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**Intelligente Verkehrssysteme –
DATEX-II-Datenaustauschspezifikationen für Verkehrsmanagement und
Verkehrsinformationen –
Teil 9: Publikationen für das Lichtsignalanlagen-Management im
städtischen Umfeld;
Englische Fassung CEN/TS 16157-9:2020**

Intelligent transport systems –
DATEX II data exchange specifications for traffic management and information –
Part 9: Traffic signal management publications dedicated to the urban environment;
English version CEN/TS 16157-9:2020

Systèmes de transport intelligents –
Spécification DATEX II d'échange de données pour la gestion du trafic et l'information
routière –
Partie 9: Publications pour la gestion des feux de circulation dédiées à l'environnement
urbain;
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DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

Nationales Vorwort

Dieses Dokument (CEN/TS 16157-9:2020) wurde vom Technischen Komitee CEN/TC 278 „Intelligente Verkehrssysteme“ ausgearbeitet, dessen Sekretariat von NEN (Niederlande) gehalten wird.

Das zuständige deutsche Normungsgremium ist der Gemeinschaftsarbeitsausschuss NA 052-02-71 GA „Gemeinschaftsarbeitsausschuss NAAutomobil/DKE: Intelligente Verkehrssysteme“ des DIN-Normenausschusses Automobiltechnik.

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Zur vorliegenden Technischen Spezifikation wurde kein Entwurf veröffentlicht.

Das Präsidium des DIN hat mit seinem Beschluss 1/2004 festgelegt, dass von dem in den Regeln der europäischen Normungsarbeit von CEN/CENELEC verankerten Grundsatz, wonach Europäische Normen in den drei offiziellen Sprachen Deutsch, Englisch und Französisch veröffentlicht werden, in begründeten Ausnahmefällen abgewichen und auf die deutsche Sprachfassung verzichtet werden kann.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die Englische Fassung von CEN/TS 16157-9:2020.

Dieses Dokument legt eine gemeinsame Menge von Datenaustausch-Spezifikationen fest, um die Vision eines interoperablen Austauschs von Verkehrs- und Reiseinformationsdaten über Grenzen hinweg zu ermöglichen.

Dieses Dokument basiert weiterhin auf einem Weißbuch der Europäischen Kommission, welches die Koordination von Verkehrsmanagement und die Entwicklung von übergangslosen paneuropäischen Diensten festlegt.

Dieser Teil der Reihe beschäftigt sich mit der Publikation von Informationen zu Lichtsignalanlagen, die wesentlich für den städtischen Bereich sind. Die technische Spezifikation legt Informationsstrukturen und -definitionen fest, welche innerhalb von zwei Veröffentlichungen ausgetauscht werden können:

- Die Kartendatenveröffentlichung übermittelt statische Informationen bezogen auf ampelgesteuerte Kreuzungen und Straßenabschnitte eines Straßennetzes. Die Kartendatenveröffentlichung ist die UML-Übersetzung der MapData-Botschaft (MAP) nach CEN ISO/TS 19091 und dessen europäischem Profil;
- Die Veröffentlichung zu Verkehrssignalphase und Zeitvorgaben übermittelt die dynamische Information bezogen auf ampelgesteuerte Kreuzungen eines Straßennetzes. Die Veröffentlichung zu Verkehrssignalphase und Zeitvorgaben ist die UML-Übersetzung der SignalPhaseAndTiming-Botschaft (SPAT) nach CEN ISO/TS 19091 und dessen europäischem Profil.

Erfahrungen mit dieser Technischen Spezifikation sind erbeten:

- vorzugsweise als Datei per E-Mail an eric.wern@vda.de in Form einer Tabelle. Die Vorlage dieser Tabelle kann im Internet unter <http://www.din.de/stellungnahme> abgerufen werden;
- oder in Papierform an den Normenausschuss Automobiltechnik, Behrenstr. 35, 10117 Berlin.

Nationaler Anhang NA (informativ)

Begriffe

Die Benummerung der folgenden Begriffe und Abkürzungen ist identisch mit der Benummerung in der englischen Fassung.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe aus DIN EN 16157-1, DIN EN 16157-2 und DIN EN 16157-7 und die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

- IEC Electropedia: verfügbar unter <http://www.electropedia.org/>
- ISO Online Browsing Platform: verfügbar unter <http://www.iso.org/obp>

3.1

Bitkette

(en: bit string)

einfacher Typ, dessen unterschiedliche Werte eine geordnete Sequenz von Null, Eins oder mehr Bits sind

[QUELLE: ISO/IEC 8824-1:2015]

3.2

Ausfahrtsweg

(en: egress path)

Fluss von Fahrzeugen oder anderer Art von Verkehr, der einen Kreuzungsbereich in einer oder mehreren festgelegten Fahrspuren verlässt

[QUELLE: SAE J2735:2016]

3.3

Einfahrtsweg

(en: ingress path)

Fluss von Fahrzeugen oder anderer Art von Verkehr, der einen Kreuzungsbereich in einer oder mehreren festgelegten Fahrspuren erreicht

[QUELLE: SAE J2735:2016]

3.4

Fahrspur

(en: lane)

Streifen oder Transportweg, der dazu dient, eine Reihe fahrender Fahrzeuge aufzunehmen, und häufig durch Straßenmarkierungen festgelegt ist

[QUELLE: ISO 6707-1:2017]

3.5

Verbindung

(en: link)

direkte topologische Verbindung zwischen zwei Knoten, welche eine geordnete Sequenz von einem Segment oder mehreren Segmenten umfasst und durch eine geordnete Sequenz von Null oder mehreren Formpunkten dargestellt wird

[QUELLE: ISO/TS 20452:2007]

3.6

Manöver

(en: manoeuvre)

Sammlung von zusammengehörenden Verbindungen und Kurven, die in Kombination in einer Route verwendet werden

Anmerkung 1 zum Begriff: Manöver werden verwendet, um Kurven in angenehmen und legalen Kombinationen zu clustern. Sie können einfach wie einfache Kurven sein, eine Kombination von engen Kurven oder sehr komplexe Kombinationen, bestehend aus Einfahrt, Ausfahrt und angeschlossenen Straßen.

[QUELLE: EN ISO 19133:2007]

3.7

Knoten

(en: node)

Null-dimensionale topologische Grundform

[QUELLE: EN ISO 19107:2005]

3.8

Fahrzeugtrajektorie

Trajektorie

(en: vehicle trajectory, trajectory)

Pfad eines ausgewählten Punktes auf dem Fahrzeug im ortsfesten Koordinatensystem

[QUELLE: ISO 8855:2011]

English Version

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Intelligente Verkehrssysteme —
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Verkehrsmanagement und Verkehrsinformationen —
Teil 9: Publikationen für das
Lichtsignalanlagen-Management im städtischen
Umfeld

This Technical Specification (CEN/TS) was approved by CEN on 13 January 2020 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (CEN/TS 16157-9:2020) has been prepared by Technical Committee CEN/TC 278 “Intelligent transport systems”, the secretariat of which is held by NEN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a standardization request given to CEN by the European Commission and the European Free Trade Association.

As a user of this document, attention is drawn to the resources of www.datex2.eu < <http://www.datex2.eu> >. This website contains related software tools and software resources that aid the implementation of EN 16157 DATEX II.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This document defines a common set of data exchange specifications to support the vision of a seamless interoperable exchange of traffic and travel information across boundaries, including national, urban, interurban, road administrations, infrastructure providers and service providers.

Standardization in this context is a vital constituent to ensure that interoperability, reduction of risk, reduction of the cost base and promotion of open marketplace objectives are achieved that will lead to many social, economic and community benefits as a result of more informed travellers, network managers and transport operators.

With the aim to support sustainable mobility in Europe, the European Commission has been supporting the development of information exchange mainly between the actors of the road traffic management domain for a number of years. In the road sector, DATEX II has been long in fruition, with the European Commission being fundamental to its development through an initial contract and subsequent cofunding through the Euro-Regional projects, and well as support for Programme Support Action activities.

DATEX II is referenced within European regulations:

- EU Commission Delegated Regulation, (EU) 2013/885 of 15 May 2013 regarding the provision of information services for safe and secure parking places for trucks and commercial vehicles,
- EU Commission Delegated Regulation, (EU) 2013/886 of 15 May 2013 regarding data and procedures for the provision, where possible, of road safety-related minimum universal traffic information free of charge to users,
- EU Commission Delegated Regulation, (EU) 2015/962 of 18 December 2014 regarding the provision of EU-wide real-time traffic information services,
- EU Commission Delegated Regulation, (EU) 1926/2017 of 31 May 2017 regarding the provision of EU-wide multimodal travel information services.

This document includes the framework, context and specification for exchanges, the modelling approach, data content, data structure and relationships.

This document supports a methodology that is extensible.

This document, which is Part 9 of the CEN 16157 series, deals with the publication of traffic signal related information that is most relevant in the urban environment. It specifies the structures and definitions of information that may be exchanged within two publications:

- The Map Data publication conveys static information related to the intersections and road segments belonging to a road network, related to traffic signal-controlled intersections. The Map Data Publication is the translation in UML of the MapData message (MAP) as it is defined in CEN ISO/TS 19091 and its European profile.
- The Traffic Signal Phase and Timing Publication conveys the dynamic information related to traffic signal-controlled intersections belonging to a road network. Traffic Signal Phase and Timing Publication is the translation in UML of the SignalPhaseAndTiming message (SPAT) as it is defined in CEN ISO/TS 19091 and its European profile.

