataType»
Relationship name: CircularCurve		
	Definition:	This specialization relationship represents that CircularCurve class is one of the horizontal alignments for road physical characteristics.
	Relationship type:	Inheritance
	Value type:	CircularCurve
	Stereotypes:	«DataType»
Relationship name: Clothoid		
	Definition:	This specialization relationship represents that Clothoid class is one of the horizontal alignments for road physical characteristics.
	Relationship type:	Inheritance
	Value type:	Clothoid
	Stereotypes:	«DataType»
Relationship name: StraightElement		
NOTE Attributes are inherited by child classes.		

Table 23 (continued)

Definition:	This specialization relationship represents that StraightElement class is one of the horizontal alignments for road physical characteristics.
Relationship type:	Inheritance
Value type:	StraightElement
Stereotypes:	«DataType»

NOTE Attributes are inherited by child classes.

9.3.2.15 Overlapping class

An overlap occurs where there are merges and branches of roads or lanes. An overlapping area is determined by a common terminal line, a left or right sideline of a road (i.e., the crossing side of the road), and a right or left sideline of another road (i.e., the crossed side of another road). Therefore, the Overlapping class defined in the RoadBeltSegment or LaneBeltSegment class specifies a side identification of a sideline only.

[Table 24](#) defines the details of the Overlapping class.

Table 24 — Overlapping class

Class: Overlapping	
Definition: An area where a belt feature overlaps another belt feature.	
Subtype of:	
Stereotypes: «DataType»	
Attribute: overlapSideline	
Definition:	Identification to specify the belt sideline which crosses to an adjacent road or lane for a branch or merge.
Value type:	SidelineIdentificationEnum
Multiplicity:	1
Stereotypes:	«Enumeration»

9.3.2.16 StraightElement class

The StraightElement class is a basic element for a horizontal alignment which represents a shape by a straight-line function. The properties of StraightElement are inherited from the HorizontalAlignmentElement class.

[Table 25](#) defines the details of StraightElement class.

Table 25 — StraightElement class

Class: StraightElement	
Definition: The basic items of a horizontal alignment element defined by a straight line.	
Subtype of: HorizontalAlignmentElement	
Stereotypes: «DataType»	
NOTE This class inherits the attributes sequenceNumber, startPoint, endPoint, and elementLength from the horizontal alignment element superclass.	

9.3.2.17 VerticalAlignment class

The VerticalAlignment class consists of a single or series of VerticalAlignmentElements defined by a mathematical function, and is a common characteristic defined for a road and lane, with the location specified by a centre line of a road or lane belt segment. If a vertical alignment is defined for an entire road belt element, the road belt segment specifies the entire road belt element.

[Table 26](#) defines the details of VerticalAlignment class.

Table 26 — VerticalAlignment class

Class: VerticalAlignment		
Definition: Trace of the rate of elevation change along the centre line of a carriageway (or lane) consisting of either a single element or a series of vertical alignment elements.		
Subtype of:		
Stereotypes: «DataType»		
Attribute: beginningPoint		
	Definition:	Beginning point of vertical alignment located on the first partition line of a belt segment.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: endPoint		
	Definition:	End point of vertical alignment located on the second partition line of a belt segment.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Relationship role name: verticalAlignmentElement		
	Definition:	Specifies the component elements of VerticalAlignment class.
	Relationship type:	Composition
	Value type:	VerticalAlignmentElement
	Multiplicity:	1..*
	Stereotypes:	«DataType»

9.3.2.18 VerticalAlignmentElement class

The VerticalAlignmentElement class represents a primitive element of a vertical alignment element for physical characteristics of segmented roads and is defined by either a vertical curve or a vertical gradient.

[Table 27](#) defines the details of VerticalAlignmentElement class.

Table 27 — VerticalAlignmentElement class

Class: VerticalAlignmentElement		
Definition: A single element that composes a vertical alignment.		
Subtype of: VerticalAlignment		
Stereotypes: «DataType»		
Attribute: sequentialNumber		
	Definition:	A sequential number beginning with 1 specifying the order of the vertical alignment element.
	Value type:	Integer
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: startPoint		
	Definition:	Coordinates of the start point of the vertical alignment element.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: endPoint		

Table 27 (continued)

	Definition:	Coordinates of the end point of the vertical alignment element.
	Value type:	PointData
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: elementTypeEnum		
	Definition:	A type of a vertical alignment element
	Value type:	VerticalAlignmentTypeEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Relationship name: VerticalCurve		
	Definition:	provides vertical curve of vertical alignment
	Relationship type:	Inheritance
	Value type:	VerticalCurve
	Stereotypes:	«DataType»
Relationship name: VerticalGradient		
	Definition:	provides vertical gradient for the linearly ascending or descending section of the carriageway or lane
	Relationship type:	Inheritance
	Value type:	VerticalGradient
	Stereotypes:	«DataType»

9.3.2.19 VerticalAlignmentTypeEnum class

The VerticalAlignmentTypeEnum class is an enumeration type item for specifying a type of vertical alignment element.

