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TECHNICAL SPECIFICATION

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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

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Foreword

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

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

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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 to be 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.

The purpose of this document is to define a data model for connected and automated driving systems.

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 terminological 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, represented by belt concept, bounded by three or more Edges or four or more NET coordinate Tuple

[SOURCE: ISO 20524-2:2020, 3.1, modified — "represented by belt concept" added.]

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 sideline 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
sideline
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 added.]

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
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 (7.3)

— Relationship to dynamic information (7.4)

— Annex A (normative) Abstract test suite

— Annex B (normative) Basic data types and stereotypes

— Annex C (informative) Rsolution 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.

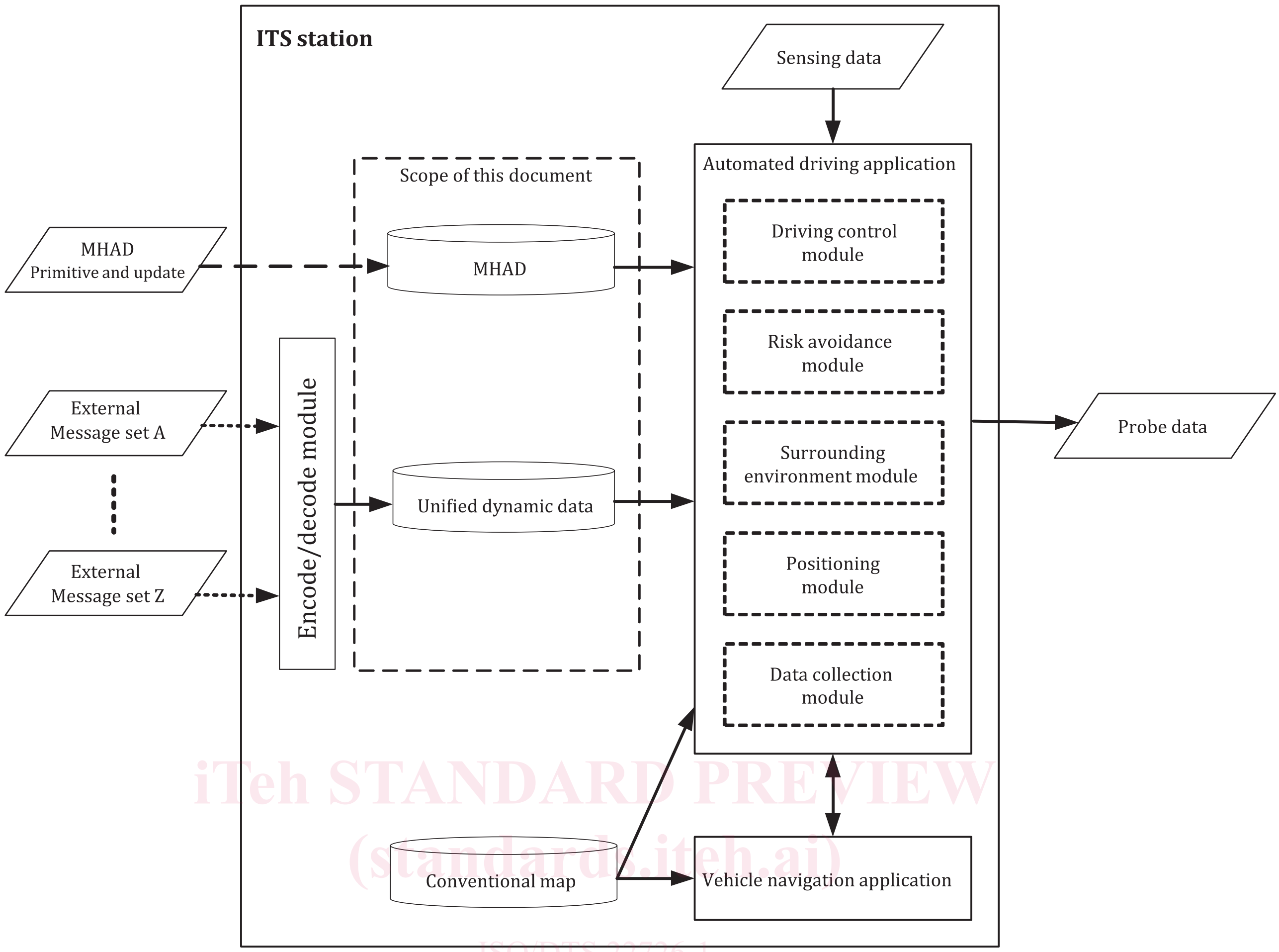


Figure 1 — Conceptual system architecture

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

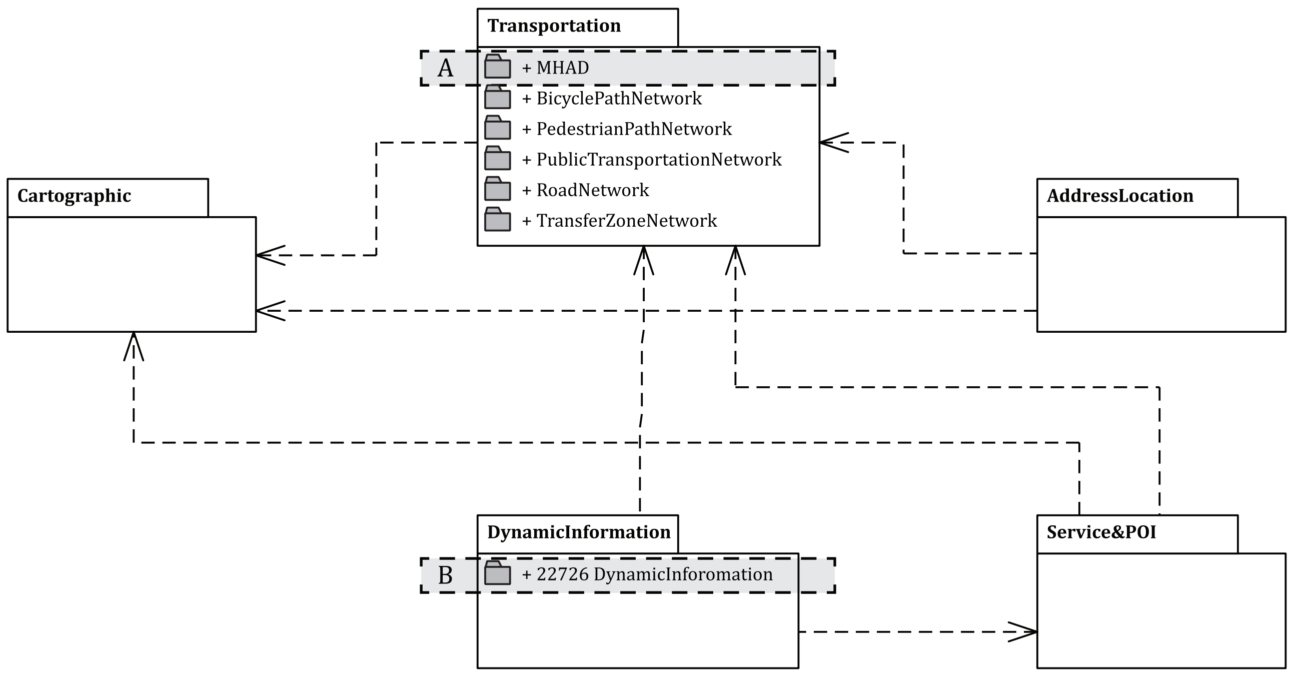
— DynamicInformation: external information in association with transportation data for providing real-time conditions and/or status.

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

The DynamicInformation package is specified in ISO/TS 22726-2:—[1)].

The overall map data model is shown in Figure 2.

