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Intelligent transport systems (ITS) — Location referencing for geographic databases —

Part 3 Dynamic location references (dynamic profile)

Systèmes intelligents de transport (SIT) — Localisation pour bases de données géographiques —

Partie 3: Localisations dynamiques (profil dynamique)

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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.

ISO 17572-3 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

ISO 17572 consists of the following parts, under the general title *Intelligent transport systems (ITS) — Location referencing for geographic databases*:

— *Part 1: General requirements and conceptual model*

— *Part 2: Pre-coded location references (pre-coded profile)*

— *Part 3: Dynamic location references (dynamic profile)*

Introduction

A Location Reference (LR) is a unique identification of a geographic object. In a digital world, a real-world geographic object can be represented by a feature in a geographic database. An example of a commonly known Location Reference is a postal address of a house. Examples of object instances include a particular exit ramp on a particular motorway, a road junction or a hotel. For efficiency reasons, Location References are often coded. This is especially significant if the Location Reference is used to define the location for information about various objects between different systems. For Intelligent Transport Systems (ITS), many different types of real-world objects will be addressed. Amongst these, Location Referencing of the road network, or components thereof, is a particular focus.

Communication of a Location Reference for specific geographic phenomena, corresponding to objects in geographic databases, in a standard, unambiguous manner is a vital part of an integrated ITS system, in which different applications and sources of geographic data will be used. Location Referencing Methods (LRM, methods of referencing object instances) differ by applications, by the data model used to create the database, or by the enforced object referencing imposed by the specific mapping system used to create and store the database. A standard Location Referencing Method allows for a common and unambiguous identification of object instances representing the same geographic phenomena in different geographic databases produced by different vendors, for varied applications, and operating on multiple hardware/software platforms. If ITS applications using digital map databases are to become widespread, data reference across various applications and systems must be possible. Information prepared on one system, such as traffic messages, must be interpretable by all receiving systems. A standard method to refer to specific object instances is essential to achieving such objectives.

Japan, Korea, Australia, Canada, the US and European ITS bodies are all supporting activities of Location Referencing. Japan has developed a Link Specification for VICS. In Europe, the RDS-TMC traffic messaging system has been developed. In addition, methods have been developed and refined in the EVIDENCE and AGORA projects based on intersections identified by geographic coordinates and other intersection descriptors. In the US, standards for Location Referencing have been developed to accommodate several different Location Referencing Methods.

This International Standard provides specifications for location referencing for ITS systems (although other committees or standardization bodies may subsequently consider extending it to a more generic context). In addition, this version does not deal with public transport location referencing; this issue will be dealt with in a later version.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning procedures, methods and/or formats given in this document in Clauses 8 and 9 and Annexes A, B and C.

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Intelligent transport systems (ITS) — Location referencing for geographic databases —

Part 3:
Dynamic location references (dynamic profile)

1 Scope

This International Standard specifies Location Referencing Methods (LRM) that describe locations in the context of geographic databases and will be used to locate transport-related phenomena in an encoder system as well as in the decoder side. This International Standard defines what is meant by such objects, and describes the reference in detail, including whether or not components of the reference are mandatory or optional, and their characteristics.

This International Standard specifies two different LRMs:

— pre-coded location references (pre-coded profile);

— dynamic location references (dynamic profile).

This International Standard does not define a physical format for implementing the LRM. However, the requirements for physical formats are defined.

This International Standard does not define details of the Location Referencing System (LRS), i.e. how the LRMs are to be implemented in software, hardware, or processes.

This part of ISO 17572 specifies the dynamic location referencing method, comprising:

— attributes and encoding rules;

— logical data modelling;

— TPEG physical format specification for dynamic location references;

— coding Guidelines for Dynamic Location References;

— compressed Data Format Specification.

It is consistent with other International Standards developed by ISO/TC 204 such as ISO 14825, *Intelligent transport systems — Geographic Data Files (GDF) — Overall data specification*.

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.

ISO 17572-1, *Intelligent Transport Systems (ITS) — Location referencing for geographic databases — Part 1: General requirements and conceptual model*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17572-1 and the following apply.