[Table 28](#) defines the details of VerticalAlignmentTypeEnum class.

Table 28 — VerticalAlignmentTypeEnum class

Class: VerticalAlignmentTypeEnum		
Definition: List of available enumerations for the types of vertical alignment elements.		
Subtype of: VerticalAlignmentElement		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	verticalGradient	Vertical alignment is represented by a single gradient (including a level section).
2	circularArc	Vertical alignment is represented by a circular arc.
3	parabolicArc	Vertical alignment is represented by parabolic arc.

9.3.2.20 VerticalCurve class

The VerticalCurve class is a primitive element for a vertical alignment which is represented a shape by a circular arc or parabolic arc.

NOTE VerticalCurve inherits the attributes a sequentialNumber, a startPoint, and an endPoint from the attributes of the vertical alignment element superclass.

[Table 29](#) defines the details of VerticalCurve class.

Table 29 — VerticalCurve class

Class: VerticalCurve		
Definition: Segment of a vertical alignment that is defined by a circular arc or parabolic arc to be inserted at the change point of the vertical gradient.		
Subtype of: VerticalAlignmentElement		
Stereotypes: «DataType»		
Attribute: verticalCurveType		
	Definition:	Quadratic curve type to represent the elevation change.
	Value type:	VerticalCurveTypeEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Attribute: curveProfile		
	Definition:	Type of the profile of the vertical curve.
	Value type:	VerticalCurveProfileEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Attribute: lengthOfCurve		
	Definition:	Horizontal length of the segment of the vertical curve.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
Attribute: vertexPositionOfParabola		
	Definition:	Horizontal distance along the centre line from the start point to the vertex position of the parabola if the vertical curve is a parabolic arc.
	Value type:	Length
	Multiplicity:	0..1
	Stereotypes:	«PrimitiveType»
Attribute: radiusOfCurvature		
	Definition:	Radius of the vertical curve is one of either: a) the radius of curvature at the vertex of the parabola, when the vertical curve is a parabolic arc, or b) the radius of a circular arc when the vertical curve is a circular arc.
	Value type:	Length
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
NOTE This class inherits the attributes a sequentialNumber, a startPoint, and an endPoint from the attributes of the vertical alignment element superclass.		

9.3.2.21 VerticalCurveProfileEnum class

The VerticalCurveProfileEnum class is an enumeration type item for specifying a vertical curve profile.

[Table 30](#) defines the details of VerticalCurveProfileEnum class.

Table 30 — VerticalCurveProfileEnum class

Class: VerticalCurveProfileEnum		
Definition: List of available enumerations for the longitudinal profile defining the vertical curve.		
Subtype of: VerticalCurve		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	crest	Vertical curve at a crest profile.
2	sag	Vertical curve at a sag profile.

9.3.2.22 VerticalCurveTypeEnum class

The VerticalCurveTypeEnum class is an enumeration type item for specifying a type of vertical curve.

[Table 31](#) defines the details of VerticalCurveTypeEnum class.

Table 31 — VerticalCurveTypeEnum class

Class: VerticalCurveTypeEnum		
Definition: List of available enumerations of the types of quadratic curves.		
Subtype of: VerticalCurve		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	circularArc	Vertical alignment is represented by a circular arc.
2	parabolicArc	Vertical alignment is represented by a parabolic arc.

9.3.2.23 VerticalGradient class

The VerticalGradient class is a primitive element for a vertical alignment which is represented a shape by a straight. VerticalGradient inherits the attributes a sequentialNumber, a startPoint, and an endPoint from the attributes of the vertical alignment element superclass.

[Table 32](#) defines the details of VerticalGradient class.

Table 32 — VerticalGradient class

Class: VerticalGradient		
Definition: Segment of a vertical alignment that element has a single longitudinal gradient ratio.		
Subtype of: VerticalAlignmentElement		
Stereotypes: «DataType»		
Attribute: gradientRatioValue		
	Definition:	Longitudinal slope ratio as a percentage where the value is positive for ascending cases and negative for descending cases. Example: value = +5,000 %
	Value type:	Decimal
	Multiplicity:	1
	Stereotypes:	«PrimitiveType»
NOTE This class inherits the attributes a sequentialNumber, a startPoint, and an endPoint from the attributes of the vertical alignment element superclass.		

9.4 TrafficRegulation package

9.4.1 Modelling policy of Traffic regulations

Traffic regulations are rules and/or directives made and maintained by the authorities about the traffic that use a road network. To manage and control vehicular traffic on roads, the traffic authority specifies the traffic regulation contents, the applied places (i.e., road/lane), and the validity period (i.e., permanent/temporary).