Both publications are specified as Level B Extensions to the DATEX II model.

The present document was developed by project team PT1709 funded by the European Commission under grant agreement SA/CEN/GROW/EFTA/546/2016-10 'Urban ITS - Traffic Management Data

Models and interfaces' (M/546 [1]). The focus of M/546 is Intelligent Transport Systems in the urban environment – but this does not preclude this document being used in the non-urban environment.

It is noted that the terms and concepts utilized in this document draw heavily on those defined in CEN ISO/TS 19091 and SAE J2735.

1 Scope

This document constitutes a part of the CEN 16157 DATEX II series of standards and technical specifications. This series specifies and defines component facets supporting the exchange and shared use of data and information in the field of traffic and travel. The component facets include the framework and context for exchanges, the modelling approach, the data content, the data structure and relationships and the communications specification.

Part 9, this document, specifies additional data model structures that are applicable for traffic signal management applications in the urban environment. This part specifies data concepts to support the exchange of traffic signal status messaging, intersection geometry definition and attribution in a consistent way with existing C-ITS standards and technical specifications.

It establishes specifications for data exchange between any two instances of the following actors:

- Traffic Information Centres (TICs),
- Traffic Control Centres (TCCs),
- Service Providers (SPs).

Use of this document may be applicable for use by other actors.

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.

EN 16157-1:2018, *Intelligent transport systems - DATEX II data exchange specifications for traffic management and information - Part 1: Context and framework*

EN 16157-2, *Intelligent transport systems - DATEX II data exchange specifications for traffic management and information - Part 2: Location referencing*

EN 16157-7:2018, *Intelligent transport systems - DATEX II data exchange specifications for traffic management and information - Part 7: Common data elements*

CEN ISO/TS 19091:2017, *Intelligent transport systems – Cooperative ITS – Using V2I and I2V communications for applications related to signalized intersections*

SAE J2735:2016, *Dedicated Short Range Communications (DSRC) Message Set Dictionary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16157-1, EN 16157-2 and EN 16157-7 and the following apply.

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

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

3.1

bit string

simple type whose distinguished values are an ordered sequence of zero, one or more bits

[SOURCE: ISO/IEC 8824-1:2015]

3.2

egress path

egress

flow of vehicular or other types of traffic leaving an intersection on one or more of the defined lanes of travel

[SOURCE: SAE J2735:2016]

3.3

ingress path

ingress

flow of vehicular or other types of traffic approaching an intersection on one or more of the defined lanes of travel

[SOURCE: SAE J2735:2016]

3.4

lane

strip of carriageway intended to accommodate a single line of moving vehicles, frequently defined by road markings

[SOURCE: ISO 6707-1:2017]

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]

3.6

manoeuvre

collection of related links and turns used in a route in combination

Note 1 to entry: Manoeuvres are used to cluster turns into convenient and legal combinations. They could be as simple as a single turn, a combination of quick turns or very complex combinations consisting of entry, exit, and connecting roadways.

[SOURCE: EN ISO 19133:2007]

3.7

node

0-dimensional topological primitive

[SOURCE: EN ISO 19107:2005]

3.8 vehicle trajectory trajectory

path of a selected point on the vehicle in the earth-fixed coordinate system

[SOURCE: ISO 8855:2011]

4 Conformance

The Traffic Signals Namespace sub-model is a part of the DATEX II platform independent data model. The Traffic Signals Namespace sub-model corresponds to a Level B extension as defined in EN 16157-1.

Conformance with this Part shall require platform independent models from which platform specific models are generated to comply with the UML modelling rules defined in EN 16157-1 and with the following requirements of this sub-model, which are expressed in this document:

- comply with all stipulated minimum and maximum multiplicity requirements for UML elements and relationships,
- comply with all definitions, types and ordering,
- employ optional elements as specified,
- comply with all expressed constraints.

It should be noted that conformance of a publication service with all the structural requirements stated above does not necessarily ensure that the informational content of that service will be semantically comprehensible.

5 Symbols and abbreviations

DE	Data Element
DF	Data Frame
GUID	Globally Unique identifier
ITS	Intelligent Transport Systems
PIM	Platform Independent Model
SPaT	Signal Phase and Timing
UML	Unified Modelling Language

6 UML notation

The UML notation used in this document is as described in ISO/IEC 19505. An explanation of the UML notation used in this document is provided in EN 16157-1.

7 TheTrafficSignals model

7.1 Overview

The TrafficSignals model shall comprise the packages used in the SignalPhaseAndTiming Publication and the MapData Publication and the Classes and Enumerations specific for these publications. Figure 1 illustrates the sub-packages contained within the Traffic Signals package, which shall include the

SignalPhaseAndTimingPublication package, the MapDataPublication package, the data types and the enumerations within the <<D2Namespace>> TrafficSignals.

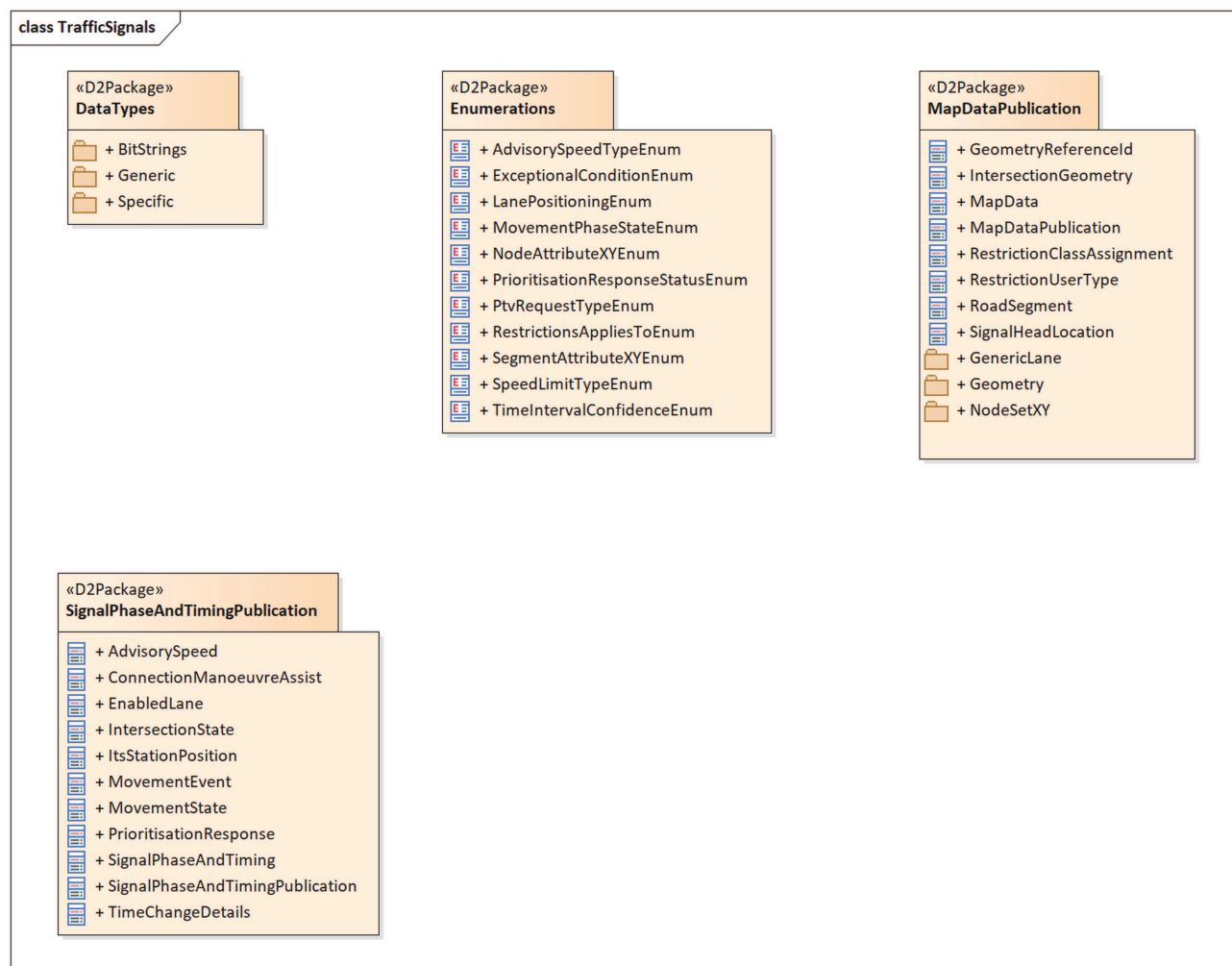


Figure 1 — The “TrafficSignals” package class model

As illustrated in Figure 2, the “SignalPhaseAndTimingPublication” class and the “MapDataPublication” class shall be specializations of the GenericPublication class, as specified in CEN / EN16157-7, with the relationships defined as D2LevelBExtension. A dedicated namespace “TrafficSignals” has been created to host them, which uses the namespace prefix “tsi”.

NOTE For most applications using the TrafficSignals, model use of both the SignalPhaseAndTiming and MapData Publications can be expected due to the cross-referencing between the two Publications.

