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Intelligent transport systems — Extension of map database specifications for Local Dynamic Map for applications of Cooperative ITS

National foreword

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This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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TECHNICAL SPECIFICATION

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Intelligent transport systems — Extension of map database specifications for Local Dynamic Map for applications of Cooperative ITS

Systèmes intelligents de transport — Extension des spécifications de base de données cartographiques pour cartes dynamiques locales aux applications collaboratives des SIT

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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

— an ISO Technical Specification (ISO/TS) represents an agreement between the members of a technical committee and is accepted for publication if it is approved by 2/3 of the members of the committee casting a vote.

An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

ISO/TS 17931 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This corrected version of ISO/TS 17931 contains higher quality figures in Annex D, which improve legibility.

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Introduction

The purpose of this proposal 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 proposal 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.

The scope of this proposal is within the scope of ISO 14296[1)] which was approved in April, 2011. However, in order to meet the schedule requirement of Mandate M/453 issued by European Commission, the scope of this proposal is limited to publishing a Technical Specification for the Local Dynamic Map component of ISO 14296.

1) Under preparation.

Intelligent transport systems — Extension of map database specifications for Local Dynamic Map for applications of Cooperative ITS

1 Scope

This Technical Specification provides the map-related functional requirements, data model (logical data model/logical data organization), and data elements for Local Dynamic Map for those applications of Cooperative ITS that require information derived from map databases.

It is focused on data elements of a static nature.

2 Conformance

Data structures shall be provided as specified in Clauses 8.

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

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

3 Normative references

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

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

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*

ETSI TC ITS TR 102638, *Basic set of applications definitions*

ETSI TC ITS TR 102863, *Intelligent Transport Systems (ITS); Vehicular Communications; Basic set of applications; Local Dynamic Map (LDM); Rationale for and guidance on standardization*

4 Terms and definitions

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

Note 1 to entry: Address Location is one of the six application categories.

4.2
Advisory Point
data model entity that provides information about an approaching condition on a road that may require some action by the driver of a vehicle

4.3
Application category
basic sub-function within the set of functionality for vehicle navigation and traveler information system applications

Note 1 to entry: This Technical Specification identifies six application categories: Positioning, Route Planning, Route Guidance, Map Display, Address Location, Services and POI Information Access.

4.4
Background
data model package that is composed of Background Imagery, Map Data Background, Cartographic Feature Type, Figure Element and Picture file entity for displaying Map

4.5
Background Imagery
data model entity that provides background images upon which the road network of an area may be displayed

4.6
Building & Facility
data model entity that provides the location and shape of road side features such as a toll gate, or a fixed Road Side ITS station

4.7
Cartographic
data model package represents geometric information for display purposes, having non-explicit topology and 0-, 1- and 2-dimensional types and images

4.8
Cartographic Feature Type
data model entity that provides cartographic feature by their type (Symbol, Point, Polyline and Polygon)

4.9
Caution Point
data model entity that provides warning information about an approaching potential hazard on the Road Elements that may require some action by the driver of a vehicle

4.10
Detailed Special Route
data model entity that provides the detailed information of Special Route such as the ordered sequence of Link and Intersection lists, length of route and fee of toll road

4.11
Direction Guide
data model entity that provides the guidance information for a path which is composed of the entrance Link and the exit Link connected to an Intersection

4.12
Display point
0-dimensional type of cartographic feature

4.13
District Name
data model entity that provides the name of a geographic area feature for each Link connected to an intersection

4.14
Figure Element
data model entity that provides the shape data of a cartographic feature for displaying a map

4.15
Geo cording
determination of a link or node based on address information describing and/or naming a location

4.16
Graphic Text
data model entity that stores name text that is associated with all or part of a cartographic feature

Note 1 to entry: It is language-dependent and can contain a suggested display location, orientation, language code, priority (or importance), suggested scale range, and bounding box.

4.17
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

4.18
Intersection Connecting Point
data model entity for a topological junction of two or more links or end bounding a link

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

4.19
Intersection Cost
data model entity that provides the time or monetary cost between the entrance Link and exit Link of Intersection for calculating route

4.20
Intersection Link
data model entity that provides the Links in the Intersection used for determining the path through an intersection

4.21
Intersection Link Shape
data model entity that provides the shape of the Intersection Link for displaying a path

4.22
Intersection Name
data model entity that provides the name of an Intersection. An Intersection may have one or more names corresponding to the direction of entering into the intersection

4.23
Junction
it represents a 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

4.24
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.

4.25
Lane
data model entity that provides the lane information such as lane direction or lane width of Road Element

4.26
Lane Shape
data model entity that provides the shape geometry of the lane

4.27
Layer
sub-set of map data resulting from a subdivision of data of the same coverage area based on contents (similar to ISO-GDF layer) and which is typically related to one or only a few of the application categories

EXAMPLE Route guidance data can be considered as one layer.

4.28
Level
sub-set of map data resulting from classification of data of the same semantically 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.

4.29
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

4.30
Link Cost
data model entity that provides the time or monetary cost of the Link for calculating route

4.31
Local Dynamic Map
a conceptual data store which is embedded in an ITS station and which contains topographical, positional and status information

4.32
Location Image
data model entity that provides a background image of the Road Element and the intersection upon which guidance information is displayed

4.33
Map Data Background
data model entity that provides map database features for background display

4.34
Map Display
application category that deals with graphical information presentation

Note 1 to entry: Map Display is one of the six application categories.

4.35
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

4.36
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.

4.37
Picture File
this entity is the file of picture object

4.38
Place
named area which can be used as part of address location

4.39
Place Reference Point
data model entity that provides a representative point within a Place

4.40
Point of Interest
destination and/or site of interest to travelers, usually non-commercial by nature

4.41
Polygon
2-dimensional type of cartographic feature

4.42
Polyline
1-dimensional type of cartographic feature

4.43
Positioning
application category that deals with the determination of vehicle location and map-matching

Note 1 to entry: Positioning is one of the six application categories.

4.44
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

4.45
Regular parcel
parcel shaped like a rectangle

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

4.46
Reverse geo cording
determination of the address description of a link or node (i.e. determination of an upwards path across the place tree)

4.47
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

4.48
Road Bridge and Tunnel
data model entity that provides information such as the length, height and slope of bridges and tunnels

4.49
Road Element
data model entity that is a primitive road feature. Road Element is the same as the Link except for connecting to the Intersection

Note 1 to entry: Road Element is the same as Link.

4.50
Road Element Shape
data model entity that provides the shape geometry of the Road Element for displaying Road and Positioning

4.51
Route Guidance
application category that deals with the generation of graphical, textual, and/or audio instructions for following a planned route

4.52
Road Marking
data model entity that provides the shape of painted markings on roads such as lane markings these may be used for display purposes

4.53
Road Section
data model entity that is represented by an ordered sequence of one or more Road Element

4.54
Road Signage
data model entity that provides the detailed text of the road signage on the Road Element

Note 1 to entry: Route Guidance is one of the six application categories elements and joining two intersections, serving as the smallest independent unit of a road network at GDF level 2.

4.55
Route Planning
application category that deals with the determination of routes between specified points

Note 1 to entry: Route Planning is one of the six application categories.

4.56
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

4.57
Service
data model entity for a commercial activity of interest to travelers as a destination and/or orientation that is associated with Road Element(s), by which it can be accessed, and place(s)

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.

4.58
Service and POI Information Access
application category that deals with the provision of POI information to the navigation application

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

4.59
Service and POI Reference Point
data model entity that provides a representative point of a Service and POI

4.60
Shape point
position along a link used to more accurately represent its geometric course, bounded by exactly two segments

4.61
Special Route
data model entity that provides the pre-determined route such as scenic route or highway route

4.62
Street Address
data model entity that provides the geocoded Street Address of the Road Element

4.63
Symbol
it represents an icon associated with a cartographic feature

4.64
Topological Road Network
data model package that is composed of Road Element, Intersection, Link Cost, Intersection Cost, Traffic Restriction, Special Route and Detailed Special Route

4.65
Traffic Location
data model entity that contains an external reference (e.g. VICS or RDS-TMC) and is linked to either place or Road entities

4.66
Traffic Restriction
data model entity that provides the traffic restrictions such as one way or turn restrictions for route calculation purposes

4.67
Transportation element
any feature from the Roads and Ferries feature theme of the GDF

5 UML Expressions for diagrams

This Technical Specification 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.

6 Symbols (and abbreviated terms)

ADAS Advanced Driver Assistance System

BSA Basic set of applications

DB Database

GDF Geographic Data File

ITS Intelligent Transport System

LDM Local Dynamic Map

LDO Logical Data Organization

POI Point of Interest

PSF Physical Storage Format

7 Requirements

7.1 Introduction

This Technical Specification defines application requirements and functional requirements.

7.2 Application Requirements

This Technical Specification supports Basic set of applications of Cooperative systems, Driving support services, and navigation services.

Basic set of applications of Cooperative systems are defined in Annex C. Driving support services are defined in Annex D. Relationship between Basic set of applications of Cooperative systems and Driving support services are defined in Annex F.

7.3 Functional Requirements

7.3.1 Overview

Six functions (Map Display, Positioning, Route Planning, Route Guidance, Service/POI Information Access and Address Location) are the same as ISO/TS 20452:2007. The other functions are newly defined by this technical specification.

7.3.2 Map Display

7.3.2.1 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).

7.3.2.2 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 is also selectable by level.

7.3.2.3 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. display a map at the current location of the navigation system;

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

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

— R-15. display 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. provide latitude and longitude, street address, and other information for a point indicated by the cursor on the display;

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

— R-18. highlight the point on a displayed map of a particular routing maneuver.

— 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.

7.3.3 Positioning

7.3.3.1 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.

7.3.3.2 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 Technical Specification.

7.3.3.3 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. The specification 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 maneuver 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 is 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.

7.3.4 Route Planning

7.3.4.1 General Description

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

7.3.4.2 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. Routing 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.

7.3.4.3 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 Technical Specification.

7.3.5 Route Guidance

7.3.5.1 General Description

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

7.3.5.2 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 maneuver details such as turn angle, merges, and road name changes. Route Guidance may be given using text, voice or graphics.

7.3.5.3 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 maneuver “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. provide guidance while the navigation system is in motion, based on a calculated route and map matching;

— R-94. track progress along the route and provide maneuver 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.

7.3.6 Service/POI Information Access

7.3.6.1 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, 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.

7.3.6.2 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 Third Party Data (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.

7.3.6.3 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;

7.3.7 Address Location

7.3.7.1 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.

7.3.7.2 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 specification 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).

7.3.7.3 Requirements for Data model

— R-105. Address Location is the determination of a location 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.

7.3.8 Driving support

7.3.8.1 General Description

The Driving Support function is used to provide information for supporting safe driving.

7.3.8.2 Requirements for Data model

— R-108. Provide the driver with the attention information on intersection and road.

— R-109. Provide the driver with the Road Signage information on intersection and road.

— R-110. Provide the driver with detailed road segment information around the vehicle.

EXAMPLE Lane, Lane Shape, Surface shape of Intersection, and Surface shape of Link.

— R-111. The location reference for cooperating to external system shall be defined.

— R-112. The data for Driving support services shall keep the coverage, accuracy, and freshness.

7.3.9 Update

— R-113. Updating data of each record shall be possible (addition, correction, and deletion).

— R-114. The addition of the new data entity in the future shall be possible.

— R-115. Data structure shall receive the minimum influence by updates.

— R-116. Updating intersection information shall be possible by the boundary.

— R-117. Updating protocols and data structures shall be achieved by ISO 24099.

7.3.10 System Performance

— R-118. Data structure shall be possible to suit ISO 17267 API for car navigation system.

— R-119. Data structure shall be possible to select both Relational DB and Navigable DB.

8 Logical Data Model

8.1 Overall Model

8.1.1 General

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

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

— Map
  — Transportation
  — Cartographic
— Address Location
— Service/POI
— Dynamic Traffic Information

Figure 1 illustrates Overall Model.

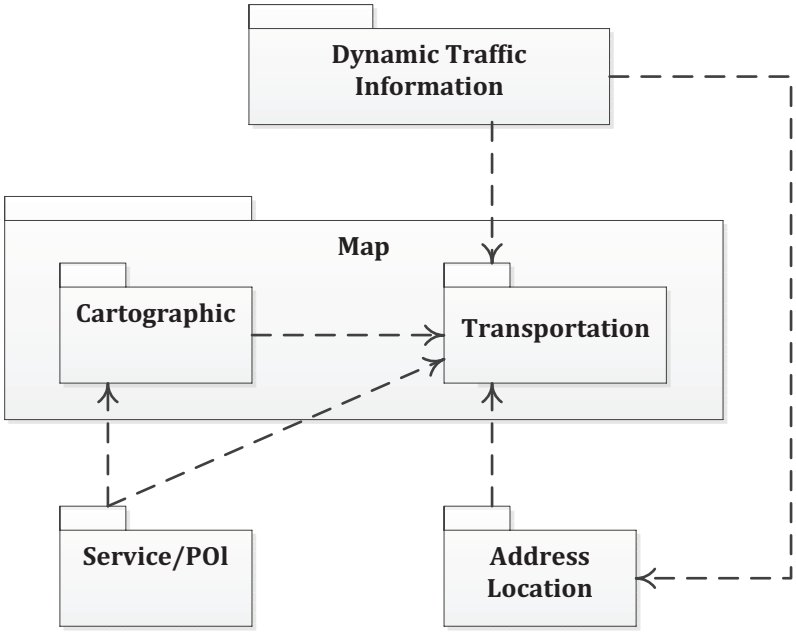


Figure 1 — Overall Model

In the following section, extensionally-defined entities are shown "Transportation package", "Cartographic package", "Service/POI package" and "Address Location package".

8.2 Transportation

8.2.1 Overview

Transportation is reconstructed to support Cooperative ITS.

Transportation consists of Road data, Topological Road Network and Guidance.

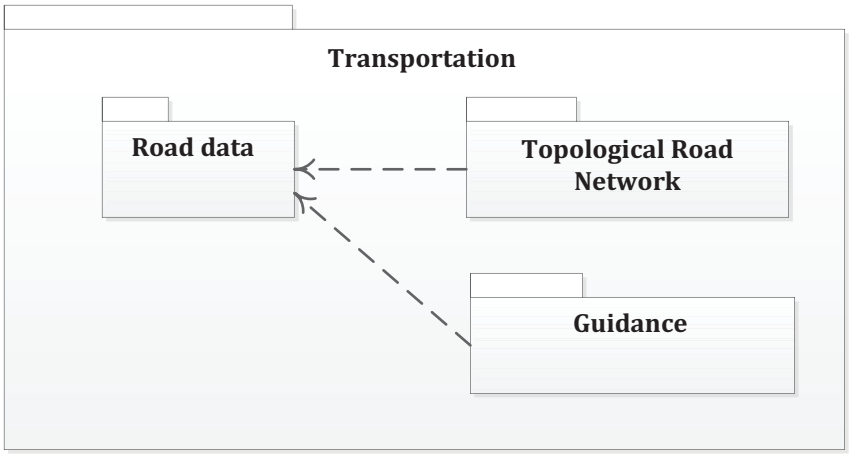


Figure 2 — Transportation

8.2.2 Road data

8.2.2.1 Overview

Road data are set up as the independent entity.

Road data consists of 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 and Advisory Point.

Figure 3 illustrates Road data.

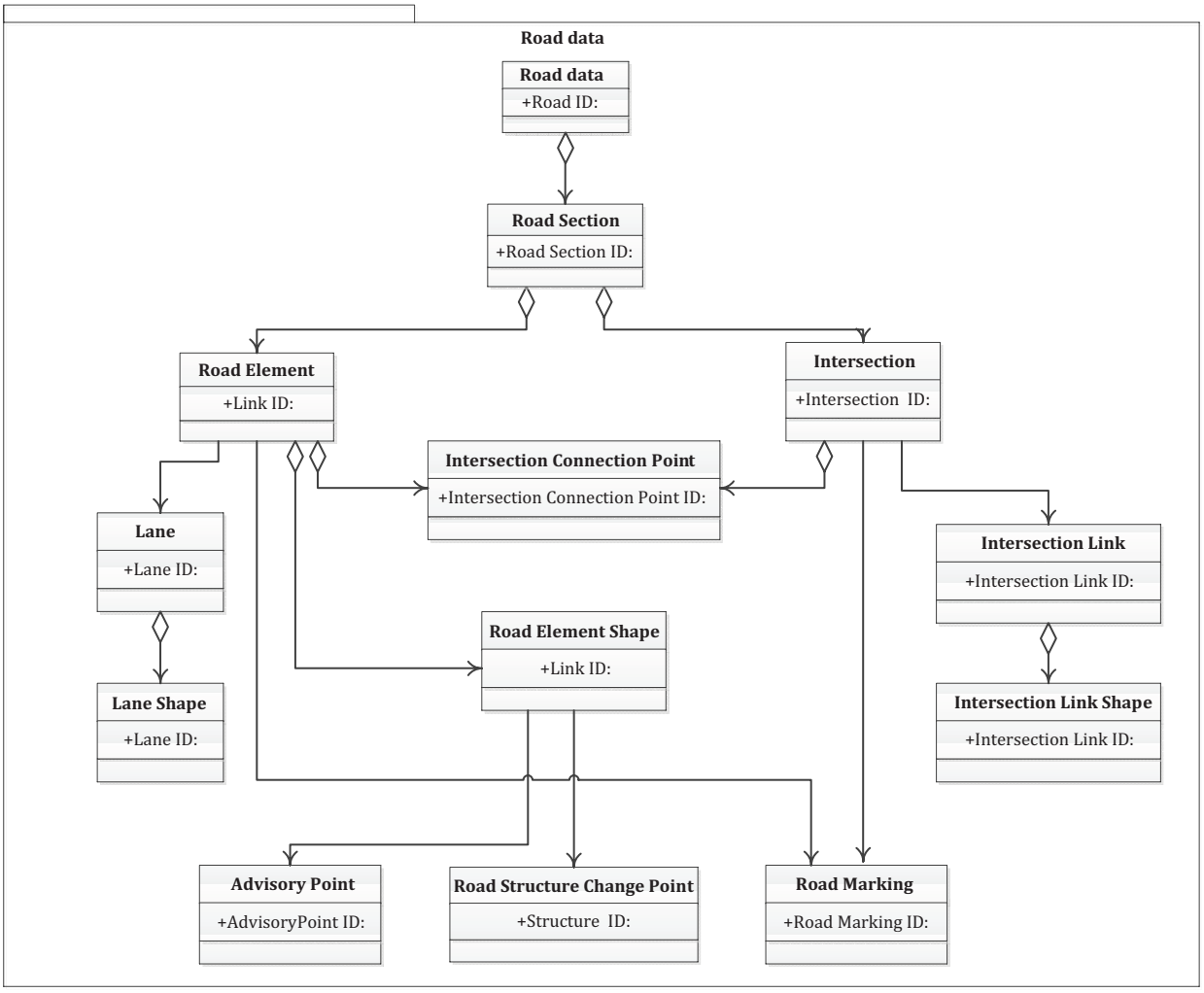


Figure 3 — Road data

8.2.2.2 Road data

8.2.2.2.1 Definition of Road data

Road data are a root entity of the Road.

Road object is a passable area which is called a street / road etc in specific parcel area.

Each Road object is separated and/or divided into the road section objects.

8.2.2.2.2 Data elements of Road data

Data elements of Road data are described in Table 1.

Table 1 — Data elements of Road data

Data Element / Attribute	Note
Road ID	reference key
number of Road Section	
Road class	
Road Route Number	it is set by road operator
Road identifier code	it is set by road operator

8.2.2.3 Road Section

8.2.2.3.1 Definition of Road Section

Road Section is a part of the street is composed of the road element and the intersection.

Road Section is expressed by intersection – road element – intersection (or end of road element).

Start and end of Road Section are intersections.

If road is expressed by double Line, each line is defined by each Road Section.

Road Section ID is set as an entity identifier.

Road Section entity has the Road Section information.

The Road Section does not include the same Road Element (link) that is used for other road section in the same level.

NOTE Expression of the road by road section is the same as used the multi-link of TS20452, except the intersection part. Then road is changed from double line (simple link) to single line (complex link), it sets the merge intersection on the changing point and two road sections are set. One is to define the road section A and the other is to define the road section B. Double lined road section in the lower level can aggregate the single line road section in the upper level.

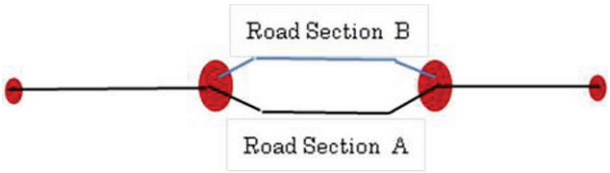


Figure 4 — Road Section

8.2.2.3.2 Data elements of Road Section

Data elements of Road Section are described in Table 2.

Table 2 — Data elements of Road Section

Data Element / Attribute	Note
Road ID	
Road Section ID	reference key
Road Route Number	
Road identifier code	
number of Intersection in this road section	
start Intersection ID	
end Intersection ID	
existing Link flag corresponding to traffic information	it corresponds to ITS-RSU, VICS / RDS/TMS
Tool road flag	

8.2.2.4 Road Element (Link)

8.2.2.4.1 Definition of Road Element (Link)

Road Element (Link) is composed of two Intersection Connection Point that are in each intersection of the road section.

Road Element has the road element information and attributes for the shape information.

The start and end of Road Element are an Intersection Connection Point at intersection.

Link ID is set as an entity identifier.

Road Element also has an attributes for the lane information.

Shape information of link expresses the road by line (polyline) and/or surface (polygon).

However surface shape information of link is optional.

Link ID must be unique in the system.

The same road element (link) in the different level which is composed of the same Intersection Connecting Point must set the same link ID.

The purpose that Road Element (Link) does not contain the Intersection, Link is to be used for new application.

8.2.2.4.2 Data elements of Road Element (link)

Data elements of Road Element (link) are described in Table 3.

