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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

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Exigences et modèle de données logiques pour un format de stockage physique (PSF), une interface de programme d'application (API) et une organisation de données logiques pour un PSF utilisé dans la technologie de base de données des systèmes de transport intelligents (ITS)

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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:

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ISO/TS 20452 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

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Introduction

ISO/NP 14826, *Physical Storage for TICS Database Technology*, was introduced into ISO/TC 204 with the objective of standardizing a physical storage format (PSF) for navigation map data and related information stored on physical media used by in-vehicle navigation systems. The intent was to facilitate an interoperable in-vehicle navigation market environment by developing a standard PSF that would enable navigation media offered by different providers to be used by any navigation system and navigation systems made by any developer to be able to read the same media.

There was widespread international participation in this effort. Many of the different companies within the different participating national delegations possessed their own respective formats[1)] that were commercially available. It was decided early on that since none of these existing formats would be adopted wholesale as the standard physical storage format, the functional requirements of these existing systems would be submitted and consolidated into a universal set and organized into the major categories of application functionality predominantly used by in-vehicle navigation systems.

This gathering of market-driven requirements was the first step of an agreed development process that would proceed according to a top-down development approach. A sequential work plan was defined which included a logical data model based on the requirements, followed by the development of a logical organization of the data types used in the model. This logical data organization (LDO) would be used as a basis for the definition of a physical data organization (PDO), which would be defined to a sufficient level of granularity to specify a single standard PSF.

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It took several years to develop and gain consensus on the requirements, the logical data model, and the logical data organization. During the development there were several input documents submitted by various national delegations. At the beginning of the development of the PDO it was decided to use a Japanese PDO input document[2)] as a framework for the PDO discussion.

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Shortly after the PDO discussion began, the project ISO/NP 14826 expired and there was not sufficient international support for resubmitting a new work item proposal to continue the work, nor was there consensus that the PDO work could be finished within an acceptable time frame. Consequently, a standard PSF as envisioned within the scope of the work item would not be realized.

However, the requirements, logical data model, and logical data organization documents developed in this process reflect international consensus and still provide value for the navigation system market and other emerging products and services which use navigation map data. Thus it was agreed to convert these documents into a Technical Specification which could be used for future developments.

This Technical Specification can help developers of applications that use map databases to realize efficiencies by providing guidelines on setting up an appropriate architecture for navigation systems. This provides a potential benefit to the developer's ability to develop systems in a shorter timeframe, thereby shortening time-to-market for products. Although this Technical Specification was originally developed for navigation system applications, it may also facilitate other market development activities by providing insight into solving common data modelling and organization issues in the fields of telematics and location-based services.

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1) These formats are identified in the Bibliography of this Technical Specification.

2) Kiwi Format Specification version 1.2.2 (see Bibliography).

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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

1 Scope

This Technical Specification describes the functional requirements and Logical Data Model for PSF and API and the Logical Data Organization for PSF that were completed under ISO/NP 14826. It does not specify a Physical Data Organization.

2 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.

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ISO 14825, *Intelligent transport systems — Geographic Data Files (GDF) — Overall data specification*

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3 Terms and definitions

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

3.1
Address Location
application category that deals with the task of expressing a real-world position in terms of the PSF data representation

NOTE Address Location is one of the six application categories supported by the PSF and the API.

3.2
address type
attribute of road section entity, specifying the type of house number ranges

EXAMPLE distinction between base address, county address, commercial address, etc., or no address.

3.3
application category
basic sub-function within the set of functionality for vehicle navigation and traveller information system applications

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

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3.4
Application Program Interface
API
〈ISO context〉 specification interface and set of function calls between application software and data access libraries of vehicle navigation systems

3.5
base map
the whole of all transportation elements and all services, including their relationships to transportation elements

3.6
Branded Third Party Data
BTPD
information about services which is supplied by third party data providers (e.g. tourist or motoring organizations) who may impose proprietary restrictions on the use and presentation of the data

NOTE 1 Access to BTPD is subject to authorization and licensing.

NOTE 2 BTPD is a sub-set of Third Party Data (TPD).

3.7
cartographic feature
data model entity that represents geometrical information for display purposes, having non-explicit topology and 0-, 1- and 2-dimensional types

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EXAMPLES Display Point, Polyline and Polygon.