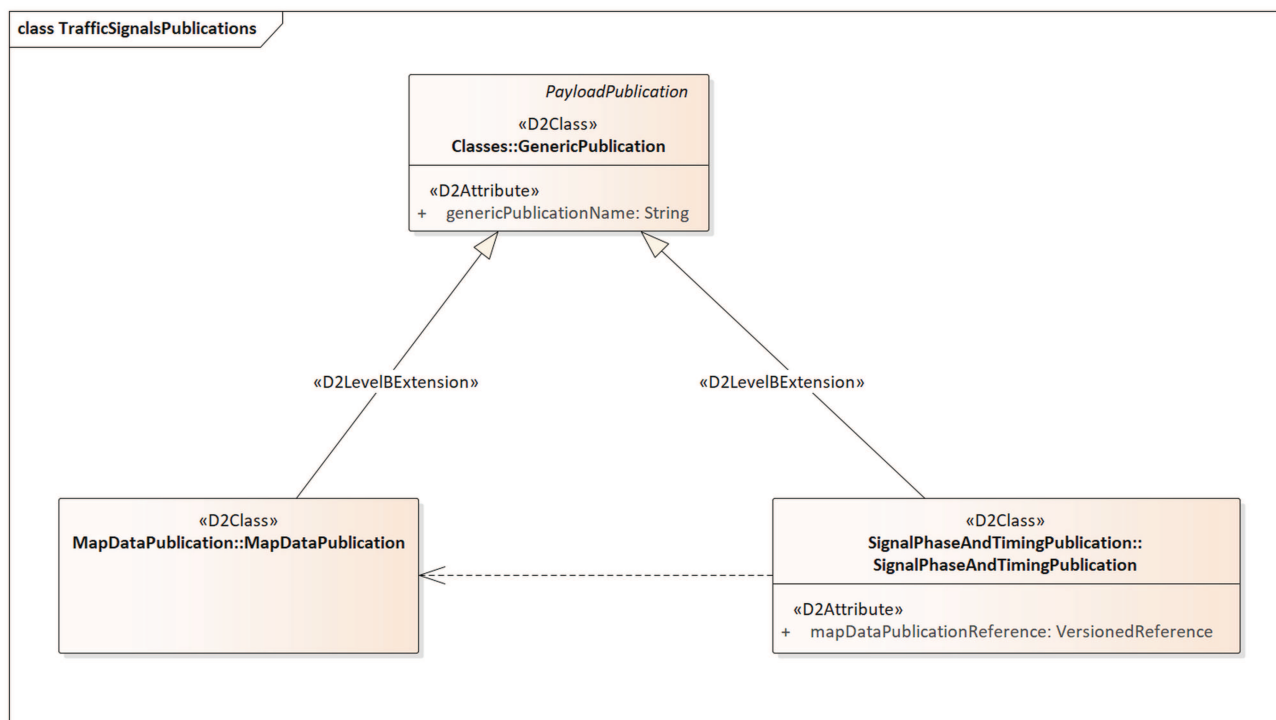


Figure 2 — The “TrafficSignals” publications

7.2 <<D2Package>> MapDataPublication

7.2.1 Overview

The package “MapDataPublication” supplies classes and attributes for the static information related to the intersections and road segments belonging to a road network. The “MapDataPublication” class shall be defined as a Level B Extension to the “GenericPublication” class. The package “MapDataPublication” is the translation in UML of the MapData message (MAP) as specified in CEN ISO/TS 19091 and specifically its European profile (Annex G), which heavily relies upon terms, definitions and concepts from the standard SAE J2735. It is pictured including the relationships between the classes in Figure 3.

The MapDataPublication is used in combination with the second publication defined in this document, i.e. “SignalPhaseAndTimingPublication” which represents the dynamic content of the stages and phase of traffic signals. As both publications are DATEX II extensions they are located in the “Extension” namespace of the DATEX II tree structure, under the parent package “TrafficSignals”.

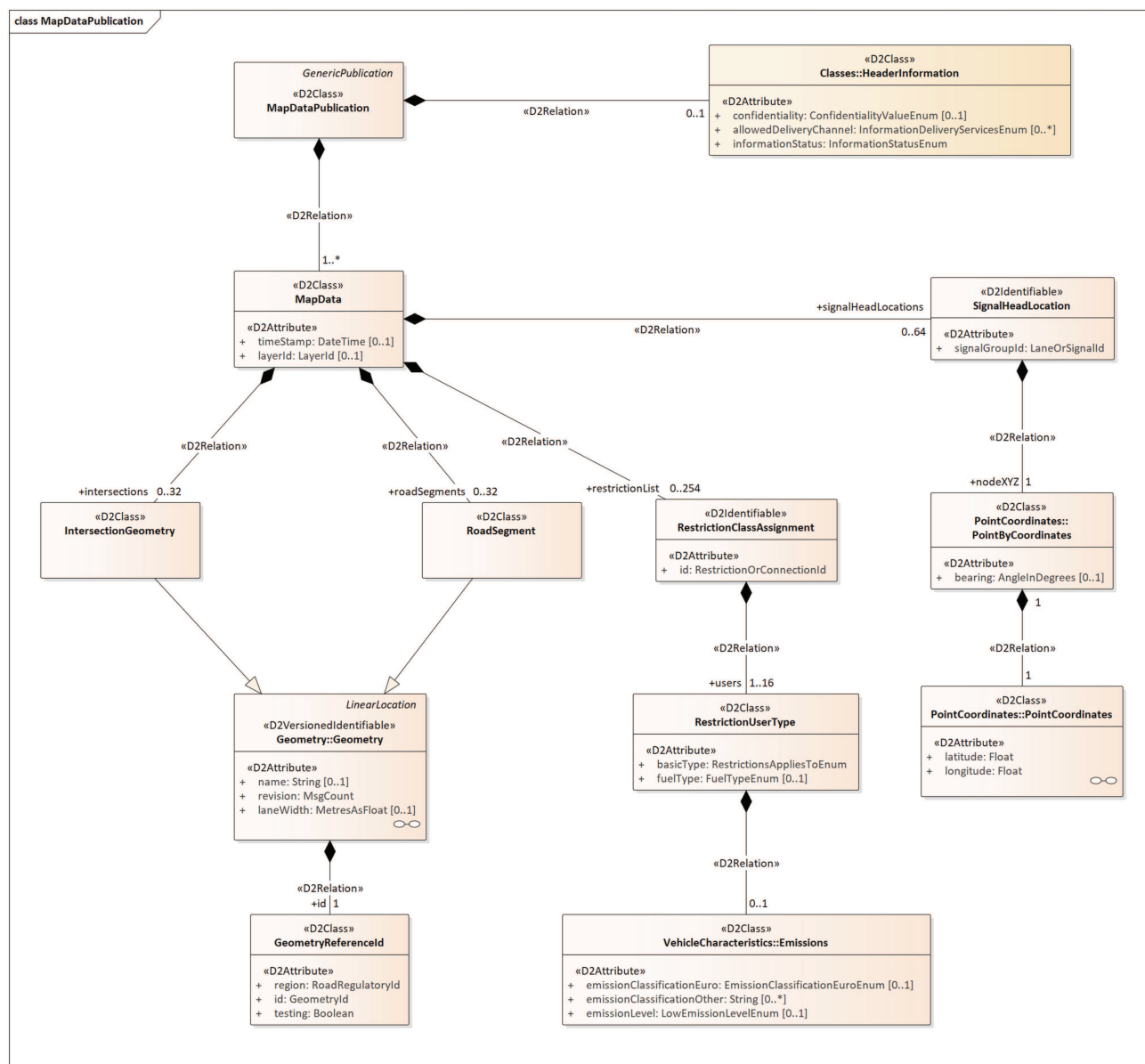


Figure 3 — The MapPublication class model

7.2.2 Semantics

The entry point of this package is the class “MapDataPublication”. Being an extension, it is derived from the “GenericPublication” class defined in EN 16157-7. It shall contain at least a set of data defining different road geographic features (class “MapData”). As every publication in DATEX II it is associated with general information (class “HeaderInformation”) representing among others its status (e.g. if it is “real” or for “test”). This latter class is defined in EN 16157-7.

This set of road geographic features may include data related to:

- Complex intersections description (class “IntersectionGeometry”) (up to 32 different instances);
- Road segments description (class “RoadSegment”) (up to 32 instances);
- Restrictions applicable to a road user category (class “RestrictionClassAssignment”) (up to 254 instances);

— The position of traffic signal heads (class “SignalHeadLocation”) (up to 64 instances).

Each occurrence of map data may be timestamped.

Every intersection description and every road segment description are based on a common geometrical description realized by the “Geometry” class. Each occurrence of the class is identified through the identification mechanism of DATEX II as specified in EN 16157-7 (stereotype “D2VersionedIdentifiable”). It shall own a revision number (between 0 and 127) incremented at each revision to communicate the valid release of the geometry description for the same publisher. If there is no change in the deployed geometry description, the same revision counter is transmitted. If a revised deployment of the geometry description (e.g. new lane added, identifiers changed, etc.), the revision number is increased by one. This number shall be reinitialised, when the publisher changes, or when the value 127 is reached.

