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

**Part 1:  
General requirements and conceptual  
model**

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

*Partie 1: Exigences générales et modèle conceptuel*



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Published in Switzerland

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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.

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](http://www.iso.org/directives)).

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

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This third edition cancels and replaces second edition (ISO 17572-1:2015), which has been technically revised.

The main changes are as follows:

- [Annex C](#) has been significantly reduced;
- Annex D, Annex E and Annex F have been deleted;
- cross-references have been updated throughout the document to refer to the most recent edition of the relevant publication;
- various minor editorial modifications have been made throughout.

A list of all parts in the ISO 17572 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

## 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 are 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 standardized, unambiguous manner is a vital part of an integrated ITS system in which different applications and sources of geographic data are 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 standardized 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, it is necessary for data referencing across various applications to be possible. Information prepared on one system, such as traffic messages, needs to be interpretable by all receiving systems. A standardized method to refer to specific object instances is essential in achieving such objectives.

LR activities are currently supported by Japanese, Korean, Australian, Canadian, US and European ITS bodies. Japan has developed a link specification for vehicle information and communication systems (VICS). In Europe, the radio data system – traffic message channel (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 document provides specifications for location referencing for ITS systems (although other committees or standardization bodies can subsequently consider extending it to a more generic context). Other LR methods for transport protocol experts group (TPEG) and geographic information are defined in the following documents:

- ISO/TS 21219-21, *Intelligent transport systems — Traffic and travel information via transport protocol experts group, generation 2 (TPEG2) — Part 21: Geographic location referencing (TPEG-GLR)*
- ISO/TS 21219-22, *Intelligent transport systems — Traffic and travel information (TTI) via transport protocol experts group, generation 2 (TPEG2) — Part 22: OpenLR location referencing (TPEG2-OLR)*
- ISO 19148, *Geographic information — Linear referencing*

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

## Part 1: General requirements and conceptual model

### 1 Scope

The ISO 17572 series specifies location referencing methods (LRMs) that describe locations in the context of geographic databases and that are intended for use in locating transport-related phenomena both in an encoder system and from the decoder side. This document 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.

The ISO 17572 series specifies three different LRMs:

- pre-coded LRM (pre-coded profile);
- dynamic LRM (dynamic profile);
- precise relative LRM (precise relative profile).

The ISO 17572 series does not define a physical format for implementing the LRM. However, the requirements for physical formats are defined.

The ISO 17572 series 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 document specifies the following general LRM-related subjects:

- requirements of an LRM;
- conceptual data model for LRMs;
- inventory LRMs (see [Annex A](#)).

This document also provides:

- examples of conceptual model use (see [Annex B](#));
- a comparison of definitions with ISO/TC 211 (see [Annex C](#)).

### 2 Normative references

There are no normative references in this document.

### 3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

**3.1  
accuracy**

measure of closeness of results of observations, computations, or estimates to the true values or the values accepted as being true

**3.2  
area**

two-dimensional, geographical region on the surface of the Earth

Note 1 to entry: An area can be represented as an implicit area or an explicit area.

**3.3  
area location**

two-dimensional location, representing a geographical region on the surface of the Earth

**3.4  
attribute**

characteristic property of a real-world feature

Note 1 to entry: This property allows the identification of a specific feature by its attributes. An attribute has a defined type and contains a value. Attributes can be either simple, consisting of one atomic value, or composite (see composite attribute).

**3.5  
coordinate**

one of an ordered set of  $N$  numbers designating the position of a point in  $N$ -dimensional space

Note 1 to entry:  $N$  would be 1, 2 or 3.

**3.6  
complex intersection**

intersection that consists at least of two or more junctions and one or more road elements

**3.7  
datum**

parameter or set of parameters that realize the position of the origin, the scale, and the orientation of a coordinate system

[SOURCE: ISO 19111:2019, 3.1.15, modified — admitted term ("reference frame") removed.]

**3.8  
descriptor**

characteristic of a geographic object, usually stored as an attribute

EXAMPLE Road names or road numbers.

**3.9  
digital map database**

structured set of digital and alphanumeric data portraying geographic locations and relationships of spatial features

Note 1 to entry: Typically, such structures represent, but are not limited to, the digital form of hard copy maps. For example, drawings can be imported into a geographic information system (GIS) and considered as a form of digital map.

**3.10  
dynamic location reference**

location reference generated on-the-fly based on geographic properties in a digital map database

**3.11****explicit area**

two-dimensional face on the surface of the earth, with a specified outline either being a simple geometric figure or an irregular outline/polygon

**3.12****geodetic reference frame**

reference frame or datum describing the relationship of a two- or three-dimensional coordinate system to the Earth

[SOURCE: ISO 19111:2019, 3.1.34, modified — Note 1 to entry has been removed.]

**3.13****implicit area**

selection of road segments to be referenced belonging to a certain area (subnetwork)

Note 1 to entry: One implicit area can be built up of multiple subnetworks that are geographically connected.