3.1
bearing
angle between a reference direction and the direction to an object measured clockwise

NOTE Unless otherwise specified, the reference direction is generally understood to be geographic north.

3.2
connection angle
CA
difference between **side road bearing** and **bearing** at a point

3.3
connection point
location point captured in the location reference core, which forms the start point of a path external to the location

NOTE 1 Connection points are used to connect a location reference extension to a location reference core and to connect linear locations to form a subnetwork. The connection point is identified using its connection point index.

NOTE 2 The connection point index is implicitly defined by the order of the points in a location reference.

3.4
connectivity
status of being topologically connected

NOTE In a graph two or more edges are said to be connected if they share one or more nodes.

3.5
coordinate pair
set of two coordinates (one longitude value and one latitude value), representing a position on the earth model

NOTE Within the scope of this International Standard the earth model is embodied by ITRS and by ITRF coordinates.

3.6
core point
CP
point belonging to the location reference core

3.7
destination location
location to be used as the end location of a journey for a route guidance application

3.8
extension point
EP
point belonging to the location reference extension

3.9
great circle
circle on the surface of a sphere that has the same circumference as the sphere

NOTE The connection between two points on a sphere along the great circle passing through said two points is the shortest connection (airline distance, or distance 'as the crow flies').

3.10
intersection point
IP
core point representing an intersection, located at places where the road section signature at the location changes

NOTE The intersection point is one of the three defined core point types.

3.11
location point
LP
core point that bounds or is located on the location

NOTE Location points may coincide with intersection points or routing points. The start and end of the location is always represented by a location point. Additional intermediate location points may be created to represent the shape of the location. The location point is one of the three defined core point types.

3.12
location reference core
point or set of points that is available in any location reference

NOTE The rules in Clause 8 control the data to be stored in the location reference core.

3.13
location reference extension
additional point or set of points, not belonging to the location reference core, available in a location reference under special conditions

NOTE The rules in Clause 8 specify the conditions under which a location reference extension is to be used and control the data to be stored in a location reference extension.

3.14
next point
point that is directly (topologically) connected to a given point, in a direction that is defined by the defined direction of the location

NOTE A point may have zero or more next points.

3.15
next point relation
ordered pair of points (A, B) for which a direct connection exists from A to B along the path of the referenced location

NOTE In the road network, a direct connection between points A and B exists when point B can be reached from point A via part of the road network, without visiting intermediate points in the location reference. This excludes points connected in a GDF graph via a node representing an intersection-not-at-grade. Such points are not considered to be directly connected.

3.16
parallel carriageway indicator
non-negative integer which indicates if a road segment contains more than one carriageway in parallel in the direction of interest, and how many

3.17
precise geometry description
shape along the location, coded on the most detailed level of the digital map, lying in a corridor with a defined perpendicular distance to the great circle connection between two successive points on a location

3.18
road descriptor
full road number, or a significant substring of the official road name

NOTE The road descriptor is ideally three to five characters in length.

3.19
road network location
location which has a one-dimensional and continuous structure, being part of a road network

NOTE It is a continuous stretch of that road network as realized in the database, which may cover different roads, and may be bounded on either side by an intersection. Alternatively it may be bounded on either side by a position on a road.

3.20
road section signature
road signature
value of the attribute quadruple {functional road class, form-of-way, road descriptor, driving direction}

3.21
routing point
RP
point used to reconstruct the location by route calculation.

NOTE RPs are intended to allow point-based matching to the map database of the end user. When such an RP match is found, the location then can be further reconstructed using the connectivity of the road network as represented in the map database of the end user. The routing point is one of the three defined core point types.

3.22
side road section
road section which is not part of the location to be referenced, but connected to it via an at least trivalent junction

3.23
side road bearing
bearing of the side road section

3.24
side road direction
driving direction of the side road section

3.25
side road signature
road section signature of a side road section

3.26
status location
location to be used to position location-based status information

EXAMPLE A location for speed limit information or traffic level information.