Every occurrence of geometry may be given a name and/or a lane width, which is used as a default value for all the described lanes unless a new lane width is provided. It shall be given a unique external reference identification (class “GeometryReferenceId”) which shall be composed of an identifier (integer number between 256 and 65535). In case of testing usage, the corresponding flag (“testing”) shall be set to “true”. The “region” attribute may be used to identify a local road authority assigning generic reference identification for intersection geometries or road segments.

NOTE The usage of such an external reference identification is only of interest for creating MAP and SPAT messages. It is not used internally.

Every position of traffic signal head is defined by a geographic point defined by coordinates (according to CEN ISO/TS 19091:2017,G.5.2.7, this definition shall be tridimensional).

7.3 <<D2Package>> Geometry

7.3.1 Overview

The package “Geometry” supplies classes and attributes for the definition of a geometry usable when defining geometric features of an intersection or a road segment including the relevant attributive items of these features. It is pictured including the relationships between the classes in Figure 4.

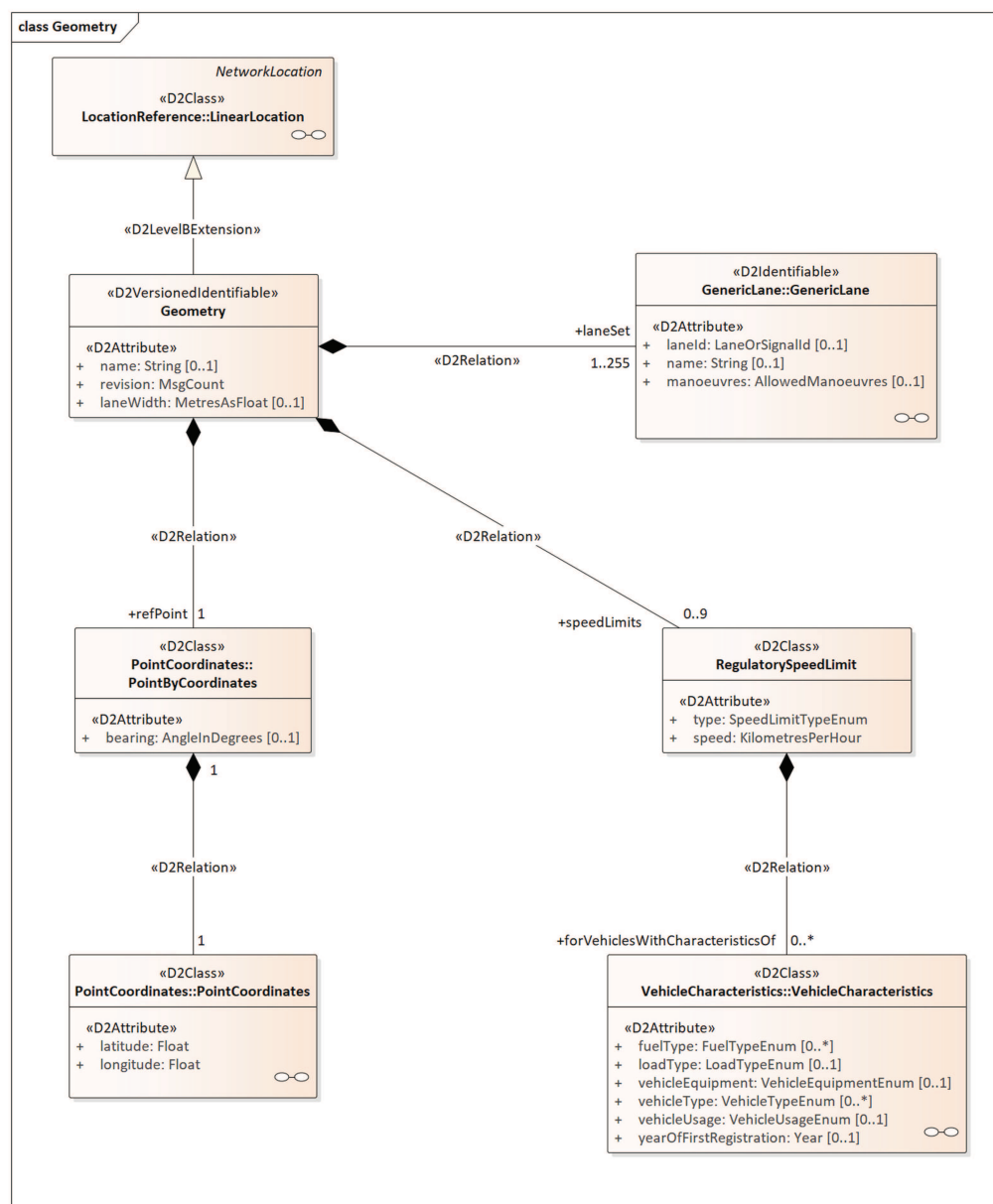


Figure 4 — “Geometry” package class model

7.3.2 Semantics

The common geometry description is defined by the class “Geometry” which is already defined in 7.2.2. To this geometry are associated:

- One point location (class “PointByCoordinates” associated through “refPoint”) which represents a reference of this intersection of this road segment (e.g. for representational purpose). According to CEN ISO/TS 19091 this point shall be defined in three dimensions. This point is defined as required in EN 16157-2. This point may be used for calculating the offsets of the other points belonging to the same geometry during the MAP message generation;
- A set of up to 9 speed limit values (class “RegulatorySpeedLimit”) applicable to the whole geometric element and corresponding to certain types and to the vehicle type (class “VehicleCharacteristics”). This latter class is defined in EN 16157-7;

- A set of up to 255 generic lane definition (class “GenericLane”) which allow describing every lane belonging to the Geometry feature in terms of geometry, topology and attributes.

The “<<D2Class>>Geometry” class shall be the only entry point of the “Geometry” package and is a specific VersionIdentifiable instance.

7.4 <<D2Package>> GenericLane

7.4.1 Overview

The package “GenericLane” supplies classes and attributes for the definition of a generic lane part of an intersection or a road segment including the relevant attributive items of these features. It is pictured including the relationships between the classes in Figure 5.

The notion of generic lane is taken in a very wide meaning. Items, such as “pedestrian crossing”, “pavement” or “parking lanes”, are also considered as “generic lanes”.

