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Intelligent transport systems — Extension of map database specifications for applications of cooperative ITS

Systèmes intelligents de transport — Extension des spécifications de base de données cartographiques aux applications collaboratives des SIT

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Foreword

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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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

Introduction

The purpose of this International Standard is to extend the existing specifications for map databases in order to provide greater support for applications and/or application developments of cooperative ITS that may use Local Dynamic Map.

The functional requirements and data model for in-vehicle navigation are already defined in ISO/TS 20452. However, the map-related functional requirements, data model, and data elements needed for Local Dynamic Map for Cooperative ITS have not yet been defined.

This International Standard can help developers of applications for Cooperative ITS by broadening its applicability. Such applications will benefit by the availability of a standardized data model and data elements. The resulting work will shorten developers' time-to-market for new products and services.

In order to meet the schedule requirements of Mandate M/453 "Standardisation mandate addressed to CEN, CENELEC and ETSI in the field of Information and Communication Technologies to support the interoperability of Co-operative systems for Intelligent Transport in the European Community" issued by the European Commission, ISO/TS 17931 was published as the Local Dynamic Map component of this International Standard.

This International Standard includes all of the contents of ISO/TS 17931.

This International Standard defines the Logical Data Model for Multi-Modal navigation system. It does not define the data model for individual navigation service except for in-vehicle navigation.

This International Standard uses UML to express specific circumstances; the graphical elements are used to express specific constraints and structural relationships. A full definition can be found in ISO/IEC 19501:2005. However, a short introduction of elements is given in Annex B.

Intelligent transport systems — Extension of map database specifications for applications of cooperative ITS

1 Scope

This International Standard provides the map-related functional requirements, data model (logical data model/logical data organization), and data elements for those applications of cooperative ITS that require information derived from map databases.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14825:2011, *Intelligent transport systems — Geographic Data Files (GDF) — GDF5.0*

ISO/IEC 19501:2005, *Information technology — Open Distributed Processing — Unified Modeling Language (UML) Version 1.4.2*

ISO/TS 20452:2007, *Requirements and Logical Data Model for a Physical Storage Format (PSF) and an Application Program Interface (API) and Logical Data Organization for PSF used in Intelligent Transport Systems (ITS) Database Technology*

3 Conformance

Data structures shall be provided as specified in Clause 7.

Any data structure claiming conformance with this International Standard shall pass the requirements presented in the abstract test suite in Annex A.

UML Expressions for diagrams in this International Standard shall be compliant with ISO/IEC 19501:2005.

4 Terms and definitions

For the purposes of this document, the terms and definitions in ISO 14825 and ISO/TS 20452 and the following apply.

4.1
Address Location
application category that deals with the task of expressing a real-world position in terms of the PSF data representation

4.2
application category
basic sub-function within the set of functionality for cooperative ITS support

Note 1 to entry: This International Standard identifies eight application categories: Positioning, Route Planning, Route Guidance, Map Display, Address Location, Services and POI Information Access, cooperative ITS including Driving support, Multi-Modal Travel.

4.3
display point
0-dimensional type of cartographic feature

4.4
geocoding
determination of a link or node based on address information describing and/or naming a location

4.5
intersection
GDF level 2 representation of a crossing which bounds a road or a ferry as a complex feature composed of one or more GDF level 1 junctions, Road Elements and enclosed traffic areas

4.6
itinerary
plan of a journey, including the route and the places visited

4.7
junction
navigable feature which is either a named GDF junction or named GDF intersection, and that relates a named navigable feature to a set of links and nodes and a place

4.8
landmark
point, line or area feature that can be used to clarify the directions generated to describe a route

Note 1 to entry: It can be associated to a node or a link.

Note 2 to entry: A landmark cannot be in the Services, Administrative Areas, or Public Transportation Feature themes of the GDF; however a facility in which a service is located can be a landmark.

4.9
layer
sub-set of map data resulting from a subdivision of data of the same coverage area based on contents (similar to ISO 14825 GDF layer) and which is typically related to one or only a few of the application categories

EXAMPLE District name, which is one of the data items for Route Guidance applications, is included in a layer.

4.10
level
sub-set of map data resulting from classification of data of the same semantic contents based on the level of details/density, related to the concept of different map scales

Note 1 to entry: Level 0 is considered the lowest level (greatest detail); higher levels are numbered level 1, level 2, etc.

EXAMPLE Map Display data can be organized into 6 levels representing different zoom scales.

4.11
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

4.12
Local Dynamic Map
conceptual data store which is embedded in an ITS station and which contains topographical, positional and status information

4.13
Map Display
application category that deals with graphical information presentation

4.14
Multilink
ordered aggregation of links which are at the same level, connected in sequence, share the same functional classification, form of way, direction of travel, and perhaps additional PSF-builder-specified characteristics, such that each link is contained in exactly one Multilink

4.15
Multi-Modal Travel Service
application category that provides information on a trip from an origin to a destination using alternative modes of transportation or a combination of transport modes for one trip

Note 1 to entry: This service may include navigation.

4.16
Multi-Modal Travel Support
application function for Multi-Modal Travel Service

4.17
parcel
database partitioning unit, corresponding to a certain coverage area and associated with one level and containing data of one or more layers

Note 1 to entry: A parcel contains (at least) all nodes with positions enclosed by or located on the outline of its coverage area plus (parts of) all links attached to these nodes.

Note 2 to entry: It can be partitioned such that the amount of data of one parcel is nearly the same as that of another.

4.18
place
named area which can be used as part of Address Location

4.19
Point of Interest
POI
destination and/or site of interest to travellers, usually non-commercial by nature

4.20
polygon
2-dimensional type of cartographic feature

4.21
polyline
1-dimensional type of cartographic feature

4.22
Positioning
application category that deals with the determination of vehicle location and map-matching

4.23
position-on-the-link
position on the road or road side used to identify the access point between the road network and entrance or exit of facilities such as station, bus stop and building

4.24
rectangle
unit of geographic space, defined by two parallels of min/max latitude and by two meridians of min/max longitude, that represents the coverage area of the map data enclosed by or located on the outline of the rectangle

4.25
regular parcel
parcel shaped like a rectangle

Note 1 to entry: Regular parcels on the same generalization level are not intended to overlap.

4.26
reverse geocoding
determination of the address description of a link or node (i.e. determination of an upwards path across the place tree)

4.27
road
GDF level 2 feature composed of one, many or no Road Elements and joining two Intersections, serving as the smallest independent unit of a road network at GDF level 2

4.28
route
ordered list of route links, or of stop points respectively, defining a single path through the transport network, with a direction

4.29
Route Guidance
application category that deals with the generation of graphical, textual, and/or audio instructions for following a planned route

4.30
route link
oriented link between two route Points defining a unique path through the transport network

4.31
Route Planning
application category that deals with the determination of routes between specified points

4.32
segment
straight section of a link connecting either two successive shape points, or a shape point and a node, or two nodes in case the link does not contain shape points

4.33
service
data model entity for a commercial activity of interest to travellers as a destination and/or orientation that is associated with Road Element(s) or place(s), by which it can be accessed

Note 1 to entry: Service is further described by attributes including (at least) name and type; it can be associated with other services by parent/child relationships (many to many).

Note 2 to entry: Service is used synonymously with POI within the logical data model.

4.34
Service and POI Information Access
application category that deals with the provision of POI information to the navigation application

Note 1 to entry: Service and POI Information Access is one of the eight application categories.

4.35
shape point
position along a link used to more accurately represent its geometric course, bounded by exactly two segments

4.36
stop point
position where passengers get in or off a (public transport) vehicle

4.37
symbol
icon associated with a cartographic feature

5 Symbols and abbreviated terms

ADAS	Advanced Driver Assistance System
BSA	Basic set of applications
DB	Database
GDF	Geographic Data File
ITS	Intelligent Transport System
ITS-RSU	Intelligent Transport System - Road Side Unit
LDM	Local Dynamic Map
LDO	Logical Data Organization
POI	Point of Interest
PSF	Physical Storage Format

6 Requirements

6.1 Introduction

This clause defines application requirements and functional requirements.

6.2 Application requirements

This International Standard supports BSA of cooperative ITS systems, Driving support services, and navigation services for in-vehicle and Multi-Modal Travel.

BSA of cooperative ITS systems are defined in Annex C. Driving support services are defined in Annex D. The relationship between BSA of cooperative ITS systems and driving support services are defined in Annex E and Multi-Modal Travel services are defined in Annex F.

6.3 Functional requirements

6.3.1 Overview

Six application categories (Map Display, Positioning, Route Planning, Route Guidance, Service/POI Information Access and Address Location) for navigation functionality are the same as those defined in ISO/TS 20452:2007. Cooperative ITS (including driving support) and Multi-Modal Travel Support functions are newly defined by this International Standard.

6.3.2 Map Display

6.3.2.1 General description

The Map Display function is used to display a map of a specified geographic area. An application may display maps to the end-user. The application may also accept end-user input that references the Map Display (such as from a point and click device).

6.3.2.2 Functional description

An application may display points, features, lines features, areas features, cartographic text and symbols for a specified geographic area. This may include roads, physical features, administrative boundaries, and names for all of these. Text and symbols can be positioned on a display to annotate this map.

The Map Display function provides cartographic data that can be used to display a map of any application specified arbitrarily-oriented rectangle in the database. The data consist of the following database entities to support a variety of map drawing styles: Cartographic Features, Cartographic Text and Symbols.

The application may allow the map to be zoomed in or out. The application may display different levels of detail on a Map Display based on the zoom level. The application may allow the map to be rotated and scrolled. When scrolling, if detailed data are not available, the application may automatically zoom the map out to a level where data are available. The application may allow the end-user to access additional information by selecting objects on the display. The application may display multiple windows. Generating map images and managing displays are beyond the scope of this function.

To facilitate data access speed, this application groups cartographic data into levels. The higher levels contain only the more significant cartographic features. The set of cartographic data are also selectable by level.

6.3.2.3 Requirements for data model

Map Display provides the following methods of accessing data:

— R-1. via the Cartographic Features, Cartographic Text and Symbols for an application-specified rectangle, level and feature type;

— R-2. via the coordinates for application-specified Cartographic Features;

— R-3. via attributes for Cartographic Features, such as: feature type, name, and functional classification;

— R-4. via the complete or partial Cartographic Features associated with application-specified Transportation Elements;

— R-5. via the area (size) of an application-specified Area Feature;

— R-6. via the ability to retrieve additional information for Point, Line and Area Features which are associated with Cartographic Features which may have been selected from the displayed map;

— R-7. via the Cartographic Text associated with a Cartographic Feature;

— R-8. via the Symbol associated with a Cartographic Feature;

— R-9. via returning the Cartographic Features and Cartographic Text in “draw-order”. For example, if water is drawn before bridges, water features should be returned before bridge features.

— R-10. When no map data are available for an area requested by a function, the function may distinguish between the case of “off the map” and the case of “no data at this location at this level”.

— R-11. The API shall allow a pre-fetch area of interest to be specified by a rectangle and application specified *level* for retrieving Map Display data.

— R-12. displays a map at the current location of the navigation system;

— R-13. displays a marker on the map indicating the navigation system's current location;

— R-14. scrolls the displayed map as the navigation system moves, maintaining the position of the marker indicating the navigation system's current location;

— R-15. displays a map at any location selected by the end-user. The end-user may specify the location as an Address, an Intersection, a service, or by cursor position on the display;

— R-16. provides latitude and longitude, street address, and other information for a point indicated by the cursor on the display;

— R-17. highlights a route on the display;

— R-18. highlights the point on a displayed map of a particular routing manoeuvre.

— R-19. Several levels of data are required for cartographic data, corresponding to different map scale ranges. At the higher levels, the drawing detail for line features and area features is generalized.

— R-20. Access is required for data from all GDF Feature Themes, as well as attributes and conditions.

— R-21. Map Display data shall be organized into parcels.

— R-22. In order to allow easy identification of parcels, parcels shall be rectangular.

— R-23. Links crossing parcel boundaries shall be cut at the parcel boundary.

— R-24. In order to minimize the number of parcels accessed, any link crossing into a parcel, with or without a node or intermediate point in that parcel, shall be represented in that parcel.

6.3.3 Positioning

6.3.3.1 General description

The Positioning function is used to determine vehicle location, for example latitude and longitude of a road network entity and for Map Matching. Map Matching is the method of determining where the navigation system has moved in the road network based on the navigation system's previous location and data about the navigation system's motion from external inputs. It corrects the geo-localization on the routes.

6.3.3.2 Functional description

"Positioning" seeks a position and orientation of a navigation system relative to the transportation network with respect to the map data representing the real world. An application may dynamically determine the navigation system's current position while the navigation system is in motion. Map Matching can continue "in the background" even while other functions are being performed so the navigation system always "knows where it is", with an accuracy depending on the map-matching. Map Matching algorithms are beyond the scope of this document.

6.3.3.3 Requirements for data model

For the purpose of Positioning, the following functions shall be provided:

— R-25. a single set of coordinates for an application-specified Point Feature in the Roads and Ferries theme;

— R-26. the set of Edges, Nodes and/or Intermediate Points for an application-specified Feature or set of connected Features in the Roads and Ferries theme;

— R-27. the set of topologically connected Features in the Roads and Ferries Theme connected to an application specified Feature in the Roads and Ferries theme;

— R-28. a single set of coordinates for an application-specified Line Feature in the Roads and Ferries theme and application-specified percentage of the distance along the Feature;

— R-29. the set of Features, Edges, Nodes and/or Intermediate Points in the Roads and Ferries theme within an application-specified rectangle;

— R-30. Positioning related Attributes, Conditions and Relationships (i.e. Prohibited Manoeuvres, Direction of Traffic Flow) for an application-specified Feature in the Roads and Ferries theme;

— R-31. the entry and exit angles for the set of Transportation Elements connected to an application-specified Intersection or junction;

— R-32. this International Standard shall support a single, world-wide, latitude/longitude-based coordinate reference system. The International Terrestrial Reference Frame (ITRF) is chosen because it is maintained by an international body. It is considered equivalent to WGS84 because the two systems currently have less than 1 m difference;

— R-33. only one coordinate system can be used in a single piece of storage media;

— R-34. when an application tracks progress along the route and provides manoeuvre instructions at appropriate points to the end-user;

— R-35. when an application determines whether the navigation system has left the planned route;

— R-36. when an application calculates a route to the requested destination from the navigation system's current position;

— R-37. when an application scrolls the displayed map;

— R-38. when an application selects services by geographic proximity;

— R-39. when an application is displaying the navigation system's position on a map;

— R-40. when an application displays a map around a location relative to the navigation system's current position;

— R-41. Positioning may receive planned route information from the Route Planning application for use in Map Matching.

— R-42. Only access to the lowest level of data are required.

— R-43. Only access to the data represented in the Roads and Ferries theme is required.

— R-44. Positioning data shall be organized into parcels.

— R-45. In order to minimize the number of parcels accessed, any link crossing into a parcel, with or without a node or intermediate point in that parcel, shall be represented in that parcel.

— R-46. In order to allow fast spatial access to parcels, parcels shall be accessed by their bounding rectangles. The shapes of parcels on the lowest level shall not overlap.

6.3.4 Route Planning

6.3.4.1 General description

The Route Planning function is used to determine routes from one user-specified location to another.

6.3.4.2 Functional description

Navigation applications may calculate routes based on attributes of the transportation network. Applications may allow end-users to specify criteria for the route such as "shortest distance", "no highways", etc. As a basic operation, a user indicates a departure position, which could be the navigation

system's current position, and selects a destination (place to go) and possibly one or more waypoints. A suitable route is then calculated. Route Planning is not limited to automobile transportation only. This function supports routing via any mode represented in the database. This may include rail and water ferries, taxis, and routes only accessible by bicycle or foot. Other forms of public transportation may be considered in the future.

The route calculation algorithms are outside the scope of this functional description.

To improve data access speed, the Logical Data Organization groups transportation features into levels. The higher levels contain only the more significant features (e.g. highways and main roads). These may be aggregated. Correspondences between features at different levels shall be made available to the application. The functions specified in the requirements below allow selection by level.

6.3.4.3 Requirements for data model

The Route Planning application provides the following methods of accessing data that can be used for routing:

— R-47. via the set of topologically connected *Links* for an application-specified Link at an application-specified level;

— R-48. via routing-related attributes for an application-specified Transportation Element or set of connected Transportation Elements, such as: node coordinates (of the bounding nodes of a link), measured length, functional road class, number of lanes, average speed, divided Road Element, form of way, as well as access characteristics, conditions, and other relationships;

— R-49. via navigation attributes for roads and intersections;

— R-50. via corresponding link for an application-specified link at an application-specified different level;

— R-51. via a set of topologically connected GDF roads for an application specified GDF road at an application specified level at certain levels to be determined;

— R-52. via a set of GDF Road Elements and GDF junctions, which comprise a GDF road or GDF intersection;

— R-53. via the GDF road or GDF intersection for an application-specified GDF road element or GDF junction;

— R-54. via the corresponding entity representing a GDF junction or Intersection for an application-specified entity representing a GDF junction or intersection at an application-specified different level;

— R-55. via effective time or date periods for turn, travel, or other conditions;

— R-56. via location references which are stored in the database for an application-specified set of transportation elements;

— R-57. via a set of transportation elements for an application-specified location reference which is stored in the database;

— R-58. via the entry and exit angles for the set of links connected to an application-specified Intersection or junction;

— R-59. via historic and forecast traffic conditions, incidents, and events information for a specified transportation element or set of transportation elements;

— R-60. via a DAL capable of providing transparent access to static and dynamic traffic information. It shall not preclude or require the integration of dynamic traffic information from external systems;

— R-61. via an API allowing a pre-fetch area of interest specified by feature ID or rectangle for retrieving Route Planning data at an application-specified level.

— R-62. the Route Planning application accepts other information from the Positioning application when calculating a route to the requested destination from the navigation system's current position.

— R-63. the Route Planning application provides information about the planned route to the Positioning application when determining whether the navigation system has left the planned route.

— R-64. the Route Planning application provides information about the planned route to the Route Guidance application for generating driving instructions.

— R-65. the Route Planning application provides information about the planned route to the Services and POI Information Access application for geographic selection of services with proximity to the planned route.

— R-66. the Route Planning application accepts input from the Services and POI Information Access and Address Location application when determining end-points or way-points for a route.

— R-67. the Route Planning application provides information about the planned route to the Map Display Application when indicating the course of the planned route on the graphical Map Display.

— R-68. Only access to the data represented in the roads and ferries theme is required. Enclosed traffic areas shall be represented by links and nodes.

— R-69. the shape of a parcel on a given level shall be contained in the shape of exactly one parcel at a higher level. The shapes of parcels on the same level shall not overlap.

— R-70. For Route Planning data, references to parcels on the same level and on the level(s) above and below are required.

— R-71. In order to have optimally filled parcels, parcels may have different coverage sizes.

— R-72. For Route Planning data, no intermediate points are required for the representation of links. A representation of turn angles, link length and the link cost are required.

— R-73. There is no requirement to create an additional node where a link crosses a parcel boundary.

— R-74. For Route Planning data, links crossing a parcel boundary should be stored as a whole in those parcels where they are connected to other links in the same parcel.

— R-75. In order to have fast access to parcels, parcels shall be accessed by their bounding rectangles.

— R-76. A separate computation is required to find nodes or links in the network data corresponding to origin, intermediate and destination points. The manner in which the nodes or links are found is outside the scope of this International Standard.

6.3.5 Route Guidance

6.3.5.1 General description

The Route Guidance function is used to generate instructions for following a route.

6.3.5.2 Functional description

The Route Guidance function generates step-by-step instructions for following a route. These instructions may include compass heading, distance, road names, sign text, landmarks, and still or motion images. These instructions may also include manoeuvre details such as turn angle, merges, and road name changes. Route Guidance may be given using text, voice or graphics.

6.3.5.3 Requirements for data model

Route Guidance provides the following methods of accessing data used for guidance of a route:

— R-77. via guidance-relevant features and relationships related to an application-specified transportation element, or set of transportation elements, such as: intersecting Road Elements, signpost Information, conditions and landmarks along the transportation element;

— R-78. via guidance attributes for an application-specified transportation element, or set of transportation elements, such as: road names, length, direction of traffic flow, and form of way;

— R-79. via indicating whether an application-specified junction is a part or all of an Intersection;

— R-80. via indicating whether an application-specified link is a regular link, a super link or part of a super link;

— R-81. via connected transportation elements for an application-specified junction;

— R-82. via connected transportation elements for an application-specified Intersection which are not part of that Intersection, such as the set of Road Elements connected to a roundabout;

— R-83. via component transportation elements of an application-specified Intersection, such as the set of Road Elements and junctions which make up a roundabout;

— R-84. via data about the transition from an application-specified link to an application-specified series of connected links, such as: the existence of a tollbooth or gate;

— R-85. via node and intermediate point positions for line features to support displaying manoeuvre “arrows” for Route Guidance;

— R-86. via cartographic data for the line features comprising an Intersection for the derivation of intersection schematics;

— R-87. via entry and exit angles for the set of transportation elements connected to an application-specified intersection or junction;

— R-88. via phonetic strings in an application-specified language for pronunciation of any named entity in the database;

— R-89. via phonetic strings in an application-specified language for commonly used guidance words;

— R-90. via digitized pronunciation data in an application-specified language for commonly used guidance words;

— R-91. via API allowing a prefect area of interest specified by a rectangle for retrieving Route Guidance data;

— R-92. via image data for optional picture guidance;

— R-93. provides guidance while the navigation system is in motion, based on a calculated route and map matching;

— R-94. tracks progress along the route and provide manoeuvre instructions at appropriate points to the end-user;

— R-95. Route Guidance data shall be organized into parcels;

— R-96. In order to allow fast access to parcels, parcels shall be accessed by their bounding rectangles;

— R-97. In order to have optimally filled parcels, parcels may have different coverage area sizes.

6.3.6 Service and POI Information Access

6.3.6.1 General description

The Service and Points-of-Interest (POI) Information Access function provides access to data which are commonly used as origins or destinations for a route and which contain information useful to travellers. Services are single point or area locations that are typically known by name rather than address. Services include traveller-related commercial services such as hotels, restaurants, and gas stations. Services also include locations or points of interest to travellers, such as national parks, monuments, and tourist attractions. Services can be categorized by type (e.g. airport, city centre, and hotel) and may carry a variety of other attribute information (e.g. rating, cuisine type, credit cards accepted).

Typically, third party organizations, such as tourist or motoring organizations, can offer a rich content of traveller information which may be of interest to the user. This type of service information is called Third Party Data (TPD). The amount of service information supplied by Third Parties may vary and may consist of comprehensive service data, including locational aspects and a linkage to the road network. Some TPD may originate from a party which has imposed proprietary restrictions on the use of the data. This is a subset referred to as Branded Third Party Data (BTPD) which imposes additional requirements.

6.3.6.2 Functional description

An application may provide service data to the end-user. Also, an application may allow the use of services in Address Location, Route Planning, and Map Display. An application may provide information about services, including TPD. The services may be selectable by types, geographic areas (e.g. within a rectangle or within distance of a point), places (e.g. Administrative areas, Districts, Postal areas), service attributes, or whether the service is associated with TPD. Services may be associated with Road Elements or other components of the Transportation Network based on their location. This provides a location on a Road Element which gives access to a service.