Table 3 — Road Element (link)

Data Element / Attribute	Note
Road Section ID	
Link Connection order	it intents to store link order
Link ID	reference key
start Intersection ID	
One-way Information	
Investigation Information	
Lane information flag	

Table 3 *(continued)*

Data Element / Attribute	Note
Road Bridge and Tunnel Point flag	Has this link a Road Bridge and Tunnel objects
start Intersection Connecting Point ID	
end Intersection Connecting Point ID	
Upper level Existence flag	
Upper level Link ID	
Link Type code	
Road functional code	
Slope information	Ascent/ descent/ flat
Adjacent intersection Link flag	
Street Name Existence flag	
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	
number of Traffic sign except with in resection	for pedestrian crossing / crosswalk
Pass-through flag	
On-the-street parking lot flag	

8.2.2.5 Intersection Connection Point

8.2.2.5.1 Definition of Intersection Connection Point

The Intersection Connection Point is a point where the link connects with the intersection link or links of other road element at intersection.

The Intersection Connection Point is the start point and the end point of shape of the links. Also it is used for defining Intersection Link.

Intersection Connection Point ID is set as an entity identifier.

The location of the Intersection Connection Point is set to the position where the expression that shows the connection of the shape of the link and the shape of the intersection link are appropriate.

When the location of the Intersection Connection Point is different such as aggregated point in the upper level and two or more points in the intersection, different Intersection Connection Point ID is given to each point.

Intersection Connection Point has the information on some attributes.

When the connection of the roads disappears in the upper level, the Intersection Connecting Point is not set in the upper level.

NOTE The location of Intersection Connection Point; 1) to show the road shape in a single-line, it shall be defined in the centre of the intersection. 2) To show the road shape in double-lines, it shall be defined at the entrance point of the intersection or connection point of other link. When there are two or more Intersection Connecting Points in the intersection, each Intersection Connecting Point is given different Intersection Connecting Point ID. Also when they are aggregated in the upper level, different Intersection Connecting Point ID is given to each Intersection Connecting Point.

8.2.2.5.2 Data elements of Intersection Connection Point

Data elements of Intersection Connection Point are described in Table 4.

Table 4 — Data elements of Intersection Connection Point

Data Element / Attribute	Note
Intersection Connection Point ID	Reference key
Intersection ID	
Coordinates of Intersection Connection Point	
Offset from Intersection reference	
Intersection Connection Point Type	normal, boundary
number of Connected Link	

8.2.2.6 Intersection

8.2.2.6.1 Definition of Intersection

The Intersection is a connecting place in road sections. Also dead end of road and dividing / margining point of roads is defined as intersection.

Intersection ID is set as an entity identifier.

Intersection relates the attribute information and the shape information of the intersection.

One or more Intersection Connecting Point exists in the intersection.

The reference location of the intersection;

1) When there is an Intersection Connecting Point in the intersection, a location of the intersection is the same as the location of Intersection Connecting Point.

2) When there are some Intersection Connecting Points in the intersection, a location of intersection is the same as the location of aggregated Intersection Connecting Point in the upper level.

The ID and the position of the intersection do not change in the upper level.

A new intersection in the upper level cannot be defined by aggregating intersections in the lower level.

The shape information of the intersection is shown in a point and surface shape. The point is shown at the location of intersection, and the surface shape is optional.

NOTE When the Intersection Connecting Point is not set at the upper level, the intersection is not set in the upper level. When the links / Intersection Connecting Points are aggregated in the upper level, the location of the aggregated Intersection Connecting Point in upper level is set at the location of the intersection in lower level. Because neither the location nor the ID of the intersection is changed between the levels, the identity of the intersection is secured in intersection ID. When the Intersection Connecting Point of neighbourhood is set as a separate intersection in the lower level, it is not possible to aggregate it into an intersection by the upper level. When two or more Intersection Connecting Points are aggregated into an Intersection Connecting Point by the upper level, it shall be defined from the lowest level as the same intersection.

8.2.2.6.2 Data elements of Intersection

Data elements of Intersection are described in Table 5.

Table 5 — Data elements of Intersection

Data Element / Attribute	Note
Intersection ID	Reference key
number of Intersection Connecting Point in the Intersection	
Intersection Connecting Point ID list	
Type of Intersection	normal, boundary, runabout, plaza, marge
reference coordinates of the Intersection	
Boundary flag	
Boundary Intersection type	parent/child
number of connected Link	
coverage of Upper level	
Traffic signal flag	

8.2.2.7 Road Element Shape

8.2.2.7.1 Definition of Road Element Shape

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

The beginning point of Road Element Shape is defined by an Intersection Connection Point, and it is set as the shape point information on the order of appearance of shape data.

The ending point of Road Element Shape is adjusted to the position of the adjacent Intersection Connecting Point. The ending point of the last shape point is the location of the adjacent Intersection Connecting Point.

Link ID is used as an entity identifier.

Because the Road Element does not include the intersection link, Road Element Shape does not include the shape of the intersection link.

Road Element Shape has three dimensional data. However, the altitude is set by optional entity.

8.2.2.7.2 Data elements of Road Element Shape

Data elements of Road Element Shape are described in Table 6.

Table 6 — Data elements of Road Element Shape

Data Element / Attribute	Note
Road Section ID	
Link Connection order	
Link ID	
start Intersection Connection Point coordinates	
number of Shape point	
coordinates Offset list	Polyline data
X coordinates offset	
Y coordinates offset	
Road Structure Change Point ID	if it exists on this offset
Advisory Point ID	if it exists on this offset

8.2.2.8 Intersection Link

8.2.2.8.1 Definition of Intersection Link

This entity is set as the link between Intersection Connecting Points at the intersection.

Intersection Link ID is set as an entity identifier.

Intersection Link Shape is optional part of this entity.

NOTE This entity is used for expressing a path of a right-turn, left-turn, go-straight, U-turn, and the roundabout way at the intersection. Because its shape can be shown by using the position of the Intersection Connecting Point when the shape of intersection link is a straight line, the intersection link shape is assumed to be optional. It does not have the altitude information. Rule of the intersection link ID is the same as that of link ID.

8.2.2.8.2 Data elements of Intersection Link

Data elements of Intersection Link are described in Table 7.

Table 7 — Data elements of Intersection Link

Data Element / Attribute	Note
Intersection ID	
Intersection Link ID	Reference key
start Intersection Connecting Point ID	
end Intersection Connecting Point ID	
Link Type code	
length of intersection Link	
average traveling time	
Offset from Intersection coordinates	

8.2.2.9 Intersection Link Shape

8.2.2.9.1 Definition of Intersection Link Shape

This entity is optional part of intersection link.

It is the shape information of the intersection link.

Intersection Link ID has used as an entity identifier.

Nonlinear shape of the intersection link is necessary so that this entity is set.

NOTE This shape information is the same definition as Road Element Shape.

8.2.2.9.2 Data elements of Intersection Link Shape

Data elements of Intersection Link Shape are described in Table 8.

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	
Offset from Intersection coordinates	
start Intersection Connecting Point coordinates	
Shape point offset list	
X coordinates offset	
Y coordinates offset	

8.2.2.10 Lane

8.2.2.10.1 Definition of Lane

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

Lane information is used when the new application needs detailed information and shape information of lane.

Road Element consists of one or more serial Lane sections for treating the Lane data. When Road Element has bidirectional Lane, different Lane section must be set up. Lane section is a portion between the points where the number of the lane changes. Lane sections are put in order according to the direction of passing. Lane section consists of one or more parallel Lanes. Lane data are set up from left-hand side in Lane section.

Figure 5 illustrates Lane structure.

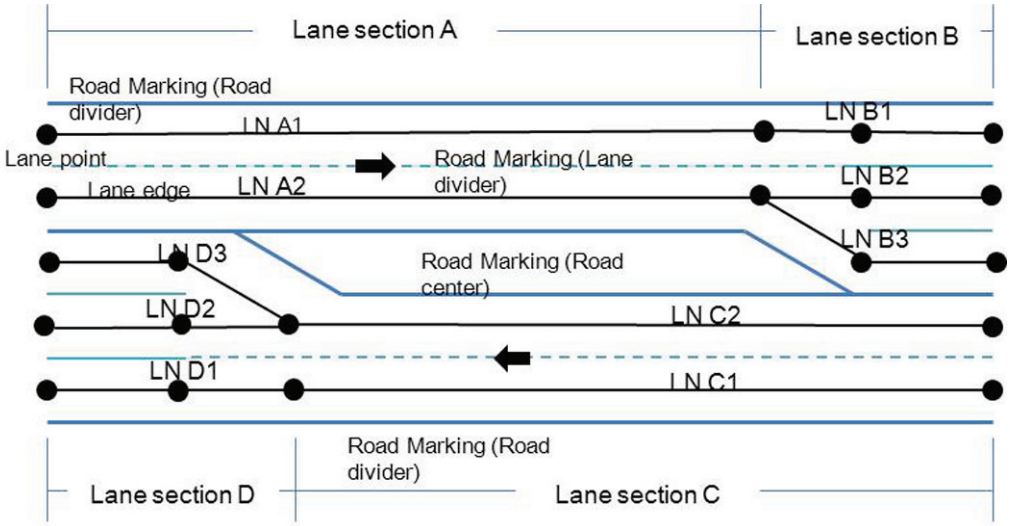


Figure 5 — Lane structure

8.2.2.10.2 Data elements of Lane

Data elements of Lane are described in Table 9.

Table 9 — Data elements of Lane

Data Element / Attribute	Note
Road section ID	
Link ID	
Order/ Reverse of traffic flow of Road Element	
Lane section ID	Order number is available
Lane section attributes	number of Lane,
Lane position in same Lane section	Lane position from left-hand side is defined
Lane ID	
start Lane point ID	
end Lane point ID	
Lane usage type	Normal, Bus, HOV, reversible
Direction of travel at lane end	sharp left, left, slight left, straight, slight right, right, sharp right, u-turn

8.2.2.11 Lane Shape

8.2.2.11.1 Definition of Lane Shape

This entity is as optional part of lane.

Lane shape provides shape data of each lane in road element.

Lane Shape consists of one or more serial Shape data.

Shape data are defined by the polyline in the central line of each lane.

Shape data are composed of Lane point and Lane edge. Lane point is the starting / ending point of Lane edge. Lane edge is defined by polyline. Lane point is defined at starting / ending point of Lane and changing point of attributes of Lane edge.

8.2.2.11.2 Data elements of Lane Shape

Data elements of Lane Shape are described in Table 10.

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	Lane position of most left-hand side is defined
Lane ID	
number of Lane edge	
Lane edge List	
Lane edge ID	
Lane edge attributes	Length of Lane edge,
start Lane point ID and coordinates	
end Lane point ID and coordinates	
Adjoining Lane moving availability	
number of shape point	
Shape point Offset List	
X coordinates offset	
Y coordinates offset	

8.2.2.12 Road Marking

8.2.2.12.1 Definition of Road Marking

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

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

Road Marking ID is set as an entity identifier.

The sideline 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 is related to surface shape of link and intersection. Not all the Road Marking information is maintained now. It expects that surface shape and Road Marking shall be provided by the public sector.

8.2.2.12.2 Data elements of Road Marking

Data elements of Road Marking are described in Table 11.

Table 11 — Data elements of Road Marking

Data Element / Attribute	Note
Road Section ID	
Link ID	reference key
Intersection ID	reference key
Road Marking ID	
Road Marking type code	
paint color	white, yellow, orange, red, blue, others
reference coordinates	
shape data	Shape of Road Marking is Polyline or Polygon

8.2.2.13 Road Structure Change Point

8.2.2.13.1 Definition of Road Structure Change Point

When link has the change point of the road structure, this entity is set for the road structure information at the lowest level for expressing the road.

Road structure Change Point ID is used as an entity identifier.

This entity is set on the shape point of the Road Element Shape.

NOTE The drawing style of shape of the road is changed at road structure change point, such as tunnel and bridge.

8.2.2.13.2 Data elements of Road Structure Change Point

Data elements of Road Structure Change Point are described in Table 12.

Table 12 — Data elements of Road Structure Change Point

Data Element / Attribute	Note
Road section ID	
Link connection order	
Link ID	
Road Structure Change Point ID	reference key
length and coordinates offset	number of shape point of Road Element Shape
Road Structure ID	it points the road structure object in guide data
Road Structure object Type	EX: Bridge, Tunnel, Over/Under path
length of road structure object	

8.2.2.14 Advisory Point

8.2.2.14.1 Definition of Advisory Point

This entity provides information about an approaching condition on a road that may require some action by the driver of a vehicle.

When Road Element has the advisory information, this entity is set for the advisory information at the lowest level for driving support.

It contains the curvature value, slope value, and the section of attention regarding the shape of the road.

Advisory Point ID is used as an entity identifier.

NOTE This entity is also set on the shape point of the Road Element Shape.

8.2.2.14.2 Data elements of Advisory Point

Data elements of Advisory Point are described in Table 13.

Table 13 — Data elements of Advisory Point

Data Element / Attribute	Note
Road Section ID	
Link connection order	
Link ID	
Advisory Point ID	reference key
length from start point	number of shape point of Road Element Shape
Attention code	it is used for driving support
Attention Text	

8.2.3 Topological Road Network

8.2.3.1 Overview

Topological Road Network is set up as the independent entities.

Topological Road Network consists of Intersection (Topological Node), Road Element (Topological Link), Link Cost (Topological Link cost), Intersection Cost (Topological Link cost), Traffic Restriction (Topological Traffic Restriction), Special Route, Detailed Special Route.

Figure 6 illustrates Road Network.

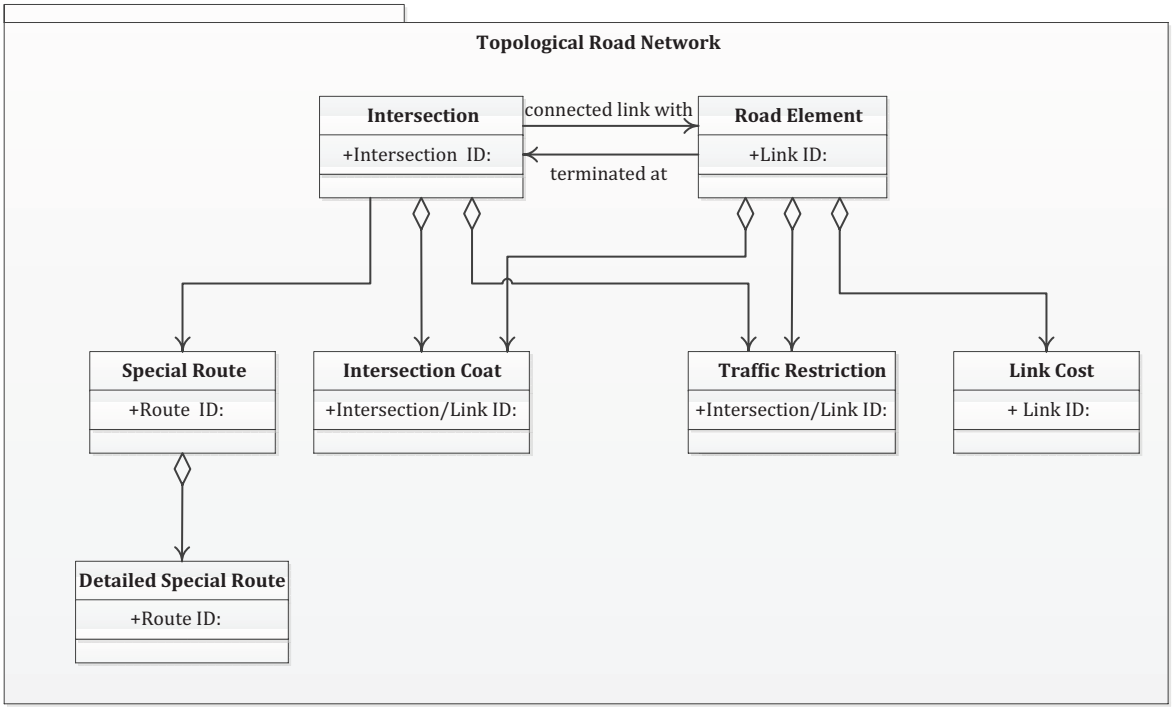


Figure 6 — Topological Road Network

8.2.3.2 Intersection (Topological Node)

8.2.3.2.1 Definition of Intersection (Topological Node)

This entity is the same as Intersection in Road data. This entity is set for route calculation.

The reference location of Intersection is the same as the location of intersection in the lowest level.

Intersection ID is used as an entity identifier.

NOTE In most current systems, the algorithms of route calculation have used the link and node. The node and aggregated node in the current system have the same meaning as the intersection in this Technical Specification.

8.2.3.2.2 Data elements of Intersection (Topological Node)

Data elements of Intersection (Topological Node) are described in Table 14.

Table 14 — Data elements of Intersection (Topological Node)

Data Element / Attribute	Note
Level number	
Parcel ID	
Practical code	
Intersection ID	reference key
boundary flag	
Special Route flag and ID	option:

8.2.3.3 Road Element (Topological Link)

8.2.3.3.1 Definition of Road Element (Topological Link)

This entity is the same as Link in Road.

This entity provides the connection between two intersections.

Link ID is used as an entity identifier.

NOTE Even if the road is expressed by double-lined link in the lowest level, it is preferable to express it by single-line link-T.

8.2.3.3.2 Data elements of Road Element (Topological Link)

Data elements of Road Element (Topological Link) are described in Table 15.

Table 15 — Data elements of Road Element (Topological Link)

Data Element / Attribute	Note
Level number	
Parcel ID	
Practical code	
Link ID	reference key
Road functional code	
start Intersection ID	
end Intersection ID	

8.2.3.4 Link Cost (Topological Link cost)

8.2.3.4.1 Definition of Link Cost (Topological Link cost)

This entity is considered to be one of the attributes of Link. However, this entity is set up as the independent entity.

Link Cost (Topological Link cost) is set for the route calculation.

Link ID is used as an entity identifier.

8.2.3.4.2 Data elements of Link Cost (Topological Link cost)

Data elements of Link Cost (Topological Link cost) are described in Table 16.

Table 16 — Data elements of Link Cost (Topological Link cost)

Data Element / Attribute	Note
Link ID	
start Intersection ID	reference key
end Intersection ID	reference key
coverage of Upper level Link	
Link ID of upper level	
Traffic status of Link	
Toll / Free flag	
number of Traffic signal	
Link direction	
opposite lane crossing flag	
same Link cost flag	
Link type code	
Road functional code	
length	
average traveling time	
Slope information	Ascent/ descent/ flat

8.2.3.5 Intersection Cost (Topological Link cost)

8.2.3.5.1 Definition of Intersection Cost (Topological Link cost)

This entity is considered to be one of the attributes of Intersection. However, this entity is set up as the independent entity.

This entity is set for the level of the route calculation.

Intersection ID and/or two link IDs are used as entity identifier.

8.2.3.5.2 Data elements of Intersection Cost (Topological Link cost)

Data elements of Intersection Cost (Topological Link cost) are described in Table 17.

Table 17 — Data elements of Intersection Cost (Topological Link cost)

Data Element / Attribute	Note
Intersection ID	
Entrance Link ID	reference key
Exit Link ID	reference key
length	
average traveling time	

8.2.3.6 Traffic Restriction (Topological Traffic Restriction)

8.2.3.6.1 Definition of Traffic Restriction (Topological Traffic Restriction)

This entity provides the traffic restrictions such as one way or turn restrictions for route calculation purposes.

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

Entrance link ID and exit link ID are used as entity identifier.

EXAMPLE Local Dynamic Map Example of Type1 Data; Statutory speed limit descriptor

8.2.3.6.2 Data elements of Traffic Restriction (Topological Traffic Restriction)

Data elements of Traffic Restriction (Topological Traffic Restriction) are described in Table 18.

Table 18 — Data elements of Traffic Restriction (Topological Traffic Restriction)

Data Element / Attribute	Note
Intersection ID	
Entrance Link ID	reference key
Exit Link ID	reference key
Traffic Restriction code	

8.2.3.7 Special Route

8.2.3.7.1 Definition of Special Route

This entity provides the pre-determined route such as scenic route or highway route.

This entity provides calculated route between two intersections such as intersection for entering the toll road. Therefore Special Route is related with Intersection. Route using highway network is fixed.

NOTE The motorway, the scenic road, the detour, and the evacuation route and so on, are assumed to be the Special Route. The existing judgment of the Special Route in intersection also sets the level where the start / end intersection of the route exists.

8.2.3.7.2 Data elements of Special Route

Data elements of Special Route are described in Table 19.

Table 19 — Data elements of Special Route

Data Element / Attribute	Note
Intersection ID	
Route ID	reference key
Intersection ID of opposite side	
Route Type	Highway, scenic road, evacuation route
starting flag	Y: start N: end
Fee (Charge)	Then toll road

8.2.3.8 Detailed Special Route

8.2.3.8.1 Definition of Detailed Special Route

This entity is set for the detailed information of Special Route.

Route ID is used as an entity identifier.

8.2.3.8.2 Data elements of Detailed Special Route

Data elements of Detailed Special Route are described in Table 20.

Table 20 — Data elements of Detailed Special Route

Data Element / Attribute	Note
Route ID	reference key
start Intersection ID	
end Intersection ID	
Route name	
Link ID list	
Intersection list	

8.2.3.9 Connected Link (Topological Connected Link) relation

8.2.3.9.1 Definition of Connected Link (Topological Connected Link) relation

Connected Link information is considered to be one of the attributes of Intersection. However, Connected Link (Topological Link cost) is set up as the independent entity.

This entity defines the link connected with the intersection.

Connected link is set for the route calculation.

Intersection ID and link ID are used as entity identifies.

8.2.3.9.2 Data elements of Connected Link (Topological Connected Link) relation

Data elements of Connected Link (Topological Connected Link) are described in Table 21.

Table 21 — Data elements of Connected Link (Topological Connected Link) relation

Data Element / Attribute	Note
Intersection ID	reference key
Link ID	reference key
adjacent Intersection ID	
Boundary Link flag	
Urban / Suburbs identifier	
Link direction	
Link ID of straight on	
Link angle	

8.2.4 Guidance

8.2.4.1 Overview

The information for guidance is considered to be one of the attributes of Intersection. However, main attributes of Link and Intersection are set up as the independent entity.