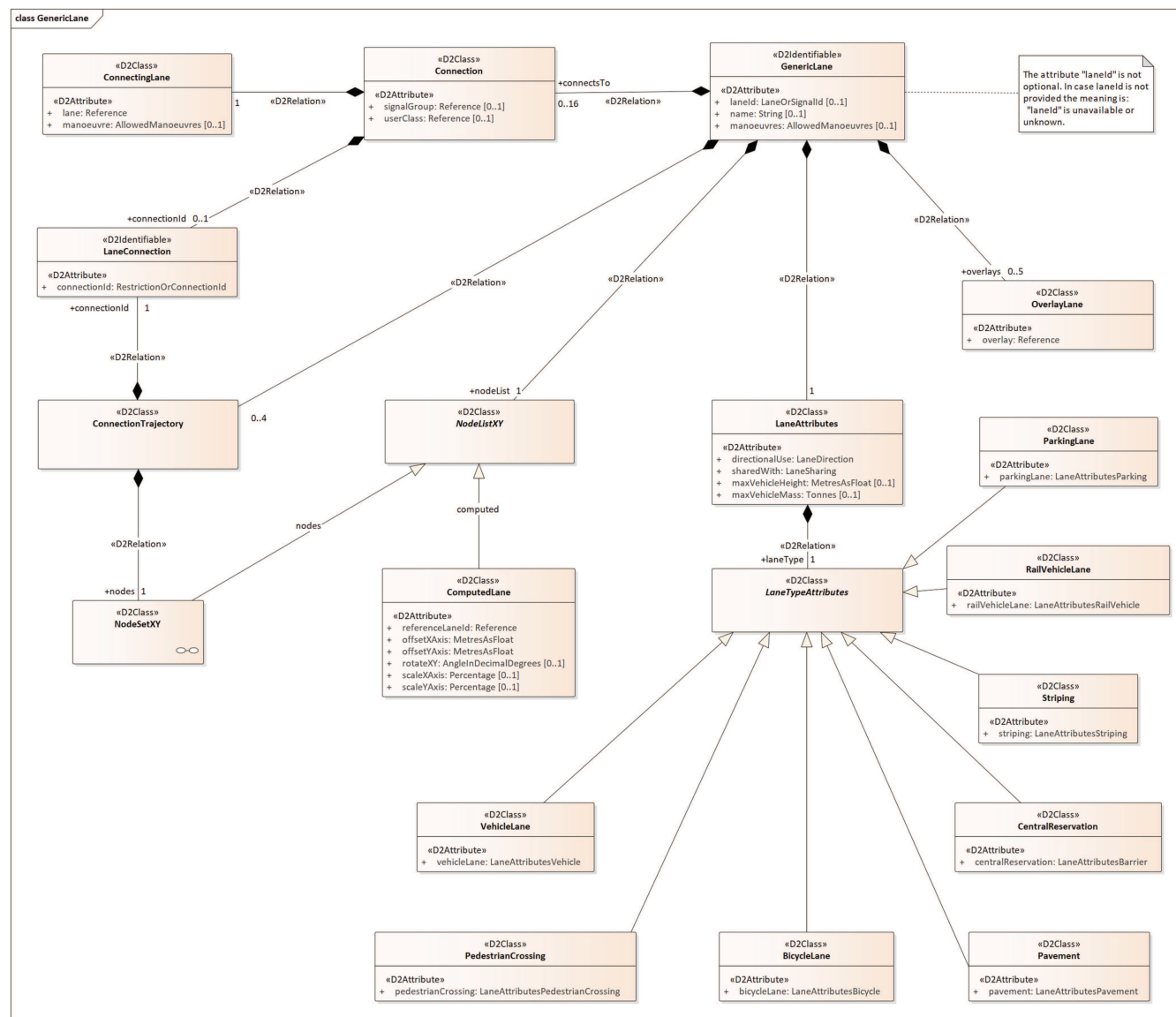


Figure 5 — "GenericLane" package class model

7.4.2 Semantics

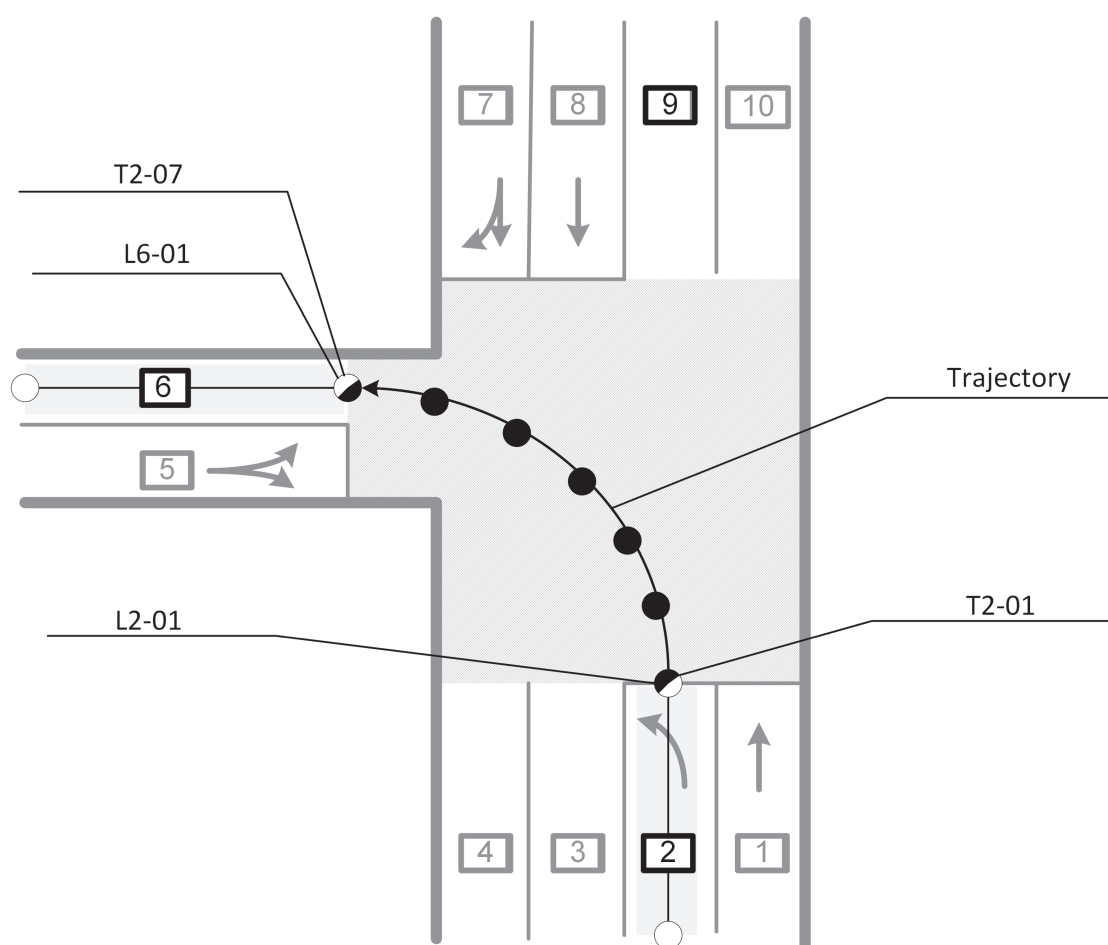
A generic lane is defined as an elementary element of a road. Its description includes a geometric description of its centreline (class “NodeListXY”), information about attributes (class “LaneAttributes”) and about connectivity to other lanes (classes “Connection” and “ConnectionTrajectory”). Each occurrence of generic lane shall have an external lane identifier, which is used when building MAP messages. If the identity of LaneId is unknown the LaneId attribute shall not be supplied. Information on the allowed manoeuvres may be added using the attribute “manoeuvres”. When another lane shares a part of its reference centreline with the considered generic lane, the references of these lanes are added through the class “OverlayLane”.

The geometric definition of this lane can be achieved using two methods:

- Using a sequence of nodes (class “NodeSetXY”). This method is specified in 7.5;
- By computing it from another lane geometry by using mathematical transformation as translations, rotation and/or homothecy (class “ComputedLane”).

The connectivity with other lanes is defined in two ways:

- The first way is based on the class “ConnectionTrajectory” that links it with a sequence of nodes (class “NodeSetXY”) with a given traffic signals stage (class “LaneConnection”). Only up to 4 trajectories are allowed being defined following this way and according to CEN ISO/TS 19091:2017, G.5.1.2. In case a lane has more than 4 connecting trajectories, priority should be given to connecting trajectories of motorised traffic and complex manoeuvres. Figure 6 (source: CEN ISO/TS 19091:2017, Figure G.3) illustrates how such a connection trajectory is defined.



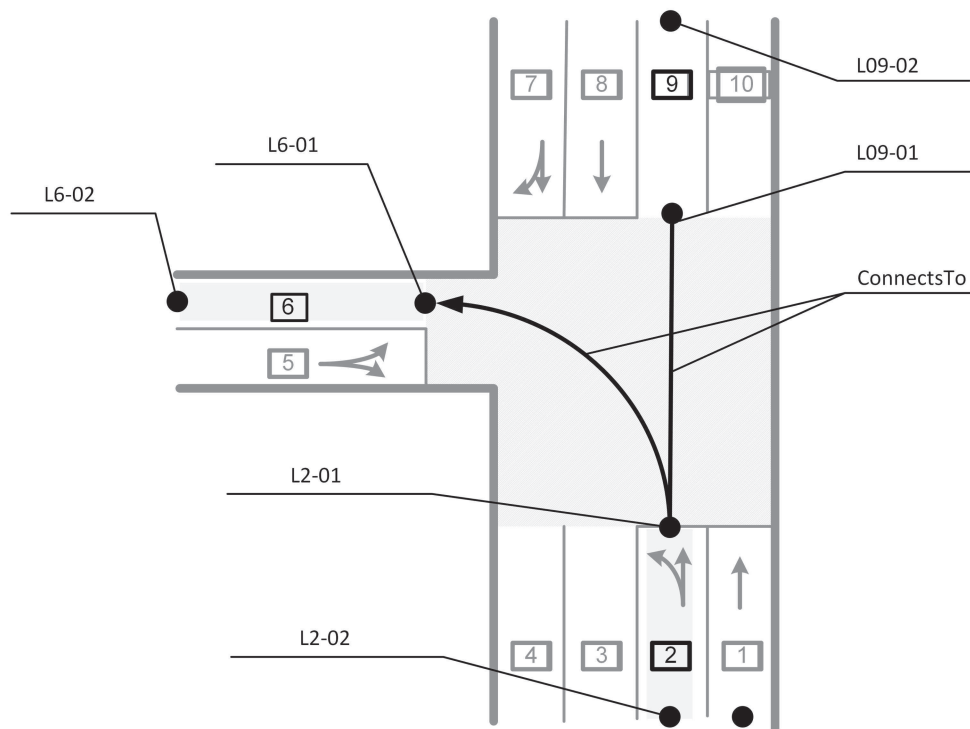
Key

L6-01	first node of L6 (egress lane)
L2-01	first node of L2 (ingress lane)
T2-01	first node of Trajectory
T2-07	last node of Trajectory
Trajectory	connecting lane 2 with lane 6

Figure 6 — ConnectionTrajectory (Source: CEN ISO/TS 19091:2017)

EXAMPLE The connecting trajectory on this figure is defined between the ingress lane 2 and the egress lane 6. The two nodes T2-07 and L6-01 share the same point location.

- The second way is based on the class “Connection” that links it with another lane (class “ConnectingLane”) and optionally with a traffic signals group (attribute “signalGroup” which refers to the class “SignalHeadLocation” see 7.2.1) and/or a user restriction class assignment (attribute “userClass” which refers to the class “RestrictionClassAssignment”). According to SAE J2735:2016, 6.14, the attribute “signalGroup” shall be provided except in case the intersection is not signal controlled. Up to 16 connections are allowed being defined following this way. Figure 7 (source: CEN ISO/TS 19091:2017, Figure G.5) illustrates how such a connection is defined.



Key

L6-01	first node - egress lane
L6-02	last node - egress lane
L2-01	first node - stop bar - ingress lane
L2-02	last node - ingress lane
L09-01	first node - egress lane
L09-02	last node - egress lane

EXAMPLE The lane 2 of the Figure 7 is connected through the class “Connection” (association end “connectsTo”) to the other lanes 6 and 9.