Additionally, searches for services may be qualified by an application-specified partial or full spelling match to the beginning of the service type, attribute, name, or to any individual word within the type, attribute or name.

Services may be associated with each other. A primary service is called a parent. A parent service may have many secondary services called child services. A child service may also have many parent services. One example of how this relationship is used is in the definition of an airport service that has multiple parking lots. In this case, the airport is designated as the parent service and the parking lots are designated as children of that parent.

A Service may be associated with multiple places. For example, the Dallas/Fort Worth Airport is physically located in Arlington and Grapevine. It is also logically associated with Dallas and Fort Worth.

Service and POI Information Access shall support different entry orders by means of appropriate data structures. Typically, a hierarchical top-down entry order may be used. However, permutations thereof shall also be supported, e.g. POI brand name first.

Service and POI Information Access shall support extensions to the search criteria when no match is found. The user may demand an expanded search area, i.e. areas close to the specified place(s) or spelling tolerance for similarly pronounced/written names.

6.3.6.3 Requirements for data model

Service data may be accessed by the following methods:

— R-98. via service attribute data for an application-specified service (to the extent they exist in the database) for example: name, address, phone number, chain, facility type, and days and times the service is open;

— R-99. via the coordinates of an application-specified service;

— R-100. via the related Road Elements and position along the Road Elements for the entry to an application-specified service;

— R-101. via the related services of an application-specified Road Element;

— R-102. via the set of services within an application-specified set of places;

— R-103. via the set of services within an application-specified set of rectangles;

— R-104. via the set of services where an application-specified partial or full spelling matches the beginning of the service name.

6.3.7 Address Location

6.3.7.1 General description

This function is used to access data that are used to determine positions, both on the earth and in the map data representation of the earth.

6.3.7.2 Functional description

Address Location is the determination of a location based on information describing or naming the location. An application may determine locations based on various types of information. For example, this information can be an address or cross-streets. There are also two basic methods of Address Location:

Geocoding: determining a link or a node, or a polygon or representative point by its address description.

Reverse geocoding: determining an address description of a link or node or representative point or area.

End users or applications may not know the complete standard of a location. For example, they may not know the complete address and administrative area, or they may not know whether a street is a “street” or an “avenue”. They may need to search the database based on the information they do know, and examine a set of locations matching their criteria.

Address Location may support different entry orders by means of appropriate data structures. Typically, a hierarchical top-down entry order may be used. However, permutations thereof shall be supported (e.g. street name first).

Address Location may support extensions to the search criteria when no match is found. The user may demand an expanded search area (e.g. areas close to the specified place(s) or spelling tolerance for similarly pronounced/written names).

6.3.7.3 Requirements for data model

The following requirements may apply to data model:

— R-105. Determination of a location may be based on information describing or naming the location;

— R-106. An application may determine locations based on various types of information. For example, this information can be an address or cross-streets;

— R-107. There are also two basic methods of Address Location.

6.3.8 Cooperative ITS support (including driving support)

6.3.8.1 General description

This function is used to provide information for supporting cooperative ITS and safe driving.

6.3.8.2 Requirements for data model

The following requirements may apply to data model:

— R-108. Advisory information on intersection and road may be provided to a driver;

— R-109. Road Signage information on intersection and road may be provided to a driver;

— R-110. Detailed road segment information around the vehicle may be provided to a driver;

EXAMPLE Lane, Lane Shape, Surface shape of Intersection, Surface shape of Road Element and Road Marking.

— R-111. The location information provided by an external system such as RDS-TMC shall be translated into road object location or place object location.

— R-112. Cautionary information on intersection or road may be provided to a driver and cooperative ITS applications;

— R-113. Traffic Signal information on intersection or road may be provided to a driver and cooperative ITS applications;

— R-114. The relation between traffic signal and lane may be provided to a driver and cooperative ITS applications;

— R-115. Coverage, accuracy and freshness of data may be maintained to be consistent with the policy of Driving Support services.

6.3.9 Multi-Modal Travel Support

6.3.9.1 General description

Multi-Modal Travel Support function consists of seven sub functions: Positioning, Map Display, Multi-Modal Route Planning, Multi-Modal Route Guidance, Service and POI Information Access, Address Location and Travel information access and provision.

6.3.9.2 Functional description

Positioning sub function has some small differences in comparison with the function that is described in 6.3.3. Positioning sub function provides the position of the traveller to the Multi-Modal Travel Support application and other six sub functions.

Positioning sub function for the Multi-Modal Travel Support application may be supported by Positioning functions of the navigation application for car, public transportation, bicycle and pedestrian.

In addition, the position of the traveller may be provided by the information from an external Positioning system such as GPS, position server, etc. Positioning sub function has an interface to external Positioning system optionally.

Map Display sub function for Multi-Modal Travel Support application is the same function that is described in 6.3.2.

The Multi-Modal Route Planning sub function for Multi-Modal Travel Support application is slightly different from the function described in 6.3.4. The Route Planning function provides a route between two locations serviced by a single transport mode. The Multi-Modal Route Planning sub-function combines the routes of the different transport modes integrating transfers and provides the itinerary. The itinerary may contain transfer locations, timing information, transport mode etc. Of course the Multi-Modal Travel Support application may use some Route Planning functions for car, public transportation, bicycle and pedestrian.

The Multi-Modal Route Guidance sub function for Multi-Modal Travel Support application is slightly different from the function that is described in 6.3.5. The Route Guidance function provides the Route

Guidance for trips using a single transport mode. The Multi-Modal Route Guidance sub function combines the Route Guidance for different trips, each one using a single transport mode and provides the Route Guidance through the transfer to the traveller.

The Service and POI Information Access sub function for Multi-Modal Travel Support application is the same function that is described in the 6.3.6.

The Address Location sub function for Multi-Modal Travel Support application is the same function that is described in 6.3.7.

The travel information access and provision sub function for Multi-Modal Travel Support function gathers respective travel information for a single mode in accordance with the traveller's order or application's order.

6.3.9.3 Requirement for data model

The following requirements shall apply to the data model:

— R-116. Road network shall contain the connection data for transferring between transport modes;

— R-117. the schedule of a segment of the route (e.g. time-table of public transportation) shall be provided;

— R-118. the entire route generated by Multi-Modal Route Planning may be displayed as a set of shapes;

— R-119. the entire itinerary may be provided by the textual list;

— R-120. the guidance data for the navigation path through the transfer shall be provided.

6.3.10 Update

6.3.10.1 General description

Update is general function for maintaining the data elements that is used by the above functions.

6.3.10.2 Requirement for data model

The following requirements for Update shall apply to the data model:

— R-121. Updating data element shall be possible (addition, correction, and deletion);

— R-122. The addition of the new data entity in the future shall be possible;

— R-123. Data structure shall receive the minimum influence by updates;

— R-124. Updating Intersection information on the boundary of parcel shall be possible;

— R-125. Updating protocols and data structures shall be achieved by ISO 24099.

6.3.11 System performance

6.3.11.1 General description

System performance refers to the impact of data structure and data model on how well a cooperative ITS system will perform.

6.3.11.2 Requirement for data model

The following requirements for system performance shall apply to data model:

— R-126. It shall be possible for data structure to comply with ISO 17267.

— R-127. It shall be possible for data structure to adopt both Relational DB and Navigable DB.

7 Logical data model

7.1 Overall model

7.1.1 General

The overall model expresses the static map data for ITS services, and relation between map data and the dynamic external information for ITS.

The overall model as shown in Figure 1 presents the relation between the following data model packages.

This overall model is based on ISO/TS 20452. It consists of the following packages:

— Transportation package;

— Cartographic package;

— Address Location package;

— Service and POI package;

— Dynamic Information package.

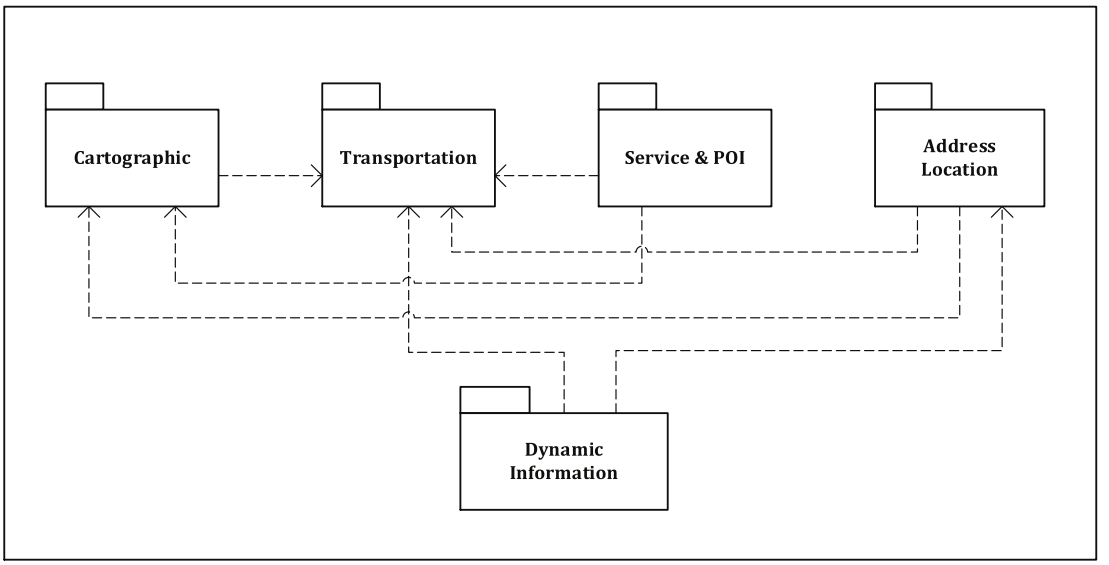


Figure 1 — Overall model

NOTE Some data objects that are defined in this International Standard may have a geometric description (shape information) and coordinates. The definition of coordinate system is out of the scope of this International Standard.

7.2 Transportation package

7.2.1 Overview

Transportation package defines the network data objects for ITS services which are cooperative ITS service supported by LDM, the Multi-Modal Travel Support service, car navigation, public transportation service, bicycle navigation and pedestrian navigation.

Transportation package consists of five packages: Transfer Zone Network package, road Network package, Public Transportation Network package, Bicycle Path Network package and Pedestrian Path Network package.

It assumes that Multi-Modal Travel Support services will be supported by expanding the application and data model of existing services such as car navigation, Public Transportation Travel service, Bicycle navigation and Pedestrian navigation. And it assumes that cooperative ITS application used Local Dynamic Map will be supported by Road Network package.

Transfer Zone Network is used for transferring, Road Network is used for cooperative ITS application (e.g. LDM application includes car navigation), Public Transportation Network is used for Public Transportation applications, Bicycle Path Network is used for Bicycle navigation and Pedestrian Path Network is used for Pedestrian navigation.

The scope specifies how to transfer between the road network and public transportation network but not between one public transportation mode and another public transportation mode. Transfer between public transportation modes is specified in ISO 19132.

Transfer Zone Network package defines the relation between Transportation networks: Road Network, Public Transportation Network, Bicycle Path Network and Pedestrian Path Network for Multi Modal Travel services.

This International Standard defines the detail of Road Network data for providing road data to target application.

However, this International Standard does not define the detail of Public Transportation Network, Pedestrian Path Network and Bicycle Path Network.

Figure 2 below illustrates the Transportation package.

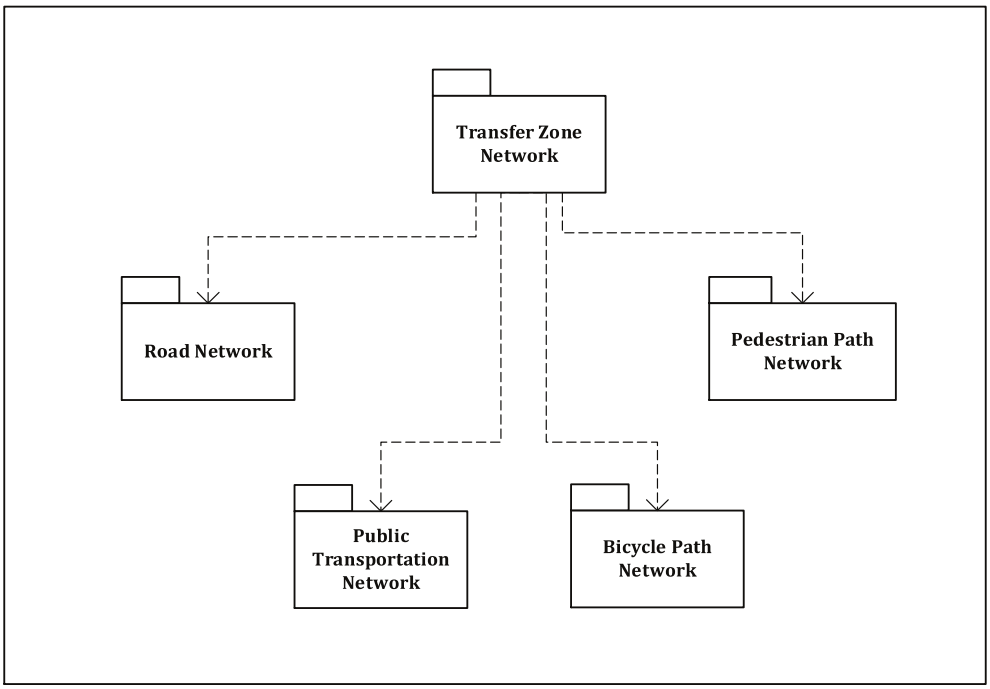


Figure 2 — Transportation package

7.2.2 Road network package

7.2.2.1 Overview

Road Network package defines the static road data for cooperative ITS application. There are a variable number of data levels in road network, and there are relations between the levels.

Road Network package consists of three sub packages: Road Network Object, Topological Road Network and Intersection and Road Element Guidance shown in Figure 3.

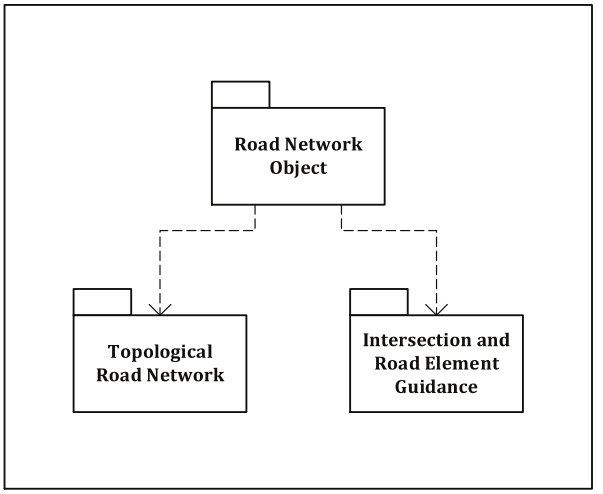


Figure 3 — Road network package

7.2.2.2 Road network object package

7.2.2.2.1 Overview

Road Network Object package defines the data structure and characteristics of the road.

Road Network Object package consists of 14 entities: Road Object, Road Section, Road Element, Intersection Connection Point, Intersection, Road Element Shape, Intersection Link, Intersection Link Shape, Lane, Lane Shape, Road Marking, Road Structure Change Point, Advisory Point/Section and Traffic Signal as shown in Figure 4.

Road Element Shape, Lane Shape, Intersection Link Shape and Road Marking in Road Network Object package contain the geometric information.

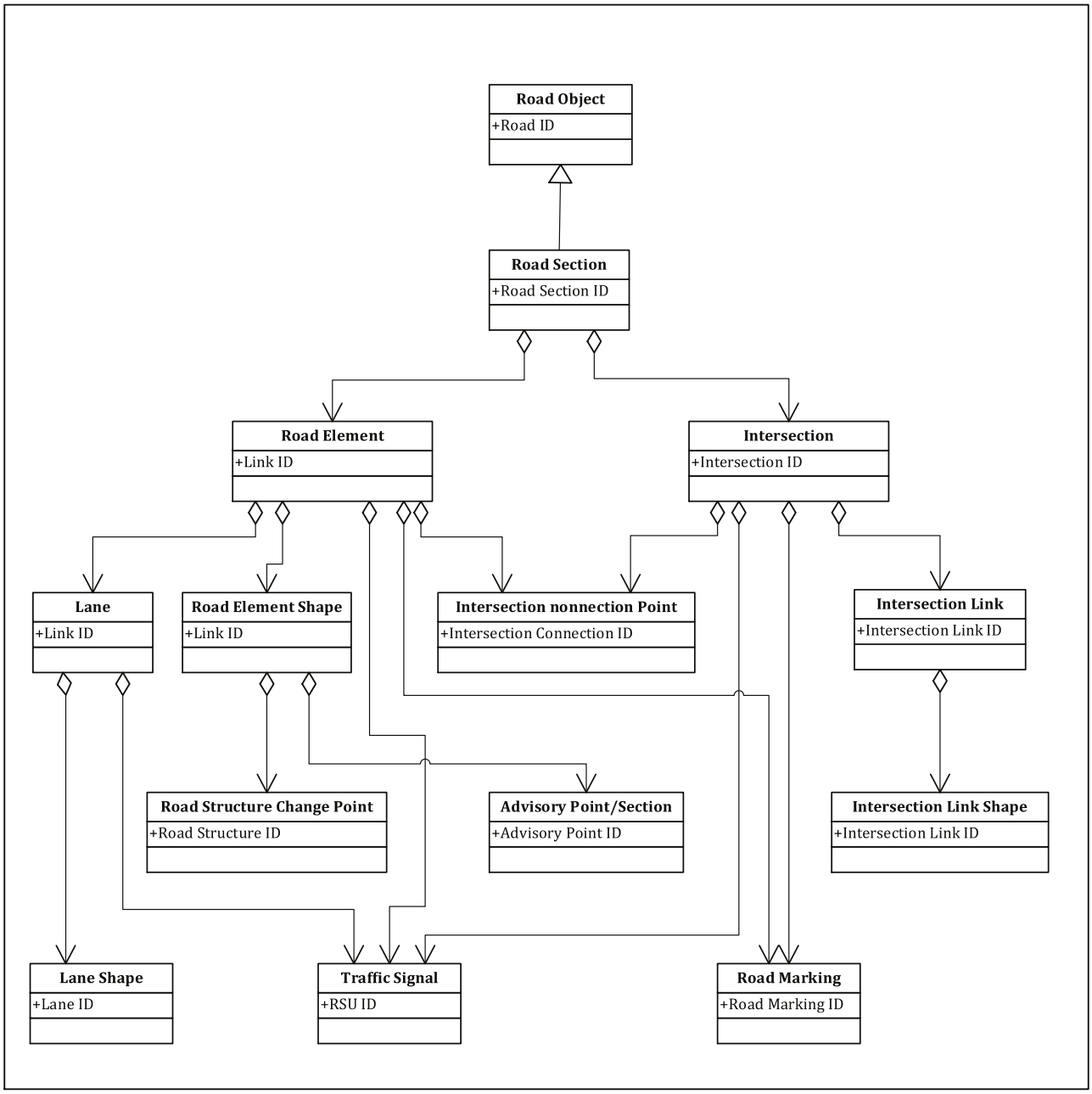


Figure 4 — Road network object package

7.2.2.2.2 Road object

7.2.2.2.2.1 Definition of road data

Road Object is a root entity of the Road Network Object package.

Road Object is a passable area which is called a street / roadway in specific parcel.

Each Road Object is an aggregation of Road Sections as shown in Figure 4.

7.2.2.2.2.2 Data elements of road object

Road Object is specified by Road ID.

Table 1 lists data elements of Road Object.

Table 1 — Data elements of road object

Data Element / Attribute	Note
Road ID	
number of Road Section	
road class	
road route number	it is set by road operator
road identifier code	it is set by road operator

7.2.2.2.3 Road section

7.2.2.2.3.1 Definition of road section

Road Section is a serial aggregation of Road Elements and Intersections.

Each Road Section consists of one or more Road Elements and two or more Intersections, and both ends of Road Section are Intersections.

If a Road Object has two carriage ways which are expressed by double Line as shown in Figure 5, each carriage way shall be defined by respective Road Sections.

Road Section is associated with Road Object and Road Section associates with Road Element and Intersection.

The Road Section shall not include any Road Element that composes other Road Section in the same data level.

NOTE Expression of the Road Section is the same as used the Multilink of ISO/TS 20452, except the intersection part. For example in Figure 5, when the constitution of the road changes from double line to single line, two Road Sections are set as Road Section A and B. Road Section B and part of the double line of Road Section A may be aggregated to the single lined Road Section in the upper level.

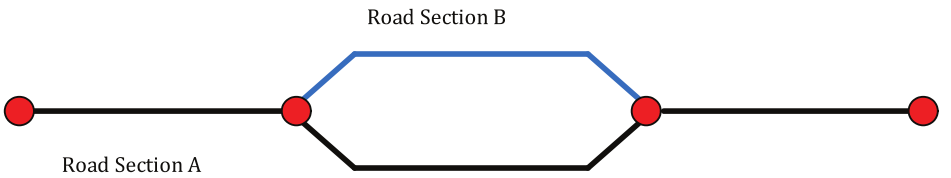


Figure 5 — Road section

7.2.2.2.3.2 Data elements of road section

Road Section is specified by Road Section ID.

Table 2 lists data elements of Road Section.

Table 2 — Data elements of road section

Data Element / Attribute	Note
Road ID	
Road Section ID	
road route number	
road identifier code	
number of Intersection in this Road Section	
start Intersection ID	
end Intersection ID	
external traffic information system flag	whether or not the Road Section is associated with information from ITS-RSU/VICS / RDS / TMS
toll road flag	whether or not the Road Section is a toll road

7.2.2.2.4 Road element

7.2.2.2.4.1 Definition of road element

Road Element (alias Link) is connected to two Intersection Connection Points that are in each Intersection in the Road Section.

The start and end of Road Element are an Intersection Connection Point at Intersection. Therefore Road Element connects to Intersection logically.

Road Element is associated with Road Section. Road Element associates with Road Element Shape, Lane, Traffic Signal and Road Marking in Road Network Object package. Also Road Element associates with Street Address, Caution Point, District Name, Location Image, Road Signage and Bridge and Tunnel in Road Element Guidance package.

Road Element does not contain any shape information of the road. Road linear shape information defined by polyline is set into Road Element Shape, and road surface shape information defined by polygon is set into Road Marking as option.

The same Road Element in the different level which is composed of the same Intersection Connecting Point must set the same link ID.

7.2.2.2.4.2 Data elements of road element

Road Element is specified by Link ID (i.e. Road Element ID).

Table 3 lists data elements of Road Element.