In the MHAD traffic regulation model, traffic regulation data do not contain application location data, therefore the application locations are identified by associating traffic regulations with road features. Additionally, since this model does not contain regional data, traffic regulations applied to a region should be associated with applicable road data.

Traffic regulation content is represented by the TrafficRegulation class Including VehicleCondition and TimeCondition class which are used to identify the target scope of the traffic regulation.

If a validity period is permanent, the traffic regulation is specified in the properties of the static road and lane features, identified at the applied place. If a validity period is temporary, the traffic regulation is specified as the TemporaryAppliedPlace class and the Regulation Validity class, identify the applied place and the validity period. If a temporary traffic regulation is issued and disseminated from an authority dynamically, the applied place and the validity period for the temporary regulation may be generated or converted from dynamic information by application software and is temporarily stored in the dataset of the traffic regulation model.

The MHAD road data model introduced characteristics of basic traffic rules related to road features (i.e., roadway, intersection, lane), such as one-way, traffic direction on a road. Therefore, if the specific traffic regulations can be determined by property data already defined by the road feature, these road features do not need a relationship to the traffic regulations.

Since, the vehicles that violate vehicle regulations and vehicle operation regulations, are not permitted to travel on all roads, the traffic regulation model does not include traffic restrictions regarding vehicles that exhibit conditions of violation.

Traffic regulations are divided into restriction/instruction/warning/advice. This model defines 'restriction' as a mandatory rule with penalties for violation and 'instruction' as a selective rule with no penalties for violations.

Since traffic regulations applied to some roadways are implicitly valid for all lane on that roadway, therefore any lane on that roadway can omit the traffic regulations.

Traffic regulations in this model are defined as either a prohibited type or an allowed type in order to consider the implementation cost of traffic regulation data. A prohibited regulation is used when the entire road has no regulation. An allowed regulation is used when the entire road has regulation. For example, in the parking regulation, 'no parking' at a parking allowed zone is as a prohibited type and 'allowed parking' at no parking zone is as an allowed type.

Traffic regulations are specified in RoadBeltElement, RoadBeltElementSegment, RoadBeltSideline, RoadBeltSidelineSegment or ManoeuvrePath classes depending on the regulation content. For example, traffic regulations of road shoulders such as parking and waiting are specified to RoadBeltSideline or RoadBeltSidelineSegment classes. The same applies to lanes.

In the real world, road signs represent the regulation contents and the locations of traffic regulations, however road sign features in the model are not associated with traffic regulations. Additionally, road markings represent the locations of traffic regulations, however road marking features in the model are not associated with traffic regulations.

Typically, traffic regulation data can be expressed in a complementary method.

EXAMPLE A bus-only road regulation can be expressed by two setting methods of regulations:

- (A) the regulation "allowed type: allowed travel" and the vehicle condition "exclusive: bus", or

- (B) the regulation "prohibited type: no travel" and the vehicle condition "exclusion: bus" or "application: vehicles other than bus".

9.4.2 General description

TrafficRegulation package consists of the following three sub-packages:

- TrafficRegulation(Main) sub-package — defines data classes and their relationships for main part of the traffic regulation model,
- TimeCondition sub-package — defines data classes and their relationships for time condition part of the traffic regulation model, and
- VehicleCondition sub-package — defines data classes and their relationships for vehicle condition part of the traffic regulation model.

Figure 11 shows the package diagram of the TrafficRegulation package.