4 Abbreviated terms (and attribute codes)

4.1 Abbreviations

AGORA	Name of a European project 1999-2002 Implementation of Global Location Referencing Approach
DLR	Dynamic Location Reference — also known as DLR1 because this is the first LRM under dynamic profile
GDF	Geographic Data Files — data model, data specification and exchange standard for geographic data for road transport applications
ISO	International Organization for Standardization
ITRF	International Terrestrial Reference Frame
ITRS	International Terrestrial Reference System
ITS	Intelligent Transport System
LR	Location Reference
LRM	Location Referencing Method
LRS	Location Referencing System
NLR	Network Location Reference
RDS	Radio Data System — digital data channel on FM sub carrier
RFU	Reserved for Future Use
SSF	Syntax, Semantics and Framing Structure (TPEG ISO/TS 18234-2)
TMC	Traffic Message Channel — system for broadcast of (digitally encoded) traffic messages on RDS
UML	Unified Modelling Language
VLC	Variable Length Coding
XML	Extensible Markup Language

4.2 Attribute codes

AFR	Accessible For Routing flag
BR	Bearing
CA	Connection Angle
CPI	Connection Point Index
DCA	Distance measure CA
DD	Driving Direction
DMB	Distance Measure Bearing
DSF	DeStination Flag
FC	Functional road Class
FCM	Functional road Class Minimal
FW	Form of Way
IT	Intersection Type
PCI	Parallel Carriageway Indicator
PD	Point Distance
PDM	$D_{perp\text{-}max}$ — Attribute to measure distance on shapes
RD	Road Descriptor
RDI	Road Descriptor of Intersection
RP	Routing Point
SNI	SubNetwork Index

5 Objectives and requirements for a location referencing method

For details, see ISO 17572-1:2008, Clause 4.

For an Inventory of Location Referencing Methods, see ISO 17572-1:2008, Annex A.

6 Conceptual data model for location referencing methods

For details, see ISO 17572-1:2008, Clause 5.

For Examples of Conceptual Data Model Use, see ISO 17572-1:2008, Annex B.

7 Specification of dynamic location references

7.1 General Specification

Dynamic Location Referencing is also known as the AGORA-C method and relies on specific attributes that are mostly available in current digital map databases. Consequently this LRM is adequate for LRSs that have a physical format specification based on GDF. The method relies on real-time access by the software to the original or translated values of the relevant attributes from its own digital map. This LRM will also be called "on-the-fly referencing" because the location reference code can be immediately discarded after internal definition of the location has been decoded. The dynamic location referencing concept is designed to compensate for differences that may exist between the map used at the sending system (the encoding side) and the map on board of the receiving system (the decoding side). Such map differences can be caused by the receiving system using an older map dataset of the same supplier, or vice versa, or the receiving system using a map dataset from a different supplier.

Dynamic Location Referencing is often not as compact as pre-coded location coding. However, it is generally accepted that if dynamic location reference codes can on average stay within 50 bytes for problem and status locations, this would be acceptable in terms of bandwidth occupation. The specification focuses on LRSs for two purposes, and hence provides two building blocks:

Location reference core
The location reference core is applicable to problem and status locations, e.g. road traffic messages. The location reference core is intended to provide location information much like ALERT-C location referencing [10] for which this specification actually intends to provide a light weight Dynamic Location Reference (not requiring pre-coding and the use of location tables). The location reference core prepares a function for additional robustness called precise geometry description in cases where a lack of information elements in the decoders map is expected or under conditions defined in the following clause.

Location reference extension
The location reference extension is applicable to use in routing to destination locations, i.e. the location of interest is to be used as the destination of a route guidance application. The location reference extension augments the location reference core to an extended location reference, in which, the location reference extension is provided to ensure that a path from the location of interest to the nearest part of the road network defined in the location reference core exists.

A dynamic location reference is constructed as a set of information elements, which consists of points and related attributes. All points in both building blocks of the location reference (location reference core and location reference extension) together constitute a linear set, i.e. they form a list where each point in the list except the last one relates to the next point in the list, and to no other points. Each point may have one or more attributes.