Table 3 — Data elements of road element

Data Element / Attribute	Note
Road Section ID	
Link connection order	stores the order of links
Link ID	
start Intersection ID	
one-way information	
investigation information	
Lane information existence flag	whether or not the Road Element is associated with lane information

Table 3 *(continued)*

Data Element / Attribute	Note
Bridge and Tunnel existence flag	whether or not the Road Element is a Bridge and Tunnel feature
start Intersection Connecting Point ID	
end Intersection Connecting Point ID	
upper level existence flag	whether or not this Road Element exists in the upper level
upper level Link ID	
link type code	
road functional code	
slope information	ascent/ descent/ flat
sidewalk type	
street name existence flag	whether or not the Road Element is associated with the street address
Street Address existence flag	
road name existence flag	
road width(normal direction)	the mean value
road width(opposite direction)	
number of Road Signage	
stop sign existence flag (start / end side)	
speed limits	this is a list of the vehicle type and speed limit value pair
number of Traffic Signals except for Intersections	Traffic Signals for pedestrian crossing / crosswalk in Road Element
pass-through flag	
on-the-street parking lot flag	

7.2.2.2.5 Intersection Connection Point

7.2.2.2.5.1 Definition of Intersection Connection Point

The Intersection Connection Point defines the location point where the Road Element connects with the Intersection Link or other Road Element at Intersection.

The Intersection Connection Points shall be located at the Intersection. Intersection Connection Points are the start point and the end point of Road Element including Intersection Links. Intersection Connection Point is associated with Road Element and Intersection.

When all Road Elements of other Road Section in the Intersection are omitted in the upper level, the Intersection and the Intersection Connecting Point are not set in the upper level.

For example Figure 6 shows crossing single-line roads. The location of Intersection Connection Point (abbreviated term: ICP) may be defined in the centre of the Intersection. There is an ICP in an Intersection. Figure 7 shows crossing double-line roads, the location of each ICP may be defined at entrance point of the Intersection and/or connection point of other Road Element. Four ICPs are set in an Intersection. Figure 8 shows the case of roundabout, the location of each ICP may be defined at entrance point. Four ICPs are set in an Intersection. In the case of Figure 7 and Figure 8, each ICP IDs in an Intersection are different. Also when Road Elements and/or Intersection Connecting Points are aggregated in the upper level, because a location of ICP is changed, it gives different ID to an ICP of upper level. In this case, Figure 6 may indicate an aggregated intersection in upper level and Figures 7 and 8 may indicate an Intersection in lower level.

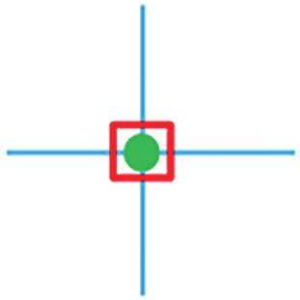


Figure 6 — Intersection and Intersection Connection Point (single-line roads crossing)

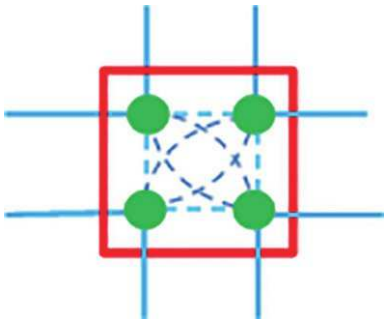


Figure 7 — Intersection and Intersection Connection Point (double-line roads crossing)

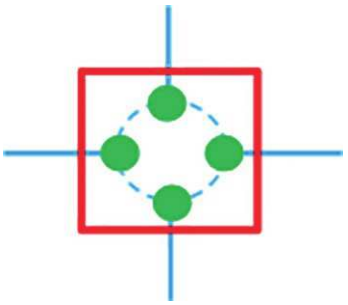


Figure 8 — Intersection and Intersection Connection Point (roundabout crossing)

NOTE In Figures 6, 7 and 8, the red quadrangle means the Intersection, the green point means the Intersection Connection Point, the blue line means the Road Element and the blue dashed line means Intersection Link.

7.2.2.2.5.2 Data elements of Intersection Connection Point

Intersection Connection Point is specified by Intersection ID and Intersection Connection Point ID.

Table 4 lists data elements of Intersection Connection Point.

Table 4 — Data elements of Intersection Connection Point

Data Element / Attribute	Note
Intersection Connection Point ID	'Intersection ID+ level+ order number' can substitute for it
Intersection ID	
coordinates of Intersection Connection Point	
offset from Intersection reference	
Intersection Connection Point type	single point / multi point / roundabout point /other (single point means that there is only one ICP in the Intersection, multi-point means that there are two or more ICPs, roundabout point means that ICPs are in a roundabout)
number of connected Link	
list of connected Link ID	

NOTE In this International Standard, coordinates is three dimensional data. A detailed definition of the coordinates is out of the scope of this International Standard.

7.2.2.2.6 Intersection

7.2.2.2.6.1 Definition of intersection

The Intersection is a place connecting more than two Road Sections. The dead end of a road and the plaza are defined as Intersection. Also the area boundary line on the road (i.e. country boundary, state boundary and city boundary) and special location points on the road (i.e. check-point and toll-gate) may be defined as Intersection.

Intersection is connected to Road Element logically by Intersection Connection Point.

Intersection is associated with Road Section. Intersection associates with Intersection Connection Point, Intersection Link, Traffic Signal and Road Marking in Road Network Object package, and associates with Building and Facility, Direction Guide and Intersection Name in Intersection and Road Element Guidance package.

The ID and the position of the Intersection that exists into two or more levels do not change in the upper level.

Plural Intersections cannot become an Intersection in upper level by aggregation.

The surface shape information of the intersection is defined by surface shape (i.e. polygon) in Road Marking. The surface shape of the intersection is optional.

NOTE 1 Figures 6, 7 and 8 show the example of Intersection types (i.e. simple, complex, roundabout) and the structure of Intersection, Intersection Connection Points, Road Elements and Intersection Links.

NOTE 2 When sequential Road Elements in lower level aggregates a Road Element in the upper level, intermediate Intersections of sequential Road Elements are omitted in the upper level.

7.2.2.2.6.2 Data elements of intersection

Intersection is specified by Intersection ID.

Table 5 lists data elements of Intersection.

Table 5 — Data elements of intersection

Data Element / Attribute	Note
Intersection ID	
number of Intersection Connecting Point in the Intersection	
Intersection Connecting Point ID list	
type of Intersection	simple/ complex/roundabout/ plaza/ boundary/ dead end/ others
representative coordinates of the Intersection	
number of connected Road Elements	
ID list of connected Road Elements	
number of Intersection Link	
Intersection Link ID list	
Intersection coverage of upper level	
Traffic Signal existence flag	whether or not there are traffic signals at this intersection
approach information	e.g. existence flags for Intersection name/ Direction guide/ District Name/ Caution Point/ Building and Facility

7.2.2.2.7 Road element shape

7.2.2.2.7.1 Definition of road element shape

Road Element Shape is defined by the polyline in the central line of Road Element.

The beginning point and ending point of Road Element Shape are an Intersection Connection Point.

Road Element Shape is associated with Road Element, and Road Element Shape associates with Road Structure Change Point and Advisory Point/Section.

The shape point of Road Element Shape may contain Road Structure ID for indicating the start/end position of specified road structure such as bridge and tunnel. Two shape points are used for indicating start/end position of road structure. It is useful for expressing the road structure on the road shape. Also the shape point of Road Element Shape may contain Advisory Point/Section ID for indicating the position/section of specified advisory point/section such as ‘curve driving attention’.

Because the Road Element does not include the Intersection Link, Road Element Shape does not include the shape of the Intersection Link.

7.2.2.2.7.2 Data elements of road element shape

Road Element Shape is specified by Link ID.

Table 6 lists data elements of Road Element Shape.

Table 6 — Data elements of road element shape

Data Element / Attribute	Note
Road Section ID	
Link connection order	
Link ID	
coordinates of start Intersection Connection Point	
coordinates of end Intersection Connection Point	

Table 6 *(continued)*

Data Element / Attribute	Note
number of shape point	
shape point list	shape point record consists of the coordinates of shape point, road Structure ID and Advisory Point ID.
-coordinates of shape point	in implementation, the coordinates may be described in relative coordinate system.
-road Structure ID	when this shape point indicates start/end position of road structure, it is set.
-Advisory Point ID	when this shape point indicates the position of advisory point/ section, it is set.

7.2.2.2.8 Intersection link

7.2.2.2.8.1 Definition of intersection link

Intersection Link provides topological link information of a pass way in the Intersection for vehicle. Intersection Link is defined by two Intersection Connection Points in the Intersection. When Intersection has two or more Intersection Connection Points, for example Figure 7, Intersection Link is set.

Intersection Link is associated with Intersection, and associates with Intersection Link Shape.

Intersection Link Shape is an optional part of this entity.

NOTE Figures 7 and 8 show situations of Intersection Link. Intersection Link may be used for expressing a passway for right-turn, left-turn, go-straight, U-turn, and roundabout way at the intersection.

7.2.2.2.8.2 Data elements of intersection link

Intersection Link is specified by Intersection ID and Intersection Link ID.

Table 7 lists data elements of Intersection Link.

Table 7 — Data elements of intersection link

Data Element / Attribute	Note
Intersection ID	
Intersection Link ID	'Intersection ID+ level+ order number' can substitute for it
start Intersection Connecting Point ID	
end Intersection Connecting Point ID	
Link type code	
length of Intersection Link	
average travelling time	

7.2.2.2.9 Intersection link shape

7.2.2.2.9.1 Definition of intersection link shape

Intersection Link Shape is an optional part of Intersection Link.

Intersection Link Shape provides the shape information of Intersection Link, and its shape is defined by polyline.

Intersection Link Shape is associated with Intersection Link.

When a shape of Intersection Link Shape is a straight line, shape point list of Table 8 may be omitted.

NOTE Figures 7 and 8 show a sample of Intersection Link Shape.

7.2.2.2.9.2 Data elements of intersection link shape

Intersection Link Shape is specified by Intersection Link ID.

Table 8 lists data elements of Link Shape.

Table 8 — Data element of intersection link shape

Data Element / Attribute	Note
Intersection ID	
Intersection Link ID	
start Intersection Connecting Point ID	
end Intersection Connecting Point ID	
start Intersection Connecting Point coordinates	
end Intersection Connecting Point coordinates	
number of shape point	when value is 0, shape point list does not exist
-shape point coordinate list	in implementation, the coordinates may be described in relative coordinate system.

7.2.2.2.10 Lane

7.2.2.2.10.1 Definition of Lane

Lane is as optional part of Road Element at the lowest level.

Lane is associated with Road Element, and Lane associates with Lane Shape.

Road Element consists of one or more serial Lane sections that are specified by the number of lane and direction of traffic flow. When Road Element has bidirectional Lane, different Lane sections for each direction must be set up. Lane section is a portion of a Road Element where the number of lanes in a single direction of travel remains the same. Lane sections are put in order according to the direction of travel. Lane section consists of one or more parallel Lanes. Individual lane is identified by Lane ID. Lane data are set up by counting lanes according to individual region or country convention.

Figure 9 below illustrates an example of Lane structure.

Lane consists of one or more serial Lane edges. Lane edge is a line that connects two Lane points. Lane point is set by a change of attributes such as the number of lanes, lane usage, and availability of moving to an adjoining lane. Lane point is located at the central line of the lane.

The black dot in Figure 9 indicates a Lane point and the black line indicates a Lane edge. The blue line and the blue dash line indicate Road Markings. The black arrow indicates a direction of traffic flow.

This Road Element in Figure 9 has four Lane sections (A-D). Lane section A has two Lanes (i.e. LN A1 and LN A2) and Lane section B has three Lanes (i.e. LN B1, LN B2 and LN B3). Lane A1 consists of a Lane edge A1. Because an attribute of Lane B3 is changed at intermediate Lane point, Lane B3 consists of two Lane edges.

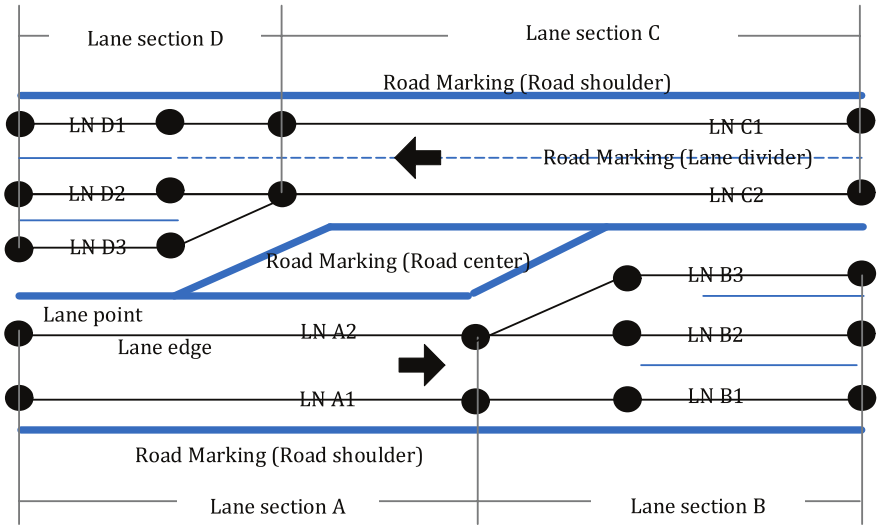


Figure 9 — Lane structure

7.2.2.2.10.2 Data elements of lane

Lane is specified by Link ID.

Table 9 lists data elements of Lane.

Table 9 — Data elements of lane

Data Element / Attribute	Note
Road Section ID	
Link ID	
order/ reverse of traffic flow of Road Element	
Lane counting convention	from left/ from right/ from centre/ from road shoulder
number of Lane section	
List of Lane section	data elements and attributes for Lane section are the following:
-Lane section ID	'Link ID+ direction of traffic+ order number' can substitute for it
-number of Lane in Lane section	
-sub-list of Lane information in Lane section	data elements and attributes for Lane information are the following
–Lane position in same Lane section	according to Lane counting convention
–Lane ID	'Lane section ID+ Lane position' can substitute for it
–start Lane point ID	
–end Lane point ID	
–useable vehicle types	automobile/ bicycle/ pedestrian/ others (e.g. tram)
–Lane usage type	normal/ Bus/ HOV/ reversible
–direction of travel at Lane end (ingress approach only)	optional; sharp left/ left/ slight left/ straight/ slight right/ right/ sharp right/ U-turn

NOTE Ingress approach is the traffic direction at end Lane point that is connected to Intersection.

7.2.2.2.11 Lane shape

7.2.2.2.11.1 Definition of lane shape

Lane Shape is optional.

Lane Shape provides shape data of each Lane that consists of one or more Lane edges. .

Lane Shape is associated with Lane.

Lane Shape contains the attributes of Lane edge such as length and availability of moving to adjoining lane. The shape of Lane edge is defined by polyline in the central line of lane. The connectivity between Lane sections is guaranteed by using same Lane point ID. Application can use the Lane and Lane shape for calculating lane route.

7.2.2.2.11.2 Data elements of lane shape

Lane Shape is specified by Lane ID.

Table 10 lists data elements of Lane Shape.

Table 10 — Data elements of lane shape

Data Element / Attribute	Note
Road Section ID	
Link ID	
Lane section ID	
lane position in same Lane section	according to Lane counting convention
Lane ID	
number of Lane edge	
Lane edge list	
-Lane edge ID	
-length of Lane edge	
-start Lane point ID	
-coordinates of start Lane point	
-end Lane point ID	
-coordinates of end Lane point	
-availability of moving to adjoining lane	
-number of shape point	
-shape point coordinate list	in implementation, the coordinates may be described in relative coordinate system

7.2.2.2.12 Road marking

7.2.2.2.12.1 Definition of road marking

Road Marking provides the shape of painted markings on roads such as lane markings these may be used for display purposes.

Road Marking is optional part of Road Element and Intersection in the lowest level.

Road Marking is associated with Road Element and Intersection.

The shoulder line of road, lane line, centre line, stop line, pedestrian crossing, and tram traffic belt are assumed.

This entity is used for drawing, map matching, giving attention, and driving support etc.

NOTE Road Marking supports surface shape of Road Element and Intersection.

7.2.2.2.12.2 Data elements of road marking

Road Marking is specified by Road Marking ID.

Table 11 lists data elements of Road Marking.

Table 11 — Data elements of road marking

Data Element / Attribute	Note
Road Section ID	
Link ID	
Intersection ID	
Road Marking ID	
road marking type code	
painted colour	white/ yellow/ orange/ red/ blue/ others
representative coordinates of Road Marking	these coordinates are used for Map Display
number of shape	Road Marking can set one or more shape
shape list	
-shape type	polygon / polyline
-number of shape point	
-shape point coordinates list	in implementation, the coordinates may be described in relative coordinate system

7.2.2.2.13 Road structure change point

7.2.2.2.13.1 Definition of road structure change point

Road Structure Change Point provides position and type of the road structure such as bridge and tunnel.

Road Structure Change Point is associated with Road Element Shape.

NOTE The drawing style of shape of the road is changed at Road Structure Change Point such as entrance/exit of tunnel and bridge. Detailed information of Bridge and Tunnel is defined into 7.2.2.4.9.

7.2.2.2.13.2 Data elements of road structure change point

Road Structure Change Point is specified by Link ID and road Structure ID.

Table 12 lists data elements of road Structure Change Point.

Table 12 — Data elements of road structure change point

Data Element / Attribute	Note
Road Section ID	
Link connection order	
Link ID	
coordinates of road Structure Change Point	
length from starting point of Road Element Shape	Optional
the number of shape point from starting point of Road Element Shape	Optional
Road Structure ID	
Road Structure object type	e.g. bridge/ tunnel/ over path/ under path
length of road Structure object	

7.2.2.2.14 Advisory point/section

7.2.2.2.14.1 Definition of advisory point /section

Advisory Point/Section provides the static data about an approaching condition on a road that may require some action by the driver of a vehicle.

Advisory Point/Section may be represented by either a point or a section along the road. The starting location of Advisory Point/Section is defined by either the coordinates or the distance from the start Intersection of Road Element. Advisory Point/Section is set for the advisory information at the lowest Level. Advisory attributes may contain the curvature radius value, slope value and length of curvature.

Advisory Point/Section is associated with Road Element Shape.

7.2.2.2.14.2 Data elements of advisory point/section

Advisory Point/Section is specified by Advisory Point/Section ID.

Table 13 lists data elements of Advisory Point/Section.

Table 13 — Data elements of advisory point/section

Data Element / Attribute	Note
Road Section ID	
Link connection order	
Link ID	
Advisory Point/Section ID	
coordinate of Advisory Point/Section	Optional
length from starting point of Road Element Shape	Optional
the number of shape points from starting point of Road Element Shape	Optional
length of Advisory Point/Section	when Advisory Point/Section is the section, it is set
advisory code	may be provided by application developer or data provider
advisory attributes	Optional
advisory Text	Optional

NOTE Advisory code may be used for specifying advisory attributes and advisory Text.

7.2.2.2.15 Traffic signal

7.2.2.2.15.1 Definition of traffic signal

Traffic Signal is a data entity that provides static data (e.g. position, size, type) about a traffic signal. A Traffic Signal may be Lane specific. Traffic Signal may include static data for pedestrian, bicycle and public transportation.

Traffic Signal is associated with Intersection, Road Element and Lane.

7.2.2.2.15.2 Data elements of traffic signal

Traffic Signal is specified by Road Side Unit ID (RSU ID).

Table 14 lists data elements of Traffic Signal.

Table 14 — Data elements of traffic signal

Data Element / Attribute	Note
RSU ID	Traffic Signal is one of Road Side Unit
Traffic Signal type	
Intersection ID	Optional
Link ID	Optional
Lane ID	Optional
Lane number	Optional
Arrangement	

7.2.2.3 Topological road network package

7.2.2.3.1 Overview

Topological Road Network package is defined mainly for Route Planning. Generally, the number of levels of Topological Road Network data may be less than the number of levels of Road Network data. Because the data size decreases and also the number of data access decreases, Route Planning using Topological Road Network data may be more efficient than Route Planning using Road Network data. Topological Road Network package is independent of Road Network Object package.

Topological Road Network consists of eight entities: Intersection (Topological Node), Road Element (Topological Link), Link Cost, Intersection Cost, Traffic Restriction, Special Route, Detailed Special Route and Road Network Connector.

Figure 10 below illustrates the Topological Road Network package.

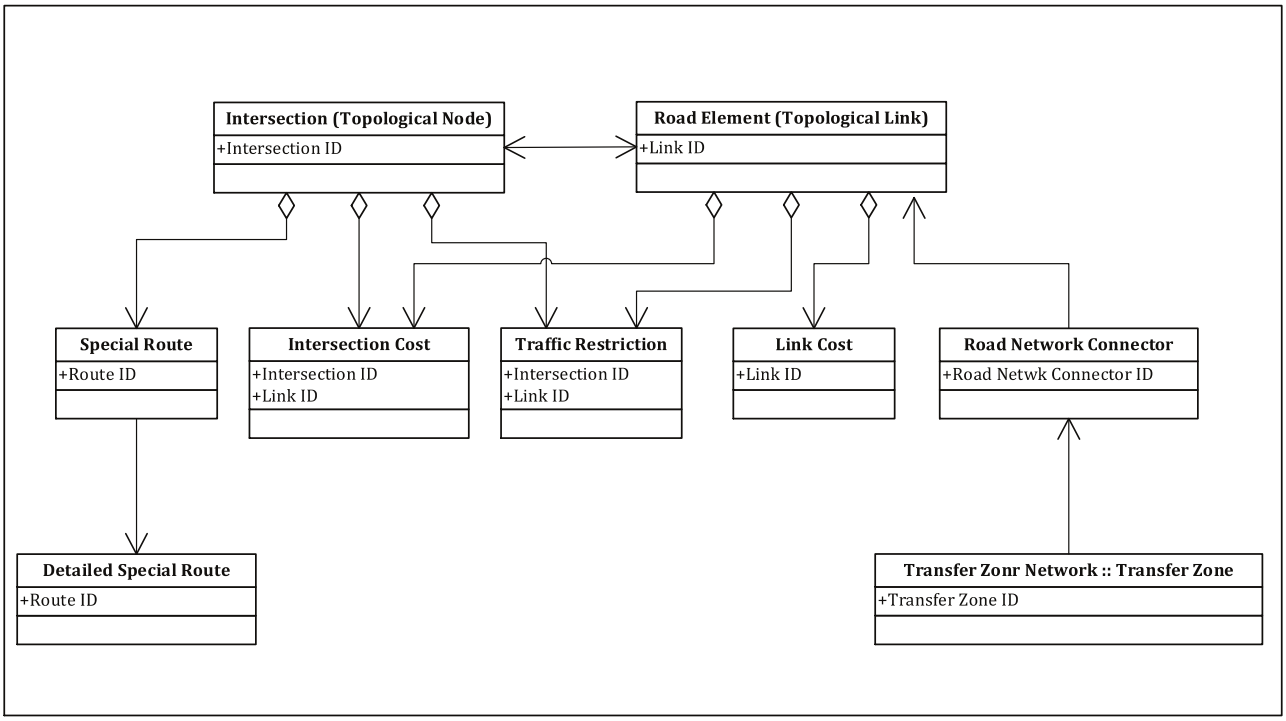


Figure 10 — Topological road network package

7.2.2.3.2 Intersection (topological node)

7.2.2.3.2.1 Definition of intersection (topological node)

Intersection (Topologic Node) is independent of Intersection of Road Network package. The behaviours and characteristics of Intersection (Topological Node) are the same as Intersection of Road Network package. For example, The ID and location of Intersection (Topological Node) are the same as Intersection of Road Network package. Intersection (Topological Node) provides the attributes for Route Planning.