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

Figure 7 illustrates Road attributes Information.

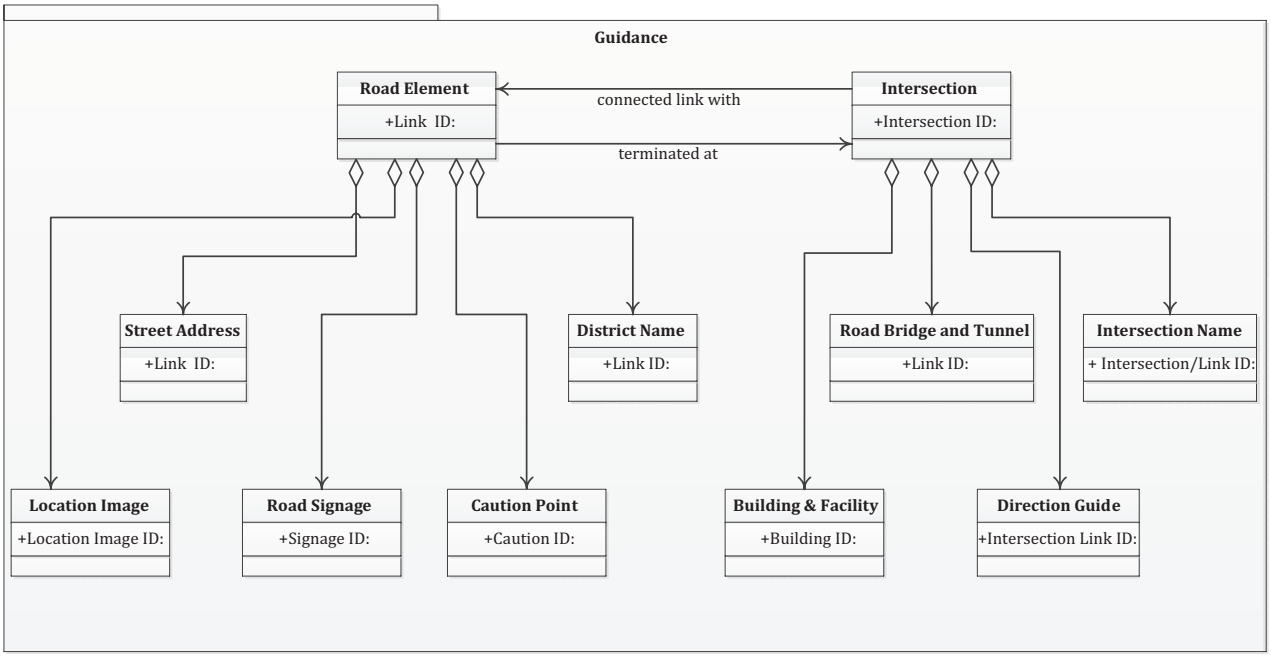


Figure 7 — Guidance

8.2.4.2 Road Element Type

This entity is the same as Road Element.

8.2.4.2.1 Definition of Road Element Type

Data elements of Guide are described in Table 22.

Table 22 — Data elements of Guide

Data Element / Attribute	Note
Type Identification	
Link ID	

8.2.4.3 Intersection Type

This entity is the same as Intersection.

8.2.4.3.1 Definition of Intersection Type

Data elements of Guide are described in Table 23.

Table 23 — Data elements of Guide

Data Element / Attribute	Note
Type Identification	
Intersection ID	

8.2.4.4 Caution Point

8.2.4.4.1 Definition of Caution Point

This entity provides the caution information on the road.

This entity includes the caution code, and location.

Caution point ID is set as an entity identifier.

NOTE Caution point information shall be made by the caution information of road sign, and other status of road and traffic. Advisory Point in road contains the attention information corresponding to road shape and Road Bridge and Tunnel. This entity contains other attention information.

8.2.4.4.2 Data elements of Caution Point

Data elements of Caution Point are described in Table 24.

Table 24 — Data elements of Caution Point

Data Element / Attribute	Note
Intersection ID	reference
Link ID	reference
Caution Point ID	reference
Caution content code	
Caution Text	

8.2.4.5 Road Signage

8.2.4.5.1 Definition of Road Signage

This entity provides the location of road sign and traffic signal.

Road Signage ID is set as an entity identifier.

NOTE In Japan, there are 4 types of road sign such as restriction, order, guidance, and caution.

EXAMPLE Local Dynamic Map Example of Type 2 Data; Traffic signals and traffic signs and Position and meaning of new signs not in the pre-loaded map data

8.2.4.5.2 Data elements of Road Signage

Data elements of Road Signage are described in Table 25.

Table 25 — Data elements of Road Signage

Data Element / Attribute	Note
Road section ID	
Link ID	
Road signage ID	reference
Method	fixed / changeable
Road Signage type	Traffic signal/ Guide/ attention /restrict/ order /other
Road signage code	
Road Signage text (numeric)	EX: speed value
Supplementary signage flag	
Supplementary signage Text	EX: BUS only
coordinates	
height	

8.2.4.6 Intersection Name

8.2.4.6.1 Definition of Intersection Name

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

8.2.4.6.2 Data elements of Intersection Name

Data elements of Intersection Name are described in Table 26.

Table 26 — Data elements of Intersection Name

Data Element / Attribute	Note
Intersection ID	reference key
Entrance Link ID	then there are some names,
Character string data	

8.2.4.7 District Name

8.2.4.7.1 Definition of District Name

This entity provides the name of District for outgoing direction from an intersection.

8.2.4.7.2 Data elements of District Name

Data elements of District Name are described in Table 27.

Table 27 — Data elements of District Name

Data Element / Attribute	Note
Intersection ID	
Entrance Link ID	reference key
Name type	
distance category	
Exit Link ID and Character string	

8.2.4.8 Location Image

8.2.4.8.1 Definition of Location Image

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

8.2.4.8.2 Data elements of Location Image

Data elements of Location Image are described in Table 28.

Table 28 — Data elements of Location Image

Data Element / Attribute	Note
Intersection ID	reference key
Entrance Link ID	reference key
Location Image ID	
Guide Type	
pattern information	
picture information	
Length before intersection	
Character string	

8.2.4.9 Direction Guide

8.2.4.9.1 Definition of Direction Guide

This entity provides direction information on the target intersection.

8.2.4.9.2 Data elements of Direction Guide

Data elements of Direction Guide are described in Table 29.

Table 29 — Data elements of Direction Guide

Data Element / Attribute	Note
Intersection ID	reference key
Entrance Link ID	reference key
Entrance Lane Information	
number of Guidance Point	
Guidance Point list	
Exit Link ID	
Intersection type	
Guide Point type	
Exit Lane flag	
Exit direction	
Guidance Code	
Guide flag	
Exit Angle	

8.2.4.10 Building and Facility

8.2.4.10.1 Definition of Building and Facility

This entity provides the shape and location of the object for road side service.

Facility contains the ETC Charge collection unit.

EXAMPLE Local Dynamic Map Example of Type 2 Data; Toll Change for each collection point

8.2.4.10.2 Data elements of Building and Facility

Data elements of Building and Facility are described in Table 30.

Table 30 — Data elements of Building and Facility

Data Element / Attribute	Note
Intersection ID	
Link ID	reference key
Building and Facility ID	
Type code	
coordinates of Building	
Entrance direction Info	
Optional coordinates	
Character String for feature name	
Shape data	
additional data for 3D icon	
Entrance/Exit Information	

8.2.4.11 Road Bridge and Tunnel

8.2.4.11.1 Definition of Road Bridge and Tunnel

This entity provides information such as the length, height and slope of bridges and tunnels.

8.2.4.11.2 Data elements of Road Bridge and Tunnel

Data elements of Road Bridge and Tunnel are described in Table 31.

Table 31 — Data elements of Road Bridge and Tunnel

Data Element / Attribute	Note
Intersection ID	
Link ID	reference key
Road Bridge and Tunnel Object ID	sub reference
Order code in Type	
Link direction	
Length	
offset length	
Height info.	
Crossing Info.	
Character String	

8.2.4.12 Street Address

8.2.4.12.1 Definition of Street Address

This entity provides the house number information for each road element.

8.2.4.12.2 Data elements of Street Address

Data elements of Street Address are described in Table 32.

Table 32 — Data elements of Street Address

Data Element / Attribute	Note
Link ID	reference key
Address Type	
Street Name	
Address(house number) Information	

8.3 Cartographic

8.3.1 Overview

Cartographic consists of Background and Graphic Text.

Figure 8 illustrates the Cartographic.

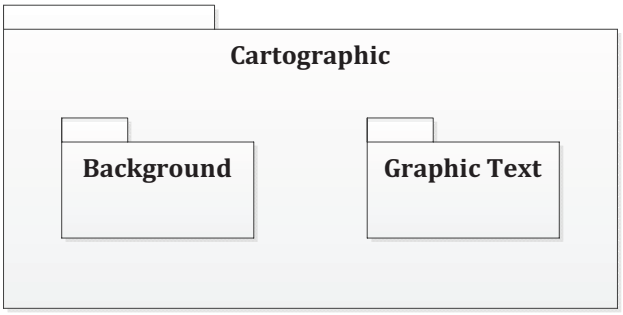


Figure 8 — Cartographic

8.3.2 Background

8.3.2.1 General

Background Imagery (raster type data) is set newly.

Background Imagery information is assumed to include the picture data such as BMP, JPEG, PNG, IMG, GeoTIFF etc.

Picture data has no GIS information such as the coordinates, and/or mesh size. Therefore Background Imagery contains pixel size, mesh size, coordinate etc. Picture data are provided by existing picture format files.

Background consists of Map Data Background, Cartographic Feature Type, Figure Element, Background Imagery and Picture file.

Figure 9 illustrates the Background.

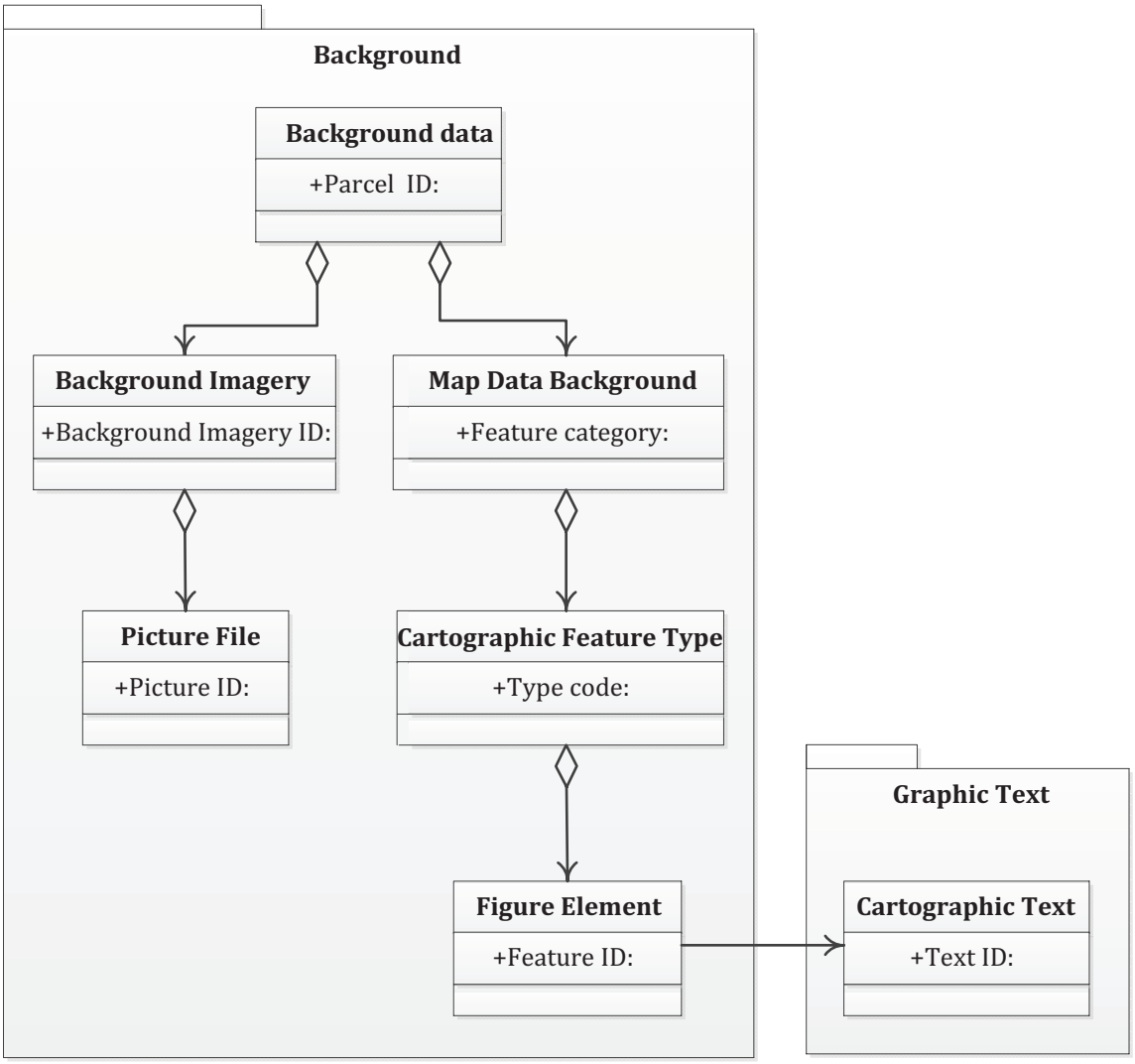


Figure 9 — Background

8.3.2.2 Map Data Background

8.3.2.2.1 Definition of Map Data Background

This entity provides map database features for background display.

Map Data Background data are classified by some categories for displaying the map features such as land, sea, lake, river, park, railroad, and so on.

8.3.2.2.2 Data elements of Map Data Background

Data elements of Map Data Background are described in Table 33.

Table 33 — Data elements of Map Data Background

Data Element / Attribute	Note
Map Data Background ID	reference key
Feature category	
number of Cartographic Feature Type	

8.3.2.3 Cartographic Feature Type

8.3.2.3.1 Definition of Cartographic Feature Type

This entity provides cartographic feature by their type (Symbol, Polyline and Polygon)

Map Data Background aggregates this entity.

8.3.2.3.2 Data elements of Cartographic Feature Type

Data elements of Cartographic Feature Type are described in Table 34.

Table 34 — Data elements of Cartographic Feature Type

Data Element / Attribute	Note
Map Data Background ID	
Feature category	
Cartographic Feature Type ID	reference key
Type of Shape	Symbol, Point, Line, Surface
number of Figure element	it points each elements

8.3.2.4 Figure Element

8.3.2.4.1 Definition of Figure Element

This entity provides the feature shape by each shape type.

This entity inherits the Cartographic Feature Type.

8.3.2.4.2 Data elements of Figure Element

Data elements of Figure Element are described in Table 35.

Table 35 — Data elements of Figure Element

Data Element / Attribute	Note
Figure element (Background feature) ID	reference key
type of Shape	
Background type code	
Element Information	
Element Name	option
Altitude of reference point	
Area code	then this element expresses specific area
POI code for 3D icon	this point expresses 3D object by Symbol.
Color code	
start coordinates	
number of offset coordinates	
Offset coordinate list	

8.3.2.5 Background Imagery

8.3.2.5.1 Definition of Background Imagery

This entity provides the location and shape of road side features such as a toll gate, or a fixed Road Side ITS station.

Background Imagery ID is set as an entity identifier.

Pixel size, reference location, coordinates a file name is set in the entity.

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

8.3.2.5.2 Data elements of Background Imagery

Data elements of Background Imagery are described in Table 36.

Table 36 — Data elements of Background Imagery

Data Element / Attribute	Note
Background Imagery ID	reference key
File name	includes directory structure
Pixel size	
Pixel reference point	

8.3.2.6 Picture File

8.3.2.6.1 Definition of Picture File

This entity is the file of picture object.

File name of picture is set as an entity identifier.

8.3.2.6.2 Data elements of Picture File

Data elements of Picture file are described in Table 37.

Table 37 — Data elements of Picture File

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

8.3.3 Graphic Text

8.3.3.1 General

Graphic text provides the Text for expressing feature name on the map.

Also Graphic text supports multi-language.

8.3.3.2 Graphic Text

8.3.3.2.1 Definition of Graphic Text

This entity is used for expressing the name of feature.

This entity is classified into some categories.

Graphic Text could be represented with some types

Graphic Text supports multi-language.

8.3.3.2.2 Data elements of Graphic Text

Data elements of Graphic text are described in Table 38.

Table 38 — Data elements of Graphic Text

Data Element / Attribute	Note
Cartographic text ID	reference key
Text attribute 1	Language codes
Text attribute 2	Expressing type
character string data for Naming	

8.4 Service/POI

8.4.1 General

Service/POI has been defined the Service in ISO/TS 20452. However, Service/POI consists of Service and Service/POI Reference Point in this specification.

The data model for Service/POI is illustrated in Figure 10 below.

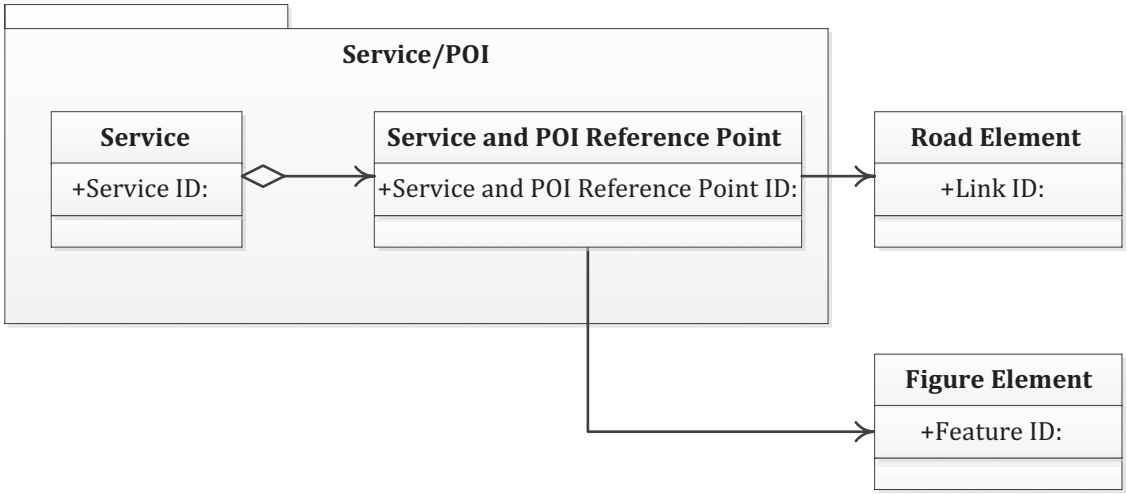


Figure 10 — Service/POI

8.4.1.1 Definition of Service/POI Reference Point

This entity provides a representative point of a Service and POI.

Service/POI relates the Cartographic, Transportation and Place Reference Point, and it is composed of some such as Service, Service and POI Reference Point and so on.

This specification does not define the detail of Service except Service/POI Reference Point.

Service/POI Reference Point information is considered to be one of the attributes of Service. However, Service/POI Reference Point is set up as the independent entity. Service/POI Reference Point provides the location information of Service/POI.

8.4.1.2 Data elements of Service/POI Reference Point

Data elements of Service/POI Reference Point are described in Table 39.

Table 39 — Data elements of Service/POI Reference Point

Data Element / Attribute	Note
Parcel ID	
POI ID	reference key
reference point coordinates	
Link and Intersection Connecting Point info.	
Service genre (category)	

8.5 Address Location

8.5.1 General

Address Location has been composed of the Place, Navigable Feature Name, Road section, Cross road, Junction and Postal code in ISO/TS 20452. However, Address Location consists of Place and Place Reference Point in this specification.

The data model for Address Location is illustrated in Figure 11 below.

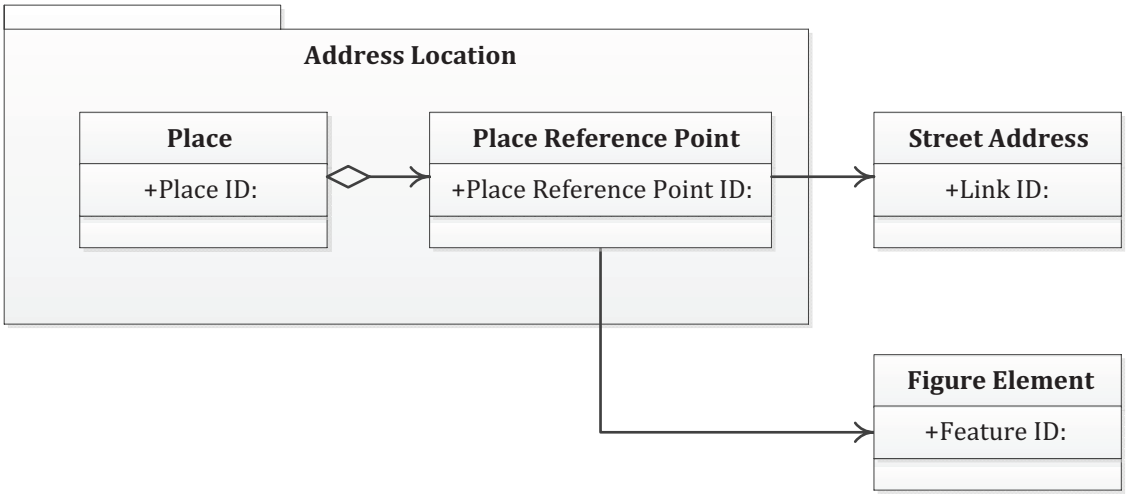


Figure 11 — Address Location

8.5.1.1 Definition of Place Reference Point

This entity provides a representative point within a Place.

Place Reference Point is considered to be one of the attributes of Place. However, Place Reference Point is set up as the independent entity.

Place Reference Point provides the location information of Place.

Area of administrative which is the part of the address such as state, county, city, town, and village, is used for searching administrative areas by Place Reference Point.

8.5.1.2 Data elements of Place Reference Point

Data elements of Place Reference Point are described in Table 40.