Figure 7 — Vehicle Lane (source: CEN ISO/TS 19091:2017)

The attributes of a generic lane are assigned using the class “LaneAttributes”. There is information about the direction of use of the lane (in terms of ingress or egress movement), if the lane is shared by different users (e.g. by pedestrians and cyclists) or if there are vehicle restrictions (height or weight). In addition, a set of indicators are added with the class “LaneTypeAttributes”. These indicators are specific to the type of lane, i.e. if it is a lane assigned to vehicles (class “VehicleLane”), or to bicycles (class “BicycleLane”) or to rail vehicles (class “RailVehicleLane”) or if is a pedestrian crossing (class “PedestrianCrossing”) or a pavement (class “Pavement”) or a central reservation (class “CentralReservation”) or for striping (class “Striping”).

7.5 <<D2Package>> NodeSetXY

7.5.1 Overview

The package “NodeSetXY” supplies classes and attributes for the definition of a geometric path of a lane including attributive items of these features. It is pictured including the relationships between the classes in Figure 8.

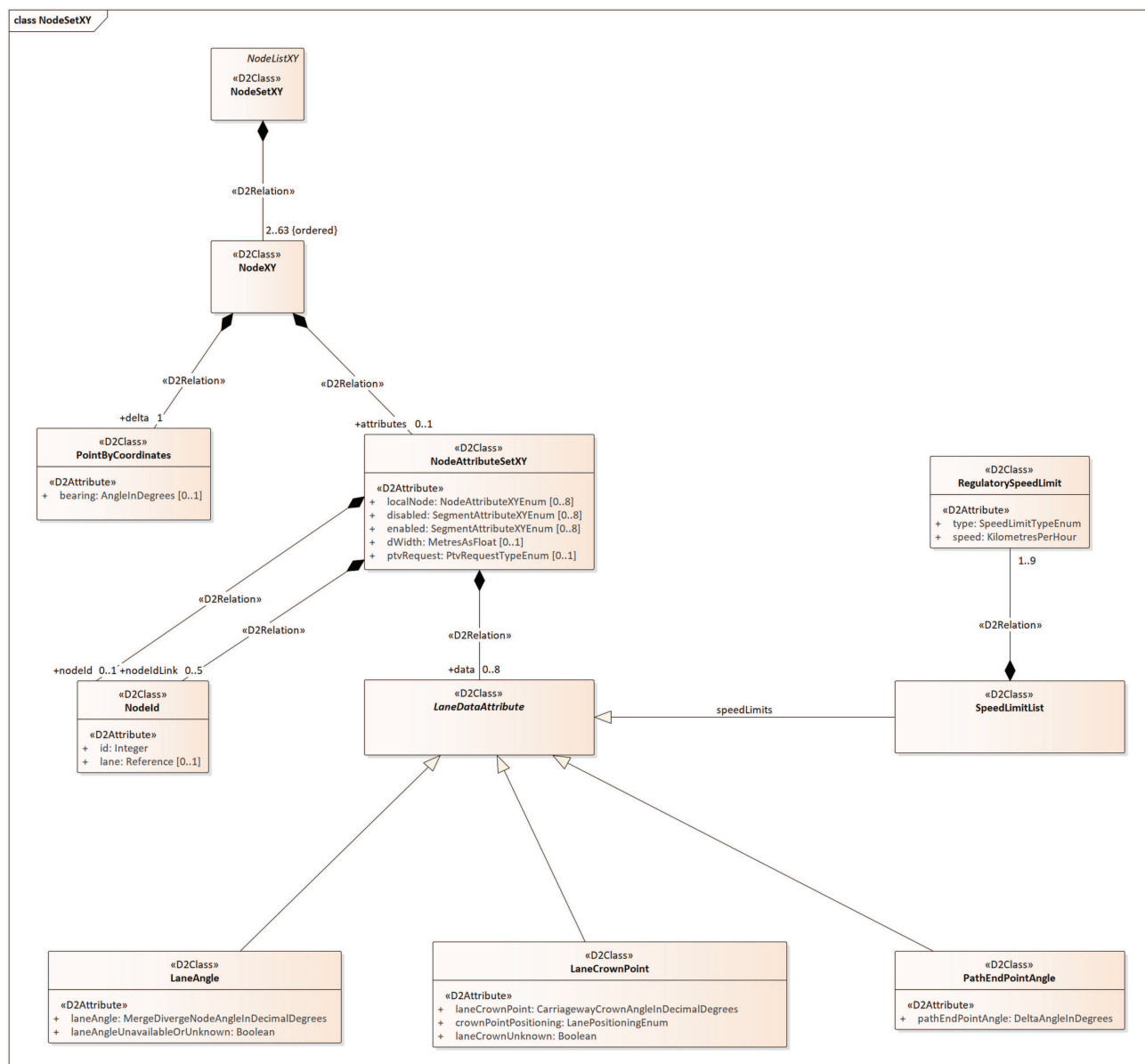


Figure 8 — “NodeSetXY” package class model

7.5.2 Semantics

A geometric path of a lane is defined by a set of up to 63 nodes (class “NodeXY”) (with at least 2 instances as a minimum).

A node is a 0-dimensional topological primitive (as defined by EN ISO 19107:2005) that is defined by:

- A three-dimensional point by coordinates delineating this node geometrically (class “PointByCoordinates”). This definition complies with EN 16157-2;
- Optionally an attribute set (class “NodeAttributeSetXY”) which includes the corresponding node identifier (class “NodeID” with the association end “nodeId”) and the identifiers of up to 5 identifiers of nodes linked to the considered node (through the association end “nodeIdLink”). It helps to precisely describe a link from a lane node to one or more nodes of another lane (see CEN ISO/TS 19091:2017, G.8.2.9). It may also include the local lane width at this location and different additional attributes.

These additional attributes are:

- A set of up to 8 attributes characterizing the node itself (seen as a point) (attribute “localNode”).

EXAMPLE: if the attribute “localNode” contains the value “stopLine” (enumeration item from the enumeration “NodeAttributeXYEnum” – see A.4.5) it means that a stop line exists across the considered lane.

- Two sets of up to 8 attributes characterizing the segment defined by the node and the subsequent one (seen as a straight line). Each list is associated with the status attributes (“enable” and “disable”), which reflects whether it is enabled or disabled.

EXAMPLE: if the attribute “enable” contains the value “mergingLaneLeft” (enumeration item from the enumeration “SegmentAttributeXYEnum” – see A.4.9) it means that the left side lane is merging with the considered lane).

- The “ptvRequest” attribute is used to qualify an activation request (used for C-ITS migration of legacy public transport prioritization systems – see CEN ISO/TS 19091:2017, G.5.3.2).

7.6 SignalPhaseAndTiming Publication

7.6.1 Overview

The package “SignalPhaseAndTimingPublication” supplies classes and attributes for the dynamic information related to the intersections belonging to a road network. It is the translation in UML of the SignalPhaseAndTiming message (SPAT), as it is defined in the standard SAE J2735. It is pictured including the relationships between the classes in Figure 9.

It is used in relation with the first publication defined in this document, i.e. “MapDataPublication”, which represents the static content of the traffic signals. It shares the same namespace TrafficSignals with the namespace prefix “tsi”.