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3.8
cartographic text
data model entity that stores name text that is associated with all or part of a cartographic feature

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

3.9
condition
information related to link(s) which is composed of condition type, condition modifiers and condition scope

3.10
crossroad
data model entity that represents the single instance of the crossing of two named navigable features; it relates to the set of links and nodes which comprise the crossing, and to the crossing of the navigable features to a place

3.11
display point
0-dimensional type of cartographic feature

3.12
dummy point
non-required entity that represents a position along a link where the link crosses a parcel boundary and does not necessarily coincide with a shape point or node

3.13
geocoding
determination of a link or node based on address information describing and/or naming a location

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3.14
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

3.15
junction
data model entity that 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

3.16
landmark
point, line or area feature that can be used to clarify the directions generated to describe a route

NOTE 1 It can be associated to a node or a link.

NOTE 2 A *landmark* cannot be in the *Services, Administrative Areas*, or *Public Transportation Feature* themes of the GDF; however a facility in which a s*ervice* is located can be a *landmark*.

3.17
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.

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3.18
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

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NOTE *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.

3.19
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*

3.20
Map Display
application category that deals with graphical information presentation

NOTE Map Display is one of the six application categories supported by the PSF and the API.

3.21
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

3.22
navigable feature name
data model entity that represents the name for the transportation element, including GDF road element, GDF ferry connection, GDF junction, GDF intersection

NOTE It is related to places, crossroads, junctions and road sections.

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3.23
node
data model entity for a topological junction of two or more links or end bounding a link

NOTE A *link* stores the coordinate value of the corresponding GDF junction.

3.24
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 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 It can be partitioned such that the amount of data of one *parcel* is nearly the same as that of another.

3.25
place
named area which can be used as part of address location

3.26
place class
attribute of place entity, classifying data into highest administrative or geographic division, administrative sub-division, postal, or colloquial (such as regions or neighbourhoods)

NOTE It is partially ordered as "place class A is below place class B" (does not imply strict or complete containment).

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3.27
place level
level associated with places of place classification "administrative sub-division"

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NOTE Higher/lower level situations are constituted by the occurrence of a parent/child place relationship between places.

3.28
place relationship
bivalent relationship between place entities, constituting the place tree, linking parent and child places ("place A is in place B")

NOTE 1 It does not imply strict or complete containment.

NOTE 2 It is attributed as: address significant, official, postal, or useful for reverse geocoding.

3.29
Point of Interest
POI
destination and/or site of interest to travellers, usually non-commercial by nature

3.30
polygon
2-dimensional type of cartographic feature

3.31
polyline
1-dimensional type of cartographic feature

3.32
Positioning
application category that deals with the determination of vehicle location and map-matching

NOTE Positioning is one of the six application categories supported by the PSF and the API.

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3.33
postal code
data model entity for a government-designated code used for specified regions for addressing

NOTE It is related to link, navigable feature name, place, and POI.

3.34
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*

3.35
regular parcel
parcel shaped like a rectangle

NOTE Regular parcels on the same generalization level are not intended to overlap.

3.36
reverse geocoding
determination of the address description of a link or node (i.e. determination of an upwards path across the place tree)

3.37
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

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3.38
Road Element Side
RES
basic component of the road section entity that represents the left or right side of a link, and corresponds to one or more unique combinations of a navigable feature and a house number range

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3.39
road section
data model entity that represents the house number ranges of both sides of a street that carries a navigable feature name

NOTE It corresponds to a link (ID).

3.40
Route Guidance
application category that deals with the generation of graphical, textual, and/or audio instructions for following a planned route

NOTE Route Guidance is one of the six application categories supported by the PSF and the API.

3.41
Route Planning
application category that deals with the determination of routes between specified points

NOTE Route Planning is one of the six application categories supported by the PSF and the API.

3.42
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

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3.43
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), by which it can be accessed, and place(s)

NOTE 1 *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 *Service* is used synonymously with *POI* within the logical data model.

3.44
service attribute
descriptive information of a service

3.45
Services and POI Information Access
application category that deals with the provision of POI information to the navigation application

NOTE Services and POI Information Access is one of the six application categories supported by the PSF and the API.

3.46
shape point
position along a link used to more accurately represent its geometric course, bounded by exactly two segments

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3.47
signpost
data model entity for a directional sign that represents a logical relationship between signpost information and two associated links where the first link (mandatory) represents the road element along which the signpost is located, and the second link (optional) is the first road element which directs exclusively to the destination indicated on the signpost

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NOTE The position of the signpost along the link and the link direction the signpost is facing are also stored.