Table 40 — Data elements of Place Reference Point

Data Element / Attribute	Note
Place ID	reference key
Country code	following items are Japanese sample Japan, Tokyo, chuo-ku, hamacho 3chome, 42banchi, 3go, sumitomo building 6 floor
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	
coordinates of reference point	
Link ID of guidance point	
Building ID	

8.6 Dynamic Traffic Information

Dynamic Traffic Information is used to deliver real-time traffic conditions. These conditions may be used for dynamic route calculations, driving support and cooperative ITS service. In addition, the traffic information may be displayed along with the rest of the map display functionality on an informational basis only.

The basic entity in Dynamic Traffic Information is the Traffic Location. In the real world this may correspond to area locations, linear locations, e.g. part of the road, or point locations, e.g. an intersection of a position along a road.

The Traffic Location may refer to either the link or the Place Reference Point.

A Traffic Location may be on several different links, and links may contain several different Traffic Location entities. A place may contain many Traffic Location entities and a Traffic Location may be in many places.

The data model for Dynamic Traffic Information is illustrated in Figure 12 below:

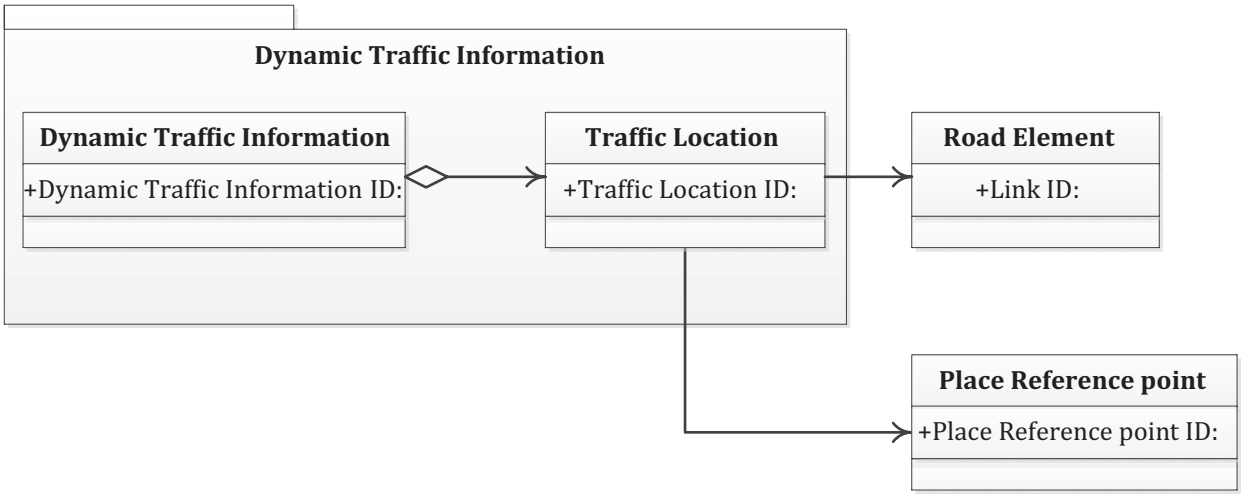


Figure 12 — Dynamic Traffic Information

8.7 Relationship of Road data entity between levels

8.7.1 General

There are number of data levels in Map entities and there are relations between the levels.

8.7.2 Relation of the Intersection and Intersection Connecting Point between levels

The Intersection Connecting Point is identified by Intersection Connecting Point ID to set the shape and the location of the road section, and the intersection is identified in intersection ID.

The coordinates of the Intersection Connecting Point are set at an appropriate position for drawing the road on the display.

The reference coordinates of the intersection are set at the location of the Intersection Connecting Point or aggregated Intersection Connecting Point.

The reference coordinates of specified intersection at all levels are the same. Therefore Intersection ID is guaranteed to the same intersection.

Intersection Connecting Points at same intersection in lower level can be integrated in upper level. Therefore Intersection Connecting Point ID between levels may be different.

8.7.3 Relation of the Links between levels

Even if the level is different, the same link has the same link ID.

However, the most links in the upper level is aggregated by some links in the lower level. Therefore, the same ID of link is very few.

The relation from a link of the upper level to a link of the lower level is defined by a relation entity that stores the link IDs of the lower levels in the link information of the upper level.

The relation between a link of the lower level and a link of upper level is defined by setting the link ID of upper level in link information of lower level.

8.8 Setting rule of Link ID, Intersection Connecting Point ID, Intersection ID between levels

In this specification, Link ID, Intersection Connecting Point ID and intersection ID have to be unique.

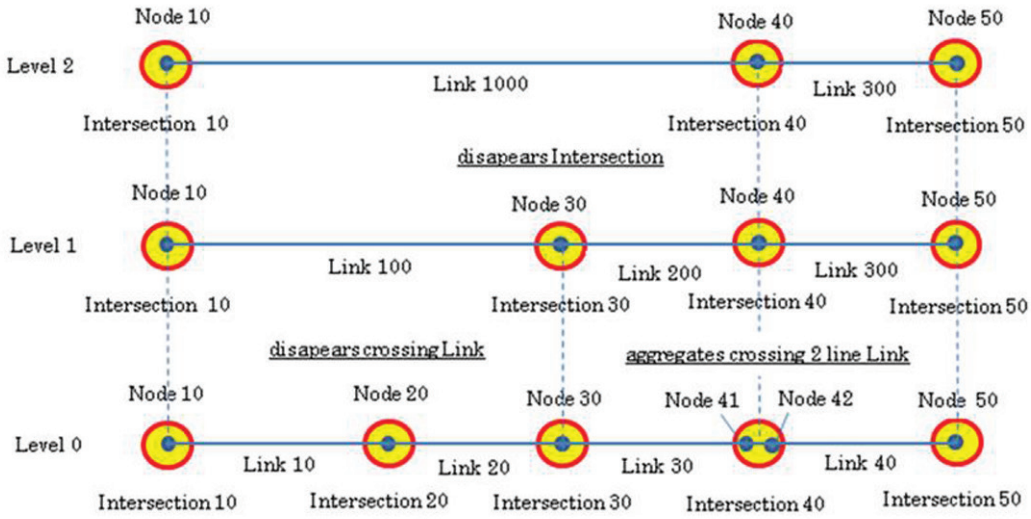


Figure 13 — Relation of Link Intersection Connecting Point Intersection between levels

Annex A
(normative)

Abstract test suite

A.1 Abstract test suite

This abstract test suite applies to the comprehensive data derived from this Technical Specification.

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 Technical Specification 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 8

c) Reference: Clauses 8

d) Test Type: Basic

Annex B
(informative)

Description of UML expression elements

This Technical Specification 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; see Reference.[2]

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

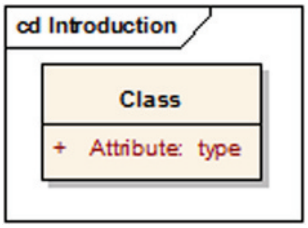
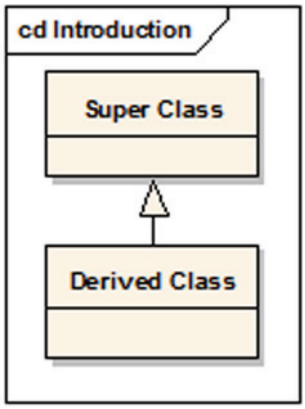
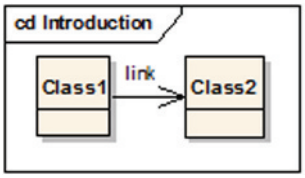
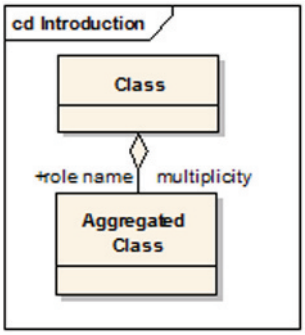
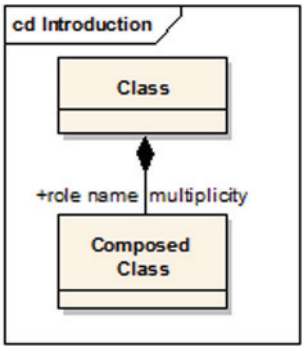
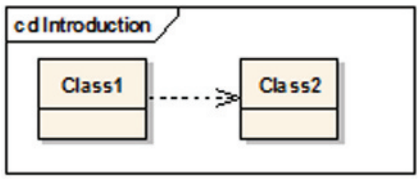
Element Name	Element	Description
Class		A class is a template for a given data element which can contain attributes. It is a rectangle divided into three compartments. The topmost compartment contains the name of the class. The middle compartment contains a list of attributes owned by that class and the bottom compartment contains a list of operations which is not shown here because operations are not used in this Technical Specification. In some diagrams, the bottom compartment of Attributes may be omitted for clarity reason. An attribute line has a specified "+, # or –" for the visibility (not used in this Technical Specification) a name of the attribute and after a colon a data type and in squared 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 imply that the derived class has at least the same attributes as the super class and normally will define more attributes to it. Reason for using an inheritance in general is the capability of having different specializations from one super class.

Table B.1 *(continued)*

Element Name	Element	Description
Association		The association shows that two classes do have a connection in between. Associations are used in this Technical Specification to express a loosely 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 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.
Aggregation		The aggregation is a more explicit design element for describing attributes. It is a more strong association telling that the class on the side of the diamond "has" a 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 that 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 -	Emergency vehicle warning
	Co-operative awareness	Slow vehicle indication
		Intersection collision warning
		Motorcycle approaching indication
	Driving assistance - Road	Emergency electronic brake lights
	Hazard Warning	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	Speed management	Regulatory / contextual speed limits notification
efficiency		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	Location based services	Point of Interest notification
services		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

Table C.1 *(continued)*

Applications Class	Application	Use case
	ITS station life cycle	Vehicle software / data provisioning and update
	management	Vehicle and RSU data calibration

Annex D
(informative)

Overview of the Target Example Services

D.1 Road Information (Warning)

D.1.1 Speed Information

1. Offer road information (Alert driver)	Feature: 1-1. Speed limit

Service overview

Offer speed information to drivers.

1. Speed limit

Inform the driver that the vehicle is exceeding speed limit.

In case of exceeding speed limit more than the given period of time, the system will alert the driver.

2. Safety speed

Inform driver of exceeding the critical speed when safety cannot be secured enough.

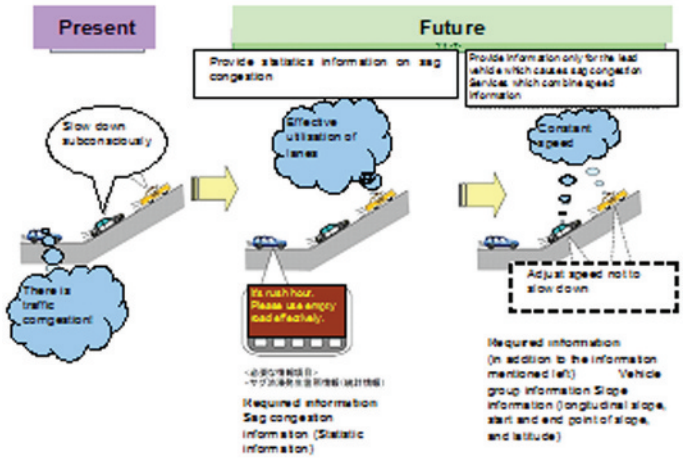
Critical speed is calculated based on the road structure (curvature and slope). Since critical speed differs from the conditions of the surface, information on road surface will also be important.

In case of over speeding the critical speed more than the given period of time, the system will alert the driver.

3. Sag congestion

Sag congestion can occur due to the decrease in speed

When driving through sag, and when decrease in speed is detected, the system will alert the driver that he/she should increase speed.



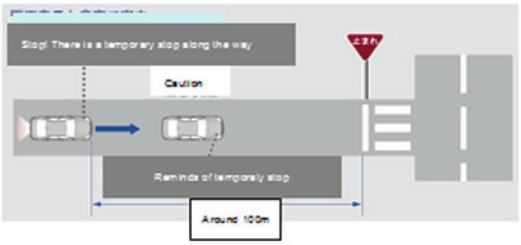
Target	Road information required	Management actor	Further note
1. Speed limit	Speed limit information	Public safety commission of each prefecture	

Advantage of the service

Reduce traffic accident due to over speeding

1. Offer road information (Alert driver)		Feature: 1-1. Speed limit	
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	
Advantage of the service Reduce traffic accident due to over speeding			

D.1.2 Traffic Restriction Information

1. Offer road information (Alert driver)		Feature: 1-2. Traffic Restriction information	
Service overview Alert the driver of over sighting Traffic Restriction. 1. Temporary stop When the driver seems to overpass the temporary stop without reducing speed, the system will alert the driver that a temporary stop exist interiorly.  2. One way When the driver travels the wrong way on one-way street, the system alerts and offers way to escape.			
Target	Traffic information required	Management actor	Further note
1. Temporary stop	Temporary stop information	Public safety commission of each prefecture	Temporary stop sign, temporary stop line
2. One way	One way information	Public safety commission of each prefecture	
Advantage of the service Reduce traffic accident due to over sighting the Traffic Restriction sign.1.Offer road information(Alert driver)			

D.1.3 Lane Information

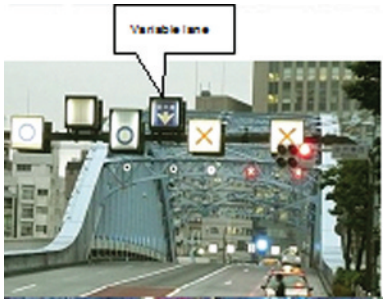
1. Offer road information (Alert driver)	Feature: 1-3. Lane informationService overview

Offer lane regulation information which changes intricately.

1. Driving lane

Offer information about right-turn-only lane, left-turn-only lane and inform the driver of driving lane.

Information about streets with reversible lane, which is set for changing direction in order to help relief the congested street, will be also offered.



At roads with bus lane, information about them will be offered and at the same time in a Traffic Restriction hour, information about NO THROUGH ROAD or right-way-road will be offered and driver will be alerted.

Target	Traffic information required	Management actor	Further 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

Advantage of the service

Reduce traffic accidents caused by the driver unaccustomed to roads whose lane is intricately regulated.

D.1.4 Sign Information

1. Offer road information (Alert driver)	Feature: 1-4. Sign informationService overview

Offer information on signs deployed on the road, and alert the driver. It would be better to reference the CISO/TS 14823.

1. Signs

Caution on driving roads, will be deployed by road administrator as alert signs.

Offer information about alert signs to the driver, the system can remind the driver of over sighting.

Target	Traffic information required	Management actor	Further note
1. Sign	Alert sign	Road administrator	Advantage of the service
Reduce risky drive caused by over sighting alert signs			

D.1.5 Traffic Information

<table>
<tr><td colspan="2">1. Offer road information (Alert driver)</td><td colspan="2">Feature: 1-5. Traffic Information</td></tr>
<tr><td colspan="4">Service Overview
Offer information on road condition.
1. Congestion information
Remind the driver of rear-end collision by offering information about the congestion and the end of congestion.
2. Road construction
Remind the driver by offering information on road construction area.
3. Temporary Traffic Restriction
Remind the driver by offering information on temporary Traffic Restriction area.
  </td></tr>
<tr><td>Target</td><td>Traffic information required</td><td>Management actor</td><td>Further note</td></tr>
<tr><td rowspan="2">1. Traffic congestion information</td><td>Traffic congestion information</td><td>Road administrator</td><td>Dynamic information</td></tr>
<tr><td>Tailback information</td><td>Road administrator</td><td>Dynamic information</td></tr>
<tr><td>2. Road construction</td><td>Road construction information</td><td>Road administrator</td><td>Dynamic information</td></tr>
<tr><td>3. TemporaryTraffic Restriction</td><td>Temporary Traffic Restriction information</td><td>Public safety commission of each prefecture
Road administrator</td><td>Dynamic information</td></tr>
<tr><td colspan="4">Advantage of the service
Reduce traffic accidents caused by changes in road condition, by offering information on road condition.</td></tr>
</table>

D.1.6 Road Surface Information

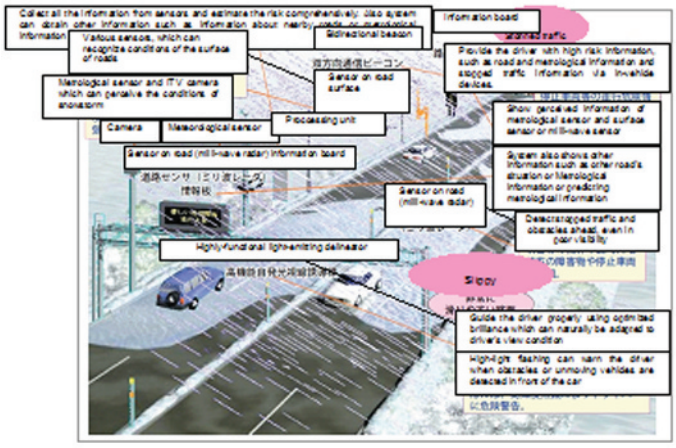
1. Offer road information (Alert driver)	Features: 1-6. Road surface information

Service overview

Remind the driver by offering information on road surface, which may obstruct traffic.

1. Flood, Freeze

Remind the driver by offering information on flood and freeze, when driving roads where flood and freeze may interfere driving.



Predict freeze and flood from its archival record and from temperature, rainfall and snowfall. Also alert the driver who may drive that road by offering the information.

Target	Traffic information required	Management actor	Further note
1. Flood and Freeze	Flood information	Road administrator	Dynamic information
	Freeze information	Road administrator	Dynamic information
	Temperature, rainfall and snowfall	Metrological Agency	Predict freeze and flood from its archival record and from temperature, rainfall and snowfall.
	Archival record	Service provider	

Advantage of the service

Reduce traffic accidents caused by aggravation of road surface, by offering information about road surface.

D.1.7 Zone Information

1. Offer road information (Alert driver)	Feature:1-7. Zone information

Service overview

Remind driver by offering information about road users.

1. School zone, elder care facility zone, residential district.

For local residents, road is a part of their lives. Therefore, the system will remind the driver by offering information about local resident's road using situation.

School zone:

Divide up road for pedestrians and for cars, in order to secure pupils and children going to school.

Setup for about 500 m in radius of elementary school or kindergarten.

There are more than 21,000 areas all over Japan.(April 2006)

Elder care facility zone:

Setup for about 500 m in radius of facilities used by elder people in order to secure them from traffic accidents.

Target	Traffic information required	Management actor	Further note
1. School zone, elder care facility zone, residential district.	School zone information	Municipality	
	Elder care facility zone information	Municipality	
	Residential district information	Municipality	

Advantage of the service

Secure the safety of drivers, pedestrians and residents.

D.1.8 Weather Information

1. Offer road information (Alert driver)	Features: 1-8. Weather information

Service overview

Remind the driver by offering weather information

1. Rainfall, snowfall, storm wind

Remind the driver by offering information about rainfall, snowfall and storm wind.

2. Sight

In case which heavy rain, fog, snow storm may disturb driver's sight and may cause problems, the system can offer information about them and remind the driver.

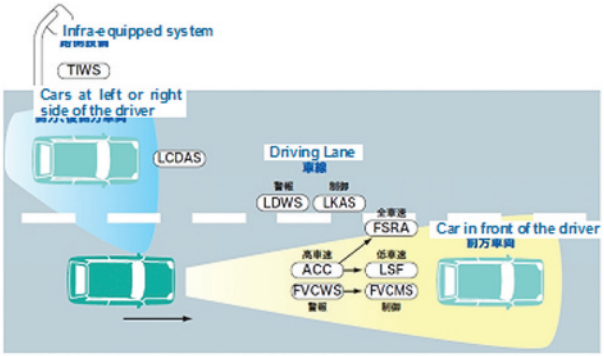
Target	Traffic information required	Management actor	Further note
1.Rainfall, snowfall, wind storm	Rainfall information	Metrological Agency	Dynamic information
	Snowfall information	Metrological Agency	Dynamic information
	Wind storm information	Metrological Agency	Dynamic information
2. Sight	Sight information	Road administrator	Dynamic information

Advantage of the service

Reduce traffic accidents caused by aggravation of weather by offering information of weather.

D.2 Information Around the Vehicle (Warning)

D.2.1 Information Around the Vehicle

<table>
<tr><td colspan="2">2. Offer information around the vehicle (Alert driver)</td><td colspan="2">Features: 2-1.Information around the vehicle</td></tr>
<tr><td colspan="4">Service overview
System will perceive situation around the vehicle (existence of other vehicles and so on) and remind driver.
1.Interflow
At interflow section, infra-equipped detector may detect other vehicle interflowing and inform the driver through vehicle-infra communication.
3. Overtaking
Remind the driver of overtaking in a road where overtaking is not permitted.
Receive information on other vehicles through camera, radar or communication system and inform the driver of existence of other vehicles.
3. Lane change
Remind the driver of lane change in a road where lane change is not permitted.
Receive information on other vehicles through camera, radar or communication system and inform the driver of existence of other vehicles.
4. Oncoming vehicle
Infra-equipped detector may detect other vehicle coming from the opposite direction on the road whose width is minimized and the system will remind the driver.
5. Trolley
In a direction of a trolley, infra-equipped communication may detect the approaching of a trolley and remind the driver.
 
</td></tr>
<tr><td>Target</td><td>Traffic information required</td><td>Management actor</td><td>Further note</td></tr>
<tr><td>1. Interflow</td><td>Interflow area</td><td>Road administrator</td><td></td></tr>
<tr><td>2. Overtaking</td><td>Overtaking prohibited area</td><td>Public safety commission of each prefecture</td><td></td></tr>
<tr><td>3. Lane change</td><td>Lane change prohibited area</td><td>Public safety commission of each prefecture</td><td></td></tr>
<tr><td>4. Oncoming vehicle</td><td>Road width minimized area</td><td>Road administrator</td><td></td></tr>
</table>

2. Offer information around the vehicle (Alert driver)		Features: 2-1.Information around the vehicle	
5. Trolley	Information about trolley direction	Road administrator	
	Information on whether driving into orbital area is possible	Public safety commission of each prefecture	
Advantage of the service Reduce traffic accidents caused by overtaking or lance change.			