Intersection (Topological Node) associates with Intersection Cost, Traffic Restriction and Special Route. And Intersection (Topological Node) relates to Road Element (Topological Link).

NOTE In most existing navigation systems, the algorithms for Route Planning have used topological link and node. The node and aggregated node in the existing navigation systems have the same meaning as Intersection in this International Standard.

7.2.2.3.2.2 Data elements of intersection (topological node)

Intersection (Topological Node) is specified by Intersection ID.

Table 15 lists data elements of Intersection (Topological Node).

Table 15 — Data elements of intersection (topological node)

Data Element / Attribute	Note
level number	
Parcel ID	
practical code	
Intersection ID	
type of Intersection	
ID list of connected Road Element	list of connected Link IDs
Special Route flag and ID	Optional

7.2.2.3.3 Road element (topological link)

7.2.2.3.3.1 Definition of road element (topological link)

Road Element (Topological Link) is independent of Road Element of Road Network package. The behaviours and characteristics of Road Element (Topological Link) are the same as Road Element in Road Network. For example, The ID and road fictional code are the same. Road Element (Topological Link) provides the attributes for Route Planning.

Road Element (Topological Link) associates with Intersection Cost, Link Cost and Traffic Restriction. And Road Element (Topological Link) relates to Road Element (Topological Link) of upper/lower levels. Also Road Element (Topological Link) is associated with Road Network Connector.

7.2.2.3.3.2 Data elements of road element (topological link)

Road Element (Topological Link) is specified by Link ID.

Table 16 lists data elements of Road Element (Topological Link).

Table 16 — Data elements of road element (topological link)

Data Element / Attribute	Note
level number	
Parcel ID	
practical code	
Link ID	
road functional code	
start Intersection ID	
end Intersection ID	

7.2.2.3.4 Link cost

7.2.2.3.4.1 Definition of link cost

Link Cost is one of the attributes of Link. However, this entity is independent of Road Element (Topological Link). Link Cost provides information about the length of a Link, travel time and the slope of a Link that may be useful for Route Planning.

For each direction of traffic flow of a Link, there is one Link Cost attribute. When the Link Costs for both directions of travel are the same, the Link Cost attribute for one direction of travel may be omitted and the 'same Link Cost flag' is set for another direction of travel.

Link Cost is associated with Road Element (Topological Link).

7.2.2.3.4.2 Data elements of link cost

Link Cost is specified by Link ID.

Table 17 lists data elements of Link Cost.

Table 17 — Data elements of Link Cost

Data Element / Attribute	Note
Link ID	
start Intersection ID	
end Intersection ID	
coverage of upper level Link	
Link ID of upper level	
historical traffic status of Link	
toll / free flag	
number of Traffic Signal	
Link direction	one-way/ two-way(forward)/ two-way(opposite)
opposite lane crossing flag	when Road Element is two-way, it is effective
same Link Cost flag	
Link type code	
road functional code	
length	
average travelling time	
slope information	ascent/ descent/ flat

NOTE The direction of traffic flow of Link is identified by a direction from start Intersection to end Intersection.

7.2.2.3.5 Intersection cost

7.2.2.3.5.1 Definition of Intersection cost

Intersection Cost is one of the attributes of Intersection. However, this entity is independent of Intersection (Topological Node).

Intersection Cost provides information about the distance and travelling time across the Intersection for Route Planning.

Intersection Cost is associated with Road Element (Topological Link) and Intersection (Topological Node).

7.2.2.3.5.2 Data elements of intersection cost

Intersection Cost is specified by entrance Link ID and exit Link ID.

Table 18 lists data elements of Intersection Cost.

Table 18 — Data elements of intersection cost

Data Element / Attribute	Note
Intersection ID	
entrance Link ID	
exit Link ID	
length	
average travelling time	

7.2.2.3.6 Traffic restriction

7.2.2.3.6.1 Definition of Traffic restriction

Traffic Restriction provides the traffic restrictions such as one way or turn restrictions for route calculation purposes. Traffic Restriction contains the regulation and condition of traffic that is specified by the Traffic Restriction code.

This entity is set for the Traffic Restriction between entrance Link and exit Link for route calculation.

Traffic Restriction is associated with Road Element (Topological Link) and Intersection (Topological Node).

7.2.2.3.6.2 Data elements of Traffic restriction

Traffic Restriction is specified by entrance Link ID and exit Link ID.

Table 19 lists data elements of Traffic Restriction.

Table 19 — Data elements of Traffic Restriction

Data Element / Attribute	Note
Intersection ID	
entrance Link ID	
exit Link ID	
Traffic Restriction code	

NOTE When entrance Link ID is set with null value, Traffic Restriction code is applied to exit Link.

7.2.2.3.7 Special route

7.2.2.3.7.1 Definition of special route

Special Route provides a topological link object that means a pre-determined route such as scenic route and detour route. Special Route contains start/end intersections of pre-determined route and route type for Route Planning. Therefore Special Route is related with Intersection.

Special Route is associated with Intersection (Topological Node), and is composed Detailed Special Route.

Special Route does not contain detailed information such as Link ID list and/or Intersection ID list.

Their information is defined in the Detailed Special Route entity.

NOTE It assumes that Special Routes are highway route, scenic route, detour route and evacuation route.

7.2.2.3.7.2 Data elements of special route

Special Route is specified by Route ID.

Table 20 lists data elements of Special Route.

Table 20 — Data elements of special route

Data Element / Attribute	Note
Intersection ID 1	one end intersection of the Special Route
Intersection ID 2	other end intersection of the Special Route
Route ID	
route type	highway/ scenic road/ detour/ evacuation route
Direction of special route flag	Value 1 corresponds to Intersection ID 1. Value 2 corresponds to Intersection ID 2.
fee (charge)	

7.2.2.3.8 Detailed special route

7.2.2.3.8.1 Definition of detailed special route

Detailed Special Route provides the detailed information of Special Route.

Detailed Special Route is a component of Special Route entity in consideration of the data handling. Also it contains the list of pre-calculated road object such as Link and Intersection.

For each Special Route there is one associated Detailed Special Route.

7.2.2.3.8.2 Data elements of detailed special route

Detailed Special Route is specified by Route ID.

Table 21 lists data elements of Detailed Special Route.

Table 21 — Data elements of detailed special route

Data Element / Attribute	Note
Route ID	
start Intersection ID	
end Intersection ID	
route name	
route attributes	e.g. toll charge/ length/ average travel time
Link ID list	
Intersection ID list	start/end Intersection ID are not contained in this list

7.2.2.3.9 Road network connector

7.2.2.3.9.1 Definition of road network connector

Road Network Connector is an object that makes the connection between Road Element and Transfer Zone of Transfer Zone Network package.

Road Network Connector is associated with Transfer Zone. Road Network Connector associates with Road Element (Topological Link), and is associated with Transfer Zone in Transfer Zone Network package.

NOTE The relationship to Transfer Zone is described in 7.2.3.

Road Network Connector contains Transfer Zone ID and the list of Link ID and position-on-the-link associated with relevant Road Element.

For example in Figure 11, a traveller can transfer from/to private car, taxi, bus, train and airplane at Charles de Gaulle International Airport. Charles de Gaulle International Airport has airport terminals, rail stations and parking buildings. In this case, Charles de Gaulle International Airport may be defined as Transfer Zone, and the airport terminals, rail station, bus stops and parking buildings located along the street may be defined as road Network Connectors. A road Network Connector has one or more relationships to Road Element. For example, a parking building in the airport area has some entrance and exit gates linked to streets. Therefore a car parking building as road Network Connector connects to some Road Elements. Rail station may be defined as road Network Connector, and also may be defined as Rail Network Connector of Rail Network. Also airport terminals and bus stops are similar to the above.

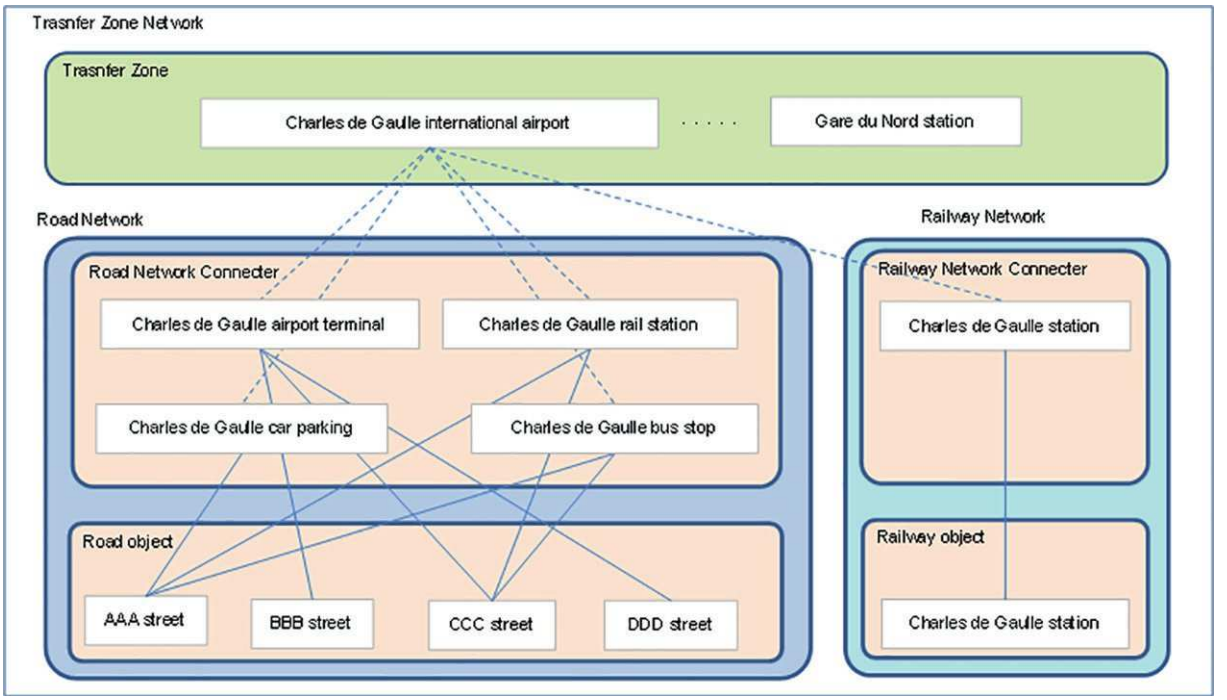


Figure 11 — Example for transfer zone and road network connector

7.2.2.3.9.2 Data elements of road network connector

Road Network Connector is specified by road Network Connector ID.

Table 22 lists data elements of Road Network Connector.

Table 22 — Data elements of road network connector

Data Element / Attribute	Note
Road Network Connector ID	
Transfer Zone ID	
representative coordinates of Road Network Connector	
number of the position related to road object	
List of the position related to road object	the position related road object consists of Link ID and position-on-the-link pair.
-Link ID	
-position-on-the-link	

7.2.2.4 Intersection and road element guidance package

7.2.2.4.1 Overview

Intersection and Road Element Guidance package includes the attributes of Intersection and Road Elements. However, the main attributes of Road Element and Intersection for guidance are independent of Road Network Object package.

Intersection and Road Element Guidance package consists of nine entities: Caution Point, Road Signage, Intersection Name, District Name, Location Image, Direction Guide, Building and Facility, Bridge and Tunnel and Street Address.

Figure 12 below illustrates the Intersection and Road Element Guidance package.

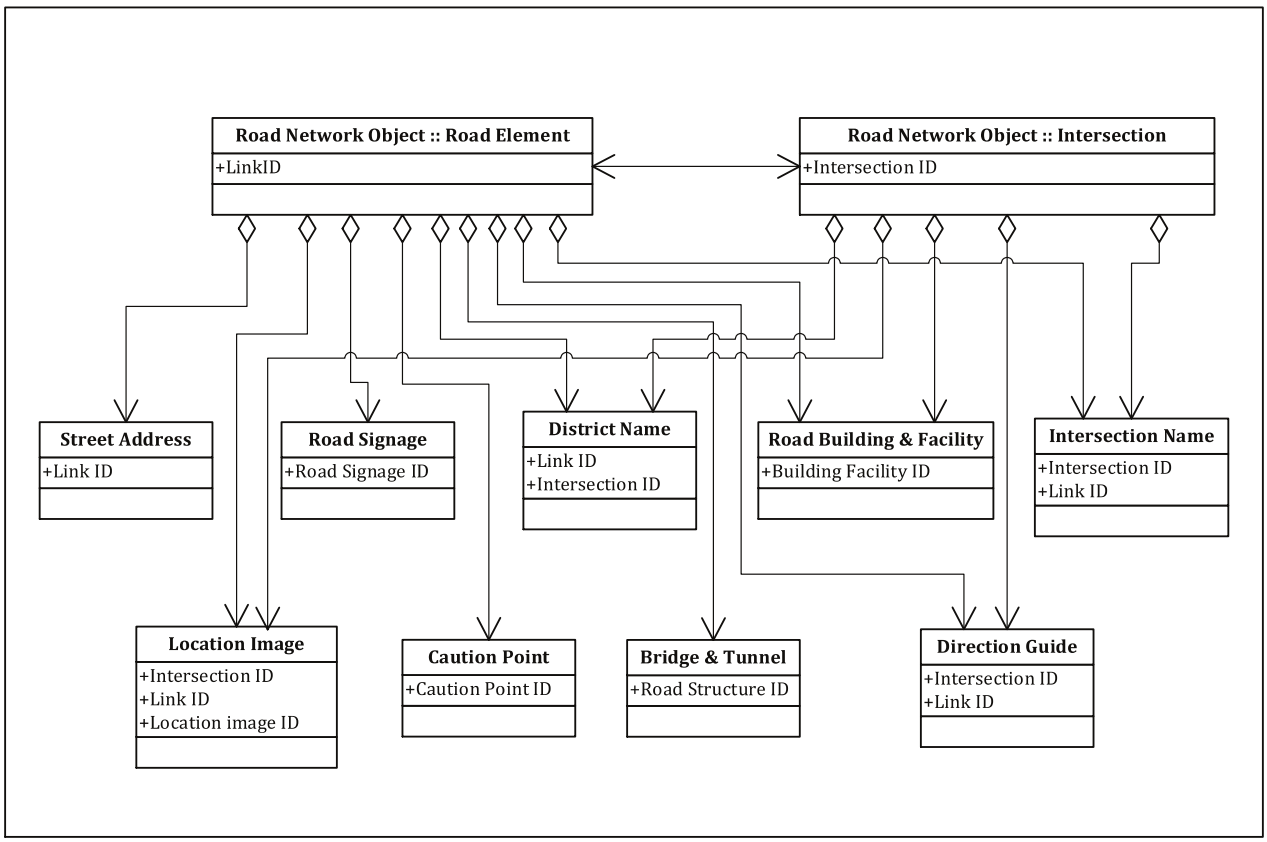


Figure 12 — Intersection and road element guidance package

7.2.2.4.2 Caution point

7.2.2.4.2.1 Definition of caution point

Caution Point provides static caution data on a road including caution content code and location.

Caution Point is associated with Road Element in Road Network Object package.

NOTE Caution Point may be made by the caution information of a road sign, static status of road and traffic. Caution Point is similar to Advisory Point/Section. Advisory Point/Section provides information to alert a driver concerning an action that may need to be taken.

7.2.2.4.2.2 Data elements of caution point

Caution Point is specified by Caution Point ID.

Table 23 lists data elements of Caution Point.

Table 23 — Data elements of caution point

Data Element / Attribute	Note
Intersection ID	
Link ID	
Caution Point ID	
caution content code	
location of Caution Point	Optional
caution attributes	Optional
caution text	Optional

7.2.2.4.3 Road signage

7.2.2.4.3.1 Definition of road signage

Road Signage provides the location and attributes of road sign that its location is fixed.

Road Signage is associated with Road Element in Road Network Object package.

7.2.2.4.3.2 Data elements of road signage

Road Signage is specified by Road Signage ID.

Table 24 lists data elements of Road Signage.

Table 24 — Data elements of road signage

Data Element / Attribute	Note
Road Section ID	
Link ID	
Road Signage ID	
direction	Forward (at link direction)/ opposite
message type	fixed / variable
road signage type	guide/ attention /restrict/ order /other
road signage code	

Table 24 *(continued)*

Data Element / Attribute	Note
road signage text (numeric)	e.g. speed value/ length/ weight
supplementary signage flag	whether or not there is supplementary signage
supplementary signage Text	e.g. bus only
position of signage	coordinates of road signage board
height	length from centre of road signage board to ground level

7.2.2.4.4 Intersection name

7.2.2.4.4.1 Definition of intersection name

Intersection may have several names that may be defined by incoming direction of intersection.

Intersection Name provides the name of Intersection for incoming direction to an intersection.

Intersection Name is associated with Intersection in Road Network Object package.

7.2.2.4.4.2 Data elements of intersection name

Intersection Name is specified by Intersection ID and entrance Link ID.

Table 25 lists data elements of Intersection Name.

Table 25 — Data elements of intersection name

Data Element / Attribute	Note
Intersection ID	
entrance Link ID	when an Intersection Name varies according to an approach direction, it is set.
text of Intersection Name	character string

7.2.2.4.5 District name

7.2.2.4.5.1 Definition of district name

District Name provides the name of the district for outgoing direction from an Intersection.

District Name is associated with Road Element in Road Network Object package.

7.2.2.4.5.2 Data elements of district name

District Name is specified by Intersection ID, entrance Link ID and exit Link ID.

Table 26 lists data elements of District Name.

Table 26 — Data elements of district name

Data Element / Attribute	Note
Intersection ID	
entrance Link ID	
name type	
distance category	short distance range/ middle distance/ long distance
exit Link ID	
name of district	Text

7.2.2.4.6 Location image

7.2.2.4.6.1 Definition of location image

Location Image provides a background image of the Road Element and the Intersection upon which guidance information is displayed.

Location Image is associated with Road Element in Road Network Object package.

7.2.2.4.6.2 Data elements of location image

Location Image is specified by Location Image ID, Intersection ID and entrance Link ID.

Table 27 lists data elements of location Image.

Table 27 — Data elements of location image

Data Element / Attribute	Note
Intersection ID	
entrance Link ID	
Location Image ID	
guide type	
-pattern information	
-picture information	
length before Intersection	
text for Location Image	

7.2.2.4.7 Direction guide

7.2.2.4.7.1 Definition of direction guide

Direction Guide provides direction information on the target Intersection.

Direction Guide is associated with Intersection in Road Network Object package.

7.2.2.4.7.2 Data elements of direction guide

Direction Guide is specified by Intersection ID and entrance Link ID.

Table 28 lists data elements of Direction Guide.

Table 28 — Data elements of direction guide

Data Element / Attribute	Note
Intersection ID	
entrance Link ID	
entrance Lane Information	number of lane and direction of traffic of each entrance Lane
number of guidance point	
guidance point list:	each guidance point has the following attributes
-exit Link ID	
-Intersection type	
-guidance point type	
-exit Lane flag	
-exit direction	
-guidance code	
-guide flag	
-exit angle	

7.2.2.4.8 Building and facility

7.2.2.4.8.1 Definition of building and facility

Building and Facility provides the shape and location of Building and Facility on the road side.

Facility contains fixed roadside station such as Toll gate and ETC Charge collection unit.

Building and Facility is associated with Intersection in road Network Object package.

7.2.2.4.8.2 Data elements of building and facility

Building and Facility is specified by Building and Facility ID.

Table 29 lists data elements of Building and Facility.

Table 29 — Data elements of building and facility

Data Element / Attribute	Note
Intersection ID	
Link ID	
Building and Facility ID	
category of Building and Facility	type code may be provided by data provider or application developer
representative coordinates of Building and Facility	
entrance direction Information	when there are two or more roads to access the Facility, it is set
coordinates to display Symbol icon	Optional
name of Building and Facility	
shape point coordinates list of Building and Facility	shape point defines the geometric contour of Building and Facility
additional Symbol icon	
entrance/exit information	Link ID, position, accessing direction

7.2.2.4.9 Bridge and tunnel

7.2.2.4.9.1 Definition of bridge and tunnel

Bridge and Tunnel provides information such as the length, height of bridges and tunnels and crossing information.

Bridge and Tunnel is associated with Road Element in road Network Object package.

7.2.2.4.9.2 Data elements of bridge and tunnel

Bridge and Tunnel is specified by road Structure ID.

Table 30 lists data elements of Bridge and Tunnel.

Table 30 — Data elements of bridge and tunnel

Data Element / Attribute	Note
Intersection ID	
Link ID	
road Structure ID	
road Structure object type	
Link direction	
representative coordinates of Bridge and Tunnel	
length of Bridge and Tunnel	
length from starting point of Road Element Shape	
height information	
crossing information	Information for other Road Elements crossing this Road Element at, for example, an under pass or over pass,
name of Bridge / Tunnel	Text

7.2.2.4.10 Street address

7.2.2.4.10.1 Definition of street address

Street Address provides the street address information for each Road Element.

Street Address is associated with Road Element in Road Network Object package.

7.2.2.4.10.2 Data elements of street address

Street Address is specified by Link ID.

Table 31 lists data elements of Street Address.

Table 31 — Data elements of street address

Data Element / Attribute	Note
Link ID	
Street Address type	
street name	
address information	i.e. postal city/settlement name, postal code and house number (includes house number range)

7.2.3 Transfer zone network package

7.2.3.1 General

Transfer Zone Network defines the place of transfer (e.g. Transfer Zone) and the corresponding to Network Connectors.

Transfer Zone Network package consists of Transfer Zone entity and relations to relevant Network Connector entity of each Network packages; Road Network, Public Transport Network, Pedestrian Path Network and Bicycle Path Network.

Figure 13 below illustrates the Transfer Zone Network package.