3.48
SuperLink
aggregation of linearly connected regular links present in the lowest level as a simplified representation of the road network in higher levels

3.49
symbol
data model entity that represents an icon associated with a cartographic feature

3.50
Third Party Data
TPD
additional descriptive and editorial information about services which is typically supplied by third party data providers (e.g. tourist or motoring organizations)

3.51
traffic location
data model entity that contains an external reference (e.g. VICS or RDS-TMC) and is linked to either place or transportation entities

3.52
transportation element
any feature from the *Roads and Ferries* feature theme of the GDF

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4 Symbols and abbreviated terms

4.1 Abbreviations

AL	Address Location
API	Application Program Interface
BTPD	Branded Third Party Data (subset of Third Party Data – TPD)
DAL	Data Access Libraries
DBD	Detailed Background Data
DRD	Detailed Road Data
GDF	Geographic Data Files
ITRF	International Terrestrial Reference Frame
LDO	Logical Data Organization
LDM	Logical Data Model
LiQ	Location in Question
MD	Map Display
MI	Metadata Information
PDO	Physical Data Organization
POI	Point(s) of Interest
PSF	Physical Storage Format (the ISO entity defined by this Technical Specification)
RDS-TMC	Radio Data System-Traffic Message Channel
RES	Road Element Side
RP	Route Planning
TI	Traffic Information
TPD	Third Party Data
VICS	Vehicle Information and Communication System
WGS84	World Geodetic System 1984

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4.2 Syntax notation used in data model diagrams

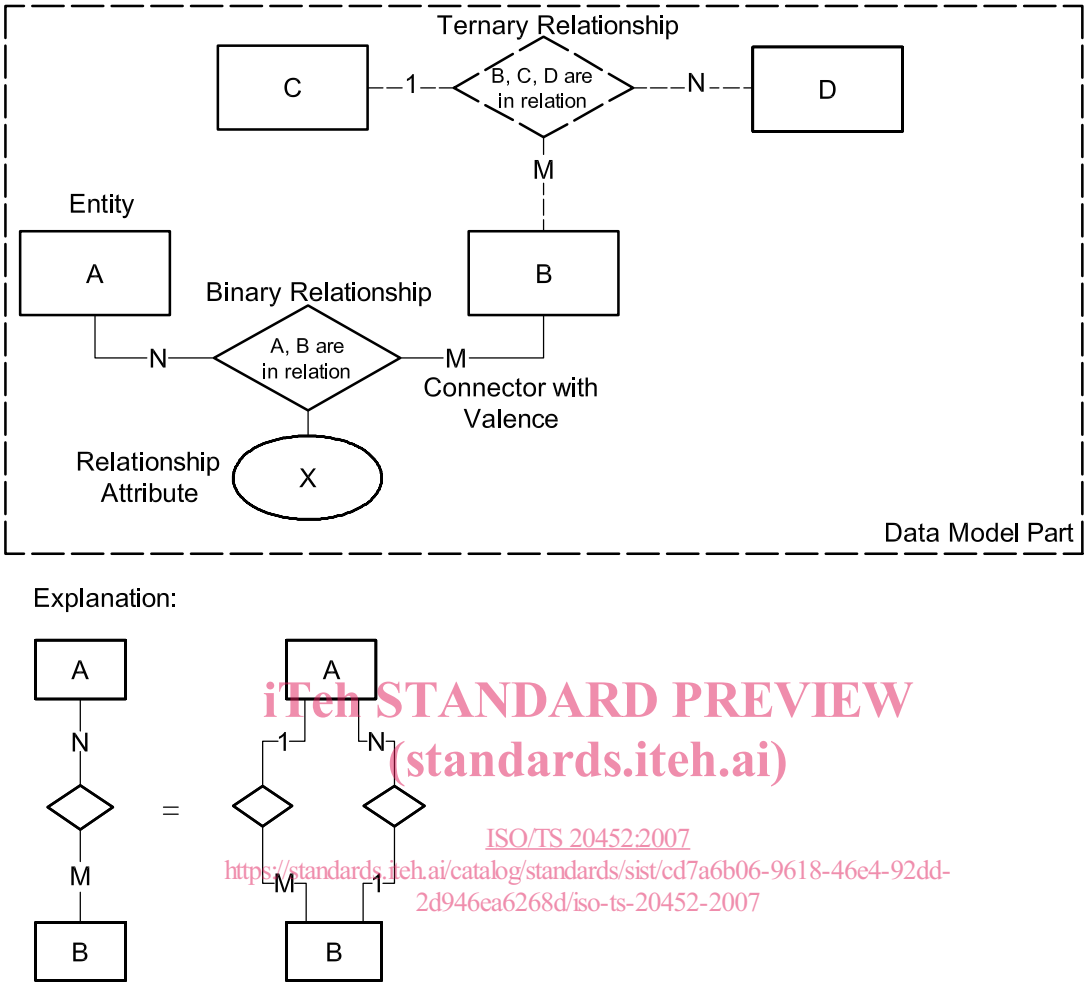

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Figure 1 — Example for Data Model Notation