D.2.2 Intersection Information

2. Information around the vehicle (Alert driver)	Features: 2-2. Intersection information

Service overview

Offer information on vehicles and pedestrians at intersections.

1. Straight

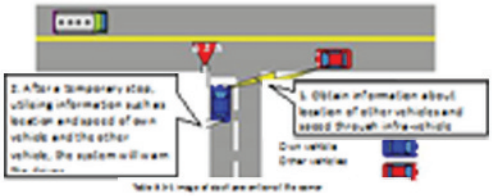
Receive information on vehicle approaching from non-preferred crossing road, which information is made from infra-vehicle communication detected by infra-equipped detector. The system will remind the driver of it, in an intersection without traffic rights.

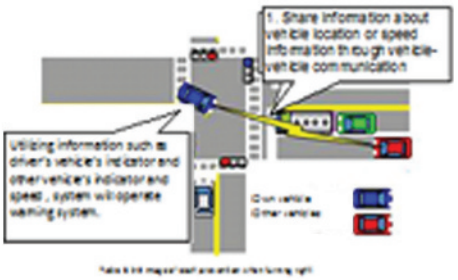
2. Right turn

Remind the driver of car from the opposite direction and pedestrians walking crosswalk, which information is received by infra-vehicle communication and detected by infra-equipped detector.

3. Left turn

Detect the existence of two-wheels driving left side by camera or such equipments, and detect pedestrians walking crosswalk by infra-equipped detector, and remind the driver through infra-vehicle communication.





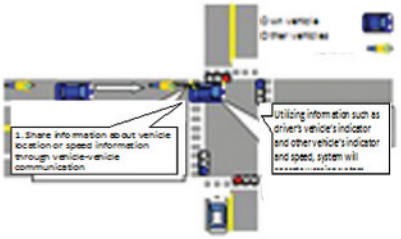


Table 3.14 Image of crash prevention when turning left

Target	Traffic information required	Management actor	Further note
1. Straight	Detailed information of intersections	Road administrator	Clarify the positions of vehicles and pedestrians In an intersection.
2. Right turn	Detailed information of intersections	Road administrator	
3. Left turn	Detailed information of intersections	Road administrator	

Advantage of the service

Reduce traffic accidents caused by oversight cars from the opposite direction, pedestrians, two-wheels at intersection.

D.3 Vehicle Control

D.3.1 Vehicle Control (Parametric Control)

3. Vehicle Control		Features: 3-1. Parametric Control	
Service Overview Improve vehicle's safety by using road data and optimizing regulation of vehicle control unit 1. ACC In ACC, it is possible that a sensor, which 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), it can optimize ACC control. 2. Shift Control Control shift appropriately by providing shift control unit with information on detailed road geometry (Curvature/Slope). Enable shift control, in response to changes of road surface condition, by providing road surface information. 3. Suspension Control Control suspension appropriately, by providing suspension control unit with information on detailed road geometry (Curvature/Slope). Enable suspension control, in response to changes of road surface condition, by providing road surface information, 4. Light Control Control light appropriately (control light distribution) by providing light control unit with detailed information on road geometry (Curvature/Slope). 5. Stability Control Control brake and engine-torque appropriately, by providing stability control unit with detailed information on road geometry (Curvature/Slope). 6. Power Control Optimize 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 electrical vehicles. Control remaining battery level appropriately, by calculating power consumption, remaining battery level, and distance to a nearest charging station.			
Target	Traffic information required	Management actor	Further 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

3. Vehicle Control		Features: 3-1. Parametric Control	
6. Electricity Control	Slope	Road administrator	
	Charging station	Service provider	
	Meteorological information	Meteorological Agency	Dynamic information
Advantage of the service Enable safe and comfortable drive by optimising vehicle controls according to uncertain road conditions			

D.3.2 Vehicle Control (Brake Control)

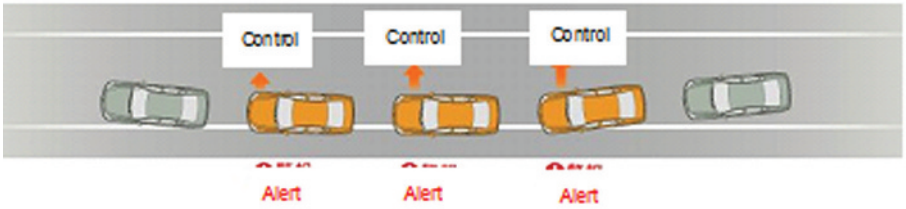
3. Vehicle Control	Features: 3-2.Vehicle Control (Brake Control)

Service Overview

Avoid dangers by controlling vehicle's brake via driving support unit

1. Lane keeping

Control each brake on each wheel individually and get the vehicle back to lane, when in-vehicle camera finds out that lane departure is likely to take place.



2. Speed Control

Operate brake and control speed not to exceed the speed limit, when it exceeds the speed limit and the driver does not reduce speed or ignore the alert.

Enable brake control, in response to changes of road surface condition, by providing information on road surface.

3. Halt operation

Operate brake and reduce speed when the driver does not slow down after halt instruction.

4. Avoidance of collision

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

Reduce damage by operating brake and activate seatbelt, when a collision is inevitable.

Enable brake control, in response to changes of road surface, by providing information on road surface.

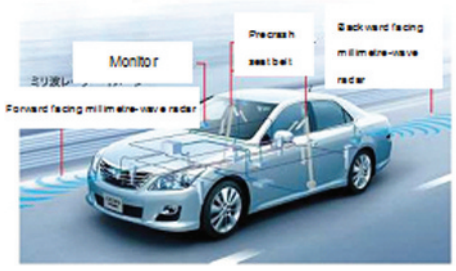
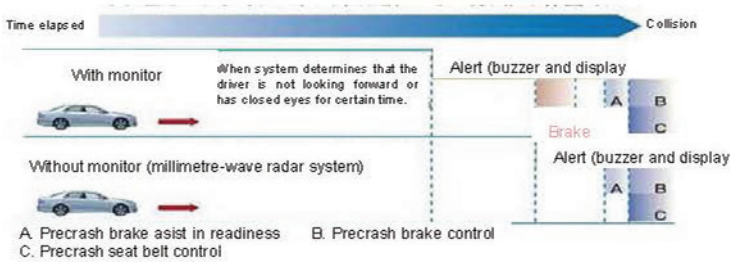


Image of Precrash safety system

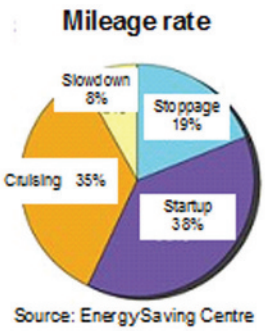


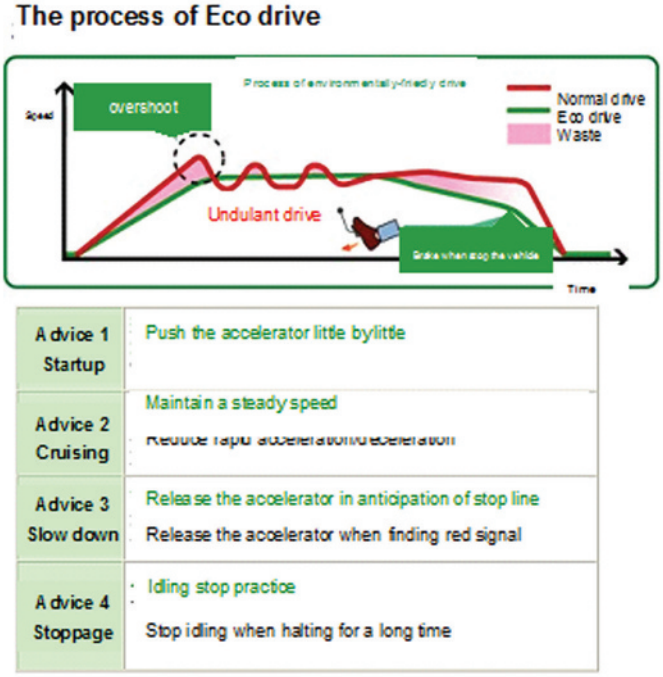
Target	Traffic information required	Management actor	Further note
1. Lane keeping	Lane information	Road administrator	

3. Vehicle Control		Features: 3-2.Vehicle Control (Brake Control)	
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. Avoidance of collision	Curvature/Slope	Road administrator	
	Road surface information	Road administrator	Dynamic information
Advantage of the service Reduce damage by controlling Blake, when the vehicle is in danger			

D.4 Transportation Information

D.4.1 Environment Information

<table>
<tr><td>4. Offer transportation Information</td><td colspan="3">Features: 4-1. Environment</td></tr>
<tr><td colspan="4">Service Overview
Provide information for environmentally-friendly drive
1. Control CO2 emission
Road geometry (Curvature, Slope), speed, and stop-start movement at intersections influence the amount of CO2 emission.
Offer driving plan (departure time, break time) and the route which minimize CO2 emission, based on the information.
 

Source: EnergySaving Centre
 

Source:Japan Automobile Federation website</td></tr>
<tr><td>Target</td><td>Traffic information required</td><td>Management actor</td><td>Further note</td></tr>
<tr><td rowspan="4">1. Control CO_2 emission</td><td>Curvature, Slope</td><td>Road administrator</td><td></td></tr>
<tr><td>Speed limit information
Intersection information</td><td>Public safety commission of each prefecture</td><td></td></tr>
<tr><td>Traffic congestion information</td><td>Road administrator</td><td>Dynamic information</td></tr>
<tr><td>Mileage</td><td>Service provider</td><td>Mileage table on actual road</td></tr>
<tr><td colspan="4">Advantage of the service
Reduce the amount of CO_2 emission</td></tr>
</table>

D.4.2 Transfer Point Information

4. Transfer Point Information	Service Function:4-2. Driving Support

Service Overview

1. Car park

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

Provide the driver with information about their cars' parking lot when he/she is not in their vehicle.

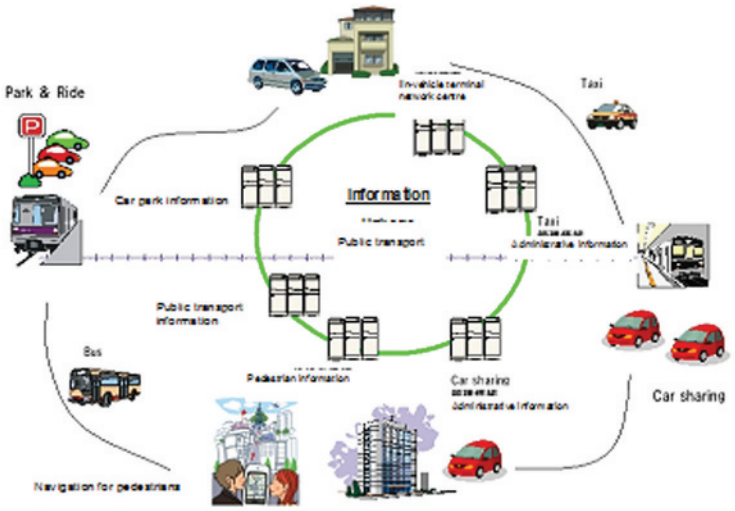
2. Park and Ride

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

Support transfer to public transport.

3. Multi-modal

Provide information on modal shift at transfer points in order to support Multimodal transfer.



Target	Traffic information required	Management actor	Further note
1. Car Park	Car Park information	Parking facility operations company	Location of car parks, opening hour, intended type of vehicles, 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. Mult-modal	Transfer point information	Transport facility	Standardization of information is necessary
Advantage of the service Reduce the amount of CO_2 emission			

Annex E
(informative)

Data Flow of the Target Example Services

E.1 General

These data flows are Japanese cases.

E.2 Road Information (Warning)

E.2.1 Speed Information

1.Offer road information(Alert driver)						Feature: 1-1. Speed information					
Detail of road information used 1. Speed limit For offering Information about speed limit, information possessed by Public safety commission of each prefecture will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Speed limit information	Public safety commission of each prefecture	Speed regulation information	—	Public safety commission of each prefecture	DRM confirms the signs on the spot	DRM	S	Not yet determined	Unknown	Basic road (Motorways, national roads and prefecture roads or roads with a width of over 5.5 m) and at the same time those around some intersections.	
				—	National Institute for Land and Infrastructure Management (NILIM) NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
2. Safety speed For offering information about safety speed, information possessed by road administrator such as curvature and slope and elevation or high risk area information and surface information possessed by road administrator and vehicles and drivers will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format

1.Offer road information(Alert driver)						Feature: 1-1. Speed information					
Curvature, slope	Road administrator	Curvature radius	—	Road administrator	DRM	DRM	S	4 times a year	Unknown	Basic road	
			30 cm	Road administrator	NILIM←NEXC	RM		Not yet determined	Unknown	Some motorways	
		Longitudinal slope	—	Road administrator	DRM	DM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
			—	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Altitude	Few m	Road administrator	Public companies	DRM	S	Not yet determined	Unknown	Basic road	
Dangerous points information	Road administrator, user										
Road surface information	Road administrator, user										

3. Sag congestion Sag congestion information possessed by road administrator and speed limit information possessed by public safety commission of each prefecture will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Sag area	Road administrator	Sag congestion information	—	Road administrator [NEXCO (East, Central, West), Honshu-Shikoku Bridge Expressway Company Limited]	Road administrator [NEXCO (East, Central, West), Honshu-Shikoku Bridge Expressway Company Limited]	DRM	S	Not yet determined	Unknown	Some motorways	
Speed limit information	Public safety commission of each prefecture	Speed regulation information	—	Public safety commission of each prefecture	DRM confirms the signs on the spot	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
			—	—	NILIM-NEXCO	DRM	S	Not yet determind	Unknown	Some motorways	

1.Offer road information(Alert driver)	Feature: 1-1. Speed information

Overview of information flow

1. Speed Limit

Public safety commission of each prefecture offers new information to Map Centre, when information about speed limit is updated.

Map Centre integrates information.

Service Centre sends speed limit information as attribute of link to vehicle-equipped system.

In-vehicle devices will operate alerting to driver, depending on information from Service Centre and responding to car location and driving speed.

2. Safety speed

Each road administrator will provide information to Map Centre when information about safety speed is updated.

Each road administrator provides surface information to Disaster Prevention Centre as needed.

Map Centre integrates data.

Service Centre transmits alert starting point and safety speed to in-vehicle devices, calculating from curvature, slope, elevation, high risk area information. Also, it transmits surface information to in-vehicle devices.

In-vehicle devices will alert the driver based on car position and driving speed, and will alert by following those data sent by Service Centre.

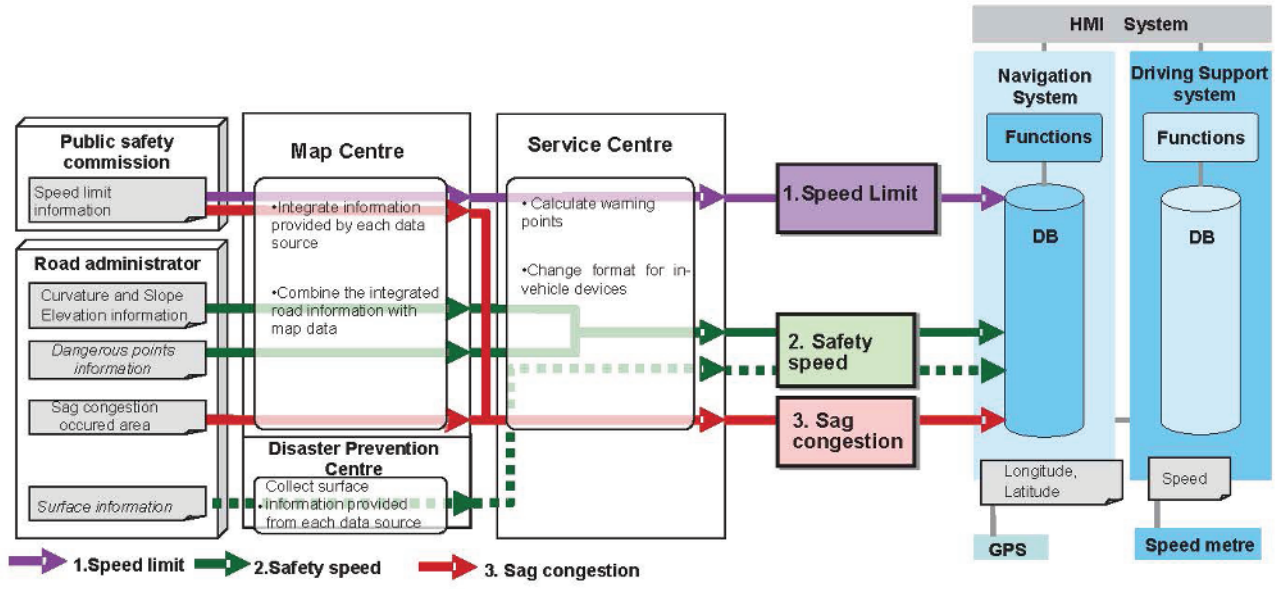
3. Sag congestion

Each road administrator and public safety commission of prefecture will provide information to map centre when information about sag is updated.

Map Centre integrates data.

Service Centre transmits information on alert staring point and recommended speed to in-vehicle devices, calculated from sag congestion information and speed regulation information.

In-vehicle devices will alert the driver, based on car location and driving speed and following those data sent by Service Centre.



Requirements for Navigation system

Store alert starting point, safety speed, recommended speed and surface information as a point.

Store speed regulation information as an attribute of link.

As for road surface information, real-time updating is necessary.

Chart. Road information used in Navigation system

Information flow			Requirements for navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Speed regulation information	—	1. Speed limit	Attributes of link	Unknown	S

1.Offer road information(Alert driver)			Feature: 1-1. Speed information		
Curvature radius Longitudinal slope Altitude information Dangerous points information	Alert starting point Safety speed	2. Safety speed	Position	Unknown	S (Curvature radius which is preexistent data is updated 4 times per year)
Road surface information	—	2. Safety speed	Position	Unknown	R
Sag congestion information	Alert starting point Recommended speed	3. Sag congestion	Position	Unknown	S
Speed regulation information					
NOTE Underlined parts are difficult to obtain after all research, and italics mean that item is uninvestigated at TG1.					

E.2.2 Traffic Restriction Information

1.Offer road information (Alert driver)						Feature: 1-2. Traffic Restriction information					
Detail of road information used 1. Temporary stop For offering information about temporary stop, stop line information possessed by road administrator and regulation sign information possessed by public safety commission will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Information on temporary stop	Road administrator Public safety commission of each prefecture	Stop line	30 cm	Road administrator	DRM measured	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
		Regulatory sign	—	Public safety commission of each prefecture	Public safety commission of each prefecture	Traffic Safety Association	S	—	Unknown	—	
2. One way For offering information about one way, Traffic Restriction information's possessed by public safety so mission of each prefecture will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	
One way information	Public safety commission of each prefecture	Traffic Restriction information	—	Public safety commission of each prefecture	Public safety commission of each prefecture	Japan Traffic Management Technology Association (JTMTA), TMI	S	Once a year (unknown from now)	Unknown	Basic road	

1.Offer road information (Alert driver)	Feature: 1-2. Traffic Restriction information

Overview of information flow

1. Temporary stop

Road administrator and public safety commission will provide information to Map Centre when information on temporary stop is updated.

Information is collected at map centre. Service Centre will calculate alert-starting-point from information on stop line and regulation sign, and will deliver it to in-vehicle devices as a point.

In-vehicle devices will operate alert system based on information received from service centre, on car location and driving speed and stop line detected by CCD camera.

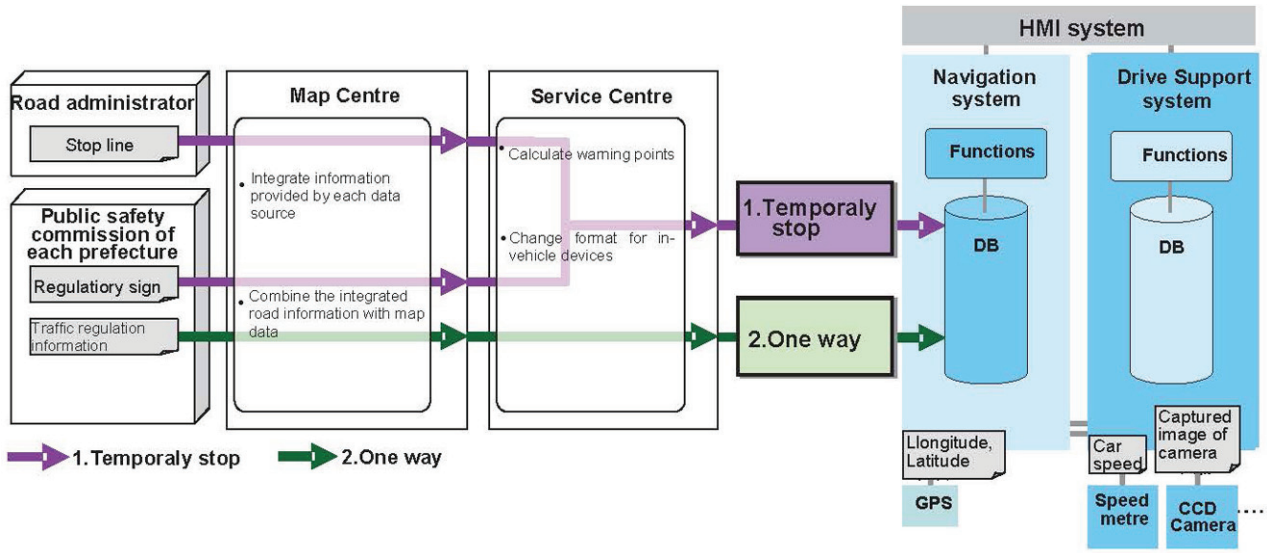
2. One way

Road administrator and public safety commission will provide information to Map Centre when information about one way is updated.

Map Centre integrates information.

Service Centre will check if there is one way or not and which way driver can drive from information about Traffic Restriction information, which will be transmitted to in-vehicle devices as an attribute of link.