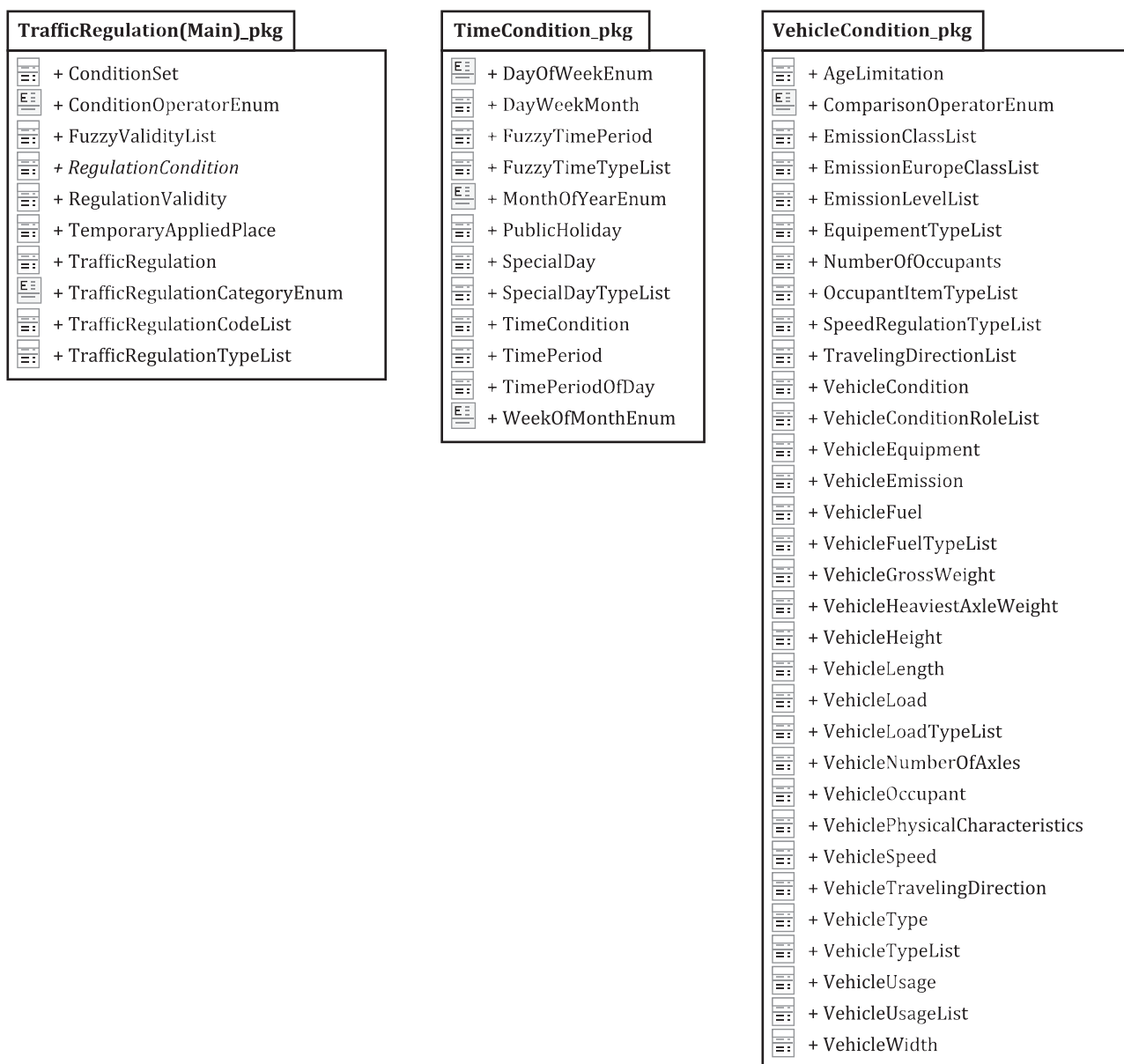


Figure 11 — Package diagram of the TrafficRegulation package

9.4.3 TrafficRegulation(Main) sub-package

9.4.3.1 General Description

TrafficRegulation(Main) sub-package represents the main part of the traffic regulation data model.

[Figure 12](#) shows the class diagram of the TrafficRegulation(Main) sub-package.



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9.4.3.2 Classes Definitions

9.4.3.2.1 General

The TrafficRegulation(Main) sub-package consists of the following classes.

9.4.3.2.2 ConditionSet class

A ConditionSet class is a combination of multiple vehicle conditions and/or time conditions.

[Table 33](#) defines the details of ConditionSet class.

Table 33 — ConditionSet class

Class: ConditionSet		
Definition: A regulation condition that combines two or more specified conditions mathematically or logically by specified operators.		
Subtype of: TrafficRegulation		
Stereotypes: «DataType»		
Attribute: conditionSetOperator		
	Definition:	The specified logical operator applied between the conditions in the set.
	Value type:	ConditionOperatorEnum
	Multiplicity:	1
	Stereotypes:	«Enumeration»
Relationship role name: regulationCondition		
	Definition:	Specifies the regulation conditions for combining in a condition set.
	Relationship type	Composition
	Value type:	RegulationCondition
	Multiplicity:	1..*
	Stereotypes:	«DataType»

9.4.3.2.3 ConditionOperatorEnum class

The ConditionOperatorEnum class is an enumeration type item for specifying condition operator.

[Table 34](#) defines the details of ConditionOperatorEnum class.

Table 34 — ConditionOperatorEnum class

Class: ConditionOperatorEnum		
Definition: List of available enumerations for the logical operator used in a test of conditions.		
Subtype of: ConditionSet		
Stereotypes: «Enumeration»		
Code	Value	Definition
1	or	Logical "OR" operator used to determine if any conditions in a test are TRUE.
2	xor	Logical "XOR" operator that outputs true only when the input values differ (one is true, the other is false).
3	and	Logical "AND" operator used to determine if all conditions in a test are TRUE.

9.4.3.2.4 FuzzyValidityList class

The FuzzyValidityList class is a code type item for specifying a fuzzy validity which ambiguous period if a start and end time of the validity cannot be fixed.