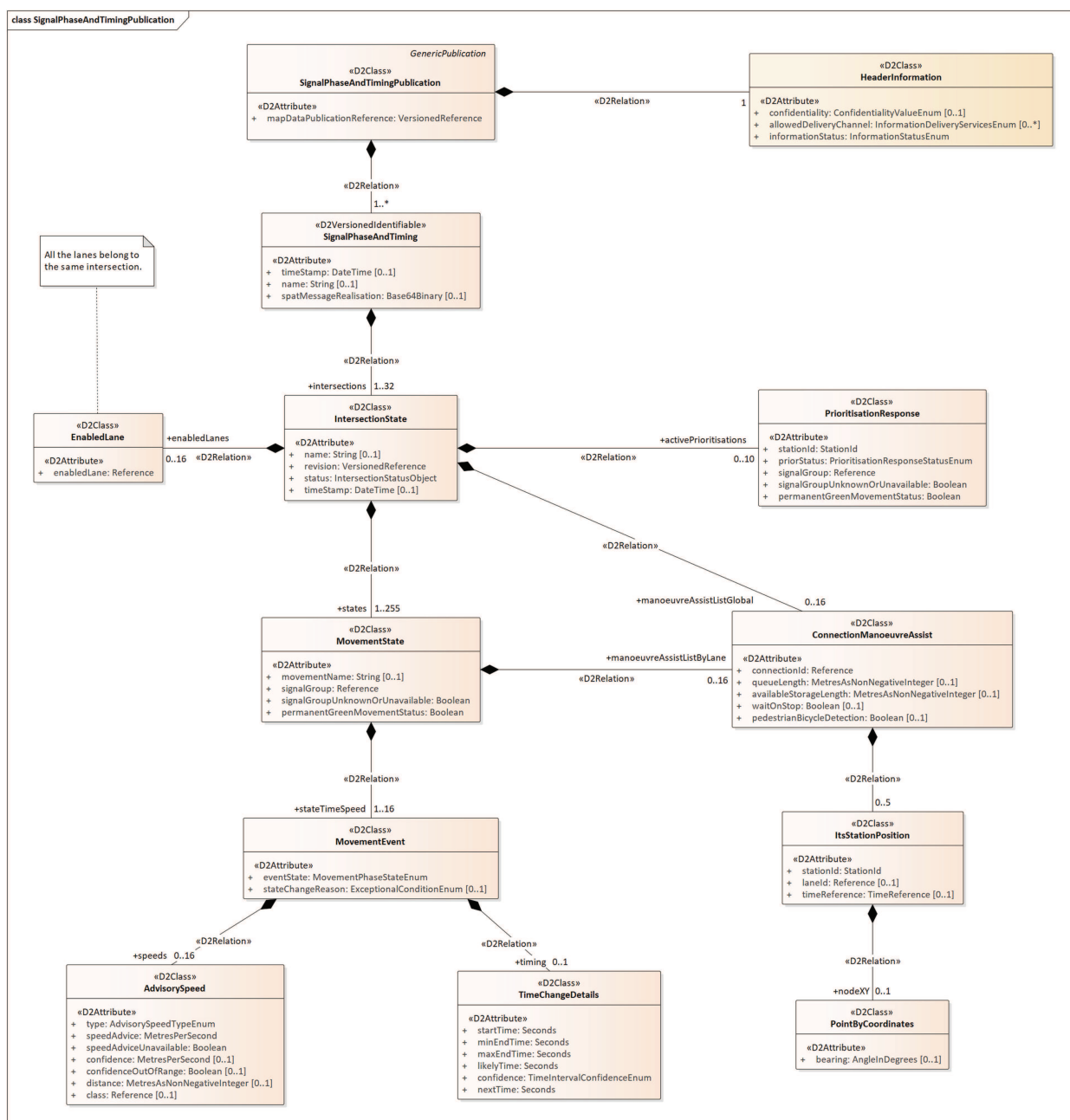


Figure 9 — “SignalPhaseAndTimingPublication” package class model

7.6.2 Semantics

The entry point of this package is the class “SignalPhaseAndTimingPublication”. Being an extension, it is derived from the “GenericPublication” class defined in EN 16157-7. It shall contain at least a set of data defining the status (class “SignalPhaseAndTiming”) of a set of 1 to 32 intersections (class “IntersectionState”). The class “SignalPhaseAndTiming” may carry a descriptive name of the set, the creation timestamp and the binary version (using UPER encoding as specified in ISO/IEC 8825-2) of the corresponding SPAT message. As every publication in DATEX II it is associated with general information (class “HeaderInformation”) representing among others its status (e.g. if it is “real” or for “test”). This latter class is defined in EN 16157-7.

Each occurrence of the class “SignalPhaseAndTiming” shall be related to an occurrence of the class “IntersectionGeometry”, which contains the descriptive data of the considered intersection for which

signal phase and timing information is provided. It shall also contain status information about the corresponding signal controller. It may have a descriptive name for the intersection and a creation time stamp. When revocable lanes are present in the corresponding map data definition (e.g. a tidal lane or a hard shoulder is opened to traffic) and marked as it, it is possible to identify their status change through the class "EnabledLane".

To each occurrence of "IntersectionState" correspond a number of stage descriptions each corresponding to a movement (class "MovementState") is related to a group of traffic signal heads defined through the MAP data publication. Additional Boolean attributes shall be used for indicating if this group identifier is unavailable (attribute "signalGroupUnknownOrUnavailable"), or if the movement corresponds to a permanent green movement (attribute "permanentGreenMovementStatus"). In turn, an occurrence of "MovementState" is composed of one or several signal stages associated to the movement. Optional information on advisory speeds (e.g. associated to a green wave) or details about the corresponding stage time (start or end) may be added.

In case prioritization procedure (like for public transport) is active additional information about the corresponding ITS station identifier (ITS-S-ID), the corresponding traffic signal group and the response status is provided through the class "PrioritisationResponse".

Additional information on lane and manoeuvre (class "ConnectionManoeuvreAssist") may be brought either globally to the intersection (associated to the class "IntersectionState") or to a specific movement (when associated with the class "MovementState"). This additional information can relate to queue length, available storage length or if a pedestrian or a cyclist is detected. The attribute "connectionId" is used to associate a given movement stage to an already defined group of lanes through the class "LaneConnection" (see 7.4).

Annex A **(normative)**

Data Dictionary

A.1 Overview

This data dictionary includes the definitions and characteristics of the different classes, attributes, association ends, data types and enumerations appearing in the data model defined in Clause 7. The data dictionary is specified in three parts, one for packages, one for <<D2Datatypes>> and one for <<D2Enumerations>>, each ordered alphabetically.

The generic data types that are used throughout all publications are defined in EN 16157-7:2018, 6.3.

The first part of the data dictionary is partitioned into subclauses that relate to each of the UML model packages and each subclause defines the contained classes, their attributes and any association ends defined for associations between the classes within that package.

The Data Dictionary tables use the following columns:

- 1) Column Class name: it provides the symbolic name (Upper Camel Case) given to the corresponding class,
- 2) Column Association End: it provides the symbolic name (Lower Camel Case) given to the corresponding association end,
- 3) Column Attribute name: it provides the symbolic name (Lower Camel Case) given to the corresponding attribute of a class,
- 4) Column Enumerated value name: It provides the symbolic name (Lower Camel Case) given to the corresponding enumerated value,
- 5) Column Designation: it provides the corresponding name in natural language of the corresponding class, attribute, association end or enumeration value,
- 6) Column Definition: it provides a comprehensive definition detailing the class, attribute or association end,
- 7) Column Stereotype: it provides a statement of the stereotype that is assigned to the class, if any - see EN 16157-1:2018, 6.2 for further details,
- 8) Column Abstract: it provides a statement as to whether the class is abstract (non-realizable) or concrete (realizable),
- 9) Column Multiplicity: it provides a statement of the allowed multiplicity for the attribute or association end,
- 10) Column Target: It provides the name of the class which is at the end of the association to which the role applies,
- 11) Column Type: it provides the name of the class used to define the data type relating to the attribute of the class.

A.2 Data Dictionary for “TrafficSignals”

A.2.1 “GenericLane” package

A.2.1.1 Location of “GenericLane” package

The location of “GenericLane” package is:

— D2Payload/Extension/TrafficSignals/MapDataPublication/GenericLane

A.2.1.2 Classes of the “GenericLane” package

Table A.1 — Classes of the “GenericLane” package

Class name	Designation	Definition	Stereotype	Abstract
BicycleLane	Bicycle lane	Lane dedicated to bicycle traffic.	D2Class	no
CentralReservation	Central reservation	Area separating the carriageways of a dual carriageway road.	D2Class	no
ComputedLane	Computed lane	Computational parameters of one lane from another lane.	D2Class	no
ConnectingLane	Connecting lane	Lane connected to the given lane through specific manoeuvres.	D2Class	no
Connection	Connection	Set of data detailing how the stop line at the end of a single lane connects to another lane beyond its stop point. [Adapted from SAE J2735:2016]	D2Class	no
ConnectionTrajectory	Connection trajectory	Trajectory for travelling through the conflict area of an intersection. The trajectory is defined by two or more nodes. [Source: CEN ISO/TS 19091:2017]	D2Class	no
GenericLane	Generic lane	Lane of any type described by a set of basic attributes.	D2Class	no
LaneAttributes	Lane attributes	Set of constant parameters used for the lane description of any type (constant means valid along the path of the lane). [Adapted from SAE J2735:2016]	D2Class	no
LaneConnection	Lane connection	Lane connected to the given lane.	D2Class	no

Class name	Designation	Definition	Stereotype	Abstract
LaneTypeAttributes	Lane type attributes	Overall characteristics of a lane of any type. [Adapted from SAE J2735:2016]	D2Class	yes
NodeListXY	Node list X Y	Sequence of points describing the geometric path of the reference centreline of the lane.	D2Class	yes
OverlayLane	Overlay lane	Other lane sharing the same layout as the considered lane.	D2Class	no
ParkingLane	Parking lane	Part of a street dedicated for vehicle parking.	D2Class	no
Pavement	Pavement	Pavement or pedestrian footway.	D2Class	no
PedestrianCrossing	Pedestrian crossing	Part of a street used by pedestrians to cross it.	D2Class	no
RailVehicleLane	Rail vehicle lane	Part of a street dedicated to railed vehicles.	D2Class	no
Striping	Striping	Horizontal road markings, often painted, denoted sections of the carriageway not intended for vehicular use, or designated for a specific use.	D2Class	no
VehicleLane	Vehicle lane	Part of a street usable by general traffic.	D2Class	no

A.2.1.3 Associations of the “GenericLane” package

Table A.2 — Associations of the “GenericLane” package

Class name	Association end	Designation	Definition	Multiplicity	Target
Connection	connectingLane	Connecting lane		1..1	ConnectingLane
	connectionId	Connection ID		0..1	LaneConnection
ConnectionTrajectory	nodes	Nodes		1..1	NodeSetXY
	connectionId	Connection ID		1..1	LaneConnection
GenericLane	laneAttributes	Lane attributes		1..1	LaneAttributes
	nodeList	Node list		1..1	NodeListXY
	connectsTo	Connects to		0..16	Connection