There are six components:

— Entity (any logical data entity);

— Binary Relationship (any relation between two entities);

— Ternary Relationship (any relation between three entities);

— Connector (notation component to connect entities with a relationship valence qualified by a number);

— Relationship Attribute (qualifies a relationship in more detail);

— Data Model Part (a conceptual sub-unit of the whole model).

In the example in Figure 1, there is an N-to-M binary relationship involving A and B, and qualified by relationship attribute X. Valences (the N and M in an N-to-M relationship, or the 1 and N in a one-to-N relationship) are interpreted as follows: An N-to-M binary relationship is always an abbreviation for two parallel relationships, as shown in Figure 1. This means that an A can correspond to multiple B's (hence the "M" on B), and in addition that a B can correspond to multiple A's (hence the "N" on A). When a variable like "N" or "M" is used, there is no implication that every A corresponds to the same number of B's or that every B corresponds

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to the same number of A's. Two different variables, N and M, are used to further imply that there is no correspondence between the number of B's per A and the number of A's per B. The existence of an N-to-M relationship in the Logical Data Model also does not imply that functionality will be supplied to follow the relationship in both directions. That is, it is not necessarily true that there need be both a function to find the B's corresponding to a given A and the A's corresponding to a given B. If there is a function to find the B's that correspond to a given A, then the 1-to-M relationship from A to B indicates that the function, given an A, might return multiple B's, and the N-to-1 relationship from A to B indicates that a given B might be in the lists returned for multiple distinct A's in separate calls.

Whether a relationship is characterised as 1-to-1, 1-to-N, or N-to-M, it is possible that a given individual entity may not participate in the relationship, or may participate in the relationship with fewer than the maximum possible number of corresponding entities. For example, there is a 1-to-N relationship between Links and Shape Points. This indicates that one Link can have multiple Shape Points, but that a given Shape Point can correspond to only one Link. However, a given Link might have no Shape Points, despite the multiplicity implied by "N". In order to keep the notation simple, we will consider this to be implicit, rather than writing expressions like "{0, 1}-to-{0, 1, …, N}".

The interpretation of ternary relationships and their valences is similar. A ternary relationship is a relationship among three entities. An example is shown as an M-to-1-to-N relationship among B, C, and D. This is interpreted as follows: There are correspondences between triples (b, c, d) of individual B's, C's, and D's. The valence M on B indicates that, if one selects a particular c0 from among the C's and a particular d0 from among the D's, there can be multiple B's that correspond to c0 and d0. There is no implication that different choices of c0 and d0 will correspond to the same number of B's. Similarly, the valence N on D indicates that, if one selects a particular b0 from among the B's and a particular c0 from among the C's, there can be multiple D's that correspond to b0 and c0. Again, there is no implication that different choices of b0 and c0 will correspond to the same number of D's. Different variables N and M are used for B and D in order to further imply that there is no correspondence between the number of B's corresponding to a fixed C and a fixed D and the number of D's corresponding to a fixed B and a fixed C. Finally, the valence 1 on C indicates that, if one selects a particular b0 from among the B's and a particular d0 from among the D's, there can be at most one C that corresponds to b0 and d0.

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As in the case of binary relationships, the existence of a ternary relationship, regardless of its valences, does not imply that functionality will be supplied to follow the relationship in all three possible directions. Of the three possible functions in this example (given a B and a C, return the corresponding D's; given a B and a D, return the corresponding C; given a C and a D, return the corresponding B's), one, two, or all three functions may be defined. Suppose, for example, that only the first of those functions is defined. Then the correct interpretation of the valences is as follows: The "N" on D means that for a given B and a given C, the function might return multiple D's. The "M" on B means that, for a fixed c0 among the C's and a fixed d0 among the D's, there might be multiple B's such that the function, called with them and with c0, will return d0 among its list of D's. Finally, the "1" on C means that, for a fixed b0 among the B's and a fixed d0 among the D's, there is at most one C such that calling the function with b0 and with that C will return d0 among its list of D's.

Binary relationships shall be drawn in solid lines, while ternary relationships shall be drawn in dashed lines.

5 Application categories

5.1 Positioning

5.1.1 General

The Positioning function is used to determine 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.

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