On reception of this location reference the receiving system needs to reconstruct the location as intended by the sending system. The encoding rules provided in Clause 8 provide the necessary semantics both for creating the location code at the sending system and for interpreting this code in the receiving system. Thus, the role of the encoding rules is both to provide constraints for selecting and creating this set of information elements at the sending system, and to provide a consistent interpretation basis for the receiving system to reconstruct the location reference as intended by the sending system.

This clause describes the building blocks for the Dynamic Location Reference and specifies different types of attributes. Clause 8 defines the Dynamic Profile LRM as a set of rules. These rules are mandatory, and any Dynamic Profile Location Reference shall adhere to these. Clause 9 defines the minimum requirements for any physical data format, which is for storing Dynamic Profile Location References of this LRM. Annex B describes hints to add optional attributes to the Dynamic Location Reference and proposes a coding procedure, which can serve as a basis for the creation of a coding algorithm. Through application of the rules and the coding procedure the sending system should be able to create a location reference that can be interpreted consistently by a variety of receiving systems if the physical format is well-known. For this reason a first physical format is defined in Annex A giving the opportunity to have at least one exchange format usable for the variety of LRS. If application of an LRM cannot implement the physical format of Annex A, the LRS might specify its own proprietary physical format, still fulfilling all format requirements defined by Clause 9 of this specification. A second physical format is defined in Annex C is specifically optimized for implicit areas and location references with precise geometry description and allows storing the location references in a very size efficient way.

Robustness of the codes is acquired by uniqueness. The information elements used and (certain aspects of) their combination shall be unique for this different parameters are defined as thresholds: e.g. the certain area around a point by the default distance D_{search_area}. These parameters are specified in different rules and the best known values are given in Table 3.

7.2 Location referencing building blocks

7.2.1 General

In 7.2.2 to 7.2.5 the building blocks for dynamic location reference encoding are defined and specified. These are points and attributes.

7.2.2 Points

The basis of the dynamic location reference is a set (or list) of points, which can be described as follows:

Point in general
A point may reference an intersection or may reference a position on the road network away from intersections. The set of points in a location reference constitute a next point relationship such that each point except the last one refers to one and only one other point (its 'next point').

Furthermore points are distinguished as to which part of the location reference they belong to: the location reference core or the location reference extension:

Core Point (CP)
Point belonging to the location reference core, which consists of a combination of three types of core points: location points, intersection points, and routing points.

1. **Location Point (LP)**
   A core point that represents the start, an intermediate, or the end point of the real-world location to be referenced.

2. **Intersection Point (IP)**
   A core point representing an intersection, located at places where the road section signature at the location changes.

3. **Routing Point (RP)**
   A core point used to reconstruct the location by route calculation.

Each core point in the set of points in the location reference core shall represent at least one of the three core point types defined in this International Standard.

Extension Point (EP)
Point belonging to the location reference extension. All points in the set of points in the location reference extension are by definition extension points.

7.2.3 Attributes

7.2.3.1 General

Table 1 lists the defined attribute types for dynamic location references, and their possible values. Note that some attributes relate to points, and other attributes to stretches of road network between points (possibly the whole length of the referenced location). An attribute that describes a characteristic of a linear stretch is linked in the location code to the point that is at the start point of the stretch. The following subclauses define some attributes in detail.

7.2.3.2 Functional Road Class

GDF defines this attribute with the purpose of "a classification based on the importance of the role that the road section or ferry connection performs in the connectivity of the total road network." It is an enumerated list of 10 different values [5] as follows:

— Main roads: the most important roads in a given network.

— First class roads.

— Second class roads.

— Third class roads.

— Fourth class roads.

— Fifth class roads.

— Sixth class roads.

— Seventh class roads.

— Eighth class roads.

— Ninth class roads: the least important roads in a given network.

NOTE 1 Dynamic Location Referencing uses this classification for distinguishing the parts of the road network, having a certain higher probability of existence in different databases. A standard Map database will deliver this attribute as defined in GDF; however, the attribute is quite differently used between countries and providers. The location referencing method considers this in the rules by leaning only on categorisations with high congruence between different map databases.