Class name	Association end	Designation	Definition	Multiplicity	Target
	overlays	Overlays		0..5	OverlayLane
	connectionTrajectory	Connection trajectory		0..4	ConnectionTrajectory
LaneAttributes	laneType	Lane type		1..1	LaneTypeAttributes

A.2.1.4 Attributes of the “GenericLane” package

Table A.3 — Attributes of the “GenericLane” package

Class name	Attribute name	Designation	Definition	Multiplicity	Type
BicycleLane	bicycleLane	Bicycle lane	Characteristics of a bicycle lane.	1..1	LaneAttributesBicycle
CentralReservation	centralReservation	Central reservation	Characteristics of a central reservation.	1..1	LaneAttributesBarrier
ComputedLane	offsetXAxis	Offset x-axis	Offset value along the x-axis in case of translation (longitude) (between -32,767 m and +32,767 m).	1..1	MetresAsFloat
	offsetYAxis	Offset y-axis	Offset value along the y-axis in case of translation (latitude) (between -32,767 m and +32,767 m).	1..1	MetresAsFloat
	referenceLaneId	Reference lane ID	Reference of the lane from which the computed lane is obtained.	1..1	Reference
	rotateXY	Rotate X Y	Global rotation angle value of the computed lane (the axis is the first point of the lane).	0..1	AngleInDecimalDegrees
	scaleXAxis	Scale x-axis	Scaling factor along the x-axis (longitude).	0..1	Percentage
	scaleYAxis	Scale y-axis	Scaling factor along the y-axis (latitude).	0..1	Percentage

Class name	Attribute name	Designation	Definition	Multiplicity	Type
ConnectingLane	lane	Lane	Reference of the other lane connected to the given lane.	1..1	Reference
	manoeuvre	Manoeuvre	List of the allowed manoeuvres at the end of the given lane towards the other lane.	0..1	AllowedManoeuvres
Connection	signalGroup	Signal group	The traffic signal group identifier (used in a SPaT message) corresponding to the connection (shall be present in case the connecting lane is signalised). [Adapted from SAE J2735:2016]	0..1	Reference
	userClass	User class	Indicates to which users the use of the signal group and lane are restricted. [Adapted from SAE J2735:2016]	0..1	Reference
GenericLane	laneId	Lane ID	External identifier allocated to the lane. When it is not provided this means it is unavailable or unknown (conditional attribute).	0..1	LaneOrSignalId
	manoeuvres	Manoeuvres	The permitted manoeuvres for this lane. [Adapted from SAE J2735:2016]	0..1	AllowedManoeuvres
	name	Name	Descriptive name given to the lane.	0..1	String
LaneAttributes	directionalUse	Directional use	Indicates which traffic directions are allowed for this lane in relation with a direction defined as going from the intersection.	1..1	LaneDirection
	maxVehicleHeight	Max vehicle height	Maximum vehicle height limit (between 0 and 6,35 m).	0..1	MetresAsFloat
	maxVehicleMass	Max vehicle mass	Maximum vehicle mass limit (greater than or equal to 0 t).	0..1	Tonnes

Class name	Attribute name	Designation	Definition	Multiplicity	Type
	sharedWith	Shared with	Indication of the other users sharing this lane.	1..1	LaneSharing
LaneConnection	connectionId	Connection ID	Identifier of a signal stage applicable to this lane.	1..1	RestrictionOrConnectionId
OverlayLane	overlay	Overlay	Reference of the lane sharing the same layout.	1..1	Reference
ParkingLane	parkingLane	Parking lane	Characteristics of a parking lane.	1..1	LaneAttributesParking
Pavement	pavement	Pavement	Characteristics of a pavement or pedestrian footway.	1..1	LaneAttributesPavement
PedestrianCrossing	pedestrianCrossing	Pedestrian crossing	Characteristics of a pedestrian crossing.	1..1	LaneAttributesPedestrianCrossing
RailVehicleLane	railVehicleLane	Rail vehicle lane	Characteristics of a railed-vehicle lane.	1..1	LaneAttributesRailVehicle
Striping	striping	Striping	Characteristics of a striping.	1..1	LaneAttributesStriping
VehicleLane	vehicleLane	Vehicle lane	Characteristics of a vehicle lane.	1..1	LaneAttributesVehicle

A.2.1.5 “Geometry” package

A.2.1.6 Location of “Geometry” package

The location of “Geometry” package is:

— D2Payload/Extension/TrafficSignals/MapDataPublication/Geometry

A.2.1.7 Classes of the “Geometry” package

Table A.4 — Classes of the “Geometry” package

Class name	Designation	Definition	Stereotype	Abstract
Geometry	Geometry	Complete description of the carriageway geometry belonging to an intersection or to a road segment.	D2Class	no
RegulatorySpeedLimit	Regulatory speed limit	The type of regulatory speed which follows.	D2Class	no

A.2.1.8 Associations of the “Geometry” package

Table A.5 — Associations of the “Geometry” package

Class name	Association end	Designation	Definition	Multiplicity	Target
Geometry	id	ID		1..1	GeometryReferenceId
	laneSet	Lane set	Data about one or more lanes.	1..255	GenericLane
	refPoint	Ref point	The reference from which subsequent data points are offset until a new point is used.	1..1	PointByCoordinates
	speedLimits	Speed limits	Reference regulatory speed limits.	0..9	RegulatorySpeedLimit
RegulatorySpeedLimit	forVehiclesWithCharacteristicsOf	For vehicles with characteristics of	The type of regulatory speed which follows, for specific vehicles.	0..*	VehicleCharacteristics

A.2.1.9 Attributes of the “Geometry” package

Table A.6 — Attributes of the “Geometry” package

Class name	Attribute name	Designation	Definition	Multiplicity	Type
Geometry	laneWidth	Lane width	Reference width (between 0 and 32,767 m) used by all subsequent lanes unless a new width is given.	0..1	MetresAsFloat
	name	Name	Human readable name.	0..1	String
	revision	Revision	Sequence number within a stream of messages (the number is changed when the content has changed from the prior message).	1..1	MsgCount
RegulatorySpeedLimit	speed	Speed	Speed limit value (between 0 and 163,8 km/h).	1..1	KilometresPerHour
	type	Type	The type of regulatory speed which follows.	1..1	SpeedLimitTypeEnum

A.2.1.10 “MapDataPublication” package

A.2.1.11 Location of “MapDataPublication” package

The location of “MapDataPublication” package is:

— D2Payload/Extension/TrafficSignals/MapDataPublication

A.2.1.12 Classes of the “MapDataPublication” package

Table A.7 — Classes of the “MapDataPublication” package

Class name	Designation	Definition	Stereotype	Abstract
GeometryReferenceId	Geometry reference ID	A globally unique value set consisting of a regionID and intersection ID assignment.	D2Class	no
IntersectionGeometry	Intersection geometry	A complete description of an intersection's roadway geometry and its allowed navigational paths (independent of any additional regulatory restrictions that may apply over time or from user classification) [SOURCE: SAE J2735]	D2Class	no
MapData	Map data	Data set to convey one or more intersection lane geometry maps within a single message. [SOURCE: Adapted from SAE J2735]	D2Class	no
MapDataPublication	Map data publication	DATEX II publication containing one or several map data contents.	D2Class	no
RestrictionClassAssignment	Restriction class assignment	Indicates the class of restriction assigned to the map elements	D2Class	no
RestrictionUserType	Restriction user type	Defines the driving restriction based on toxic emission type.	D2Class	no
RoadSegment	Road segment	Part of a road, having its start and end along that road [SOURCE: 17572-1]	D2Class	no
SignalHeadLocation	Signal head location	Signal head location in relation to the intersection reference position.	D2Class	no

A.2.1.13 Associations of the “MapDataPublication” package

Table A.8 — Associations of the “MapDataPublication” package

Class name	Association end	Designation	Definition	Multiplicity	Target
MapData	intersections	Intersections		0..32	IntersectionGeometry
	roadSegments	Road segments		0..32	RoadSegment
	restrictionList	Restriction list		0..254	RestrictionClassAssignment

Class name	Association end	Designation	Definition	Multiplicity	Target
	signalHeadLocations	Signal head locations	Signal head location in relation to the intersection reference position.	0..64	SignalHeadLocation
MapDataPublication	headerInformation	Header information		0..1	HeaderInformation
	mapData	Map data		1..*	MapData
RestrictionClassAssignment	users	Users	The list of user types/classes to which this restriction ID applies.	1..16	RestrictionUserType
RestrictionUserType	emissions	Emissions		0..1	Emissions
SignalHeadLocation	nodeXYZ	Node X Y Z		1..1	PointByCoordinates

A.2.1.14 Attributes of the “MapDataPublication” package

Table A.9 — Attributes of the “MapDataPublication” package

Class name	Attribute name	Designation	Definition	Multiplicity	Type
GeometryReferenceId	id	ID	External identifier given to a geometry. This number shall be unique for a given road authority.	1..1	GeometryId
	region	Region	Unique value assigned to a road or traffic authority to identify it.	1..1	RoadRegulatoryId
	testing	Testing	Indicates the corresponding geometry definition is for testing use.	1..1	Boolean
MapData	layerId	Layer ID	Index for fragments of large MAP descriptions.	0..1	LayerId
	timeStamp	Time stamp	Minute of the year.	0..1	DateTime