In-vehicle devices will operate alert system based on information received from Service Centre and on car location and driving speed.



Requirements for navigation system

Store alert starting point as a point.

Store available direction and existence of the one way as a attribute of Link

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Stop line Regulatory sign	Alert starting point (temporary stop)	1. Temporary stop	Spot	Unknown	S
Traffic Restriction information	Existence or non-existence of Traffic Restriction Availble direction	2. One way	Attribute of link	Unknown	S (Traffic Restriction data, which are preexistent data, will be updated once a year)

E.2.3 Lane Information

1.Offer road information (Alert driver)						Feature: 1-3. Lane information					
Detail of road information used 1. Driving Lane For providing information about driving lane, intersection regulation information and Traffic Restriction information, regulation sign information possessed by public safety commission will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Lane regulation information	Public safety commission of each prefecture	Intersection regulation information	—	Public safety commission of each prefecture	Public safety commission of each prefecture	JTMTA, TMI, etc.	S	Once a year	Unknown	Basic road	
		Traffic Restriction information	—	Public safety commission of each prefecture	Public safety commission of each prefecture	JTMTA, TMI, etc.	S	Once a year (unknown from now)	Unknown	Basic road	
		Regulatory sign	—	Public safety commission of each prefecture	Public safety commission of each prefecture	Traffic Safety Association	S	—	Unknown	—	
Variable lane information	Public safety commission of each prefecture	Same as above									
Bus lane information	Public safety commission of each prefecture	Same as above									

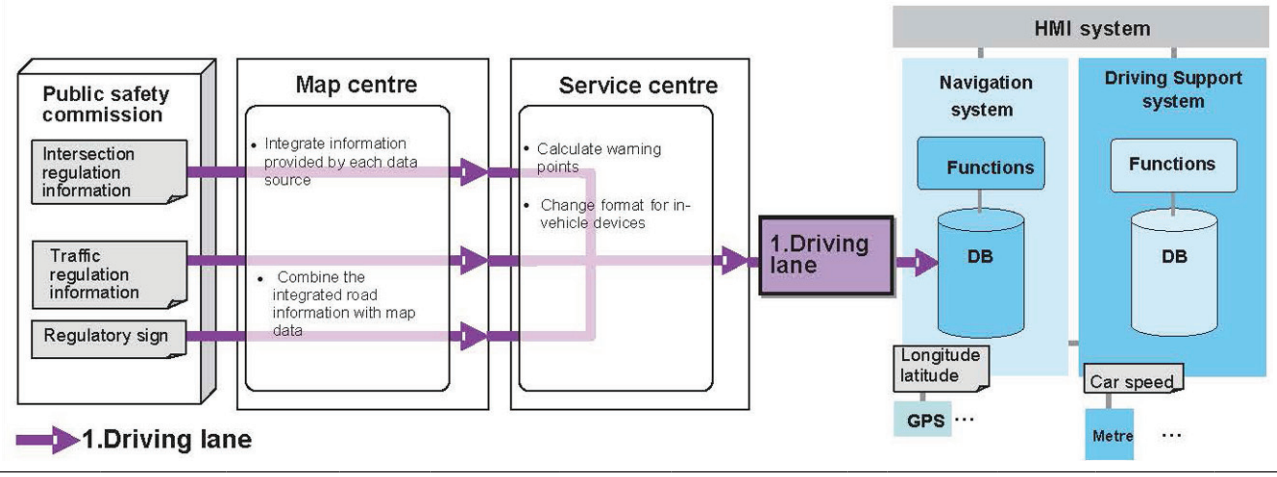
Overview of information flow

1. Driving lane

Public safety commission of each prefecture will provide information to Map Centre when information about driving lane is updated.

Map Centre integrates information. TURNRIGHT, TURNLEFT lane, Variable lane, Bus lane and those regulation conditions (regulation hours, available directions) will be calculated or detected at Service Centre to an attribute of link and it will be delivered to in-vehicle devices.

In-vehicle devices will operate alert system based on information from Service Centre and will operate following car position and driving speed.



1.Offer road information (Alert driver)			Feature: 1-3. Lane information		
Requirements for navigation system Store information about TURNRIGHT TURNLEFT lane, Variable lane and Bus lane and regulation conditions as attributes of Link. Chart. Road information used in Navigation system					
Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Intersection regulation information	TURNRIGHT, TURNLEFT lane Variable lane Bus lane Regulation information	1. Driving lane	Attribute of link	Unknown	S (intersection regulation information and Traffic Restriction information, which is preexistent information, is updated once a year
Traffic Restriction information					
Regulatory sign					

E.2.4 Sign Information

1.Offer road information (Alert driver)						Feature: 1-4. Sign information					
Detail of road information used 1. Sign In order to provide information on road signs, alert signs information possessed by road administrator will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Alert sign	Road administrator	Alert sign	—	Road administrator	Road administrator	—	S	—	Unknown	—	

Overview of information flow

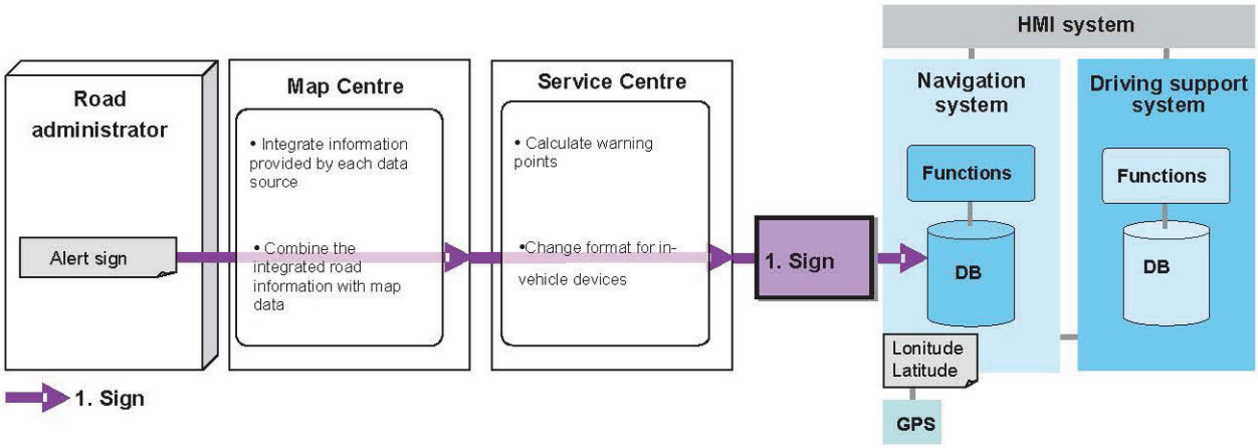
1. Sign

Each road administrator will provide information to Map Centre when information about road signs is updated.

Map Centre integrates information.

Service Centre will calculate alert starting points and alert content from alert sign information, and deliver information as a point to in-vehicle devices.

In-vehicle devices will operate alert system based on information from Service Centre, and will operate alert system following to car location.



Requirements for navigation system Store alerted sections as attributes of link, and alert started point and alerted content as a point. Chart. Road information used in Navigation system	
Information flow	Requirements for Navigation system

1.Offer road information (Alert driver)			Feature: 1-4. Sign information		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Alert Sign	Alerted section Alerted content Alert started point	1. Sign	Point Attribute of link	Unknown	S

E.2.5 Traffic Information

1.Offer road information (Alert driver)											
Feature: 1-5. Traffic information											
Detail of road information used 1. Traffic congestion information For offering information about congestion, information possessed by each prefectural police and each road administrator will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Traffic congestion information	Each prefectural police Road administrator	Traffic congestion information	—	Each prefectural police, road administrator (Regional Bureau, NEXCO, etc.)	Each prefectural police, road administrator (Regional Bureau, NEXCO, etc.)	JARTIC	R	Every 5 min	Unknown	—	
Tailback information	Road administrator										
2. Road construction For offering information about road construction, construction regulation information possessed by road administrator will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Road construction information	Road administrator	Construction regulation information	—	Road administrators	Road administrator	JARTIC, road administrator	R	Regulation in case of road construction	Unknown	—	
3. Temporarily Traffic Restriction For offering information about temporarily Traffic Restriction, closed to traffic information possessed by public safety commission of each prefecture will be used.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Temporarily Traffic Restriction	Public safety commission of each prefecture										

1.Offer road information (Alert driver)	Feature: 1-5. Traffic information

Overview of information flow

1. Traffic congestion information

Each road administrator and each prefectural police will provide Japan Road Traffic Information Centre with information on traffic congestion and the tailback as needed.

Japan Road Traffic Information Centre integrates information. Service Centre provides in-vehicle devices with traffic congestion information as an attribute of link, and information on the tailback as a point.

In-vehicle devices will operate alert system based on information from service centre, and will operate alert system following to car position.

2. Road construction information

Each road administrator provides information for Japan Road Traffic Information Centre when traffic is restricted due to road constructions.

Japan Road Traffic Information Centre integrates information. Service Centre provides in-vehicle devices with regulatory information as an attribute of link.

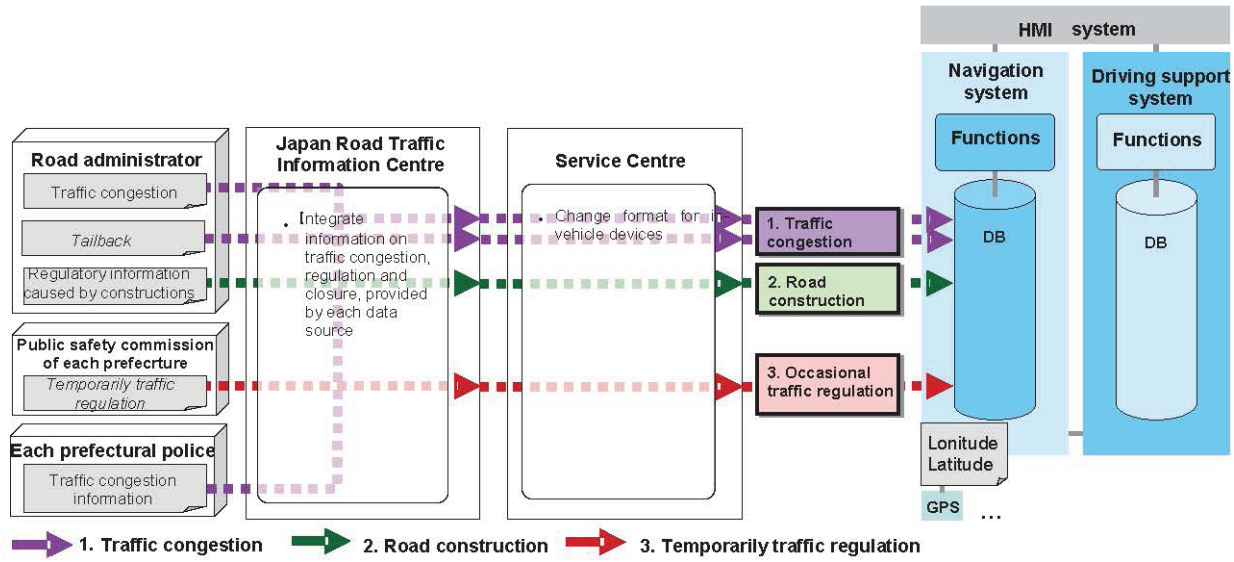
In-vehicle devices will operate alert system based on information from Service Centre, and will operate alert system following to car location.

3. Temporarily Traffic Restriction

Public safety commission of each prefecture provides information for Japan Road Traffic Information Centre when road traffic is rerouted during events.

Japan Road Traffic Information Centre integrates information. Service Centre provides in-vehicle devices with information on temporarily Traffic Restriction as an attribute of link.

In-vehicle devices will operate alert system based on information from service centre, and will operate alert system following to car location.



NOTE: Solid lines represent flow of static information, and dot-lines represent flow of dynamic information.
NOTE: Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item at TG1.

Requirements for Navigation system

Store traffic congestion information, road construction information and temporarily regulation information as attributes of link, and information on the tailback as a point.

Update traffic congestion information, road construction information and temporarily Traffic Restriction information in real time.

Chart. Road information utilized in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Traffic congestion	—	1. Traffic congestion information	Attribute of link	Unknown	R (Traffic congestion information is updated every 5 min)

1.Offer road information (Alert driver)			Feature: 1-5. Traffic information		
Tailback	—	1. Traffic congestion information	Point	Unknown	R
Regulatory information caused by constructions	—	2. Road construction information	Attribute of link	Unknown	R
Temporarily traffic information	—	3.Temporarily Traffic Restriction	Attribute of link	Unknown	R
NOTE Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item at TG1.					

E.2.6 Road Surface Information

1.Offer road information (Alert driver)						Feature: 1-6. Road surface information					
Detail of road information used 1. Flood, freeze Information service on flood and freeze uses information on flood, freeze, temperature, rainfall and snowfall, which is possessed by Metrological Agency. Also, it uses archival record possessed by service providers.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Flood information	Road administrator										
Freeze information	Road administrator										
Temperature rainfall snowfall	Meteorological Agency Road administrator	Real-time rainfall	—	Meteorological Agency Road administrator	Meteorological Agency Road administrator	Disaster prevention information centre	R	Every 10 min	Unknown	Some observation points	
Archival record	Service provider										

1.Offer road information (Alert driver)	Feature: 1-6. Road surface information

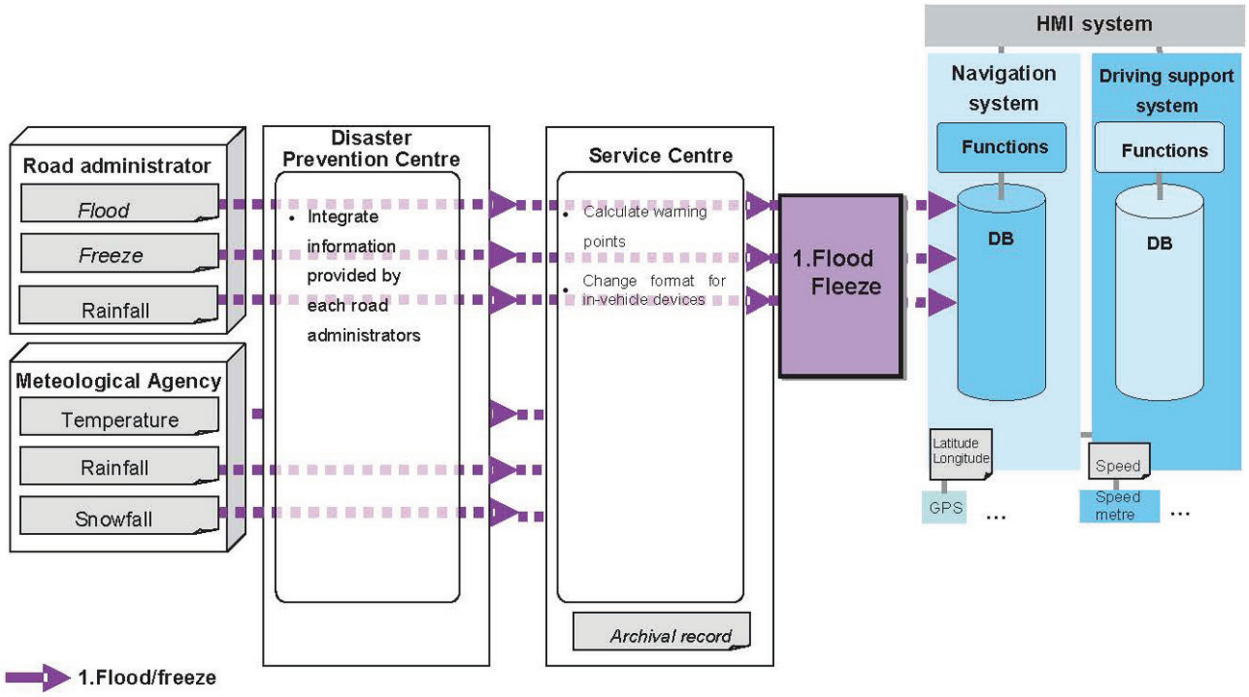
Overview of information flow

1. Flood, freeze

Each road administrator provides information on flood and freeze for Disaster Prevention Centre as needed. Metrological Agency provides information on temperature, rainfall and snowfall to the Centre as needed.

The Disaster Prevention Centre integrates information. Service Centre provides in-vehicle devices with the information on flood and freeze as spots. Also, Service Centre provides in-vehicle devices with the information on the places where flood and freeze are likely to occur as points, based on the information on temperature, rainfall, snowfall and archival record.

In-vehicle devices alert the driver, based on the location of the own vehicle and driving speed, in addition to the information on Service Centre



NOTE: Solid lines represent flow of static information, and dot-lines represent flow of dynamic information.

Store the information on flood, freeze and the places where flood and freeze are likely to occur as points.

Update information on flood, freeze and the places where flood and freeze are likely to occur in real-time.

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Flood	—	1. Flood, freeze	Point	Unknown	R
Freeze	—	1. Flood, freeze	Point	Unknown	R
Temperature rainfall snowfall	Places where flood and freeze are likely to occur	1. Flood, freeze	Point	Unknown	R (The original data on rainfall is updated every 10 min)
Archival record					

NOTE Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item.

E.2.7 Zone Information

1. Road information (Warning)	Features: 1-7. Zone information

Details of road information used

1. School zone, elder care facility zone, residential district

Information service on school zone, elder care facility zone and residential district uses information on school zone, elder care facility zone and residential district possessed by municipalities.

1. Road information (Warning)						Features: 1-7. Zone information					
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
School zone	Municipality										
Elder care facility zone	Municipality										
Residential district	Municipality										

NOTE School zone and Elder care facility zone are determined by municipalities and the regulation in these zones is determined by the police department.

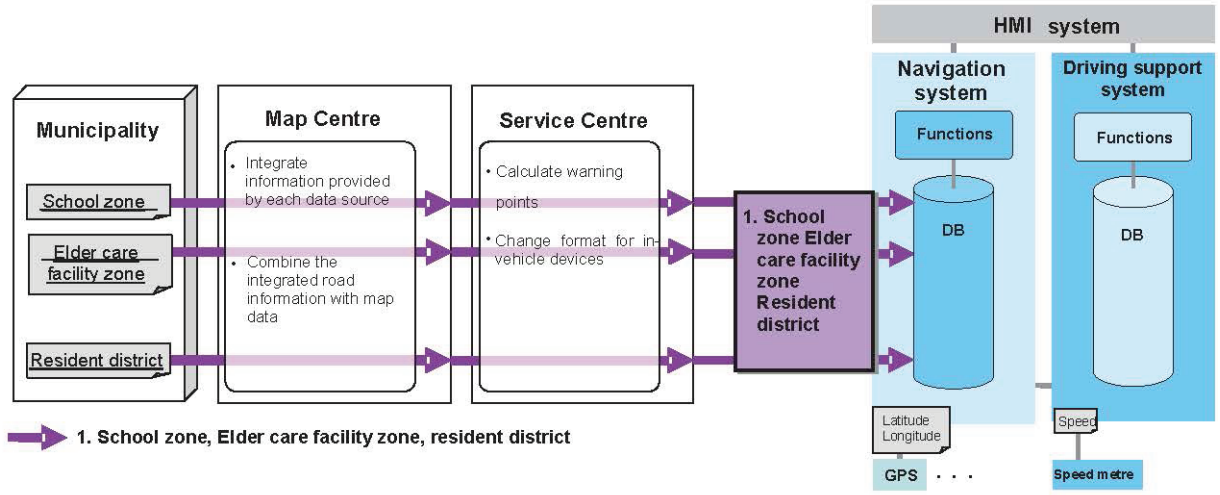
Overview of information flow

1. School zone, elder care facility zone, residential district

Each municipality provides information for Map Centre, in case the information on school zone, elder care facility zone and residential district is updated.

Map Centre integrates information. Service Centre provides in-vehicle devices with information on these zones as an attribute of link or as aspects.

In-vehicle devices alert the driver, based on the location of the own vehicle and running speed, in addition to the information provided by Service Centre.



NOTE: Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item at TG1.

Requirements for Navigation system

Store the information on school zone, elder care facility zone and residential district as attributes of link or as aspects.

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
School zone	—	1. School zone, elder care facility zone, residential district	Attribute of link Aspect	Unknown	S
Elder care facility zone	—	1. School zone, elder care facility zone, residential district	Attribute of link Aspect	Unknown	S
Residential district	—	1. School zone, elder care facility zone, residential district	Attribute of link Aspect	Unknown	S

E.2.8 Weather Information

1. Offer road information (Warning)						Features: 1-8. Weather information					
Details of road information used 1. Rainfall, snowfall, wind storm Information service on rainfall, snowfall, and wind storm uses information on rainfall, snowfall and wind storm, which is possessed by Meteorological Agency and road administrators.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Rainfall	Meteorological Agency Road administrator	Real-time rainfall	—	Meteorological Agency Road administrator	Meteorological Agency Road administrator	Disaster prevention information centre	R	Every 10 min	Unknown	Some observation points	
Snowfall	Meteorological Agency										
Wind storm	Meteorological Agency										

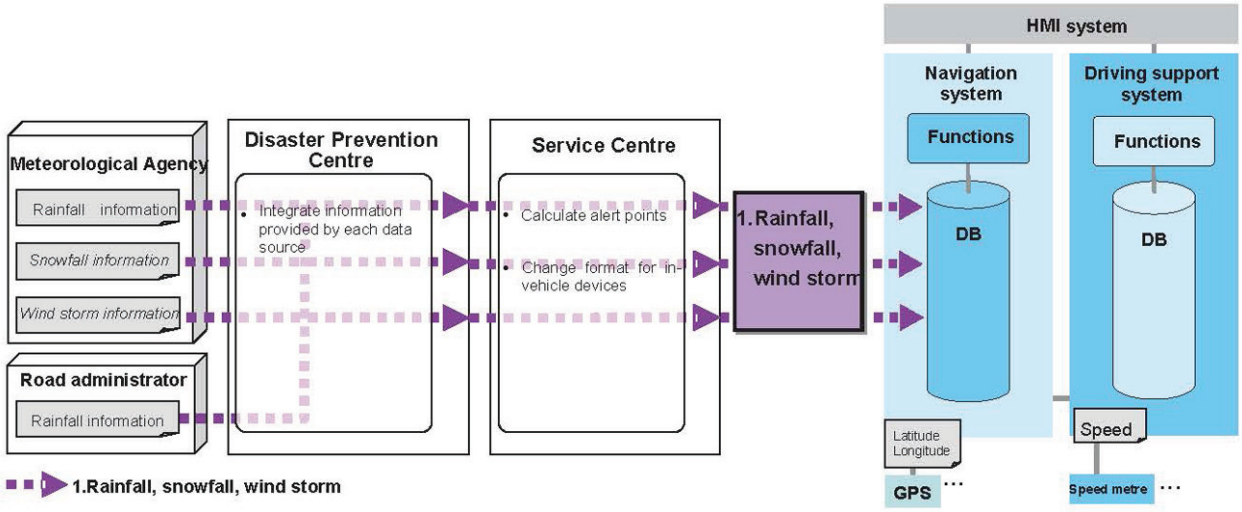
Overview of information flow

1. Rainfall, snowfall, wind storm

Meteorological Agency and road administrators provide information on rainfall, snowfall, and wind storm for Disaster Prevention Centre as needed.