**3.14****international terrestrial reference frame****ITRF**

Earth-centred global reference frame, including an Earth model, based on satellite and terrestrial data; realization of the international terrestrial reference system (ITRS)

Note 1 to entry: The ITRF is a realization of the international terrestrial reference system (ITRS). It contains primary parameters defining the shape, angular velocity and the earth mass of an Earth ellipsoid, and secondary parameters defining a gravity model of the Earth. Primary parameters are used to derive latitude-longitude coordinates (horizontal datum). The ITRF94 reference frame is defined in ISO 19161-1.

**3.15****international terrestrial reference system****ITRS**

reference system for the Earth derived from precise and accurate space geodesy measurements, not restricted to GNSS Doppler measurements, which is periodically tracked and revised by the International Earth Rotation and Reference Service

Note 1 to entry: The basic information and the requirements related to the ITRS are defined in ISO 19161-1.

**3.16****intersection**

<ITS> crossing and/or connection of two or more roads

Note 1 to entry: In the ISO 20524 series (Geographic Data Files, GDF), an intersection is a level 2 representation of a junction which bounds a road or a ferry. It is a complex feature, composed of one or more level 1 junctions, road elements and enclosed traffic areas. The definition in this document is different from that of the ISO 20524 series because the location referencing system refers to real-world objects rather than a database definition, as defined in the ISO 20524 series.

Note 2 to entry: Crossings can be at-grade or grade-separated. Crossings that are grade-separated where no connection between the road segments exists are excluded from this definition.

**3.17****road junction****junction**

elementary element in the road network, connecting two or more road elements

Note 1 to entry: In the ISO 20524 series (Geographic Data Files, GDF), a junction is a level 1 feature that bounds a road element or ferry connection. Junctions that represent real crossings are at least trivalent (having three roads connected). A bivalent junction can only be defined if an attribute change occurs along the road (e.g. road name change). A junction is also coded at the end of a dead-end road, to terminate it.

### 3.18

#### **linear location**

location that has a one-dimensional character

EXAMPLE A road segment.

### 3.19

#### **link**

#### **edge**

<ITS> direct topological connection between two nodes that has a unique link ID in a given digital map database

Note 1 to entry: A link can contain additional intermediate coordinates (shape points) to better represent the shape of curved features. A link can be directed or undirected.

### 3.20

#### **link identifier**

#### **link ID**

identifier that is uniquely assigned to a link

Note 1 to entry: A link identifier can be arbitrary or can be assigned by convention to ensure that no multiple occurrences of the same identifier will be used within one instance of a network or map database.

### 3.21

#### **link location**

location identifiable by a part of the road network database having one identifier or having a uniquely identifiable combination of attributes throughout the continuous stretch

Note 1 to entry: One link location can consist of multiple links.

### 3.22

#### **location**

particular place or position

Note 1 to entry: A location is matched to database objects by location definitions, which specify what is meant by a particular location. Without any explicit remark, it is intended to be a linear stretch in terms of topology in the database network without any loops or discontinuities in between (linear location). It can also be only a point in the network as a specialization of a linear stretch with length zero. In addition to that, a location can also be a set of road elements representing an area. This area is expressible by a polygon or a list of linear locations. For further description of different categories of locations, refer to [6.4](#).

[SOURCE: ISO 19112:2019, 3.1.3, modified — The original Note to entry and Example have been removed. A new Note 1 to entry has been added.]

### 3.23

#### **location reference**

#### **LR**

label assigned to a location

Note 1 to entry: With a single location referencing method (LRM), one reference defines unambiguously and exactly one location in the location referencing system as defined in [5.2](#). The location reference is the string of data which is passed between different implementations of a location referencing system to identify the location.

### 3.24

#### **location definition**

actual delineation of exactly what is meant, and therefore what is not meant, by a particular location within a specific database

Note 1 to entry: It is the precise location definition of the database object, or set of database objects, which is referenced.

EXAMPLE GDF road elements that make up a particular instance of an ALERT-C location.

**3.25****location referencing**

action to assign a label to a location

**3.26****location referencing method****LRM**

methodology of assigning location references to locations

**3.27****location referencing system****LRS**

complete system by which location references are generated, according to a location referencing method, and communicated, including standards, definitions, software, hardware, and databases

**3.28****matching**

<ITS> translation of a location reference to a specific object in a given map database to attempt recognition of the same identified object in both the sender's and the receiver's map database

Note 1 to entry: Matching is seen as a subsequent part to the method of decoding a location reference adhering to the defined LRM.

**3.29****node**

zero-dimensional element that is a topological junction of two or more edges or an end point of an edge

Note 1 to entry: A node is created for topologically significant points, such as simple intersections of roads or other linear features including boundaries, but also for locations such as electric beacons, kilometre-posts, or sensors detecting traffic flows, these being significant points specified in a map.