1) Under preparation. Stage at the time of publication ISO/AWI TS 22726-2:2023.



Key

A ISO/TS 22726-1 (this document)

B ISO/TS 22726-2

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;

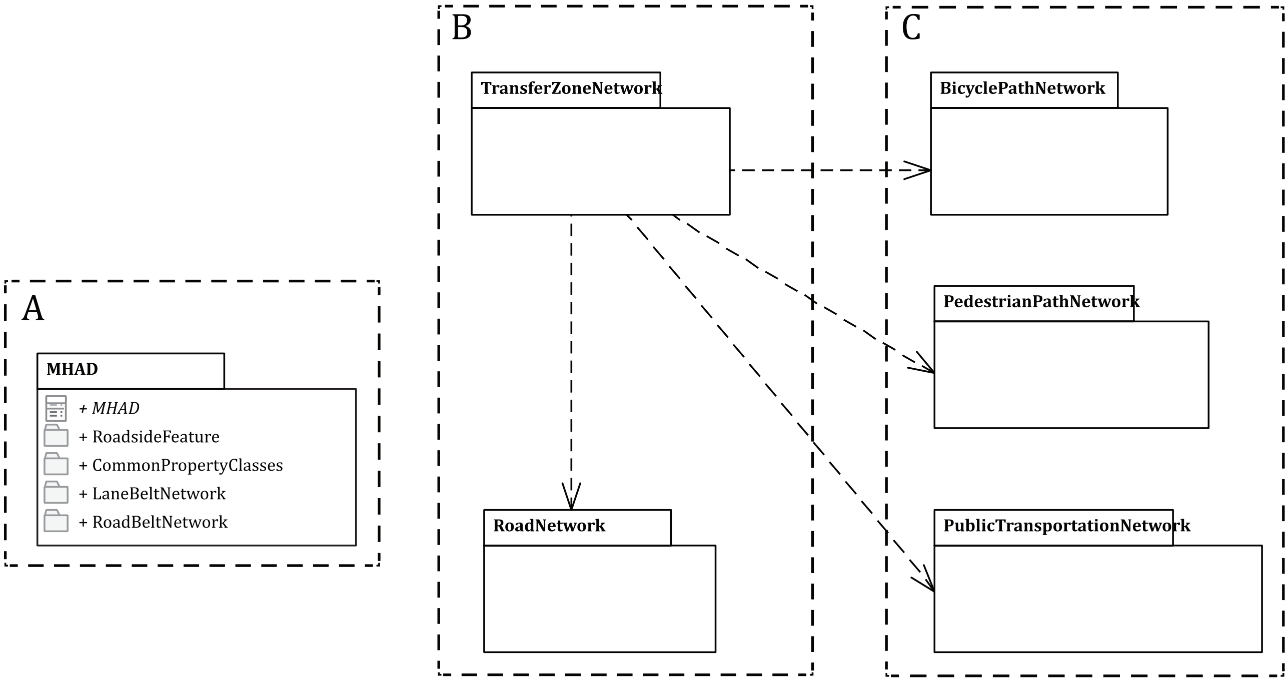
— BicyclePathNetwork: static path network data for bicycle movement; and

— 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.



Key

A ISO/TS 22726-1 (this document)

B ISO 14296

C other standards

Figure 3 — Transportation package

7.3 MHAD package

7.3.1 General

7.3.1.1 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;

— CommonPropertyClasses package — defines the data classes commonly used in multiple sub-packages belonging to the MHAD package.

Figure 4 shows the package configuration of the MHAD package.