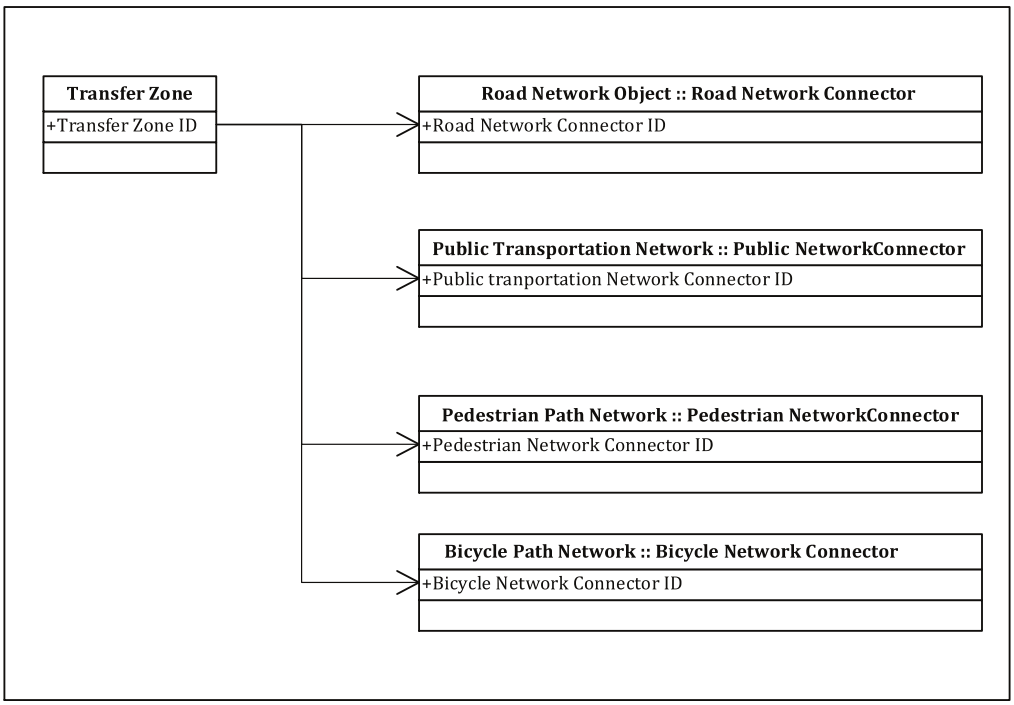


Figure 13 — Transfer Zone Network package

7.2.3.2 Transfer zone

7.2.3.2.1 Definition of transfer zone

Transfer Zone is a place where a discrete network is able to transfer to other networks. One Transfer Zone connects two or more networks by related Network Connector. For instance a station of the public transportation is a Transfer Zone. Transfer Zone is defined in Transfer Zone Network, and Network Connector is defined in each transportation network.

Transfer Zone associates with Road Network Connector in Road Network Object package and Network Connectors in other Network packages.

Transfer Zone contains an identifier, name of Transfer Zone and list of related Network Connector including type of transportation.

It assumes that Public Transport Network may have plural networks such as railway network, bus network and individual public networks.

NOTE Figure 11 shows an example of a relationship between Transfer Zone and Network Connector.

7.2.3.2.2 Data elements of transfer zone

Transfer Zone is specified by Network category, Network ID and Transfer Zone ID.

Table 32 lists data elements of Transfer Zone.

Table 32 — Data elements of transfer zone

Data Element / Attribute	Note
Transfer Zone ID	
name of Transfer Zone	
list of Network Connector	
-Network category	road/ public transportation/ pedestrian/bicycle
-Network ID	
-Network Connector ID	

NOTE For example in Figure 11, names of Transfer Zone are 'Charles de Gaulle International Airport' and 'Gare du Nord station'. In case of 'Charles de Gaulle International Airport', List of Network Connector consists of four Road Network Connectors and a Rail Network Connector.

7.2.4 Public transportation network

7.2.4.1 Overview

Public Transportation Network package is defined for using Public Transportation Travel services.

Public Transportation Network has Public Network Connector and data entity for Public Transportation Travel services. Public Transportation Network package may include several single-modal network packages such as Railway network, Subway network, Bus network, Ferry network and Flight network.

It is assumed that the existing data model for Public Transportation Network has a data entity that can be used for Public Network Connector.

This International Standard does not define the detail of Public Transportation Network.

7.2.5 Pedestrian path network

7.2.5.1 Overview

Pedestrian Path Network package is defined for using Pedestrian Travel services such as the pedestrian navigation.

This International Standard does not define the detail of Pedestrian Path Network.

7.2.6 Bicycle path network

7.2.6.1 Overview

Bicycle Path Network package is defined for using Bicycle Travel services such as the bicycle navigation.

This International Standard does not define the detail of Bicycle Path Network.

7.3 Cartographic package

7.3.1 Overview

Cartographic package is defined mainly for displaying map. There are a variable number of data levels in Cartographic package, and there are relationships between the levels. Cartographic package consists of Background package and Graphic Text package.

Graphic Text such as name of map features is one of the attributes of cartographic data. However, the text for cartographic data are independent of the Background data. Background relates to Graphic Text.

Figure 14 below illustrates the Cartographic package.

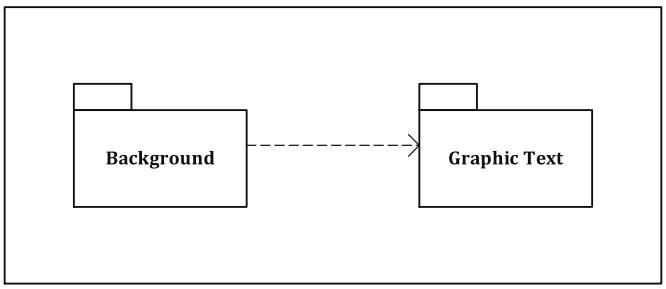


Figure 14 — Cartographic package

7.3.2 Background package

7.3.2.1 General

Background package defines static background data for ITS application. Background data are organized by the parcel. Background data has two picture types; Imagery data (raster type) and figure data (vector type).

Imagery picture data for background is used graphic data format such as BMP, JPEG, PNG, IMG, GeoTIFF etc.

Typically imagery picture data has no GIS information such as the coordinates, and/or mesh size. Imagery picture data contains attributes data such as pixel size etc. for cartographic.

Background consists of six data entities: Background Object, Map Data Background, Cartographic Feature Type, Figure Element, Background Imagery and Picture File.

Figure 15 below illustrates the Background package.

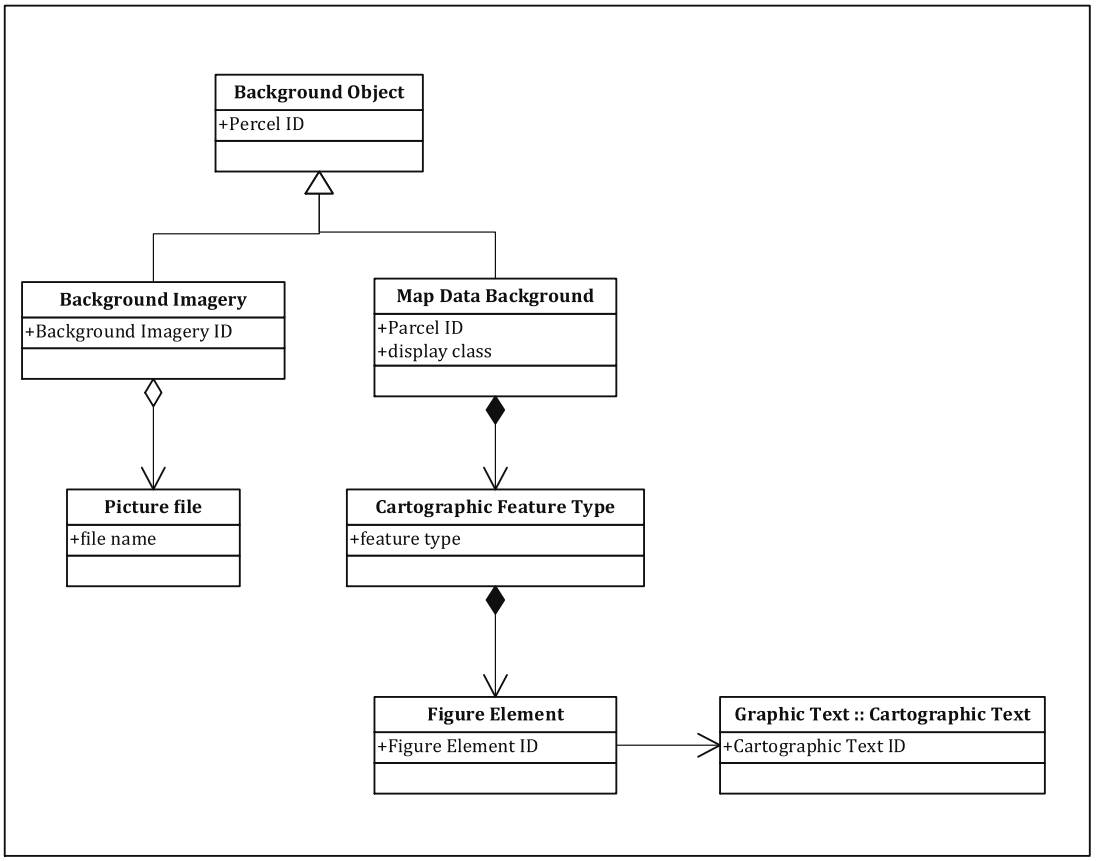


Figure 15 — Background package

7.3.2.2 Background object

7.3.2.2.1 Definition of background object

Background Object is a root entity of the Background data.

Background Object categorizes the Background data in imagery data and figure data.

Background Object generalizes Background Imagery and Map Data Background.

7.3.2.2.2 Data elements of background object

Background Object is specified by parcel ID.

Table 33 lists data elements of Background Object.

Table 33 — Data elements of background object

Data Element / Attribute	Note
parcel ID	
representative coordinates of parcel	
size of parcel	
adjacent parcel ID list	
Background category	imagery/figure

7.3.2.3 Map data background

7.3.2.3.1 Definition of map data background

Map Data Background classifies the background (figure type) data by the display class and the feature category (cartographic feature type) such as land, sea, lake, river, park, rail and road. Drawing background application may use display class and feature category for determining priority. Map Data Background provides figure data of each display class in the Parcel.

NOTE The display class is the classification of features which enables a meaningful display of these features.

Map Data Background is a type of Background Object.

7.3.2.3.2 Data elements of map data background

Map Data Background is specified by parcel ID and display class.

Table 34 lists data elements of Map Data Background.

Table 34 — Data elements of map data background

Data Element / Attribute	Note
parcel ID	
display class	
number of Cartographic Feature Type	

7.3.2.4 Cartographic feature type

7.3.2.4.1 Definition of cartographic feature type

Cartographic Feature Type, which categorizes the cartographic feature such as sea, river, lake, land, green field, desert, etc. classifies Map Data Background. Cartographic Feature Type provides figure data of each Cartographic Feature Type.

Cartographic Feature Type is a composed class of Map Data Background, and composes Figure Element.

7.3.2.4.2 Data elements of cartographic feature type

Cartographic Feature Type is specified by type of cartographic feature.

Table 35 lists data elements of Cartographic Feature Type.

Table 35 — Data elements of cartographic feature type

Data Element / Attribute	Note
parcel ID	
display class	
type of Cartographic Feature	
number of Figure Element	

7.3.2.5 Figure element

7.3.2.5.1 Definition of figure element

Figure Element provides the shape data of a cartographic feature object.

The shape data are defined by four figure types: polygon, polyline, Point and Symbol. Figure Element can consist of plural shape data such as two polyline and a polygon.

Figure Element relates to Cartographic Text in Graphic Text package for name of cartographic feature.

7.3.2.5.2 Data elements of figure element

Figure Element is specified by Figure Element ID.

Table 36 lists data elements of Figure Element.

Table 36 — Data elements of figure element

Data Element / Attribute	Note
Figure Element ID	
parcel ID	
display class	
type of cartographic feature	
background type code	sea / land
representative coordinates of Figure Element	
Cartographic Text ID	Optional
area code	optional: it indicates the area where there is this element.
POI code for 3D icon	optional: it indicates 3D object by Symbol
number of shape	
list of shape	a shape record consists of figure type, colour code, number of shape point and shape point list
-figure type	symbol/ point/ polyline/ polygon
-colour code	
-representative coordinates	
-number of shape point	
-shape point coordinates list	list of coordinates of shape point

NOTE In the case of Point and Symbol, shape point coordinates listed in Table 36 will be omitted.

7.3.2.6 Background imagery

7.3.2.6.1 Definition of background imagery

Background Imagery provides the map imagery picture.

Background Imagery is a type of Background Object.

File formats such as BMP, JPEG, PNG, IMG, and GeoTIFF should be supported.

7.3.2.6.2 Data elements of background imagery

Background Imagery is specified by Background Imagery ID.

Table 37 lists data elements of Background Imagery.

Table 37 — Data elements of background imagery

Data Element / Attribute	Note
Background Imagery ID	level #+parcel ID can substitute for it
file name	it may include file directory structure
pixel size	
pixel reference point	

7.3.2.7 Picture file

7.3.2.7.1 Definition of picture file

Picture File provides the picture content which is stored in the picture file.

7.3.2.7.2 Data elements of picture file

Picture File is specified by file name.

Table 38 lists data elements of Picture File.

Table 38 — Data elements of picture file

Data Element / Attribute	Note
picture content	content is made by BMP,JPEG, PNG, IMG, geoTIFF

7.3.3 Graphic text package

7.3.3.1 General

Graphic Text package provides the text for expressing the name of a feature on a map. Cartographic Text is related to Figure Element of the Background package.

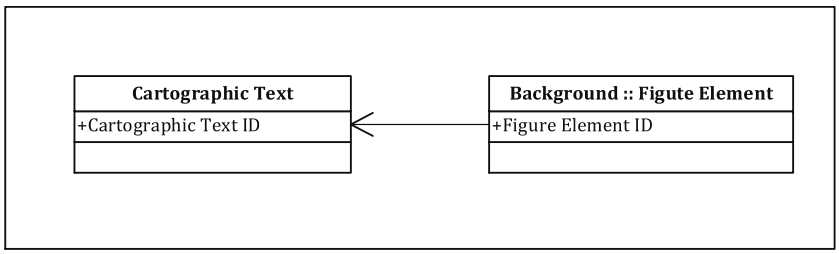


Figure 16 — Graphic text package

7.3.3.2 Cartographic text

7.3.3.2.1 Definition of cartographic text

Cartographic Text provides the text data for expressing the name of the map feature.

Cartographic Text has several types for expressing the name.

Cartographic Text is able to support multiple languages by using language code.

Figure Element of Background package refers to Cartographic Text.

7.3.3.2.2 Data elements of cartographic text

Cartographic Text is specified by Cartographic Text ID and language code.

Table 39 is set by each language code. When multiple languages are supported, the same Cartographic Text ID is used.

Table 39 lists data elements of Cartographic Text.

Table 39 — Data elements of cartographic text

Data Element / Attribute	Note
Cartographic Text ID	
language code	
expressing type	e.g. rotation, along feature
Cartographic feature name	character string data for naming

7.4 Service and POI package

7.4.1 General

Service and POI package is composed of Service entity and Service and POI Reference Point entity. Service entity includes POI data.

Service associates with Service and POI Reference Point, and Service and POI Reference Point relates to Road Element and Figure Element.

Definition of Service entity is described in ISO/TS 20452. Figure 17 below illustrates the Service and POI package.

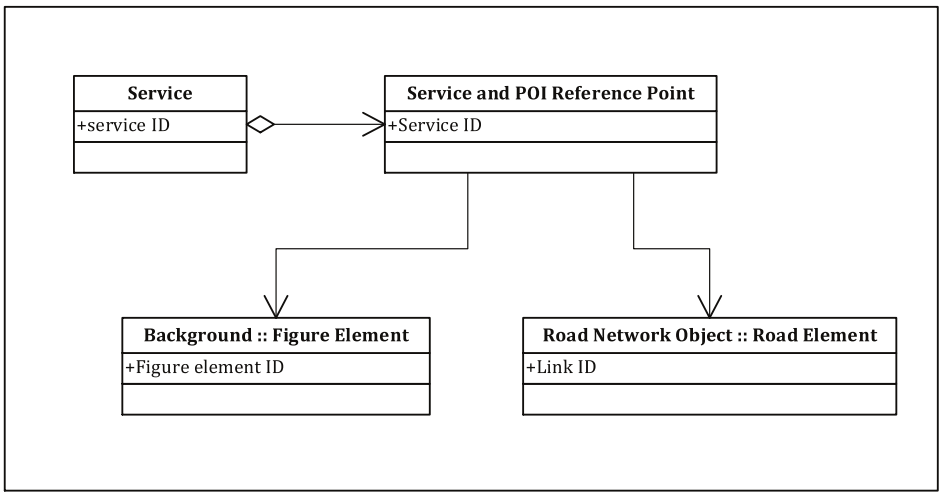


Figure 17 — Service and POI package

7.4.1.1 Definition of service and POI reference point

Service and POI Reference Point provides a representative point of a Service and POI.

Service and POI package is related to the Cartographic package and Transportation package. The location of Service and POI data corresponds to the reference point of Service and POI.

Service and POI location information is one of the attributes of Service and POI. However, Service and POI Reference Point is independent of Service and POI package. Service and POI Reference Point provides the location of corresponding service, Figure Element and Road Element.

7.4.1.2 Data elements of service and POI reference point

Service and POI Reference Point is specified by service ID.

Table 40 lists data elements of Service and POI Reference Point.

Table 40 — Data elements of Service and POI Reference Point

Data Element / Attribute	Note
service ID	It includes ID for POI
representative point coordinates	
Road Element information	optional; when Service and POI relates to road data, it is set, e.g. Link ID and position-on-the-link
Figure Element information	optional; when Service and POI relates to Background data, it is set, e.g. Figure Element ID
service category	e.g. gas station, hotel, restaurant

7.5 Address Location package

7.5.1 General

In ISO/TS 20452, Address Location package is composed of the place, Navigable Feature Name, road Section, Cross road, junction and Postal code. However, Address Location package in this International Standard consists only of place and place reference point. Place provides named areas which can be used for Address Location. Place is used to store information about a named place. Named place can be categorized as administrative areas or districts, Administrative areas are governmental entities, for example country, state and city in the United States, or country, bundesland, kreis, and municipality in Germany. Districts are named places that are not administrative areas, such as neighbourhoods or informally named regions.

Definition of Place entity is described in ISO/TS 20452.

Place associates with Place Reference Point.

Figure 18 below illustrates the Address Location package.

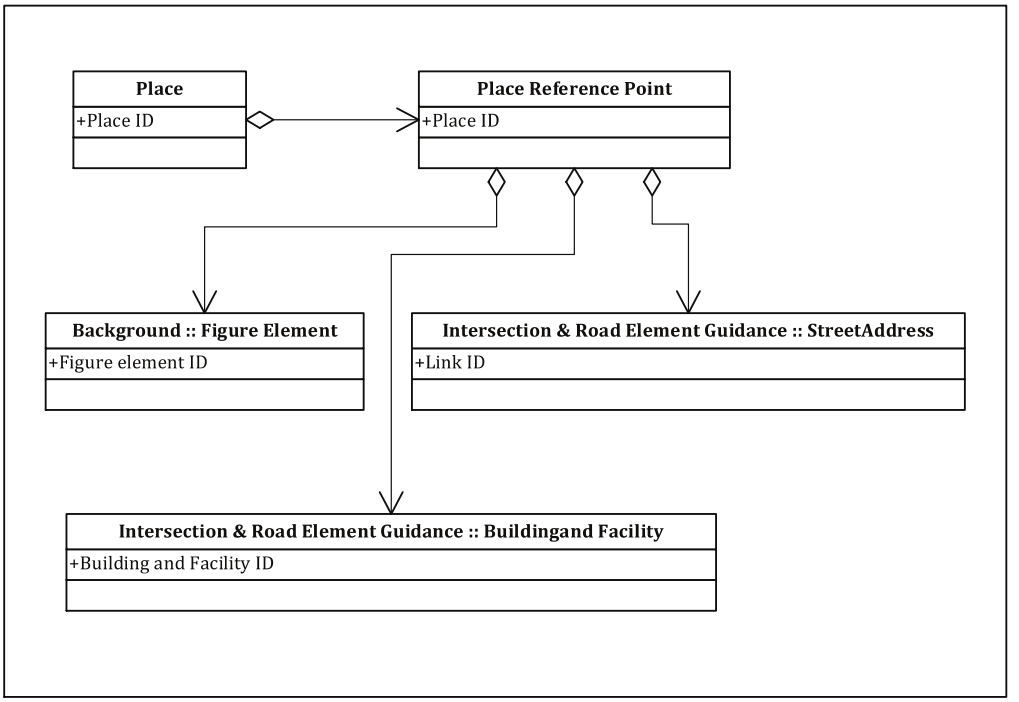


Figure 18 — Address Location package

7.5.1.1 Definition of place reference point

Place Reference Point provides a representative point within a Place.

Place Reference Point is one of the attributes of Place. However, Place Reference Point is independent of Place entity.

Place Reference Point contains the location information of Place.

Service and POI Reference Point is associated with place and relates to Street Address, Figure Element and Building and Facility.

Place Reference Point is used for searching administrative area.

7.5.1.2 Data elements of place reference point

Place Reference Point is specified by place ID.

Table 41 lists data elements of Place Reference Point.

Table 41 — Data elements of place reference point

Data Element / Attribute	Note
country code	The following items are Japanese examples: Japan, Tokyo, chuo-ku, hamacho 3chome, 42banchi, 3go, sumitomo building 6th floor This hierarchy is defined in ISO 14825 (GDF)
order-1 Area code	
order-2 Area code	
order-3 Area code	
order-4 Area code	
order-5 Area code	
order-6 Area code	
order-7 Area code	
order-8 Area	
order-9 Area (optional)	
residence name	
residence number	
residence sub-number	
Place ID	
coordinates of reference point	
Link ID	optional; for Street address data
Figure Element ID	optional; for Background data
Building and Facility ID	optional; for Building and Facility data

7.6 Dynamic information package

Dynamic Information, which may be provided externally in association with location information and is related to the map data, is used to provide real-time conditions, for example traffic information, weather information and travel information. Dynamic information may be used to enhance route calculations, driving support and cooperative ITS services.

External dynamic information for ITS is related to area locations, linear locations, e.g. part of the road, or point locations, e.g. an intersection of a position along a road on the map.

Dynamic Information package may consist of Dynamic Information Location entity, Dynamic Traffic Information (e.g. RDS-TMC, VICS), Dynamic Travel Information (e.g. train delays) and Weather Information (e.g. rain, flood, snowfall, blizzard, freezing).

The Dynamic Information Location entity depends on external dynamic information. The Dynamic Information Location entity may refer to either the Road Element entity or the place reference point entity

A Dynamic Information Location may be on several different Road Elements, and Road Elements may contain several different Dynamic information Location entities. A place may contain many Dynamic Information Location entities and Dynamic Information Location may be in many places.

The standards of Dynamic Traffic Information, Dynamic Travel Information, and Weather Information will be defined by external standards bodies. This International Standard does not define detail of Dynamic Information Location entity.

Figure 19 below illustrates the Dynamic Information package.

