SLOVENSKI STANDARD

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Inteligentni transportni sistemi - Uskladitev lokacijskih referenc za mestni ITS - 2. del: Metode pretvarjanja

Intelligent transport systems - Location Referencing Harmonisation for Urban-ITS - Part 2: Transformation methods

Intelligente Verkehrssysteme - Ortsreferenzierungsharmonisieung für Urbane ITS - Teil 2: Übersetzungsmethoden

Élément introductif - Élément central - Partie 2 : Élément complémentaire

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ICS:

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Élément introductif - Élément central - Partie 2 : Élément complémentaire

Einführendes Element - Haupt-Element - Teil 2: Ergänzendes Element

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (CEN/TS 17297-2:2019) has been prepared by Technical Committee CEN/TC 278 "Intelligent transport systems", the secretariat of which is held by NEN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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Introduction

Whilst some location data are based on a latitude/longitude system or other coordinate systems, others are based on the gazetteer reference to physical objects, e.g. bus stops, streets or bays in a car park. Translations between different location referencing systems are, therefore, a key feature for moving data between systems and between applications. Nearly all ITS applications need some form of location determination and referencing to put the data or information into a spatial context.

In data terms, for most systems, we need to know values and where the data was collected. For example, a loop detector is referenced to a particular point defined generally by a description of the road, the direction, the lane and a stated distance from a known reference point like a junction. Data from a moving probe vehicle will often be defined by XY coordinates based on an agreed location referencing systems such as WGS84. Similarly, public transport information is often referenced to identified routes and stops but historically, without the need to be concerned about where these routes and stops are in geographically physical space.

Historically, applications in the transport sector have spawned location referencing systems that have properties that suit the application itself; this silo approach has resulted in a significant number of incompatible location referencing systems, often within the same organization. A typical road authority can have 10 or more different location referencing systems for traffic control, pavement management, detectors, asset management and content dissemination etc.; none of which are compatible or easily translated from one to another because of different business rules or definitions. An example of this is ‘lanes’; is a long exit lane from a motorway counted as a running lane, and where does it start and end?

In public transport information services, location references – where they exist – can be both inconsistent with location information on the infrastructure. For example, even where a bus stop is geo-located as a point in space, this is often unmatched with the road along which the bus will be travelling. Also, there is a logical divergence on whether the “stop” is the point where passengers are expected to stand or the point where the vehicle will stand; whilst this distinction will generally be of no significance for end users of itself, it makes multimodal information – for example, planning a walk-then-bus journey – difficult and unreliable.

More generally, in the Urban-ITS context, multiple applications are required to cooperate. So, in a multimodal environment, the disparity between location referencing systems becomes a major issue.

The only solution is to first identify the characteristics of location referencing that can be “application independent” and then evolve (a) a conversion strategy for the short-term, and (b) a migration strategy for the long term; with constant pressure on budgets, this represents a major challenge.

This document has been produced by the CEN/TC 278/WG 17 Project Team PT 1703 “Location Referencing Harmonisation” under the mandate M/546 on urban ITS (U-ITS).

This document, in examples, mentions tools that can support transformation processes. It is noted that reference to particular tool does not imply that it is the only or best tool for achieving a task, or that it is currently available.

The audience for this document are those who need to combine data which use different location referencing methods due to their different applications, modes or vendors.

The informative Clause 5 describes basics on transformations between location reference systems:

— The concept of transformation is presented in 5.2.

— Data quality in the context of transformations is discussed in 5.3.

The normative Clause 6 specifies transformation requirements and presents transformation examples.

Location referencing inside buildings is not considered in this document.

1 Scope

This document specifies requirements, recommendations, and permissions related to translations between location referencing methods applicable in the urban transport environment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

EN ISO 14819-3:2013, *Intelligent transport systems — Traffic and travel information messages via traffic message coding — Part 3: Location referencing for Radio Data System — Traffic Message Channel (RDS-TMC) using ALERT-C*

ISO 19157:2013, *Geographic information — Data quality*

INSPIRE Technical Guidelines, INSPIRE, *Data Specification on Coordinate Reference Systems — Technical Guidelines. 2014*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CEN/TR 17297-1 and the following apply.