NOTE 2 The attribute FC may be not stored in some databases, but the encoder and decoder need to be able to derive it from other information available (speed, lanes, routing tables, etc.). For this purpose, Table B.1 provides an interpretation of the most used functional road classes in Clause 8.

7.2.3.3 Bearing at a point

The bearing at a given point along a location is the angle between the geographic north and the straight line connection from the given point to the intersection of the location with a measuring circle in the location direction (Pm), as depicted in Figure 1. The radius of the measuring circle is defined with the attribute "Distance for Measure of Bearing" (DMB), and if it is not provided, with the (parameter) $D_{m\text{-}bearing}$[1].

The bearing is measured in clockwise direction. The measuring distance of at least attribute DMB, respectively (parameter) $D_{m\text{-}bearing}$ ensures robustness for observed interpretation differences[2].

Once a point along a location has a bearing assigned then there is a natural way of associating one and only one road segment with the point. The road segment associated with the point except for the last point is the road segment leading away from the point in the location direction of the point's bearing. Therefore, if the point is not a junction, then the associated road segment is simply the road segment on which the point is located. If the point represents a junction, then the associated road segment is one of the road segments incident at this junction and leading away from it in the direction of the point's bearing (see Figure 1).

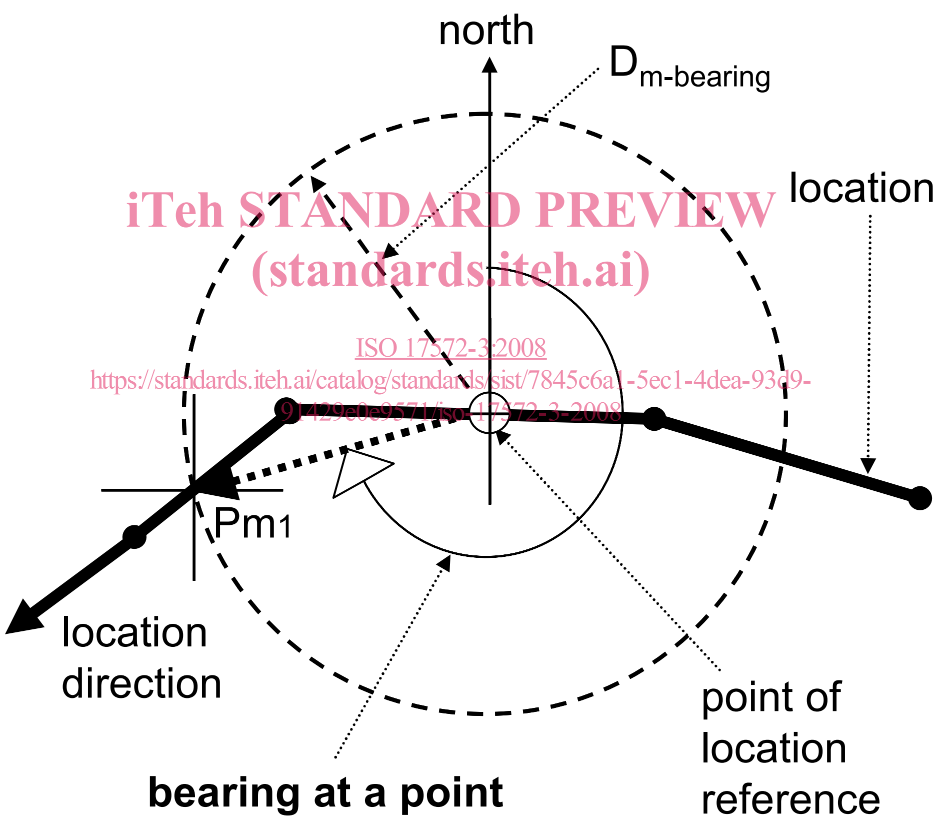

Figure 1 — Bearing at a point (general case)

In a case where a point is the last point of the location, the bearing is the angle from the intersection of the circle and the location reverse to the location direction (see Figure 2).

1) See Table 3 for values of defined parameters.

2) Road segments of less than 10m length do not provide sufficient real-world semantics. Frequently differences occur between maps of different map vendors due to interpretation differences allowed by GDF.