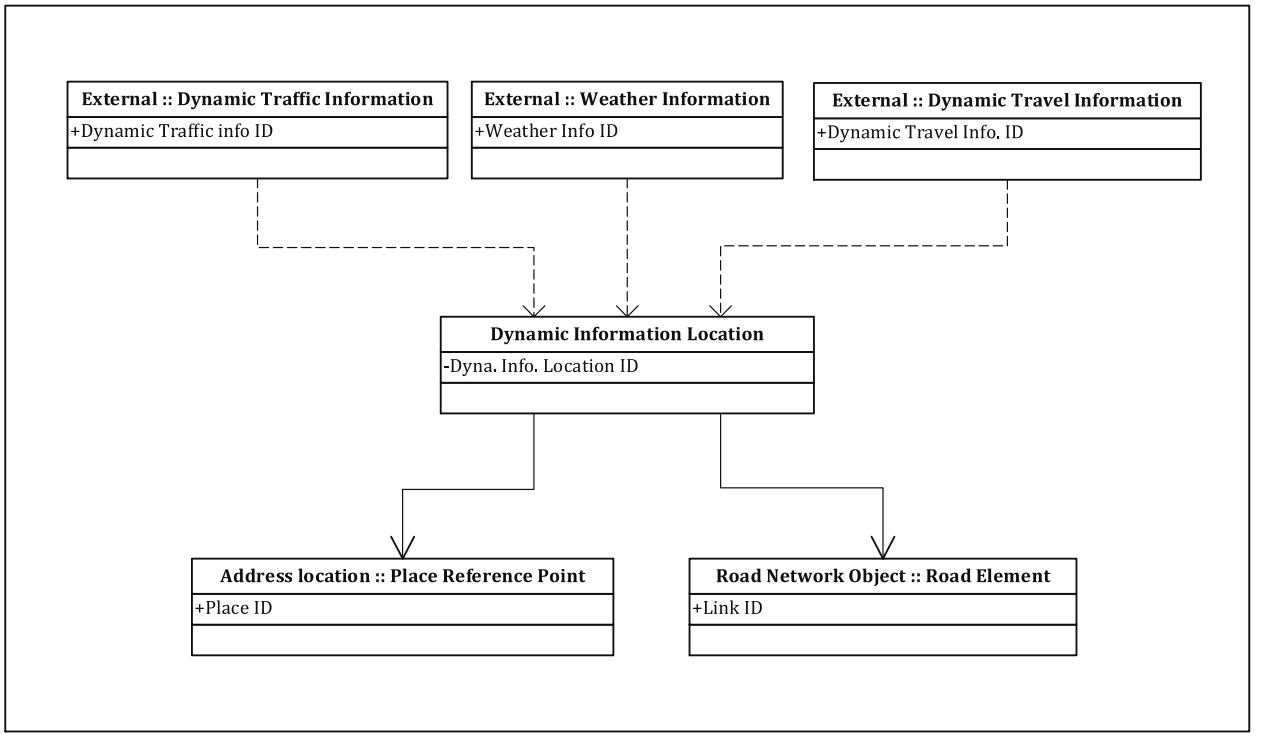


Figure 19 — Dynamic information package

7.7 Relationship of the road data between levels

7.7.1 General

This International Standard assumes the following methods regarding the road data such as Road Section, Road Element, and Intersection and Intersection Connection Point.

— The number of levels depends on used map database that is used for the application. Existing applications are using at least four levels such as town level, city level, state level and country level.

— The road data may be described using several levels.

— The road data in the lowest level may contain entire roads.

— The road data in upper levels are selected from entire roads using the road classes and the condition for an appropriate map.

There are two types of aggregation methods (e.g. serial aggregation and parallel aggregation) of Road Elements. Parallel aggregation means conversion from double line road to single line road, and Serial aggregation means extension of the length of a Road element by omitting intermediate Intersection.

7.7.2 Relation of the Intersection and Intersection Connecting Point between levels

The representative coordinates of Intersection may be set at an appropriate position such as a centre of the Intersection. When Intersection exists in two or more levels, the intersection shall be given the same ID and the same representative coordinates for each level.

The coordinates of the Intersection Connecting Point (abbreviated term: ICP) may be set at an appropriate position for expressing shape of connected roads in the same level.

For example in Figure 8 the roundabout that is a type of Intersection, connects four Road Elements, Intersection has four Intersection Links and four ICPs. When ICPs are aggregated in upper level, the

number of ICP becomes one such as Figure 6. In this case, the coordinates, type and IDs for ICPs in each level are different.

The intermediate Intersections of serial Road Elements are omitted in upper level by aggregation of Road Elements. Intersection has an existence range of levels defined in Table 5.

7.7.3 Relation of the Road Elements between levels

When the same Road Element exists in different levels, the same Link ID is used.

Generally, Road Element in upper level may be made by the aggregation of Road Elements in lower level. For example in Figure 20, Serial aggregation of Road Elements will occur by omission of crossed roads in upper level. In this case, Link IDs of upper and lower levels are different. An application is not able to refer from Road Element in lower level to Road Element in upper level by Link ID. Therefore, Road Element has an existence flag and Link ID of upper level defined in Table 3.

7.7.4 Example for Road Element, Intersection Connecting Point and Intersection between levels

Figure 20 shows the example of Road Element, Intersection Connecting Point and Intersection between levels

'Intersection 20' in level 0 does not appear in level 1. It means that 'Link 10', 'Link 20' and 'Intersection 20' are aggregated to 'Link 100' in level 1. 'Intersection 20' is removed in level 1. Similarly 'Link 100' and 'Link 200' are aggregated to 'Link 1000', and 'Intersection 30' is removed in level 2.

'Intersection Connection Point 41' and 'ICP 42' in level 0 do not appear in 'Intersection 40' in level 1, and 'ICP 40' is set in 'Intersection 40'. It means that other Links connected to 'Intersection 40' may be aggregated in level 1. 'ICP 41', 'ICP 42' and other ICPs connected to other Links in level 0 are aggregated to 'ICP 40' in level 1. Therefore 'Link 30' and 'Link 40' in level 0 are changed into 'Link 200' and 'Link 300' in level 1.

Figure 20 does not mention about the Road Section, but Road Section may be aggregated similarly.

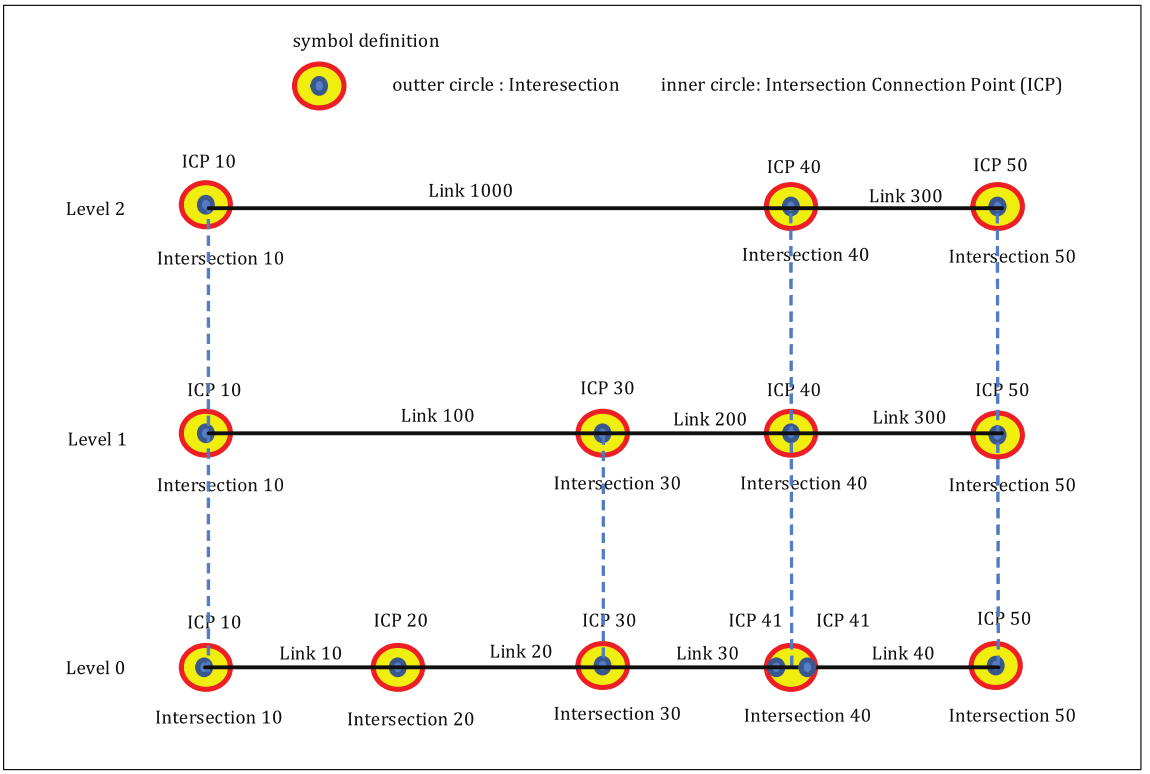


Figure 20 — Relation of Road Element, Intersection Connecting Point and Intersection between levels

Annex A
(normative)

Abstract test suite

A.1 Abstract test suite

This abstract test suite applies to the comprehensive data derived from this International Standard.

A.2 Test case identifier: Data structure test

a) Test Purpose: to determine conformance by the data structure.

b) Test Method: a comparison between this International Standard and a data structure to be tested shall be performed to determine if it covers all the data elements needed for the standard of the tested system, selected from Clause 7.

c) Reference: Clause 7.

d) Test Type: Basic.

Annex B
(informative)

Description of UML expression elements

B.1 General

This International Standard makes use of a newly developed methodology to express structural circumstances called UML. The following table shows a short description of UML diagram elements used to ensure that no misinterpretation may occur caused from further development of UML1.4, which is standardized in ISO/IEC 19501:2005; UML2 is standardized by the Object Management Group.

In different class diagrams, light or dark colouring is used to express the intent of a particular diagram. The light colour implies that the diagram is of logical/explanatory nature; the dark colour implies that a particular instantiation will be introduced afterwards; that is for the description of the structure of the proposed physical format.

Table B.1 — Description of UML Expression Elements

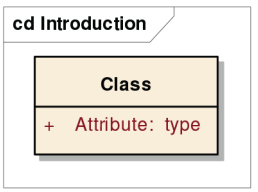
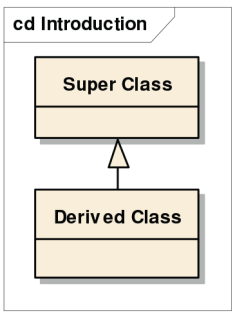
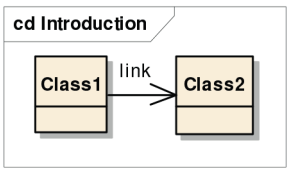
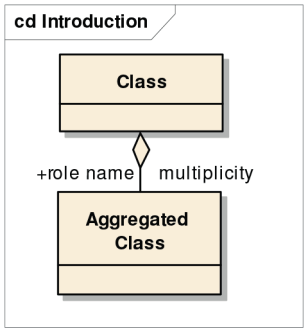
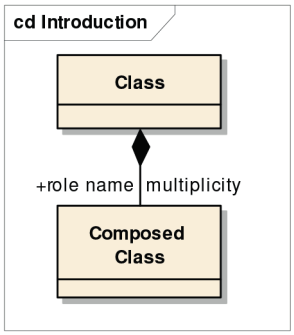
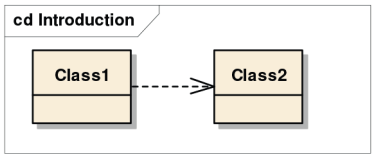
Element Name	Element	Description
Class		A class is a template for a given data element which can contain attributes. It is a rectangle divided into three compartments. The topmost compartment contains the name of the class. The middle compartment contains a list of attributes owned by that class and the bottom compartment contains a list of operations which is not shown here because operations are not used in this International Standard. In some diagrams, the bottom compartment of attributes may be omitted for clarity. An attribute line has a specified "+, # or –"for the visibility (not used in this International Standard) a name of the attribute and after a colon a data type and in square brackets the multiplicity which is described in aggregation hereunder.
Specialization		A Specialization (i.e. Inheritance) defines a general class (super class) which properties are inherited from the derived class. In data structures that implies that the derived class has at least the same attributes as the super class and normally will define more attributes to it. The reason for using an inheritance in general is the capability of having different specializations from one super class.
Association		The association shows that two classes have a connection in between. Associations are used in this International Standard to express a loose linkage having the type of that linkage as a name of the link. An arrow at the head expresses the direction of the association which means that only in direction of the arrow the association applies. In the small example the class 1 is linked (with a link) to class 2 but class 2 does not know anything about class 1. The association has no direct counterpart in data structures, but will indirectly be visible somehow.

Table B.1 *(continued)*

Element Name	Element	Description
Aggregation		The aggregation is a more explicit design element for describing attributes. It is a stronger association telling that the class on the side of the diamond "has" an instance of the aggregated class. The name of that instance is given on the left side of the connection and starts again with the "+" as specified of visibility. On the right side the multiplicity of that instance is given as a range of the allowed count of occurrences. An aggregation does let open if the aggregated element has the same lifetime as the aggregating class. In data structures the aggregation can be a reference to another data structure or an embedded data element.
Composition		The composition strengthens the type of aggregation in the way that the lifetime of the composed element is the same as the composing class, i.e. the structure can be seen as a "composition". In data structures, composition is normally seen as an embedded data element.
Dependency		The dependency is an unspecific type of relationship between two classes.

Annex C
(normative)

Basic set of applications definition

C.1 General

Basic set of applications are defined in ETSI TC ITS TR 102638 and ETSI TC ITS TR 102863 as follows.

Table C.1 — Basic set of applications

Applications Class	Application	Use case
Active road safety	Driving assistance – Co-operative awareness	Emergency vehicle warning
		Slow vehicle indication
		Intersection collision warning
		Motorcycle approaching indication
	Driving assistance – Road hazard warning	Emergency electronic brake lights
		Wrong way driving warning
		Stationary vehicle - accident
		Stationary vehicle - vehicle problem
		Traffic condition warning
		Signal violation warning
		Roadwork warning
		Collision risk warning
		Decentralized floating car data - Hazardous location
		Decentralized floating car data - Precipitations
		Decentralized floating car data - Road adhesion
		Decentralized floating car data - Visibility
		Decentralized floating car data - Wind
Cooperative traffic efficiency	Speed management	Regulatory / contextual speed limits notification
		Traffic light optimal speed advisory
	Co-operative navigation	Traffic information and recommended itinerary
		Enhanced Route Guidance and navigation
		Limited access warning and detour notification
		In-vehicle signage
Co-operative local services	Location based services	Point of Interest notification
		Automatic access control and parking management
		ITS local electronic commerce
		Media downloading
Global internet services	Communities services	Insurance and financial services
		Fleet management
		Loading zone management
	ITS station life cycle management	Vehicle software / data provisioning and update
		Vehicle and RSU data calibration

Annex D
(informative)

Overview of examples of targeted (Japanese examples) driving support services

Source: ITS Japan report, 2011.

D.1 Warning services based on road information

D.1.1 Speed information

This service offers speed information to drivers.

D.1.1.1 Speed limit

Informs the driver that the vehicle is exceeding the speed limit.

In case of exceeding the speed limit for longer than a given time, the application alerts the driver.

D.1.1.2 Safety speed

Informs the driver that the vehicle is exceeding a critical speed at which safety cannot be secured.

Critical speed is calculated based on road structure (curvature and slope). Because critical speed varies with road surface conditions, information on the road surface is also important.

In case of exceeding the critical speed for longer than a given time, the application alerts the driver.

D.1.1.3 Sag congestion

Sag congestion can occur due to a decrease in speed.

When driving through a sag, and when a decrease in speed is detected, the application alerts the driver to increase speed.

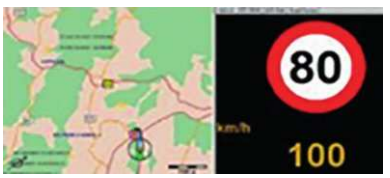


Figure D.1 — Speed limit warning

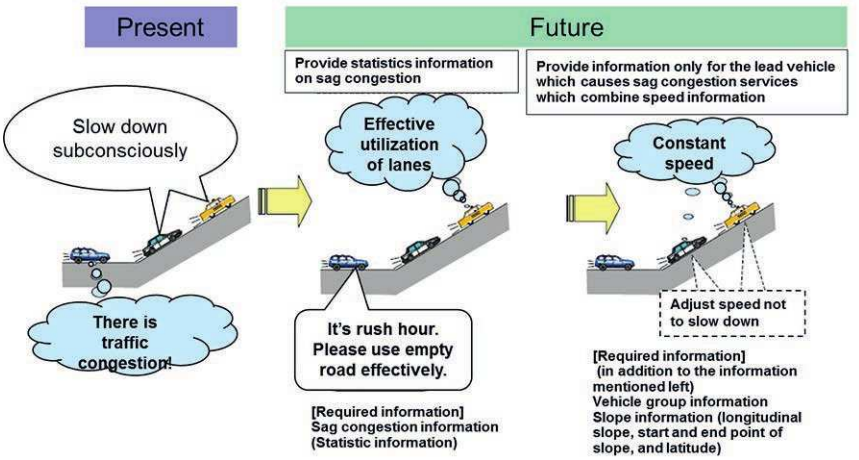


Figure D.2 — Sag warning

Table D.1 — Road information

Target	Road information required	Management actor	Additional note
1. Speed limit	Speed limit information	Public safety commission of each prefecture	
2. Safety speed	Curvature and slope	Road administrator	
	Dangerous zone information	Road administrator, driver	Information from drivers can also be the source.
	Surface Information	Road administrator, driver	Slip information detected by ESC can also be real-time information.
3. Sag congestion	Sag points	Road administrator	
	Speed limit information	Public safety commission of each prefecture	
Benefits of the service: Reduce traffic accidents due to speeding.			

D.1.2 Traffic restriction information

Service overview

This service alerts oversight to the driver.

D.1.2.1 Stop warning

When the driver goes over a stop line without reducing speed, the application alerts overlooking the stop line to the driver.

D.1.2.2 One way warning

If the driver travels the wrong way along a one-way street, the application sends an alert and offers a way to exit the street.

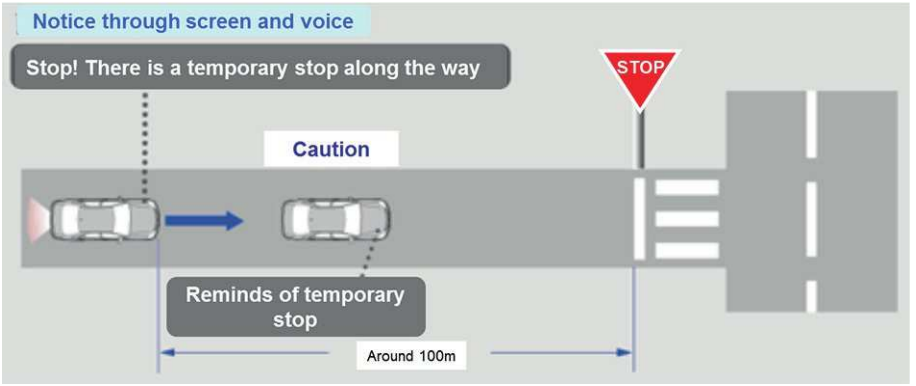


Figure D.3 — Stop warning

Table D.2 — Traffic restriction information

Target	Traffic information required	Management actor	Additional note
1. Stop alert	Stop information	Public safety commission of each prefecture	Stop sign, stop line
2. One way	One way information	Public safety commission of each prefecture	
Benefits of the service: Reduces traffic accidents due to not seeing a traffic restriction sign.			

D.1.3 Lane information

Service overview

Offers information on lane regulation information which changes often.

1. Driving lane

Offers information on right-turn-only lane, left-turn-only lane, and informs the driver of driving lane.

Figure D.4 — Driving lane advice

Information is also offered on streets with reversible lanes, which are set up to change direction and relieve congestion.

Figure D.5 — Variable lane advice

For roads with a bus lane, information is offered and at the same time hours of traffic restrictions, and information on NO THROUGH ROADS or right-of-way-roads are offered, and the driver is alerted.

Figure D.6 — Bus lane warning

Table D.3 — Lane information

Target	Traffic information required	Management actor	Additional note
1. Driving lane	Lane regulation information	Public safety commission of each prefecture	
	Variable lane information	Public safety commission of each prefecture	Dynamic information
	Bus lane information	Public safety commission of each prefecture	Regulated time, about regulation
Benefits of the service: Reduce traffic accidents caused by a driver who is unaccustomed to roads with intricately regulated lanes.			

D.1.4 Traffic sign information

D.1.4.1 Traffic signs

Traffic signage provides cautionary or regulatory information to alert drivers to potential hazards or action drivers need to take.

Applications such as ADAS can alert drivers when they ignore or miss the signs.

Table D.4 — Sign information

Target	Traffic information required	Management actor	Additional note
1. Traffic sign	Alert sign	Road administrator	
Benefits of the service: Reduces risky driving caused by not seeing alert signs.			

D.1.5 Traffic information

Provides information on road conditions.

D.1.5.1 Congestion information

Warns the driver of a potential collision by providing information on traffic congestion and duration of congestion.

D.1.5.2 Road construction

Provides the driver with information on road construction areas.

D.1.5.3 Temporary traffic restrictions

Provides the driver with information on temporary traffic restrictions.

Figure D.7 — Traffic congestion warning

Table D.5 — Traffic information

Target	Traffic information required	Management actor	Additional note
1. Traffic congestion information	Traffic congestion information	Road administrator	Dynamic information
	Tailback information	Road administrator	Dynamic information
2. Road construction	Road construction information	Road administrator	Dynamic information
3. Temporary traffic restriction	Temporary traffic restriction information	Public safety commission of each prefecture Road Administrator	Dynamic information
Benefits of the service: Reduces traffic accidents caused by changes in road conditions by offering information on road conditions.			

D.1.6 Road surface condition information

Alerts the driver by providing information on road surface conditions (flooding or freezing conditions) that may obstruct traffic.

D.1.6.1 Flooding, freezing conditions

Alerts the driver by offering information on flooding or freezing conditions that may interfere with driving.

Predicts freezing and flooding conditions from historical records about temperature, rainfall and snowfall. Also alerts driver to those potential conditions.