Disaster Prevention Centre integrates information. Service Centre provides in-vehicle devices with the information on rainfall, snowfall, and wind storm as an attribute of link, which was integrated as points.

In-vehicle devices alert the driver based on the location of the own vehicle and driving speed, in addition to the information provided by Service Centre.



NOTE: Solid lines represent flow of static information, and dot-lines represents flow of dynamic information.

NOTE: Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item at TG1.

Requirements for Navigation system

Store information on rainfall, snowfall, and wind storm as an attribute of link.

Update the information in real-time.

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable

1. Offer road information (Warning)			Features: 1-8. Weather information		
Rainfall	—	1. Rainfall, snowfall, wind storm	Attribute of link	Unknown	R (Information on real-time rainfall is updated every 10 min)
Snowfall	—	1. Rainfall, snowfall, wind storm	Attribute of link	Unknown	R
Wind storm	—	1. Rainfall, snowfall, wind storm	Attribute of link	Unknown	R

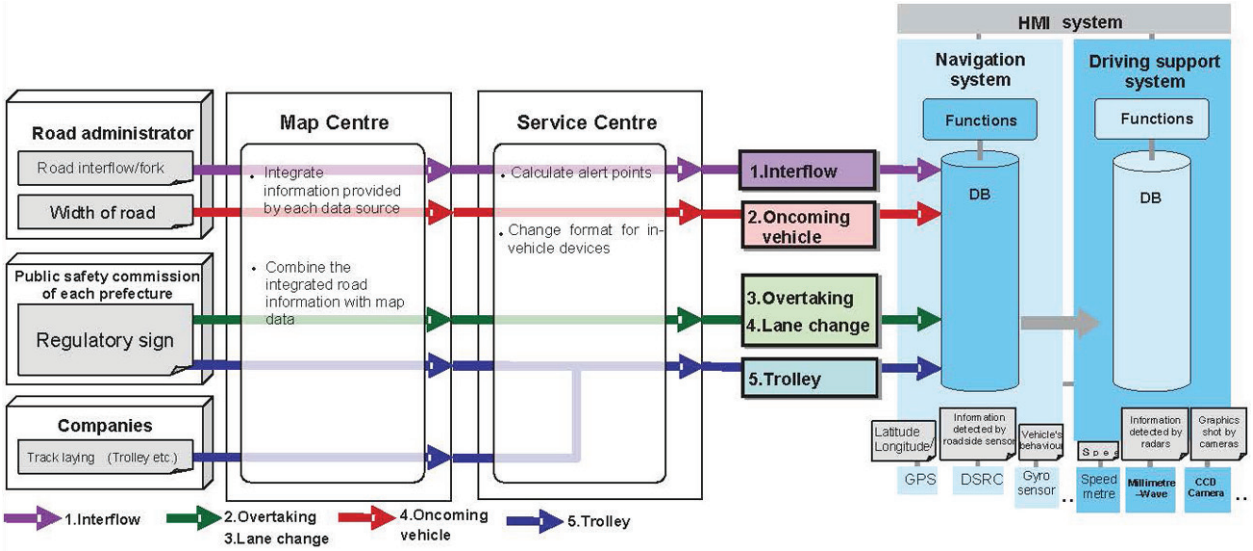
E.3 Information Around the Vehicle (Warning)

E.3.1 Information Around the Vehicle

2. Offer information around the vehicle (Warning)						Features: 2-1. Information around the vehicle					
Details of road information used 1. Interflow Information service on interflow uses information on interflow and fork of road, which is possessed by road administrators.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Interflow points	Road administrator	Interflow and fork of road	Several meters	Road administrator	Road administrator	DRM	S	4 time a year	Once a year	Basic road	
			30 cm	Road administrator	Surveyed by DRM	DRM	S	4 time a year	Once a year	Basic road and at the same time those around some intersections	
			30 cm	Road administrator	NILIM← MEXCO	DRM	S	4 time a year	Once a year	Some motorways	
2. Overtaking Information service on overtaking uses regulatory sign information possessed by public safety commission of each prefecture.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Sections where overtaking is prohibited	Public safety commission of each prefecture	Regulatory sign	—	Public safety commission of each prefecture	Public safety commission of each prefecture	Traffic Safety Association	S	—	Unknown		
3. Lane change Information service on lane change uses regulatory sign information possessed by public safety commission of each prefecture.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Sections where lane change is prohibited	Public safety commission of each prefecture	Regulatory sign	—	Public safety commission of each prefecture	Public safety commission of each prefecture	Traffic Safety Association	S	—	Unknown		
4. Oncoming vehicle Information service on oncoming vehicle uses lane width information possessed by road administrators.											

2. Offer information around the vehicle (Warning)						Features: 2-1. Information around the vehicle					
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Sections with minimum lane width	Road administrator	Lane width	Several meters	Road administrator	Road administrator	DRM	S	4 times a year	Once a year	Basic road	
5. Trolley Information service on trolley uses traffic laying information possessed by companies, and regulatory sign information by public safety commission of each prefecture.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Track of trolley	Road administrator Company	Track laying (orbital location of trolleys and structures etc.)	30 cm	Company	Surveyed by DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
Traffic in the track of trolley	Public safety commission of each prefecture	Regulatory sign	—	Public safety commission of each prefecture	Public safety commission of each prefecture	Traffic Safety Association	S	—	Unknown		
1. Interflow Each road administrator provides information for Map Centre when interflow information is updated. Map Centre integrates information. Service Centre calculates warning points based on the interflow and fork of roads, and provides in-vehicle devices with the warning point information as points. In-vehicle devices warn the driver on the information of vehicles around the vehicle and the location of the own vehicle, which is detected by infra-vehicle and vehicle-vehicle communication, in addition to the information provided by Service Centre. 2. Overtaking Public safety commission of each prefecture provides information for Map Centre when overtaking information is updated. Map Centre integrates information. Service Centre checks whether overtaking is prohibited or not, based on regulatory signs, and provides in-vehicle devices with the overtaking information as an attribute of link. In-vehicle devices warn the driver based on the information on the location of the own vehicle, driving speed, vehicle's behaviour and other vehicles around the vehicle, which is detected by CCD camera and radars, in addition to the information provided by Service Centre. 3. Lane change As with information service on overtaking, Map Centre integrates information provided by each management actor and Service Centre provides information for in-vehicle devices, then they warn the driver. 4. Oncoming vehicle Each road administrator provides information for Map Centre when lane width information is updated. Map Centre integrates information. Service Centre calculates the section with minimum lane width, based on the lane width and provides the information as an attribute of link. In-vehicle devices warn the driver, based on the information on oncoming vehicles and the location of the own vehicle, which is detected by infra-vehicle and vehicle-vehicle communication, in addition to the information provided by Service Centre. 5. Trolley Public safety commission of each prefecture and each company provide information for Map Centre when information concerning trolley is updated. Map Centre integrates information. Service Centre calculates warning points based on the information on regulatory signs and trolley tracks (orbital location of trolleys and structures etc.), and provides in-vehicle devices with the information as points. In-vehicle devices warn the driver based on the information on the location of the own vehicle, driving speed and trolleys, which is detected by infra-vehicle communication, in addition to the information provided by Service Centre.											

2. Offer information around the vehicle (Warning)	Features: 2-1. Information around the vehicle



Requirements for Navigation system

Store warning points information as a point.

Store information on sections with minimum lane width and on prohibition of overtaking and lane change as an attribute of link.

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Road interflow, fork	Warning points (interflow)	1. Interflow	Points	Several metres	S (The original data about Road interflow/fork is updated 4 times a year)
Regulatory sign	Whether overtaking is prohibited or not	2. Overtaking	Attribute of link	Unknown	S
	Whether lane change is prohibited or not	3. Lane change	Attribute of link	Unknown	S
Lane width	Sections where lanes are small in width	4. Oncoming vehicle	Attribute of link	Several metres	S (The original data about width is updated 4 times a year)
Regulatory sign	Warning points	5. Trolley	Points	Unknown	S
Track laying (Trolley etc.)					
NOTE The original data concerning interflow and fork of road requires several metres accuracy to cover the whole country. Therefore, this service requires several metres accuracy too.					

E.3.2 Intersection Information

2. Information around the vehicle (Warning)	Feature: 2-2. Intersection information
Details of road information used 1. Straight Information service on direct advance uses information on road structure, lane width, stop lines provided by road administrators, and pavement information by Public safety commission of each prefecture.	

2. Information around the vehicle (Warning)						Feature: 2-2. Intersection information					
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Detailed information on junctions	Road administrators, Public safety commission of each prefecture	Road structure information	Several meters	Road administrators	Road administrators	DRM	S	4 time a year	Once a year	Basic road	
		Lane width	30 cm	Road administrator	Surveyed by DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
		Stop line	30 cm	Road administrator	Surveyed by DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
		Pedestrian crossing	30 cm	Public safety commission of each prefecture	Surveyed by DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
2. Right turn Information service on right turn uses the same information with that of Straight. 3. Left turn Information service on right turn uses the same information with that of Straight.											

2. Information around the vehicle (Warning)	Feature: 2-2. Intersection information

Overview of information flow

1. Straight

Public safety commission of each prefecture and each road administrator provide information for Map Centre when intersection0 structure information is updated.

Map Centre integrates information. Service Centre maps the locations of pavements, stop lines, width of lanes, and road structure information, then displays detailed road structure in intersections. Service Centre also provides in-vehicle devices with planar intersection information.

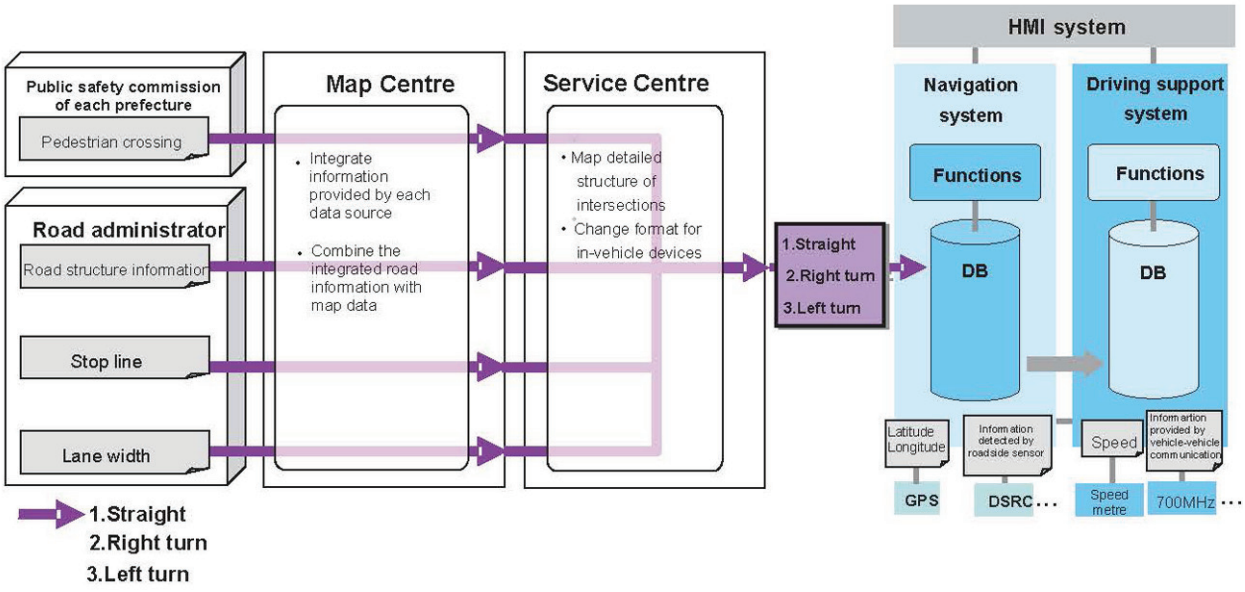
In-vehicle devices find association between the information detected by vehicle-vehicle communication, such as the vehicle location, pedestrian information, and the information provided by Service Centre. Based on the information, they warn the driver as needed.

2. Right turn

As with the situation above, Map Centre integrates information provided by each management actor, and Service Centre provides information for in-vehicle devices, then they warn the driver.

3. Left turn

As with the situation above, Map Centre integrates information provided by each management actor, and Service Centre provides information for in-vehicle devices, then they warn the driver.



Requirements for Navigation system

Store information on the structure in junctions as aspects. Also display the structure with 30 cm accuracy.

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Road structure	Detailed structure at junctions	1. Straight	Aspect	30 cm	S
Stop line		2. Right turn			(The original data about road structure is updated 4 times a year)
Lane width		3. Left turn			
Pedestrian crossing					

E.4 Vehicle Control

E.4.1 Vehicle Control (Parametric Control)

3. Vehicle Control						Feature: 3-1: Vehicular characteristic control (Parametric Control fo the control unit)					
Details of road information used 1. ACC (Adaptive Cruise Control System) ACC uses not only information from Driving Support functions of vehicles, but also information on curvature radius, longitudinal slope and altitude, which is possessed by road administrators.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Curvature, slope	Road administrators	Curvature radius	—	Road administrator	DRM	DRM	S	4 times a year	Unknown	Basic road	
			30 cm	Road administrator	NILIM← MEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Longitudinal slope	—	Road administrator	DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some junctions	
			—	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Altitude	Several metres	Road administrator	Private firm	DRM	S	Not yet determined	Unknown	Basic road	
2. Shift control Shift control uses not only information from Driving Support functions of vehicles, but also information on curvature radius, longitudinal slope and altitude, which is possessed by road administrators.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Curvature, slope	Road administrator	Curvature radius	—	Road administrator	DRM	DRM	S	4 times a year	Unknown	Basic road	
			30 cm	Road administrator	NILIM← MEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Longitudinal slope	—	Road administrator	DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
			—	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Altitude	Several metres	Road administrator	Private firm	DRM	S	Not yet determined	Unknown	Basic road	
Road Surface information	Road administrator, user										

3. Vehicle Control	Feature: 3-1: Vehicular characteristic control (Parametric Control fo the control unit)

3. Suspension control

Suspension control uses the same information with shift control.

4. Light control

Light control uses the same information with ACC.

5. Stability control

Stability control uses the same information with shift control.

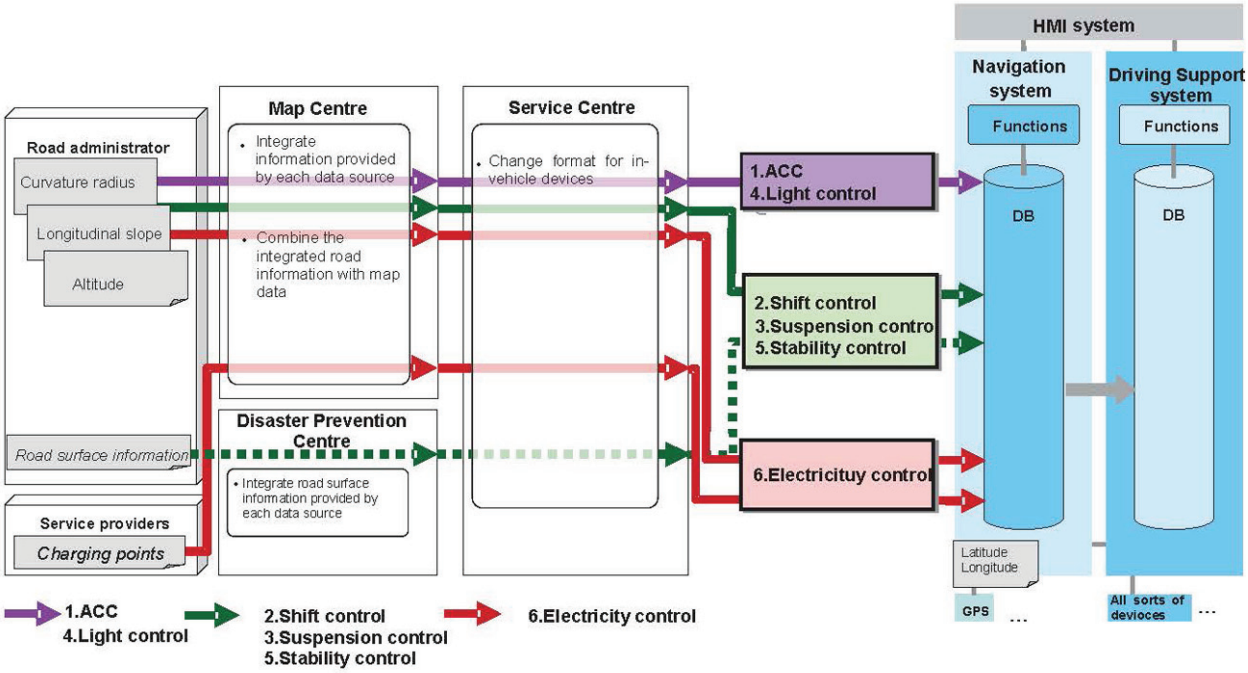
6. Electricity control

Electricity control uses not only information from Driving Support functions of vehicles, but also information on curvature radius, longitudinal slope, altitude, which is possessed by road administrators and charging points possessed by service providers.

Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Curvature, slope	Road administrator	Curvature radius	—	Road administrator	DRM	DRM	S	4 times a year	Unknown	Basic road	
			30 cm	Road administrator	NILIM← MEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Longitudinal slope	—	Road administrator	DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
			—	Road administrator	NILIM← MEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Altitude	Several metres	Road administrator	Private firm	DRM	S	Not yet determined	Unknown	Basic road	
Charging points	Service providers										

3. Vehicle Control	Feature: 3-1: Vehicular characteristic control (Parametric Control fo the control unit)
Overview of information flow 1. ACC Each road administrator provides information for Map Centre when information on curvature and slope is updated. Map Centre integrates information. Service Centre provides in-vehicle devices with information on curvature radius, longitudinal slope and altitude as an attribute of link in each section, after pointing off the link at change-points of slope and sharp curve sections. In-vehicle devices control the vehicle based on information provided by Service Centre, driving speed, and distance to leading vehicles, which is detected by in-vehicle radar. 2. Shift control Each road administrator provides information for Map Centre when the information on curvature and slope is updated. Each road administrator provides road surface information for Disaster Prevention Centre as needed. Map Centre integrates information. Service centre provides in-vehicle devices with information on curvature radius, longitudinal slope and altitude as an attribute of link in each section, after pointing off the link at change-points of slope and sharp curve sections. Also, the Centre provides in-vehicle devices with road surface information. In-vehicle devices control the vehicle in accordance with driving speed and location of the vehicle based on information provided by Service Centre. 3. Suspension control As with Shift control, Map Centre or Disaster Prevention Centre integrate information provided by each road administrator. Service Centre provides information for in-vehicle devices, and controls vehicles. 4. Light control Each road administrator provides information for Map Centre when the information on curvature and slope is updated. Map Centre integrates information. Service centre provides in-vehicle devices with information on curvature radius, longitudinal slope and altitude as an attribute of link in each section, after pointing off the link at change-points of slope and sharp curve sections. In-vehicle devices control the vehicle in accordance with running speed and location of the vehicle, based on information provided by Service Centre. 5. Stability control As with Shift control, Map Centre or Disaster Prevention Centre integrate information provided by each road administrator. Service Centre provides information for in-vehicle devices, and controls vehicles. 6. Electricity control Each road administrator and each service provider provide information for Map Centre when information on curvature, slope and charging points is updated. Map Centre integrates information. Service Centre provides in-vehicle devices with information on curvature radius, longitudinal slope and altitude as an attribute of link in each section, after sectioning the link at change-points of slope and sharp curve sections. Also, the Centre provides in-vehicle devices with information on charging points. In-vehicle devices control the vehicle, based on the information provided by Service Centre, location of the vehicle, and electricity. They provide charging point information if needed.	

3. Vehicle Control	Feature: 3-1: Vehicular characteristic control (Parametric Control fo the control unit)



NOTE: Solid lines represent flow of the static information; dot-lines represent flow of dynamic information.