**3.30****point**

zero-dimensional element that specifies geometric location

Note 1 to entry: One coordinate pair or triplet specifies the location.

**3.31****point location**

location with a zero-dimensional character

EXAMPLE A simple crossing.

**3.32****precision**

closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects

Note 1 to entry: Alternatively, the closeness of measurements of the same phenomenon repeated under exactly the same conditions and using the same techniques.

[SOURCE: ISO/IEC Guide 99:2007, 2.15, modified — The Note to entry and Example have been removed. A new Note 1 to entry has been added.]

**3.33****pre-coded location reference**

location reference using a unique identifier that is agreed upon in both a sender and receiver system to select a location from a set of pre-coded locations

### 3.34

#### **quad tree**

hierarchical data structure which, on a next lower level, subdivides a given area into four quadrants of the same size where any level has knowledge of its four sublevels and its parent level

### 3.35

#### **relationship**

<ITS> semantic or topological interrelation or dependency between locations in the location referencing system (LRS)

Note 1 to entry: Relationships can exist between locations in the LRS. These relationships will generally be structured to allow more sophisticated use of the location reference, such as a topological or hierarchical structure. For example, a county location can be defined as an aggregate of several city locations or a long stretch of road can be an aggregate of several smaller road segments. Referencing the county can be easier than referencing all the cities which make up the county. This allows scalability and ease of use in the LRSs using the location referencing method (LRM).

Note 2 to entry: The term definition in ISO/TC 211 is different because of the difference in conceptual level between the groups.

### 3.36

#### **road**

part of the road network which is generally considered as a whole and which can be addressed by a single identification like a road name or road number throughout

Note 1 to entry: In general, it is a connection within the road network, with or without crossings, which functionally can be considered as a unity. A road with multiple (associated) carriageways can be considered as one road. Within the ISO 17572 series, the term also covers the natural language term "street".

Note 2 to entry: The subsequent parts of this document intentionally do not make direct use of this term because under different circumstances it is not always possible to define exactly where a road ends. For this reason, reference is made to artificial but more precisely-definable road elements or road sections of the road network.

### 3.37

#### **road crossing**

location where two or more roads connect or intersect

Note 1 to entry: A road crossing can be "simple", corresponding to one junction, or "complex", including internal road elements and junctions.

### 3.38

#### **road element**

linear section of the road network which is designed for vehicular movement having a junction at each end

Note 1 to entry: It serves as the smallest unit of the road network at GDF level 1 that is independent.

### 3.39

#### **road section**

road segment that is bounded by two intersections and has the same attributes throughout

Note 1 to entry: Generally, the two intersections are different, only in some specific cases are the intersections the same, e.g. a tear-drop street or slip roads inside of complex intersections.

### 3.40

#### **road segment**

part of a road, having its start and end along that road

Note 1 to entry: An important difference between a road section and road segment is that the segment does not necessarily end at intersections.

**3.41****shape point**

intermediate coordinate pair to represent the shape of curved features

**3.42****subnetwork**

plurality of road segments lying in geographical or topological conjunction to each other

**3.43****topology**

properties of spatial configuration invariant under continuous transformation

Note 1 to entry: In a digital map database, this means the logical relationships among map features. It can be used to characterize spatial relationships such as connectivity and adjacency.

**4 Abbreviated terms**

|          |  |
|----------|--|
| AGORA    | implementation of global location referencing approach (name of a European Union project 2000–2002)    |
| ALERT-C  | advice and problem location for European road traffic-compact  |
| EVIDENCE | extensive validation of identification concepts in Europe (name of a European Union project 1998–1999) |
| GDF      | geographic data file   |
| GIS      | geographic information system  |
| GNSS     | global navigation satellite system   |
| ITS      | intelligent transport systems  |
| POI      | point of interest  |
| RDS      | radio data system  |
| TPEG     | transport protocol expert group  |
| TMC      | traffic message channel  |
| TTI      | traffic and traveller information  |
| UML      | unified modelling language   |
| UTM      | universal transverse mercator  |
| VICS     | vehicle information and communication system   |

NOTE The ISO 17572 series uses unified modelling language (UML) to express specific circumstances. As such, graphical elements are used to express specific constraints and structural relationships. A full definition can be found in the ISO/IEC 19505 series.

**5 Objectives and requirements for a location referencing method****5.1 Objectives for an optimal location referencing method**

ITS applications have different objectives regarding location referencing, which from their contradictory nature, cannot be fulfilled completely. In theory, an ideal location referencing method would require every LRS to have at a given time the same, completely accurate map and all locations

would be identifiable without any additional computational effort. Even though this is not achievable, the following goals should guide the definition and optimization of a location referencing method. The circumstances of the specific location referencing system can give different weight to the following goals.