Figure D.8 — Flooding condition warning on an underpass

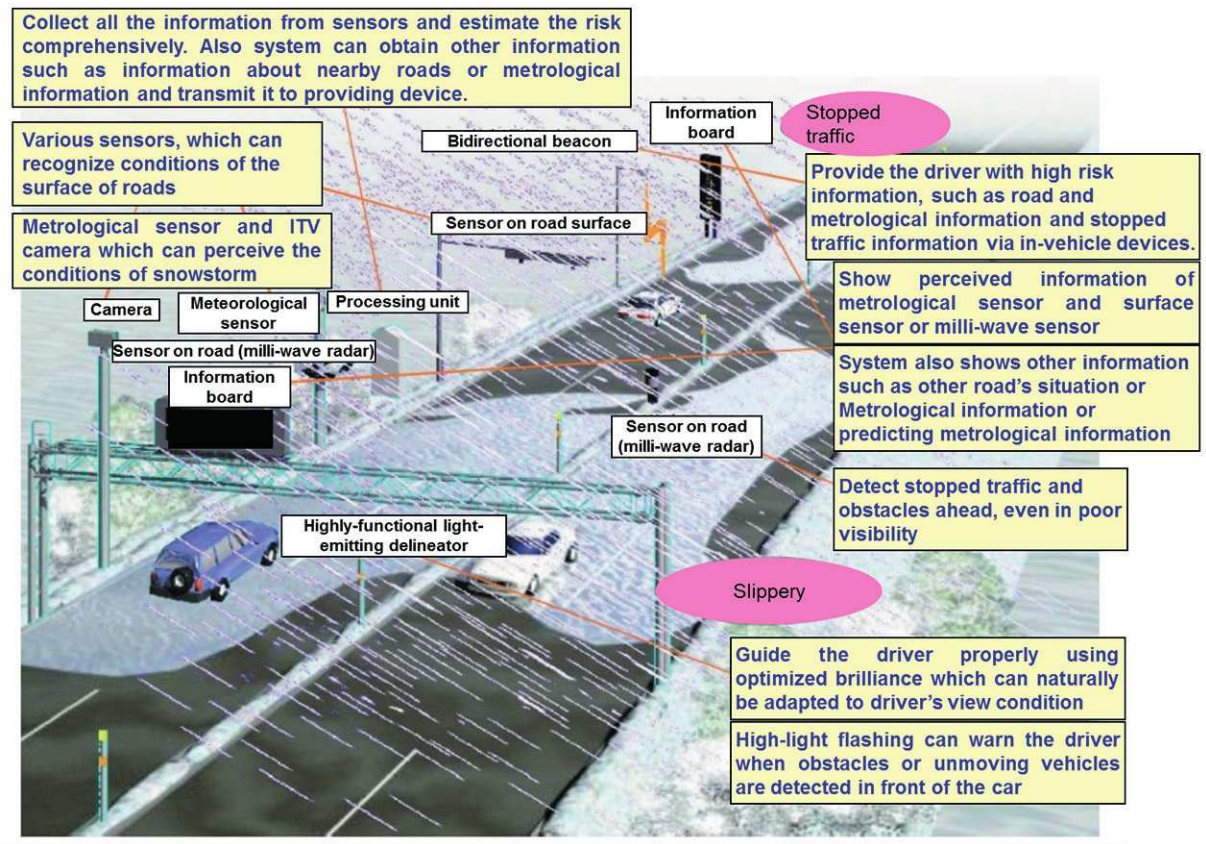


Figure D.9 — Road surface condition warning

Table D.6 — Road surface condition information

Target	Traffic information required	Management actor	Additional note
1. Flooding and freezing conditions	Flood information	Road authority	Dynamic information
	Freezing information	Road authority	Dynamic information
	Temperature, rainfall and snowfall	Metrological Agency	Predict freezing and flooding from its archival record and from temperature, rainfall and snowfall.
	Archival record	Service provider	
Benefits of the service: Reduces traffic accidents caused by poor road surface, by offering information about the road surface.			

D.1.7 Special zones

Alerts driver to the existence of local areas requiring extra attention.

D.1.7.1 School zone, elder care facility zone, residential district, blind and/or deaf persons etc

Application alerts the driver by offering information on road use by special local residents.

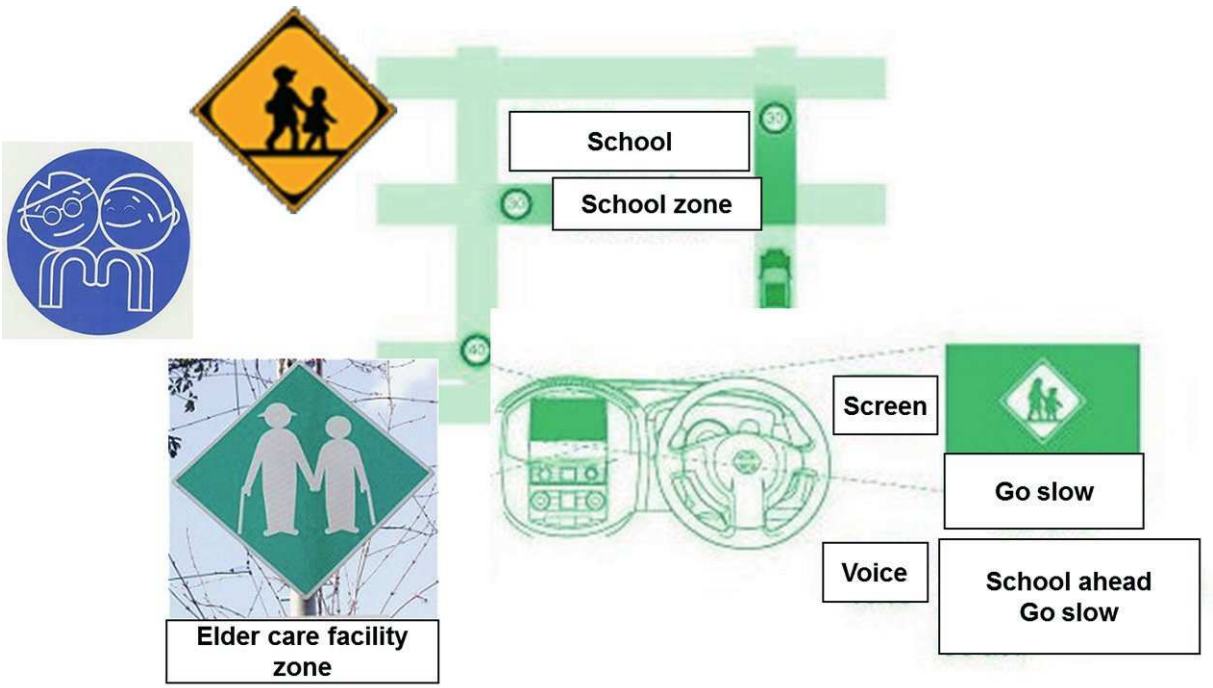


Figure D.10 — School zone and elder care facility zone warning

Table D.7 — Special zone warning

Target	Traffic information required	Management actor	Additional note
1. School zone, elder care facility zone, residential district.	School zone information		
	Elder care facility zone information		
	Residential district information		
Benefits of the service: Secures the safety of drivers, pedestrians and residents.			

D.1.8 Weather information

Provides the driver with weather information.

D.1.8.1 Rainfall, snowfall and storm winds

Provides the driver with information on rainfall, snowfall and storm winds.

D.1.8.2 Impaired visual conditions

In cases where heavy rain, fog or snow storms may impair driver vision, causing safety problems, the application can provide information to assist the driver.

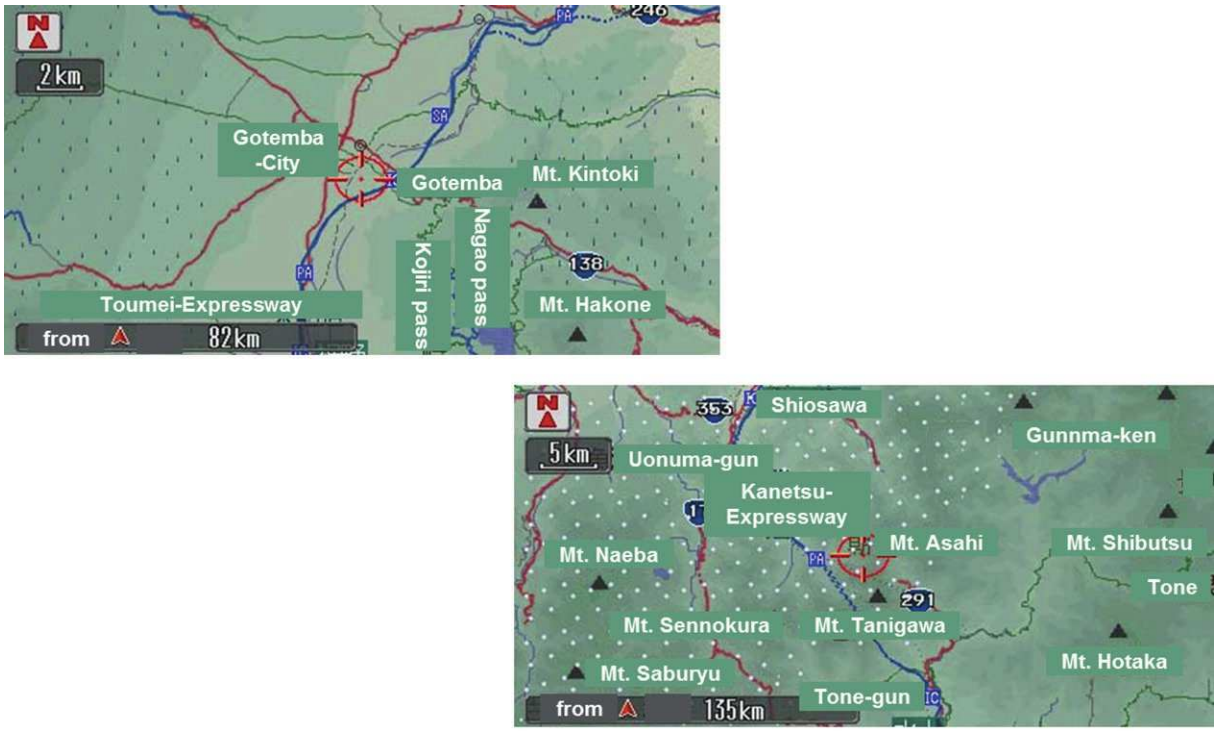


Figure D.11 — Weather information (middle area range) on map

Table D.8 — Weather information

Target	Traffic information required	Management actor	Additional note
1.Rainfall, snowfall, wind storm	Rainfall information	Meteorological Agency	Dynamic information
	Snowfall information	Meteorological Agency	Dynamic information
	Wind storm information	Meteorological Agency	Dynamic information
2. Visual conditions	Visual information	Road authority	Dynamic information
Benefits of the service Reduce traffic accidents caused by poor weather conditions.			

D.2 Warning services based on information on the situation around the vehicle

D.2.1 General road

Application detects the situation around the vehicle (existence of other vehicles etc.) and warns the driver.

D.2.1.1 Merging

In a merging area, infrared-equipped sensors detect other vehicles merging and warn the driver through vehicle communications systems.

D.2.1.2 Overtaking

Warns the driver that overtaking is not permitted.

The driver receives information on other vehicles through camera, radar or communication system and is warned of the existence of other vehicles.

D.2.1.3 Lane change

Warns the driver when a lane change is not permitted.

The driver receives information on other vehicles through camera, radar or communication system and is warned of the existence of other vehicles.

D.2.1.4 Oncoming vehicle

Sensors detect other vehicles coming from the opposite direction of the road in the same lane.

D.2.1.5 Tram / streetcar

Sensors detect the approach of a tram / streetcar and warn the driver.

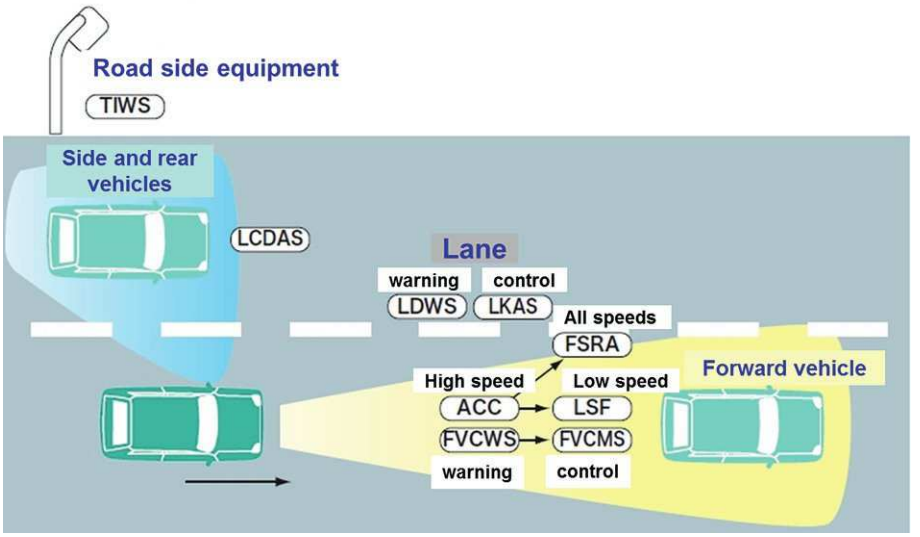


Figure D.12 — Situation around the vehicle

Table D.9 — Information on the situation around the vehicle

Target	Traffic information required	Management actor	Additional note
1. Merging	Merging area	Road administrator	
2. Overtaking	Overtaking prohibited area	Public safety commission of each prefecture	
3. Lane change	Lane change prohibited area	Public safety commission of each prefecture	
4. Oncoming vehicle	Road width minimized area	Road administrator	
5. Tram / streetcar	Information about tram direction	Road administrator	
	Information on whether driving into orbital area is possible	Public safety commission of each prefecture	
Benefits of the service: Reduce traffic accidents caused by merging, overtaking or lane change.			

D.2.2 Intersections

Provides information on vehicles and pedestrians at intersections.

D.2.2.1 Approaching vehicles without right of way

At an intersection without traffic lights, receive information from sensors on approaching vehicles without a right of way. The application warns the driver.

D.2.2.2 Right turn manoeuvres

For right turn manoeuvres, receive information from sensors about vehicles coming from the opposite direction and pedestrians in a crosswalk. The application warns the driver.

D.2.2.3 Left turn manoeuvres

For left turn manoeuvres, receives information from sensors about the existence of two-wheeled vehicles driving on the left side and pedestrians in the crosswalk. The application warns the driver.

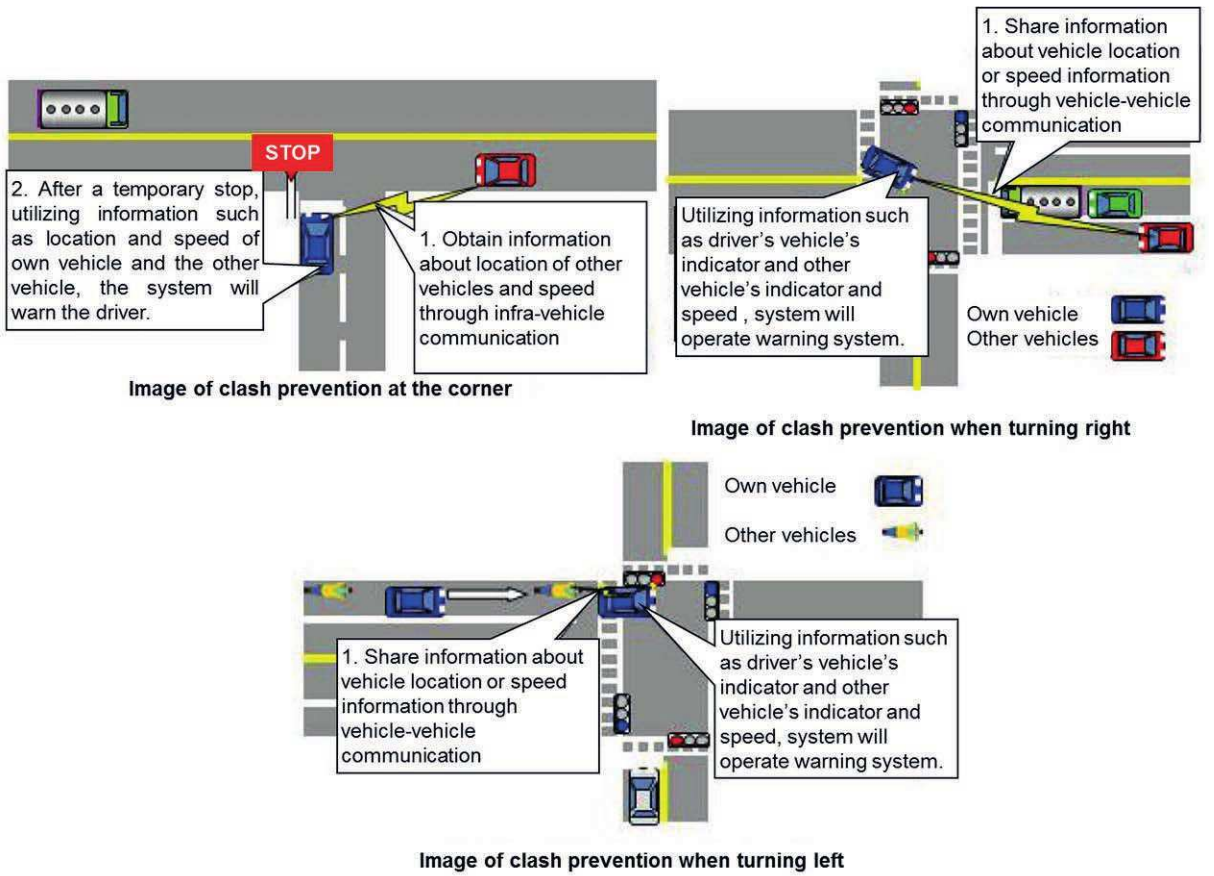


Figure D.13 — Warning at intersection

Table D.10 — Situation at intersection

Target	Traffic information required	Management actor	Additional note
1. Straight	Detailed information on intersections	Road administrator	Clarifies the position of vehicle and pedestrians at an intersection.
2. Right turn	Detailed information on intersections	Road administrator	
3. Left turn	Detailed information on intersections	Road administrator	
Benefits of the service: Reduces traffic accidents caused by oversight of the driver.			

D.3 Vehicle control

D.3.1 General control for driving support

Improves vehicle safety using road data and optimizing regulation of vehicle control unit.

D.3.1.1 Auto cruise control (ACC)

Under ACC, it is possible that a sensor that identifies leading vehicles cannot function adequately, depending on the road geometry (Curve/Slope). By providing ACC control units with information on detailed road geometry (Curvature/Slope), ACC control can be optimized.

D.3.1.2 Gear-shift control

Controls gear shift appropriately by providing gear-shift control unit with information on detailed road geometry (Curvature/Slope).

Enables gear-shift control, in response to changes in road surface conditions, by providing road surface information.

D.3.1.3 Suspension control

Controls suspension appropriately, by providing suspension control unit with detailed information on road geometry (Curvature/Slope).

Enables suspension control, in response to changes in road surface conditions, by providing road surface information.

D.3.1.4 Light control

Controls lights appropriately (control light distribution) by providing light control unit with detailed information on road geometry (Curvature/Slope).

D.3.1.5 Stability control

Controls brake and engine-torque appropriately by providing stability control unit with detailed information on road geometry (Curvature/Slope).

D.1.3.6 Power control

Optimizes control over discharge and charge by providing detailed information on road geometry (Slope) and meteorological information (temperature/ amount of insulation), which influences power consumption of hybrid and electric vehicles.

Controls remaining battery level appropriately by calculating power consumption, remaining battery level, and distance to nearest charging station.

Table D.11 — Vehicle control

Target	Traffic information required	Management actor	Additional note
1. ACC	Curvature, slope	Road administrator	
2. Shift control	Curvature, slope	Road administrator	
	Road surface information	Road administrator	Dynamic information
3. Suspension control	Curvature, slope	Road administrator	
	Road surface information	Road administrator	Dynamic information
4. Light control	Curvature, slope	Road administrator	
5. Stability control	Curvature, slope	Road administrator	
	Road surface information	Road administrator	Dynamic information
6. Power control	Slope	Road administrator	
	Charging station	Service provider	
	Meteorological information	Meteorological Agency	Dynamic information
Benefits of the service: Enables safe and comfortable drive by optimizing vehicle controls according to uncertain road conditions.			

D.3.2 Braking control

Avoids dangers by controlling vehicle braking via driving support unit.

D.3.2.1 Lane keeping

Controls each brake on each wheel individually and gets the vehicle back into the lane, when in-vehicle camera determines that lane departure is likely to take place.

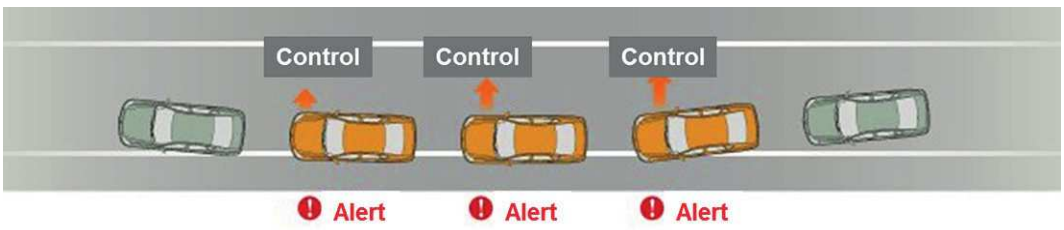


Figure D.14 — Lane keeping

D.3.2.2 Speed control

Operates brake and control speed so as not to exceed the speed limit, when exceeding the speed limit and the driver does not reduce speed or ignores the alert.

Enables brake control, in response to changes in road surface conditions, by providing information on the road surface.

D.3.2.3 Halt operation

Operates brakes and reduces speed when the driver does not slow down after a halt instruction.

D.3.2.4 Avoiding a collision

Alerts the driver when a collision with leading vehicles and obstacles is possible, judging from information provided by radar and in-vehicle camera.

Reduces damage by operating brake and activating seatbelt, when a collision is inevitable.

Enables brake control, in response to changes in the road surface, by providing information on the road surface.

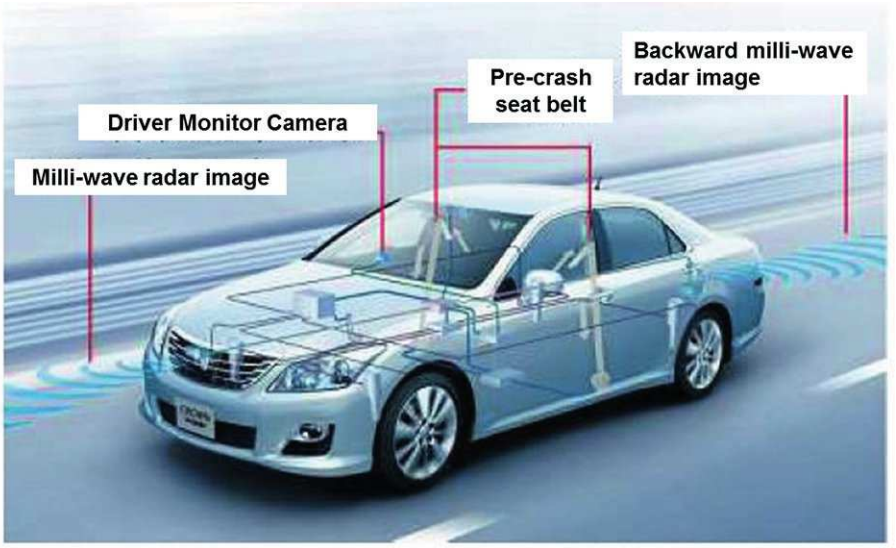


Figure D.15 — Sensors for avoiding a collision

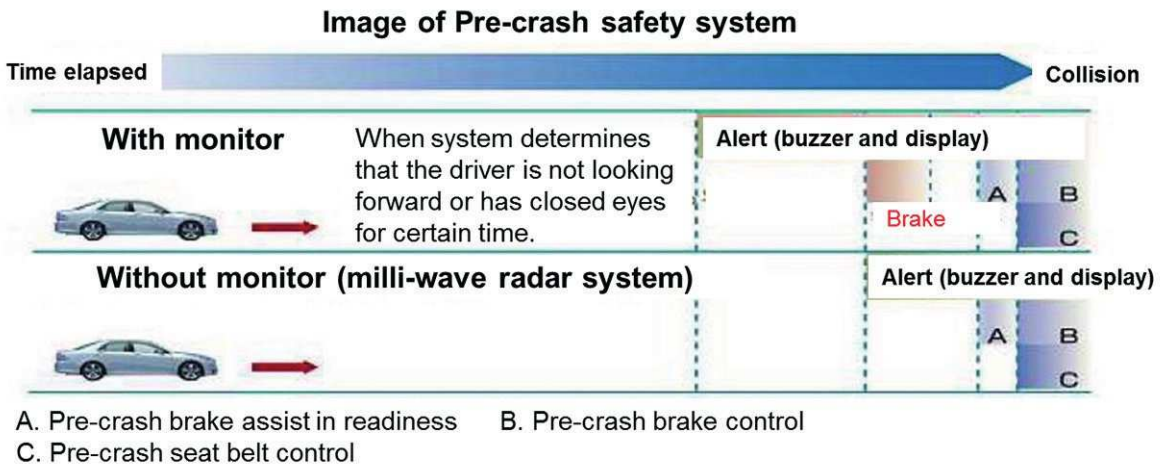


Figure D.16 — Pre-crash safety system

Table D.12 — Braking control

Target	Traffic information required	Management actor	Additional note
1. Lane keeping	Lane information	Road administrator	
2. Speed control	Speed limit information	Public safety commission of each prefecture	
	Critical speed information	Service provider	Compounded from information on curvature, slope, and dangerous point
	Road surface information	Road administrator	Dynamic information
3. Halt operation	Location of stop sign information	Public safety commission of each prefecture	
4. Avoiding a collision	Curvature/Slope	Road administrator	
	Road surface information	Road administrator	Dynamic information
Benefits of the service: Reduces damage by controlling braking when the vehicle is in danger.			