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Requirements for Navigation system

Store curvature radius, longitudinal slope, altitude information in each section as an attribute of link, after pointing off the link at sharp curve sections and change-points of slope

Store curvature radius with 30 cm accuracy

Store road surface information as spots

Update road surface information in real-time

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Curvature radius	—	1. ACC 2. Shift control 3. Suspension control 4. Light control 5. Stability control 6. Electricity control	Attribute of link	30 cm (Accuracy differs according to road category)	S (Curvature radius: 4 times a year)
Longitudinal slope	—	1. ACC 2. Shift control 3. Suspension control 4. Light control 5. Stability control 6. Electricity control	Attribute of link	Unknown	S

3. Vehicle Control			Feature: 3-1: Vehicular characteristic control (Parametric Control fo the control unit)		
Altitude		1. ACC 2. Shift control 3. Suspension control 4. Light control 5. Stability control 6. Electricity control	Attribute of link	Several metres	S
Road Surface information		2. Shift control 3. Suspension control 5. Stability control	Points	Unknown	R
Charging points		6. Electricity control	Points	Unknown	S

E.4.2 Vehicle Control (Brake Control)

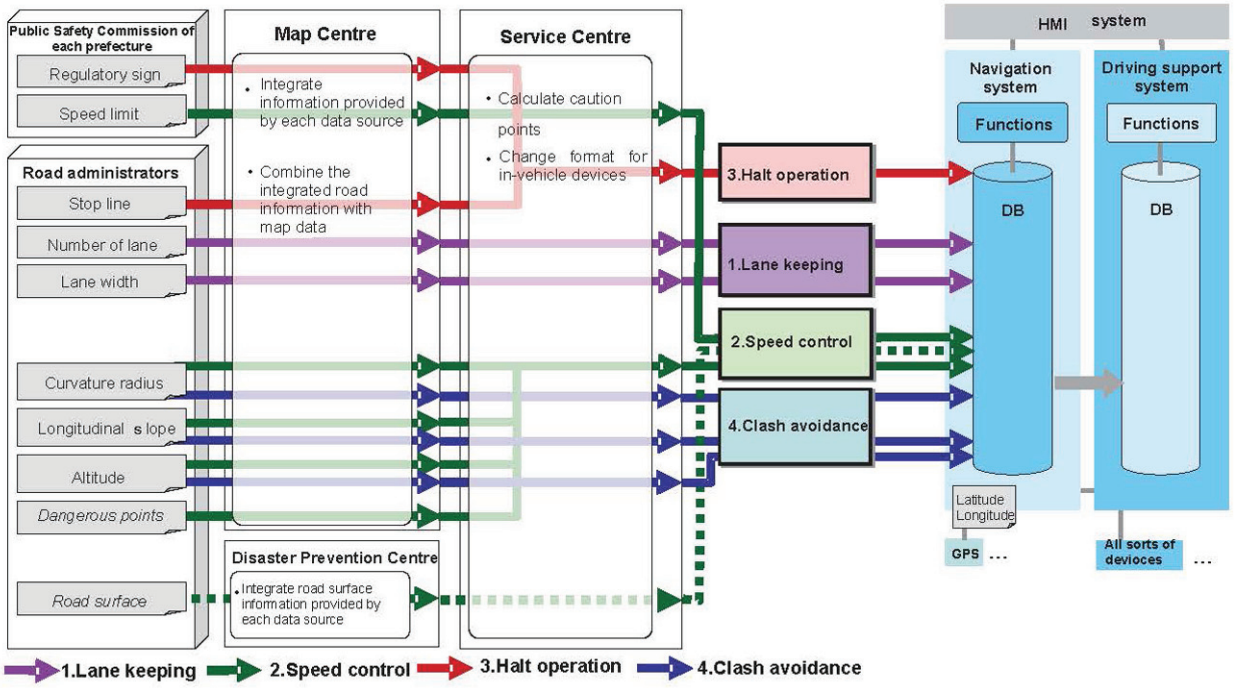
3. Vehicle Control		Features: 3-2. Vehicle control (Brake control)									
Details of road information used 1. Lane keeping Lane keeping uses information on lane width and number of lane, which is possessed by road administrators, in addition to the information provided by vehicles (Driving Support functions).											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Lane information	Road administrator	Number of lane	—	Road administrator	Traffic census	DRM	S	4 times a year	Once 5 years	Basic road	
		Lane width	30 cm	Road administrator	Surveyed by DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
			30 cm	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
2. Speed control Speed control uses speed limit information provided by each prefectural police department and information on curvature radius, longitudinal slope, altitude, dangerous points and road surface, which is possessed by road administrators, in addition to the information provided by vehicles (Driving Support functions).											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format

3. Vehicle Control						Features: 3-2. Vehicle control (Brake control)					
Speed limit information	Public safety commission of each prefecture	Speed limit	—	Public safety commission of each prefecture	Presently being confirmed by DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
			—	—	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
Critical speed (Calculated on the basis of information on curvature, slope, dangerous points)	Service providers (Original data are managed by road administrators)	Curvature radius	—	Road administrator	DRM	DRM	S	4 times a year	Unknown	Basic road	
			30 cm	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Longitudinal slope	—	Road administrator	DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
				Road administrator		DRM	S	Not yet determined	Unknown	Some motorways	
		Altitude	Several metres	Road administrator	Private firm	DRM	S	Not yet determined	Unknown	Basic road	
		Dangerous points									
Road surface information	Road administrator, user										
3. Halt operation Halt operation uses stop line information provided by road administrators and regulatory sign information by Public safety commission of each prefecture, in addition to the information by vehicles (Driving Support functions).											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Location of temporarily stop sign	Road administrator Public safety commission of each prefecture	Stop line	30 cm	Road administrator	Surveyed by DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some junctions	
		Regulatory sign	—	Public safety commission of each prefecture	Public safety commission of each prefecture	Traffic Safety Association	S	—	Unknown	—	

3. Vehicle Control						Features: 3-2. Vehicle control (Brake control)					
4. Clash avoidance Clash avoidance uses information on curvature radius, longitudinal slope and road surface provided by road administrators, in addition to the information by vehicles (Driving Support functions).											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Curvature, slope	Road administrator	Curvature radius	—	Road administrator	DRM	DRM	S	4 times a year	Unknown	Basic road	
			30 cm	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Longitudinal slope	—	Road administrator	DRM	DRM	S	Not yet determined	Unknown	Basic road and at the same time those around some intersections	
			—	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown	Some motorways	
		Altitude	Several metres	Road administrator	Private firm	DRM	S	Not yet determined	Unknown	Basic road	
Road surface information	Road administrator, user	Road surface information									

3. Vehicle Control	Features: 3-2. Vehicle control (Brake control)
Overview of information flow 1. Lane keeping Each road administrator provides information for Map Centre when lane information is updated. Map Centre integrates information. Service Centre provides in-vehicle devices with information on the number of lane and lane width as an attribute of link, after pointing off the link at change-points of lane number and lane width. In-vehicle devices maintain the vehicle based on the information provided by Service Centre, driving speed, and location of the car, which is detected by CCD camera 2. Speed control Each road administrator and public safety commission of each prefecture provide information when the information on speed limit and critical speed is updated. Each road administrator provides Disaster Prevention Centre with road surface information as needed. Map Centre integrates information. Service Centre provides in-vehicle devices with information on speed limit as an attribute of link, and safety speed and warning points as points, based on information on curvature radius, longitudinal slope, altitude and dangerous point. Also, Service Centre provides in-vehicle devices with road surface information as points. In-vehicle devices control speed based on the information provided by Service Centre, in addition to driving speed and location of the vehicle. 3. Halt operation Public safety commission of each prefecture and road administrators provide information when the information on halt is updated. Map Centre integrates information. Service Centre provides in-vehicle devices with information on the accurate location of stop lines as spots based on stop lines and regulatory signs. In-vehicle devises support halt operation based on the information provided by Service Centre and the information on running speed of the vehicle, the location of stop lines, the location of vehicle, which was detected by CCD camera. 4. Clash avoidance Each road administrator provides information for Map Centre when the information on curvature and slope is updated Each road administrator provides road surface information for Disaster Prevention Centre as needed. Map Centre integrates information. Service Centre provides information on curvature radius, longitudinal slope and altitude as an attribute of link, after pointing off the link at change-points of slope and sharp curve sections. In-vehicle devices avoid clash based on the information provided by Service Centre, in addition to the information on driving speed of the vehicle, its location and the distance from leading vehicles, which is detected by radars.	

3. Vehicle Control	Features: 3-2. Vehicle control (Brake control)



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Requirements for Navigation system

Store information on the number of lane, lane width, curvature radius, longitudinal slope, and altitude in each zone as an attribute of link after sectioning the link at the change-point of slope, the number of lane, lane width, and sharp curve sections.

Store the speed limit information as an attribute of link.

Store lane width and curvature radius with 30 cm accuracy.

Store the information on road surface, safety speed, location of stop sign, and warning points as points.

Store the detailed location of stop sign with 30 cm accuracy.

Update road surface information in real-time.

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Number of lane	—	1. Lane keeping	Attribute of link	Unknown	S (Number of lane is updated 4 times a year)
Lane width	—	1. Lane keeping	Attribute of link	30 cm	S
Speed limit	—	2. Speed control	Attribute of link	Unknown	S
Curvature radius	Warning points Safety speed	2. Speed control	Point	Unknown	S (Curvature radius, original data, is updated 4 times a year)
Longitudinal slope					
Altitude					
Dangerous points					
Road surface information	—	2. Speed control	Point	Unknown	R
	—	4. Clash avoidance	Point	Unknown	R
Stop line	Detailed location of stop sign	3. Halt operation	Point	30 cm	S
Regulatory sign					

3. Vehicle Control			Features: 3-2. Vehicle control (Brake control)		
Curvature radius	—	4. Clash avoidance	Attribute of link	30 cm (Accuracy differs according to road category)	S (Curvature radius is updated 4 times a year)
Longitudinal slope	—	4. Clash avoidance	Attribute of link	Unknown	S
Altitude	—	4. Clash avoidance	Attribute of link	Several metres	S
NOTE Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item.					

E.5 Transportation Information

E.5.1 Environmental Information

4. Driving support			Feature: 4-1. Environment								
Details of road information used 1. CO_2 emission constraint CO_2 emission constraint uses traffic congestion information provided by road administrators and each prefectural police department, and information on curvature radius, longitudinal slope, and altitude by road administrators.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Curvature, slope	Road administrator	Curvature radius	—	Road administrator	DRM	DRM	S	4 times a year	Unknown		Basic road
			30 cm	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown		Some motorways
		Longitudinal slope	—	Road administrator	DRM	DRM	S	Not yet determined	Unknown		Basic road and at the same time those around some intersections
			—	Road administrator	NILIM← NEXCO	DRM	S	Not yet determined	Unknown		Some motorways
		Altitude	Several meters	Road administrator	Private firm	DRM	S	Not yet determined	Unknown		Basic road
Trafic congestion information	Each prefectural police Road administrator	Traffic congestion information	—	Each prefectural police Road administrator (Regional Development Bureau, NEXCO etc.)	Each prefectural police, Road administrator (Regional Development Bureau, NEXCO etc.)	JARTIC	R	Every 5 min	Unknown		—

4. Driving support	Feature: 4-1. Environment

Overview of information flow

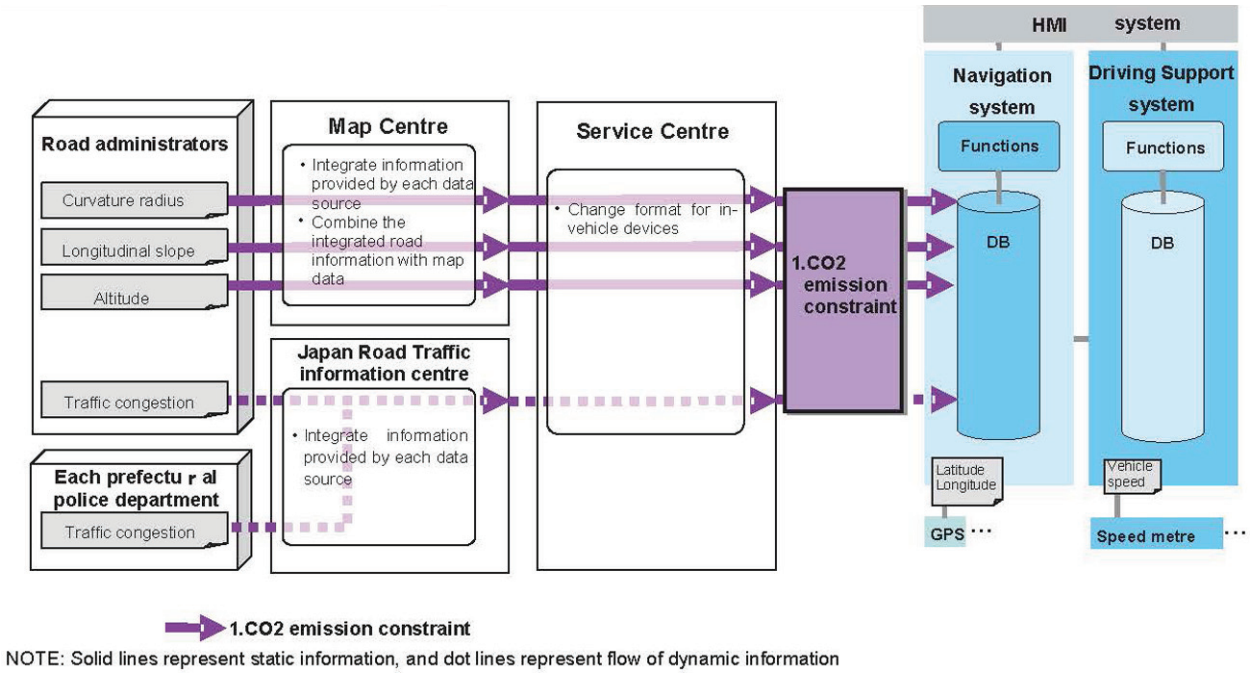
1. CO_2 emission constraint

Road administrators provide information for Map Centre when the information on curvature and slope is updated.

Each road administrator and each prefectural police department provide traffic congestion information for Japan Road Traffic Information Centre as needed. Japan Road Traffic Information Centre integrates traffic congestion information.

Map Centre integrates information. Service Centre provides in-vehicle devices with information on curvature radius, longitudinal slope and altitude as an attribute of link, after pointing off the link at the change-points of slope and sharp curve sections. Also, it provides traffic congestion information for in-vehicle devices as an attribute of link.

In-vehicle devices provide the driver with information on low-fuel consumption drive, according to the location of vehicle and driving speed based on the information provided by Service Centre.



Requirements for Navigation system

Store information on curvature radius, longitudinal slope and altitude as an attribute of link after pointing off the link at arbitrary points, such as the change-points of slope and sharp curve sections.

Store traffic congestion information as an attribute of link.

Store curvature radius information with 30 cm accuracy.

Update traffic congestion information in real-time.

Chart. Road information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable
Curvature radius	—	1. CO_2 emission constraint	Attribute of link	30 cm (Accuracy differs according to road category)	S (Curvature radius is updated 4 times a year)
Longitudinal slope	—	1. CO_2 emission constraint	Attribute of link	Unknown	S
Altitude	—	1. CO_2 emission constraint	Attribute of link	Several metres	S
Trafic congestion information	—	1. CO_2 emission constraint	Attribute of link	Unknown	R (Traffic congestion information is updated every 5 min)

E.5.2 Transfer Point Information

4.Driving support						Features: 4-2.Transfer points					
Details of road information used 1. Car park In order to provide information on car parks, the service uses information on car park, parking availability, and parking place, which is provided by parking facility operations companies.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Car park	Parking facility operations company										
Parking availability	Parking facility operations company										
Parking place	Parking facility operations company										
2. Park and Ride In order to provide information on Park and Ride, the service uses information on car parks for Park and Ride and public transport service, which is provided by public transport facilities.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Car park for park and ride	Public transport facility										
Transfer point	Public transport facility										
Public transport service	Public transport facility										
3. Multimodal In order to provide information on Multimodal, the service uses information on transfer points and public transport service, which is provided by public transport facilities, in addition to the information by private companies.											
Road information used		Details of road information considered by TG1									
Road information	Management actor	Data item	Accuracy	Administrator	Data source	Collector and user	S or R	Frequency of update	Freshness	Object	Data format
Transfer point	Public transport facility										
Public transport service	Public transport facility										

4.Driving support	Features: 4-2.Transfer points

Overview of information flow

4-2.In Driving support services, it is supposed that in-vehicle devices provide information on the vehicle's location and destination for the Centres, and the Centres search the optimal path including public transport. Then the optimal path is provided for in-vehicle devices.

1. Car park

Parking facility operations companies provide information for Map Centre when the information on car parks is updated. Also, they provide information on parking availability and parking place for Service Centre as needed.

Map Centre integrates information. Service Centre searches optimal path to a car park, using the information on car parks, parking availability, and parking place, based on the location of own vehicle and the destination, which is provided by in-vehicle devices. As a result of the search, it provides in-vehicle devices with information on the location of car parks and the available parking places as points. Also, it provides route information to a car park for in-vehicle devices.

In-vehicle devices provide the driver with information on optimal path provided by Service Centre.

2. Park and Ride

Public transport facilities provide information for Map Centre when the information on Park and Ride and transfer points is updated.

Also, they provide information on public transport services for Service Centre as needed.

Map Centre integrates information. Service Centre searches the optimal path, using information on public transport, transfer points, car parks for Park and Ride, and the information on the vehicle location and its destination, which is provided by in-vehicle devices. Based on the result of the search, it provides in-vehicle devices with information on the location of car park for Park and Ride, and the location of transfer points as positions. Also, it provides information on routes which include the use of public transport.

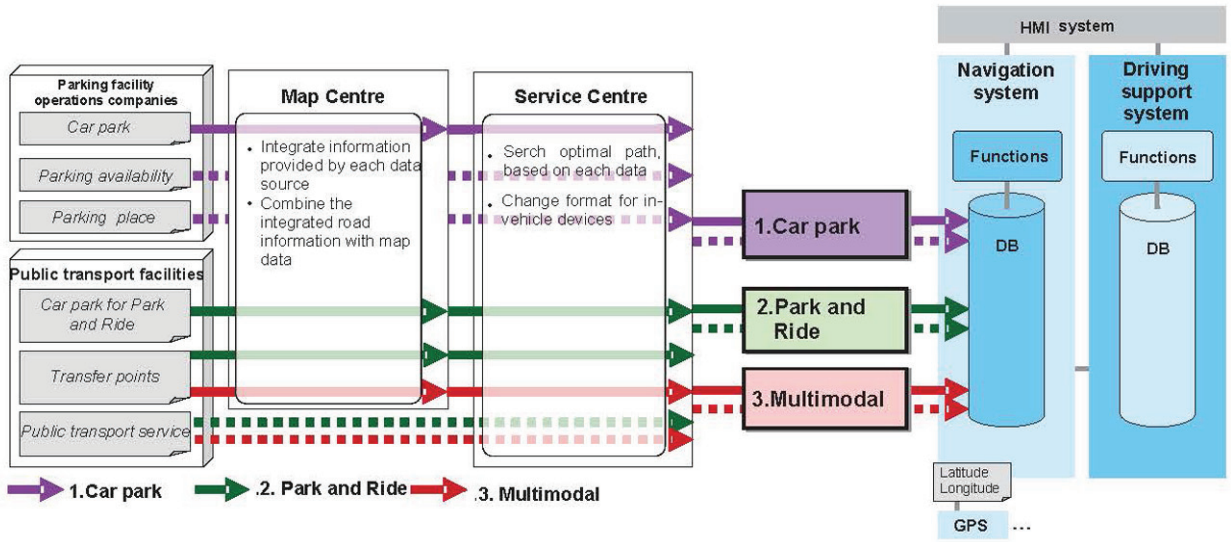
In-vehicle devices provide the driver with the result of the search, which is calculated by Service Centre.

3. Multimodal

Public transport facilities provide information for Map Centre when the information on transfer points is updated. Also, they provide information on public transport service for Service Centre as needed.

Map Centre integrates information. Service Centre searches the optimal path including public transport, using information on public transport services, transfer points, the information on the vehicle location and its destination, which is provided by in-vehicle devices. Based on the result of the search, it provides information on transfer points as positions for in-vehicle devices. Also, it suggests routes which include the use of public transport.

In-vehicle devices provide the driver with the optimal path, which is calculated by Service Centre.



NOTE: Solid lines represent static information, and dot lines represent flow of dynamic information

NOTE: Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item at

Requirements for Navigation system

Store the information on the location of parking place, parking availability, the precise location of the available parking space, the location of car park for Park and Ride, and transfer points as positions.

Store route information.

Chart. Information used in Navigation system

Information flow			Requirements for Navigation system		
Information provided by each data source	After processed at service centre	Service target	Data format providable	Accuracy providable	Frequency of update providable

4.Driving support			Features: 4-2.Transfer points		
Car park	Location of car park	1. Car park	Points	Unknown	R
Parking availability	Availability				
Parking place	Precise location of available parking space	1. Car park	Points	Unknown	R
Car park for Park and Ride	Location of car parks for Park and Ride	2. Park and ride	Points	Unknown	S
Transfer point information	Location of transfer points				
Car park for Park and Ride	Route information	2. Park and ride	Points	Unknown	R
Transfer point information					
Public transport service					
Transfer point information	Location of transfer points	3. Multimodal	Points	Unknown	S
Transfer point information	Route information	3. Multimodal	Others	Unknown	R
Public transport service					
NOTE Underlines represent unavailable information at the result of TG1, and Italics represent uninvestigated item.					

Annex F
(normative)

Relationship between Basic set of applications and Driving support services

Basic set of applications			Driving support services
Applications Class	**Application**	**Use case**	
Active road safety	Driving assistance – Vehicle	Emergency vehicle warning	D.3.1 Vehicle Control(Parametric Control) D.3.2 Vehicle Control(Brake Control)
	Co-operative awareness	Slow vehicle indication	D.1.1 Speed Information
		Intersection collision warning	D.2.2 Intersection Information
		Motorcycle approaching indication	D.2.1 Information Around the Vehicle
	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 Road Surface Information D.1.8 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	

Basic set of applications			Driving support services
Applications Class	**Application**	**Use case**	
Cooperative traffic efficiency	Speed management	Regulatory / contextual speed limits notification	D.1.1 Speed Information D.1.2 Traffic Restriction Information D.1.3 Lane Information D.1.4 Sign Information D.1.7 Zone Information
		Traffic light optimal speed advisory	
	Co-operative navigation	Traffic information and recommended itinerary	D.1.5 Traffic Information
		Enhanced route guidance and navigation	D.1.5 Traffic Information
		Limited access warning and detour notification	D.1.5 Traffic Information
		In-vehicle signage	
Co-operative local services	Location based services	Point of Interest notification	
		Automatic access control and parking management	D.4.2 Transfer Point Information
		ITS local electronic commerce	
		Media downloading	
Global internet services	Communities services	Insurance and financial services	
		Fleet management	D.4.1 Environment Information
		Loading zone management	
	ITS station life cycle	Vehicle software / data provisioning and update	
	Management	Vehicle and RSU data calibration	

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