- 1) The LRM should be simple enough to be implemented in a resource- and performance-efficient way.  
This first goal states that processing power in any case is a cost factor to be minimized.
- 2) The LRM should not unduly add to the volume of data to be transferred.  
Location referencing implies at least two systems communicating with each other. Communication also causes costs and therefore needs to be minimized.
- 3) The LRM should provide location references with the highest accuracy possible.  
This means that the aim should be to use the exact location, both in the sender and the receiver system. In many cases, it will be up to the receiver to decode the location reference as well as possible. To help the receiver to do so, it shall be implied that the sending system sends the location reference as accurately as possible.

## 5.2 Requirements of the location referencing method

In addition to the goals, a number of minimal requirements shall make the different location referencing methods feasible for the foreseen categories of locations (see 6.4).

One of the most important data characteristics for ITS applications is spatial accuracy. Spatial accuracy is an aspect of data quality and is described in ISO 20524-1 in the following way: "*The shape of a level 0 edge including all positions on the segment as a whole shall not have any position that diverges from the real shape more than an allowed error.*" Spatial data accuracy requirements for ITS vary according to the application. This means not just categories of applications but how an application works operationally. Some applications, notably those for advanced vehicle safety systems, require very accurate data. Even within a particular application, requirements for different levels of data accuracy can exist and are subject to change as applications and products evolve. The spatial data accuracy requirements impact the location referencing method chosen for an application.

One fundamental requirement across all methods is that, whichever method is used, use of that method does not result in additional spatial location error beyond that already present in the data. However, for the location referencing of area information, for example weather information or information specifying a zone of environmental contamination, some positional error is permitted due to the imprecise ("fuzzy") nature of such information. The key requirement for such references is that they be made with sufficient precision to allow the user to avoid the area or take other appropriate action. Specifically, it is a requirement that:

- 1) An LRM and the process of its operation shall not introduce a supplementary position error relative to that specified in the database from which the reference is generated. The location reference should be conveyed with sufficient spatial and temporal accuracy to enable the vehicle or user to identify the (spatial) extent of the location.

For certain locations, knowing the side of the road or block on which the location is found can be very important to the user. For example, crossing a road to a location on the opposite side can potentially not be possible for vehicles or pedestrians in some road lane configurations without additional routing, whereas turning into a location on the same side can be easily accomplished. Therefore, it is a particular requirement that:

- 2) The LRM shall enable referencing of the relative spatial relationship of objects.

In addition to spatial accuracy requirements, location referencing methods have functional requirements regarding topological relationships, for example that a point is on one side of an object or that many points shall be ordered in a certain way along a road. For example, for locations referenced

by positions along a logical or physical route, the ordering of points shall be preserved by the reference. For location referencing, the requirement is that:

- 3) The LRM shall not change the topological relationships within a set of point data by its own action, limitation, or deficiency. For referencing by geographic coordinates, spatial relationships between locations should not be confused by lack of precision or by any other attribute of the referencing system or its operation.

The ISO 17572 series is foreseen to be used in a variety of location referencing systems. However, the restriction to some specified categories of locations is understood as a first step of optimization of the defined location referencing methods. For this, the following points apply as a minimum:

- 4) The definition of an LRM shall adhere to the common terminology and conceptual model defined in this document.
- 5) The LRM shall provide means to refer only to the categories of locations explicitly defined by that LRM.
- 6) The LRM shall, in principle, allow addressing of every location on the road network.

Location referencing is an important technology for traffic telematics applications in particular and, in general, for any location-based service. It provides an understandable reference for a location about which information needs to be provided. Understandable generally means machine-readable, i.e. the location information (as well as the message content) can be understood by equipment that translates the complete message to human understandable information, e.g. position on a map or a descriptive way to reach the location. Therefore:

- 7) The location reference shall be machine-readable.

## 6 Conceptual data model for location referencing methods

### 6.1 Role of conceptual model

The conceptual model provides a framework to describe and define an LRM in generic, conceptual terms. The conceptual model is generally valid, i.e. not limited to the LRMs defined in this document. Therefore, examples of other LRMs are mentioned in [Annex B](#), to illustrate the underlying conceptual view.

### 6.2 Components of conceptual model

All location referencing methods have some form of the following components. The detailed definitions of the terms are provided in [Clause 3](#).

**Attributes:** An attribute allows the LRS to process or evaluate the information about the location. Attributes discriminate the reference in such a way that the receiver system can identify the location correctly.

**Location:** A location is a part of the road network that is intended to be identified. The sender system aims to refer to it; the receiver system aims to find it in its map database.

**Location definition:** The location definition is the defined delineation in a digital map database of exactly what is meant. The location definition in a sender system can be different from the one in a receiver system even if the location is the same.