D.4 Advice on eco driving

D.4.1 Providing messages on eco driving

D.4.1.1 Controlling CO_2 emissions

Road geometry (Curvature, Slope), speed, and stop-start movement at intersections influence CO_2 emissions.

Offers driving plan (departure time, break time) and the route that minimizes CO_2 emissions.

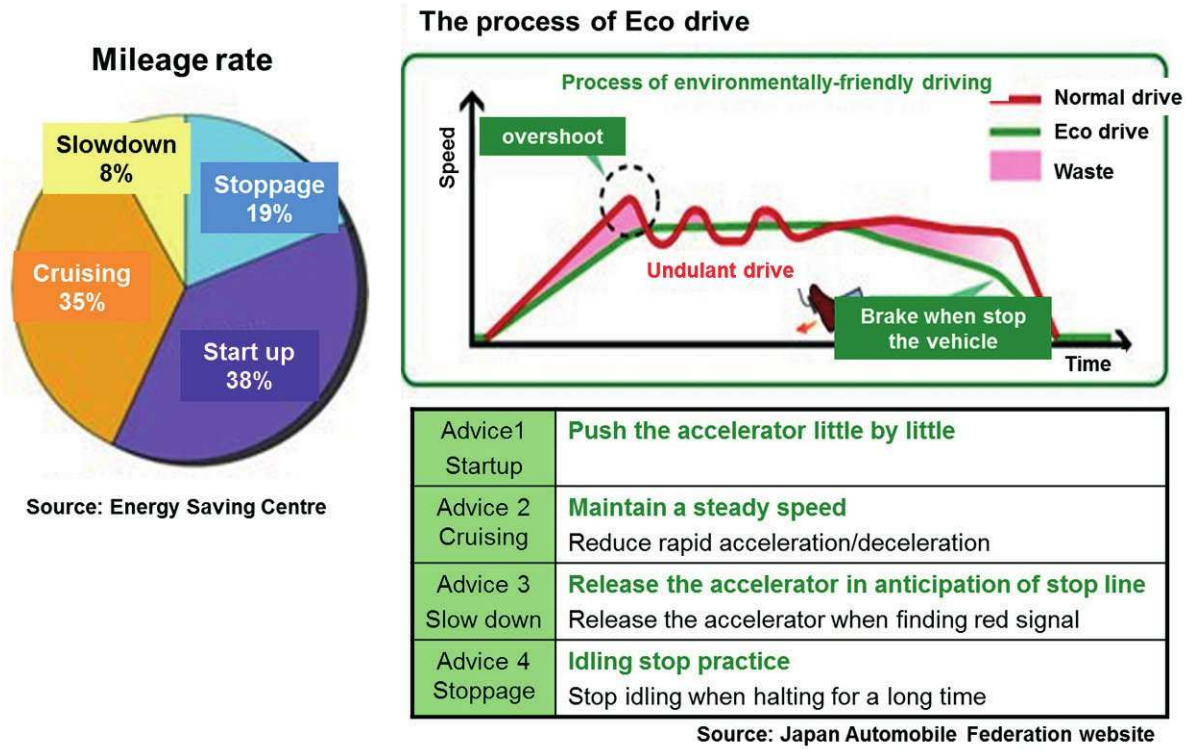


Figure D.17 — Example of advisory messages for eco driving

Table D.13 — Information on eco driving

Target	Traffic information required	Management actor	Additional note
1. Control CO_2 emission	Curvature, slope	Road administrator	
	Speed limit information Intersection information	Public safety commission of each prefecture	
	Traffic congestion information	Road administrator	Dynamic information
	Mileage	Service provider	Mileage table on actual road
Benefits of the service: Reduces CO_2 emissions.			

D.4.2 Providing Multi-Modal transfer information

D.4.2.1 Car park

Guides the driver to the best car park, judging from its location, business hours, and information on parking availability.

Provides the driver with information about the parking garage where the car is parked when he/she is not in the vehicle.

D.4.2.2 Park and ride

Offers the best route to the destination, based on information on public transportation, transfer point and car park.

Supports transfer to public transport.

D.4.2.3 Public transport Multi-Modal information

Provides information on modal shift at transfer to support Multi-Modal transfer.

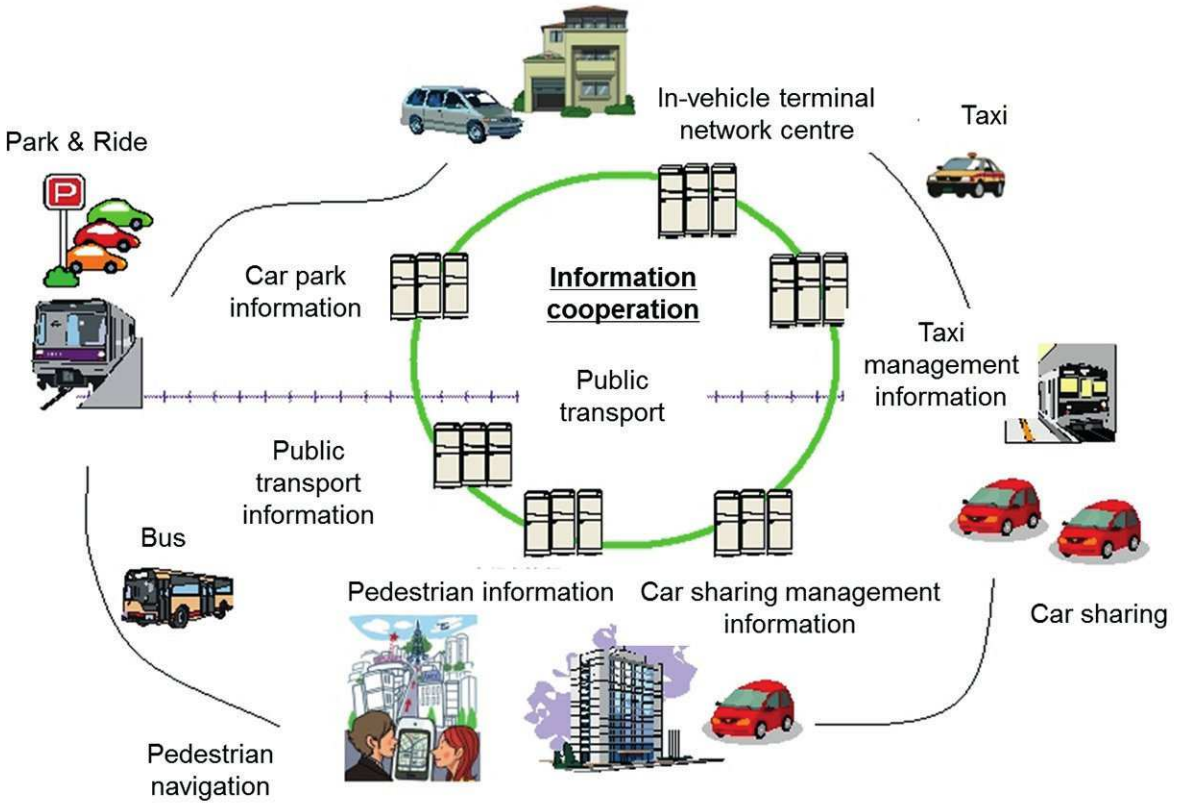


Figure D.18

Table D.14 — Transfer information for Multi-Modal

Target	Traffic information required	Management actor	Additional note
1. Car Park	Car park information	Parking facility operations company	Locations of car parks, opening hours, types of vehicle permitted, price, parking availability
	Parking place information	Parking facility operations company	
2. Park and ride	Public transport information	Public transport facility	Public transport service, car park information
	Transfer route	Public transport facility	Route from car park to public transportation
3. Public transport multi-modal information	Transfer point information	Transport facility	Standardization of information is necessary
Benefits of the service: Reduces CO_2 emissions.			

Annex E
(informative)

Relationship between basic set of applications and driving support services (Japanese example)

E.1 Relation table

Basic set of applications			Driving support services
Applications Class	**Application**	**Use case**	
Active road safety	Driving assistance - Vehicle	Emergency vehicle warning	D.3.1 General control for driving support D.3.2 Braking control
	Co-operative awareness	Slow vehicle indication	D.1.1 By speed information
		Intersection collision warning	D.2.2 At intersection
		Motorcycle approaching indication	D.2.1 At general road
	Driving assistance - Road	Emergency electronic brake lights	
	Hazard warning	Wrong way driving warning	
		Stationary vehicle - accident	
		Stationary vehicle - vehicle problem	
		Traffic condition warning	D.1.6 By road surface condition information D.1.8 By weather information
		Signal violation warning	
		Roadwork warning	
		Collision risk warning	
		Decentralized floating car data - Hazardous location	
		Decentralized floating car data - Precipitations	
		Decentralized floating car data - Road adhesion	
		Decentralized floating car data - Visibility	
		Decentralized floating car data - Wind	

Annex F
(informative)

Use case of Multi-Modal Travel Support service

F.1 Use case chart

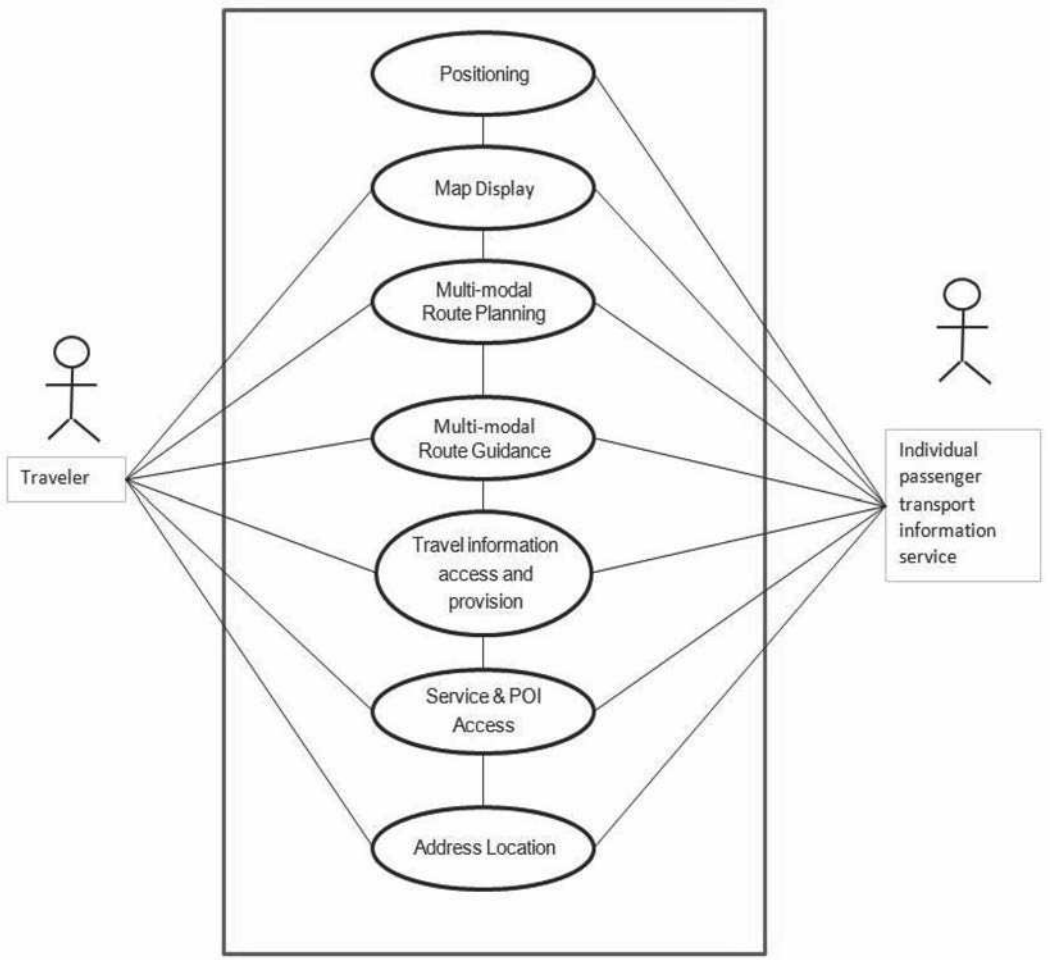


Figure F.1

F.2 Definitions of use case

Use case definition		
Item	**Description**	**Note**
Use case name	Multi-Modal Travel Support service	Top level of use case
Scope	It defines function and information for intermodal passenger transport service	
Actor	Passenger is the same as traveller, individual passenger transport information service	Passenger transport information services assumes car navigation, pedestrian navigation, indoor navigation, railway traveller information service, bus traveller information service, ferry traveller information service, flight traveller information service, car parking information service, external positioning system and traffic information service.
Execution condition		
Prior conditions		
After the event condition		
Prior process		
Main process	1. Positioning	It determines current position of traveller
	2. Map Display	It displays a map
	3. Multi-Modal Route Planning	It creates a route
	4. Multi-Modal Route Guidance	It guides moving traveller along the route
	5. Search service and place	It accesses service and POI data
	6. Search place	It accesses place data
	7. Travel information access	It provides a road traffic information and public transportation information
Post process		
Substitution flow		
Exception flow		

F.3 Definitions of main process functions for Multi-Modal Travel Support

Function name: Positioning		
Item	**Description**	**Note**
Function name	1. Positioning	
Scope and purpose	It determines the current position of traveller and provides the current position to other functions	
Actor	Traveller, Passenger transport information service	
General description	The positioning function is used to determine own location, for example latitude and longitude of a transportation network entity and for shape matching. Shape matching is a method for determining where the navigation system has moved in the transportation network based on the navigation system's previous location and data about the navigation system's motion from external inputs. There may be two types (normal / high precision) of positioning accuracy.	
Execution condition	It always provides own position.	
Prior conditions	None	

Function name: Positioning		
Item	**Description**	**Note**
Functional action	1–1. It determines the current position using map data and own sensor data.	i.e. Own sensor includes GPS device
	1–2. It determines the current position using position information from passenger transport information service	When action 1–1 is not available, action 1–2 is done.
	1–3. It provides the current position to other functions.	
	1–4. It provides the current position to passenger transport information service.	
	1–5. It stores the current position for tracking.	It contains the time-stamp.
	1–6. It provides tracking position to other functions.	
Substitution flow		
Exception flow		

Function name: Map Display		
Item	**Description**	**Note**
Function name	2. Map Display	
Scope and purpose	It displays the Map.	Map display function is used for indicating current position and surrounding feature.
Actor	Traveller, passenger transport information service	
General description	The Map Display function is used to display a map of a specified geographic area. An application may display maps to the traveller. An application may also accept traveller's input that references the map display (such as from a point and click device).	Most of this function can be supported by the Map Display function of individual passenger transport service.
Execution condition		
Prior conditions	User requires map to be displayed.	
	Other passenger transport information service is required.	
Functional action	2–1. It gets map data from individual passenger transport information service	Car navigation / pedestrian navigation / Railway travel information / bus travel information / Transfer path navigation / Indoor navigation
	2–2. It displays the map of user specified location.	There are map types such as figure and image.
	2–3. It scrolls the map.	
	2–4. It changes map scale.	
Substitution flow		
Exception flow		

Function name: Multi-Modal Route Planning		
Item	**Description**	**Note**
Function name	3. Multi-Modal Route Planning	
Scope and pupose	It creates the route from the start point to the destination point.	
Actor	Traveller, passenger transport information service	
General description	Multi-Modal Route Planning function is used to determine routes from one user-specified location to another.	User-specified locations are starting point, destination point and way points.
Execution condition		
Prior conditions		

Function name: Multi-Modal Route Planning		
Item	**Description**	**Note**
Functional action	3–1. Traveller sets the starting point, the destination point and way points.	System provides recommendation for way points.
	3–2. It provides recommendations for transfer points	
	3–3. Traveller sets the transfer points.	Traveller can use system's recommendation.
	3–4. Traveller sets the transportation mode(s).	Vehicle, railway, bus, ferry, aircraft, rental car, foot, etc.
	3–5. Traveller sets the condition of routing.	Condition: Time, fee, number of transfers, departure time, arrival time, operator, etc. Traveller can use system's recommendation.
	3–6. It requests candidate section routes between transfer points to each passenger transport information service.	
	3–7. It gets candidate section routes between transfer points from each passenger transport information service.	
	3–8. It assembles candidate routes.	
	3–9. It represents candidate routes on map.	
	3–10. It represents candidate routes as an itinerary.	
	3–11. It makes detour route.	Includes re-routing function action is the same as 3–6, 3–7.
	3–12. Traveller determines the route.	
	3–13. Traveller may specify transportation with fixed time condition.	Flight No(JL010), Train No(Nozomi21)
	3–14. It may request the path sequence for transfer and transit to the passenger transport information service.	Transfer path navigation service
	3–15. It may represent the path sequence for transfer and transit.	Transfer path navigation service
	3–16. It requests a recommendation of transfer point to each passenger transport information service.	
Substitution flow		
Exception flow		

Function name: Multi-Modal Route Guidance		
Item	**Description**	**Note**
Function name	4. Multi-Modal Route Guidance	
Scope and purpose	It gives guidance on the determined route.	
Actor	Traveller, passenger transport information service	
General description	Multi-Modal Route Guidance function is used to generate instructions for following a route. The Route Guidance function generates step-by-step instructions for following a route. These instructions may include compass heading, distance, road names, sign text, landmarks, and still or motion images. These instructions may also include manoeuvring details such as turn angle, merges, and road name changes. Multi-modal Route Guidance function may be given guidance using text, voice or graphics.	Route Guidance data are provided from each passenger transport information service.
Execution condition	The route must be determined.	
	Current position of traveller is determined	
Prior conditions	Current position exists on the route.	

Function name: Multi-Modal Route Guidance		
Item	**Description**	**Note**
Functional action	4–1. It requests a guidance data to each passenger transport information service.	
	4–2. It represents the current position and the route on the map	
	4–3. It represents the current position and the manoeuvre list of the route	
	4–4. It guides departure and arrival	
	4–5. It guides the direction of the route	
	4–6. It guides the operation status of route	
	4–7. It informs the abnormalities matter on the route	
	4–8. It may guide the path sequence for transfer	e.g. Transfer path navigation service
	4–9. It may provide a virtual guidance of the route	
	4–10. Traveller sets a guidance condition.	
	4–11. It provides the guidance information that integrates current modal guidance and next modal guidance on the connection point.	
Substitution flow		
Exception flow		

Function name: Service and POI access		
Item	**Description**	**Note**
Function name	5. Service and POI Access	
Scope and purpose	It finds the service and POI	
Actor	Traveller, passenger transport information service	
General description	Service and POI search function provides data commonly used as origins or destinations for a route and contains useful information for travellers. Service is an object-providing service, POI and facility. Services and POI are single point or area locations that are typically known by a name rather than an address. Services include traveller-related commercial services such as hotels, restaurants, and petrol stations. Services also include locations or points of interest to travellers, such as national parks, monuments, and tourist attractions. Service includes locations of facilities such as public station and terminals. Services can be categorized by category type (e.g. airport, city centre and hotel) and may carry a variety of other attribute information (e.g. rating, cuisine type, credit cards accepted).	This function contains the same functionality for car navigation. Existing car navigation service defines two functions as Service/POI information access function
Execution condition		
Prior conditions		
Function action	5–1. Traveller inputs search conditions. (name, location, place, phone, category)	
	5–2. It provides search condition to passenger transport information service for searching Service, POI and Facility. (name, location, place, phone, category)	This function is also used for making recommendations on transfer points.
	5–3. It gets the results of searches from passenger transport information service.	Results of search service may contain recommendations for transfer points.
	5–4.It presents the results of searches to travellers.	
Substitution flow		

Function name: Service and POI access		
Item	**Description**	**Note**
Exception flow		

Function name: Address Location		
Item	**Description**	**Note**
Function name	6. Address location	
Scope and purpose	It finds the location.	
Actor	Traveller, passenger transport information service	
General description	Place search function provides data that are commonly used as origins or destinations for a route and contains information that is useful to travellers. Places are single point or area locations that are typically known by name rather than address.	This function contains the same functionality for car navigation. Existing navigation service defines function as Address Location function
Execution condition		
Prior conditions		
Function action	6–1. Traveller inputs search conditions. (name, part of address, category)	
	6–2. It provides search condition to passenger transport information service for searching place	This function is also used for making recommendations on transfer points.
	6–3. It gets the search results from passenger transport information service.	Search result may contain a recommendation on transfer point.
	6–4.It presents the search result to the traveller.	
Substitution flow		
Exception flow		

Function name: Travel information access and provision		
Item	**Description**	**Note**
Function name	7. Travel information access and provision	
Scope and purpose	It provides transportation information to traveller.	
Actor	Traveller, Passenger transport information service	
General description	Travel information access function is used for selecting a transportation and transfer point for travel.	Positions of public transportation and parking can also be provided by search service and place function.
Execution condition		
Prior conditions		
Functional action	7–1. It gets dynamic road traffic information	*traffic status (normal/ confusion/ traffic congestion, travel time) *construction/ accident it may be provided by RDS/TMC, VICS etc.
	7–2. It provides road traffic information to other functions.	
	7–3. It gets static operation information of public transportation and parking	*stop point/ station/ terminal *timetable *line *bound (start station, end station) *platform/boarding gate for railway/subway/ bus terminal/ferry/airplane *service class (first/ business/ economy) *operation class (special express/express/ limited express/local) *reserved seat/non-reserved seat it may be provided by public transport information service *gate position, park and ride service
	7–4. It provides a static operational information of the public transportation and parking to other functions	
	7–5. It gets dynamic operation information of public transportation and parking	*delay time/recovery time/release time *remaining seats for reserve *line status (normal/suspension/accident/ broke down/ construction)
	7–6. It provides a dynamic operational information of public transportation and parking to other functions	
	7–7. It gets a static characteristic information of public transportation	*railway: separation of train *bus: demand riding/ stopping *air plane: share flight No.
	7–8. It provides a static characteristic information of public transportation	
Substitution flow		
Exception flow		

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