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

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

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Foreword

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

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

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

Introduction

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

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

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

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

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

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

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

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

1 Scope

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

2 Normative references

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

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

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

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

3 Conformance

Data structures shall be provided as specified in Clause 7.

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

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

4 Terms and definitions

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

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

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

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

4.3
display point
0-dimensional type of cartographic feature

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

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

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

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

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

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

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

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

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

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

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

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

4.11
link
directed topological connection between two nodes, composed of an ordered sequence of one or more segments and represented by an ordered sequence of zero or more shape points

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

4.13
Map Display
application category that deals with graphical information presentation

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

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

Note 1 to entry: This service may include navigation.

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

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

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

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

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

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

4.20
polygon
2-dimensional type of cartographic feature

4.21
polyline
1-dimensional type of cartographic feature

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

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

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

4.25
regular parcel
parcel shaped like a rectangle

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

4.37
symbol
icon associated with a cartographic feature

5 Symbols and abbreviated terms

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

6 Requirements

6.1 Introduction

This clause defines application requirements and functional requirements.

6.2 Application requirements

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

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

6.3 Functional requirements

6.3.1 Overview

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

6.3.2 Map Display

6.3.2.1 General description

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

6.3.2.2 Functional description

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

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

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

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

6.3.2.3 Requirements for data model

Map Display provides the following methods of accessing data:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6.3.3 Positioning

6.3.3.1 General description

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

6.3.3.2 Functional description

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

6.3.3.3 Requirements for data model

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6.3.4 Route Planning

6.3.4.1 General description

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

6.3.4.2 Functional description

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

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

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

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

6.3.4.3 Requirements for data model

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

- R-47. via the set of topologically connected *Links* for an application-specified Link at an application-specified level;
- R-48. via routing-related attributes for an application-specified Transportation Element or set of connected Transportation Elements, such as: node coordinates (of the bounding nodes of a link), measured length, functional road class, number of lanes, average speed, divided Road Element, form of way, as well as access characteristics, conditions, and other relationships;
- R-49. via navigation attributes for roads and intersections;
- R-50. via corresponding link for an application-specified link at an application-specified different level;
- R-51. via a set of topologically connected GDF roads for an application specified GDF road at an application specified level at certain levels to be determined;
- R-52. via a set of GDF Road Elements and GDF junctions, which comprise a GDF road or GDF intersection;
- R-53. via the GDF road or GDF intersection for an application-specified GDF road element or GDF junction;
- R-54. via the corresponding entity representing a GDF junction or Intersection for an application-specified entity representing a GDF junction or intersection at an application-specified different level;
- R-55. via effective time or date periods for turn, travel, or other conditions;
- R-56. via location references which are stored in the database for an application-specified set of transportation elements;
- R-57. via a set of transportation elements for an application-specified location reference which is stored in the database;
- R-58. via the entry and exit angles for the set of links connected to an application-specified Intersection or junction;
- R-59. via historic and forecast traffic conditions, incidents, and events information for a specified transportation element or set of transportation elements;
- R-60. via a DAL capable of providing transparent access to static and dynamic traffic information. It shall not preclude or require the integration of dynamic traffic information from external systems;
- R-61. via an API allowing a pre-fetch area of interest specified by feature ID or rectangle for retrieving Route Planning data at an application-specified level.