**Reference:** The reference is the label which is assigned to the location.

**Relationship:** Relationships to other locations in the LRS are also used to support the use of locations in an LRM.

**NOTE** Not all LRMs require relationships and attributes. For example, an LRS which uses arbitrary numbers assigned to each location can never need to define how any of the locations relate to each other. However, in an LRS which meets the system implementation requirements identified during the implementation design phase of an LRS (which can be among others: flexibility, extensibility, compactness, etc.), relationships can be inherent in the referencing procedures. For example, pre-coded locations used in RDS-TMC systems arbitrarily number locations, but since the referencing system allows the use of an “extent,” each location can carry the definitions of which location is “before” and “after” it.

### 6.3 Description of the conceptual model

A reference is the label which is assigned to a location. In a single LRS, a reference shall be defined or definable, which unambiguously identifies each location in that LRS. A location is a simple or compound geographic object, which is matched to database objects by location definitions, which specify what is meant by the particular location. A location can aggregate different attributes, which allow for the identification of the methods to process or evaluate the information about the location. Relationships associate different locations, for example, to allow more sophisticated use of the location reference, such as a topological or hierarchical structure. They are intended to reflect the possibility of two or more locations in a relationship, either ordered or unordered. See [Figure 1](#).

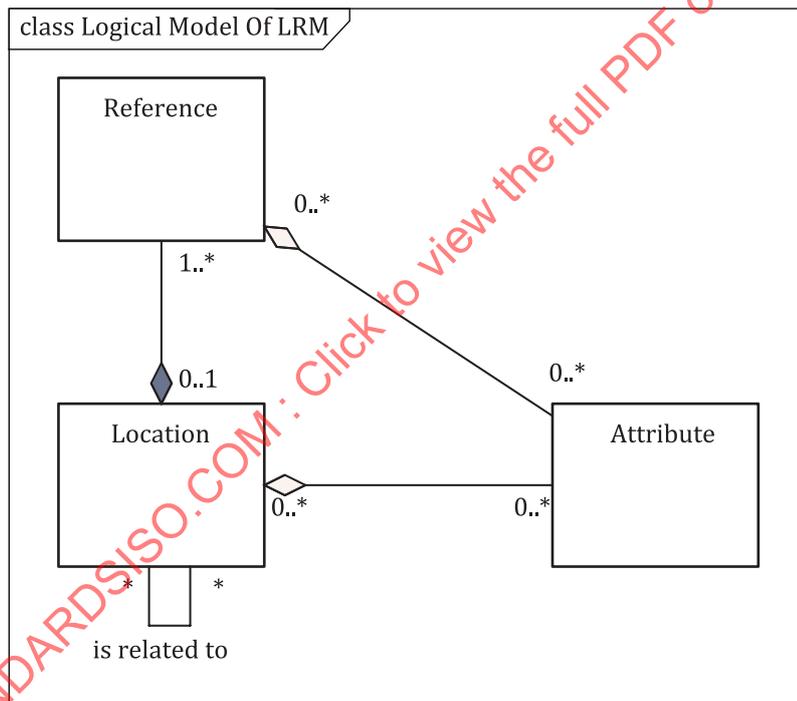


Figure 1 — Diagram of the conceptual model of an LRM

### 6.4 Location categories

Locations shall be categorized as point locations, linear locations and area locations. These location categories represent real-world objects which can be described as follows:

- existing at a single position (point location);
- between two positions within intersections as road section (linear location, in terms of one or more link locations);
- between two positions as road segment (linear location);

- consisting of two or more link locations (linear location);
- a selection of road segments belonging to a defined collection (subnetwork or collection of subnetworks) (implicit area location);
- within the boundaries of a defined area (explicit area location).

Point locations can be described as existing at a single position. Point locations include, for example, points of interest, public service facilities, commercial establishments, etc. Link locations are linear objects bound by two point locations. Linear locations are two or more consecutive link locations, bounded, therefore, by three or more consecutive point locations that define a connected linear stretch in the road network. Implicit area locations are more than one linear location of a certain area put together in one package. Explicit area locations are two-dimensional features such as governmental administrative area, postal district, telephone exchange district, etc., or just defined outlines as areas at a given place on the map.

Specific reference object instance classes within these categories include the following:

- general points (points that can or can potentially not lie on a road network, including points where a road crosses administrative boundaries or borders of map grid cells);
- points at nodes in a topological network representation of roads and their intersections;
- links defined by two consecutive intersections of roads (road sections);
- points along links bounded by intersections of roads;
- manoeuvres defined by two consecutive links (therefore, three intersections);
- areas defined by a sequence of points;
- areas defined by a sequence of link locations;
- areas defined by an origin point and attributes, such as the radius of a circle around the point or offsets defining a bounding box.

Generally, important location categories for ITS databases are human-made structures like road crossings, road sections or segments, as well as sequences of road sections necessary for describing manoeuvres. Location categories can be arranged in class/type hierarchies to aid in decoding between dissimilar receiver/sender systems.

## 6.5 Conceptual model of a road network

One purpose of location referencing is to refer to parts of the road network. The conceptual model of the road network is, therefore, depicted in [Figure 2](#) and described in this subclause to give a clear understanding of the different terms and their relationships. This is especially needed because the sophisticated definition of roads and intersections in the ISO 20524 series (GDF) does not meet the requirements of a conceptual model for location referencing.