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

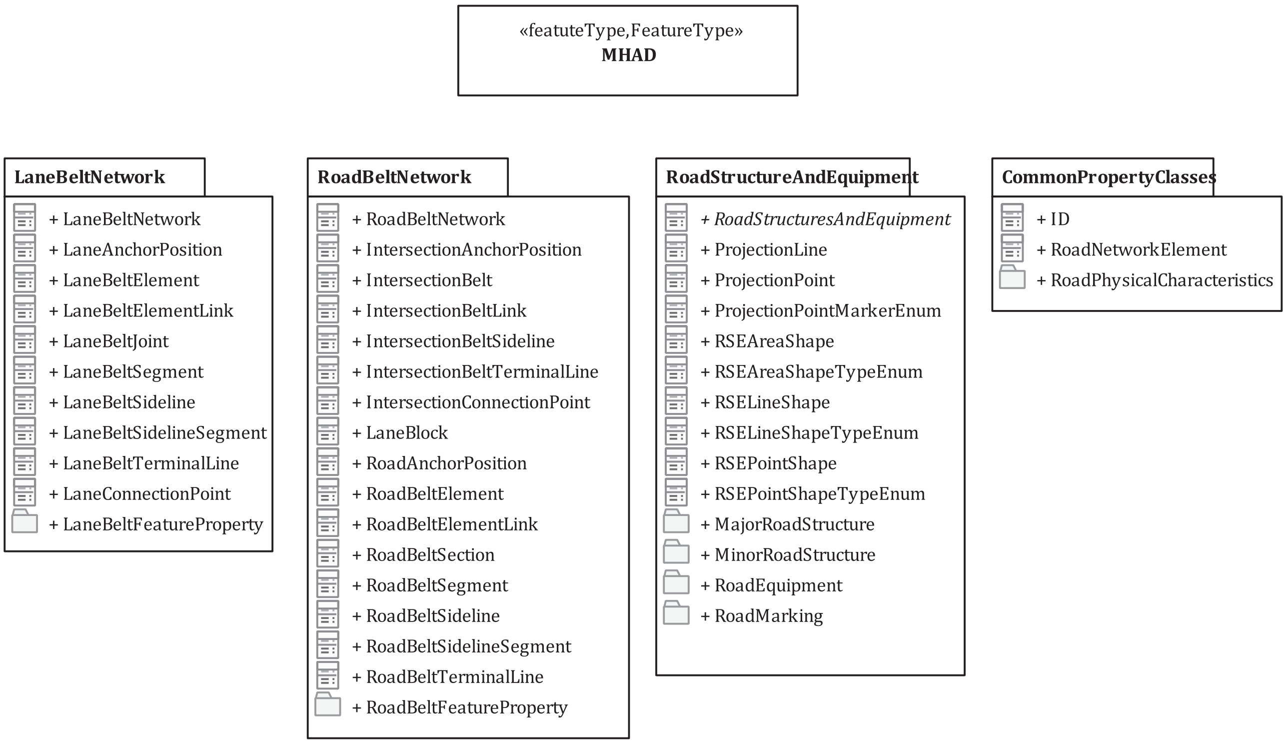


Figure 4 — MHAD package diagram

Figure 5 shows the classes and relationships for expressing the hierarchical model of the MHAD package.