In general, the road network consists of roads. A road is generally represented by a name (or number) throughout as a whole and consists of a set of road sections. On a road, a tremendous (but countable) number of road segments can be defined (and referenced). A road section consists of nodes and edges, is bounded by intersections, and can have intermediate intersections (where the road name does not change). An intersection is a connection or crossing of roads. The simplest intersection consists of just one node (i.e. junction). If an intersection has two or more nodes and one or more edges, it is considered to be a complex intersection.

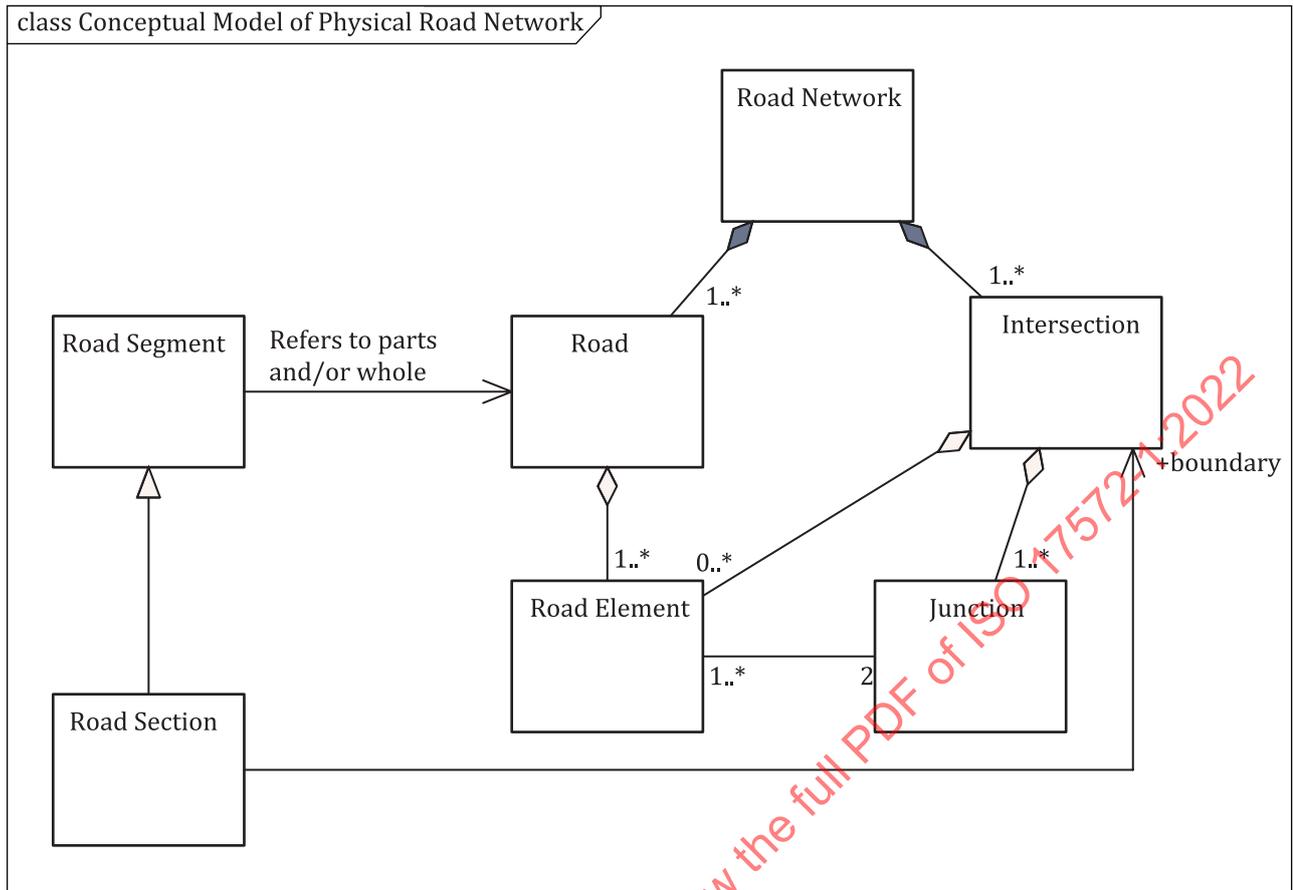


Figure 2 — Conceptual model for the physical road network

6.6 Conceptual model of area locations

An area is considered to be a two-dimensional, geographical region bounded on the surface of the earth. Area locations have specific constraints on location referencing due to requirements of the application. The different requirements of the applications determine if the full geographical figure shall be mentioned or a defined number of roads inside this region. To enable an LRM handling and defining rules for explicit and implicit area types, the conceptual model defines terms for it and describes conceptually their containment as shown in Figure 3.

In one case, it can be feasible to define the area by a geometric figure (explicitly). In other cases, it can be necessary to select a list of road elements spanning an area (implicitly).

An implicit area consists of one or more subnetwork locations which each consist of at least two road segments being aggregated to the subnetwork. The explicit area specifies a part of the Earth's surface being the area, by means of a geometric (regular) function, defined as a region; meanwhile, an area with a form freely defining its shape is called an outline. Both of the area types have at least one referenced connection to the surface allowing the decoding system to precisely position the given area.

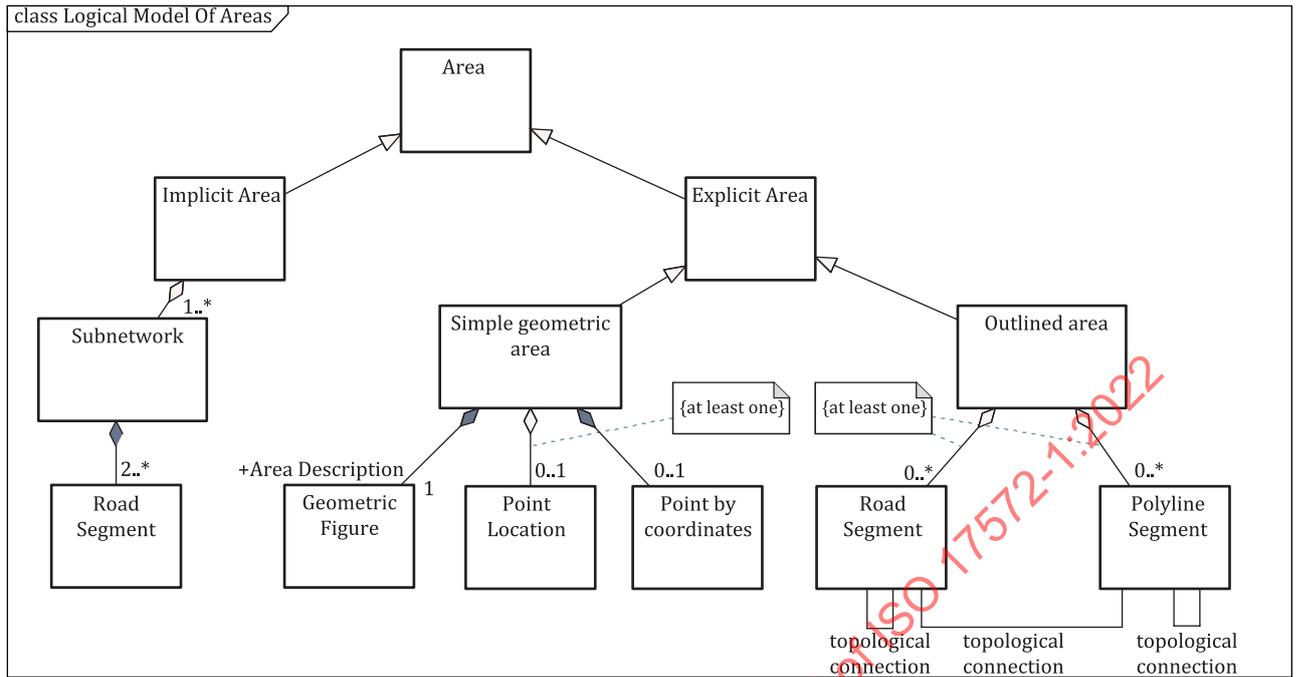


Figure 3 — Conceptual model of areas

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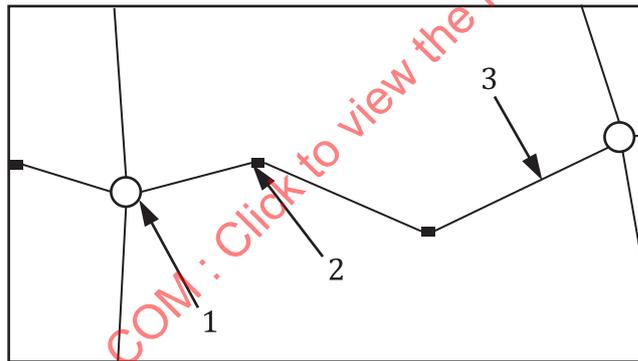
## Annex A (informative)

### Inventory of location referencing methods

#### A.1 General

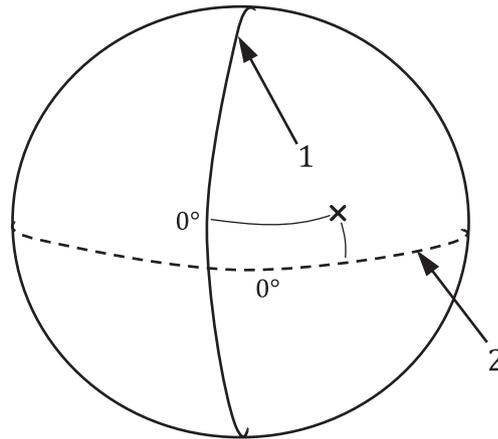
There are two essentially different ways of referencing road locations: with reference to attributes of the road network itself, including linear distances or street addresses, or with reference to a regular or irregular division of space which exists independently of the representation of the road network. The former kind of reference is sometimes called an indirect reference. The latter kind involves coordinate systems, for example UTM coordinates or geographic latitude/longitude coordinates.