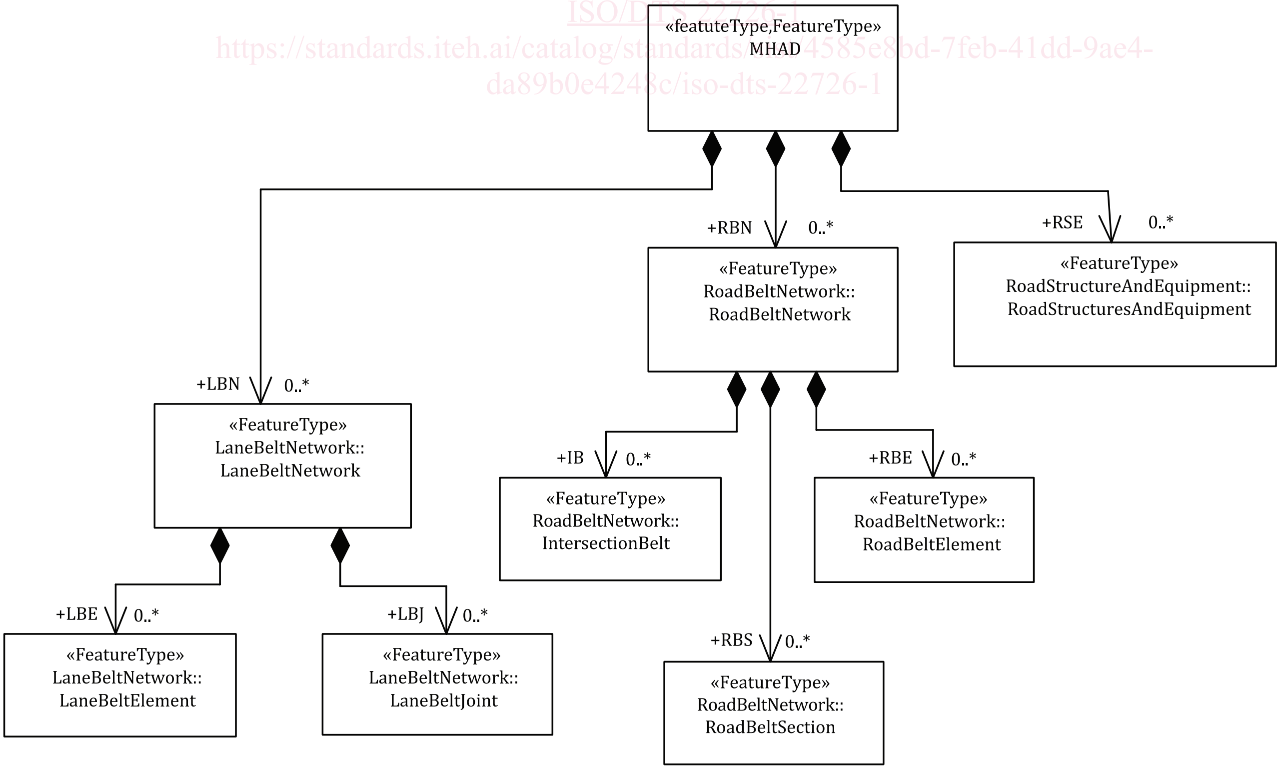


Figure 5 — Class diagram of MHAD package

7.3.1.2 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.

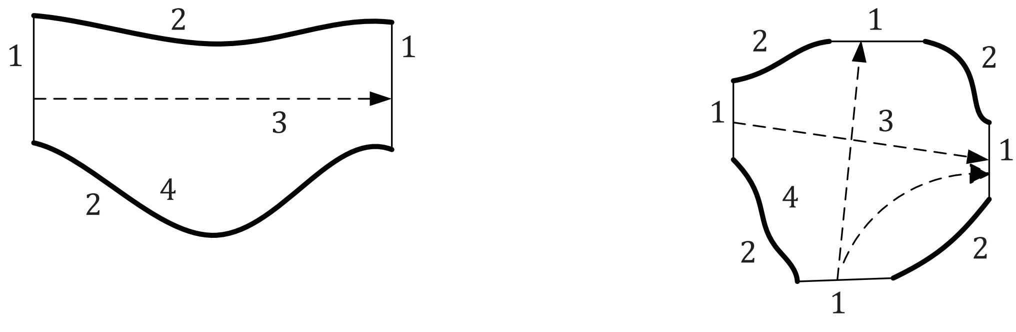
A conventional data model enables a vehicle to identify in which road and/or lane it is driving. However, an area feature in the conventional data model merely expresses a space for free motion and does not imply any specific directions. Thus, the area feature in the conventional data model does not 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 sidelines 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 sidelines 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 sidelines 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. Sidelines are also conceptually represented and can refer to real road-related objects (e.g. lane markings, flow-markings, kerbs, guardrails, etc.).



a) Road **b) Intersection**

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 a RoadBeltNetwork package and a LaneBeltNetwork package.