Some indirect referencing methods stress the topology of networks (for example, link ID and linear referencing), and some stress the attributes of the features that comprise the network (for example, cross-street offset matching and street addresses). Geographic coordinates express location directly in terms of the geodetic reference frame itself; they are simply measurements on the framework (e.g. longitude/latitude) or as quantized, regular subdivisions (e.g. quad trees). [Figure A.1](#) illustrates indirect (specifically, the link ID method) and coordinate referencing methods (specifically, the method of geographic coordinates).



- 1 node
- 2 shape pints
- 3 internal links / logical links

**Figure A.1 — Concept of Indirect (link ID) referencing method**



- 1 prime meridian
- 2 equator

**Figure A.2 — Concept of coordinate referencing method**

The following list summarizes location referencing methods in use today, which will be discussed briefly in the next clauses:

- referencing by link ID or node ID;
- referencing by geographic coordinates;
- referencing by grid;
- linear referencing;
- referencing by cross-streets;
- referencing by address information;
- combinations of the above methods.

## A.2 Referencing by link ID or node ID

Logical links represent topological connectivity between nodes corresponding to real world points like intersections. The real-world network can be represented within the data set by a planar or non-planar graph. The difference is that containing links do or do not cross without nodes. Shape points are typically inserted between nodes to represent road geometry between intersections. A link identifier (link ID) is usually a numeric identifier assigned to each link in the network. Link ID references can be passed in more than one way. The link ID can be:

- unique,
- non-unique within a hierarchical scheme, or
- derived from some manipulation of location, such as the bit interleaving of end-node coordinates.

The two modes of referencing are as follows:

- unique link ID: the link itself has one identifier (possibly corresponding to only one direction of the link and optionally complemented by a second identifier for the reverse direction, i.e. the link can either be directed or undirected);

- end node IDs: the link is then identified by two identifiers, those of the link start node and the end node.

Within a link ID reference, additional information can be specified, such as offsets from start and/or end nodes, an indicator for the side of the street or road on which a point-of-interest or linear segment-of-interest resides, or implied directionality for a unique link ID reference. The link ID LRM refers to a previously defined database of identifiers and is, therefore, categorized as a pre-coded LRM.

### A.3 Referencing by geographic coordinates

A location on the earth's surface is often expressed in terms of coordinates defined by a coordinate system (axes, origin and values) and a geodetic reference frame, the set of geodetic parameters defining the space with respect to which the location is to be referenced (see the international terrestrial reference frame, ITRF). Coordinate systems can be earth-centred or local, geodetic or planar, and can allow position specification horizontally, vertically, or both. Geodetic parameters can include the following:

- national geodetic reference frame;
- reference ellipsoid;
- projection method;
- national map grid;
- geoid undulation;
- magnetic declination.

Referencing by geographic coordinates is defined in ISO 19111 and ISO 6709. Coordinates of points on or near the crust of the Earth that are referenced to a dynamic coordinate reference system can change with time, usually due to crustal deformations such as tectonic motion and glacial isostatic adjustment. The dynamic coordinate reference system defined in ISO 19111 can describe such coordinates.

### A.4 Referencing by grid

The common element of a grid (or raster) scheme is a regular subdivision of a surface into finite shapes, typically rectangular, and the assignment of coordinates in some regular way (e.g. letters A to Z for columns and numbers 1 to 10 for rows). To minimize data set size and for efficient manipulation and search based on divide-and-conquer algorithms, hierarchical tessellations recursively subdivide a surface into regular groupings of shapes numbered hierarchically. Data sets built on hierarchical tessellations preserve information where, and only where, there is information. Such methods are therefore hybrid between continuous field representations and grids. In terms of the location referencing method here, again the grid is defined independently of the road network and is therefore categorized as dynamic LRM.

### A.5 Linear referencing

A linear (one-dimensional) referencing method is a method of identifying a location on a network or part of a network by reference to known positions of (spatial) objects. If space is constrained to the road network itself, distances along roads from established nodes (or even topologically non-significant points) can be used to specify location. Mile point or reference point sub-methods use a road label and distance measure; mile marker, reference marker, and addressing sub-methods use physical features inserted into the digital base map. Because of the reliance on predefined identifiers, this method is categorized as pre-coded LRM even if parts of the reference (e.g. a given offset) do vary inside of different references.

Linear referencing is defined in ISO 19148.