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

• IEC Electropedia: available at http://www.electropedia.org/

• ISO Online browsing platform: available at https://www.iso.org/obp

3.1
accuracy
closeness of agreement between a test result or measurement result and the true value

[SOURCE: ISO 6709:2008, definition 4.1]

3.2
area of use
geographical area in which a specific map projection applies

3.3
location reference
description of an identifiable geographic place

Note to entry: ISO 17572-1 defines a location reference as a “label which is assigned to a location”, while ISO TS 21219-7. TPEG2-LRC defines location referencing as “means to provide information that allows a system to identify accurately a location”

3.4
resolution
unit associated with the least significant digit of a coordinate

[SOURCE: ISO 6709:2008, definition 4.10]

3.5
transformation
operations to change the description of a location (a location reference) from one LRS to another LRS

4 Symbols and abbreviations

AVM	automatic vehicle monitoring
CRS	coordinate reference system
CS	coordinate system
EPSG	European Petroleum Survey Group
ETRS	European terrestrial reference system
EU	European Union
GALILEO	name of the European satellite navigation and time reference system
GIS	geographic information system
GLONASS	Global Navigation Satellite System NOTE 1 Russian: globalnaja nawigazionnaja sputnikowaja sistema NOTE 2 name of the satellite navigation and time reference system of the Russian Federation
GLR	geographic location referencing
GML	geography markup language
GNSS	global navigation satellite system
GPS	global positioning system NOTE 3 name of the satellite navigation and time reference system of the United States of America
INSPIRE	infrastructure for spatial information in Europe NOTE 4 Name of a directive on the EC; aims on creating a European Union spatial data infrastructure
IOGP	International association of oil and gas producers
ITRS	international terrestrial reference system
ITS	intelligent transport systems
LLRM	linear LRM
LRM	location referencing method
LRS	location referencing system
OEM	original equipment manufacturer
OGC	open geospatial consortium
TN-ITS	transport networks for ITS
U-ITS	urban ITS
UTM	universe transverse Mercator

5 Basics on transformations between location reference systems

5.1 Location referencing

The concept of location referencing with location referencing methods (LRMs) and location referencing systems (LRSs) is described in CEN/TR 17297-1.

5.2 The concept of a transformation

5.2.1 General

Several definitions exist for the term *transformation*, both in international standards and in other literature. In this document, the term will be used for operations that are performed to change the description of a location (a location reference) from one LRS to another LRS. The operation can be done to change from a location reference in one LRS to another LRS, both based on the same LRM, or to change between two LRSs based on different LRMs. The transformations that are described in this document are valid for LRMs and will be employed to transform between LRSs.

The individual LRMs described in CEN/TR 17297-1 have different approaches for describing a location, both in terms of how the location is described within an LRM, and also how the LRM is used to connect a location reference to the real world, see Figure 1 in CEN/TR 17297-1:2019 and Figure 1 in this document. As a result of a transformation between LRSs from two different LRMs is likely to change the location reference significantly, including the representational shape and the positional accuracy of the location reference.

Figure 1 illustrates the basic concepts of location referencing and transformation between location references in different location referencing systems. Two real-world locations are described, i.e. L_{α} and L_{β}. The location references $LR_{A1,\alpha}$ and $LR_{B2,\alpha}$ with different LRSs and LRMs, describe location L_{α}; and the location references $LR_{A1,\beta}$ and $LR_{B1,\beta}$ describe location L_{β}. A transformation can be applied to transform location reference $LR_{A1,\alpha}$ to $LR_{B2,\alpha}$ and vice versa, and to transform $LR_{A1,\beta}$ to $LR_{B1,\beta}$ and vice versa.

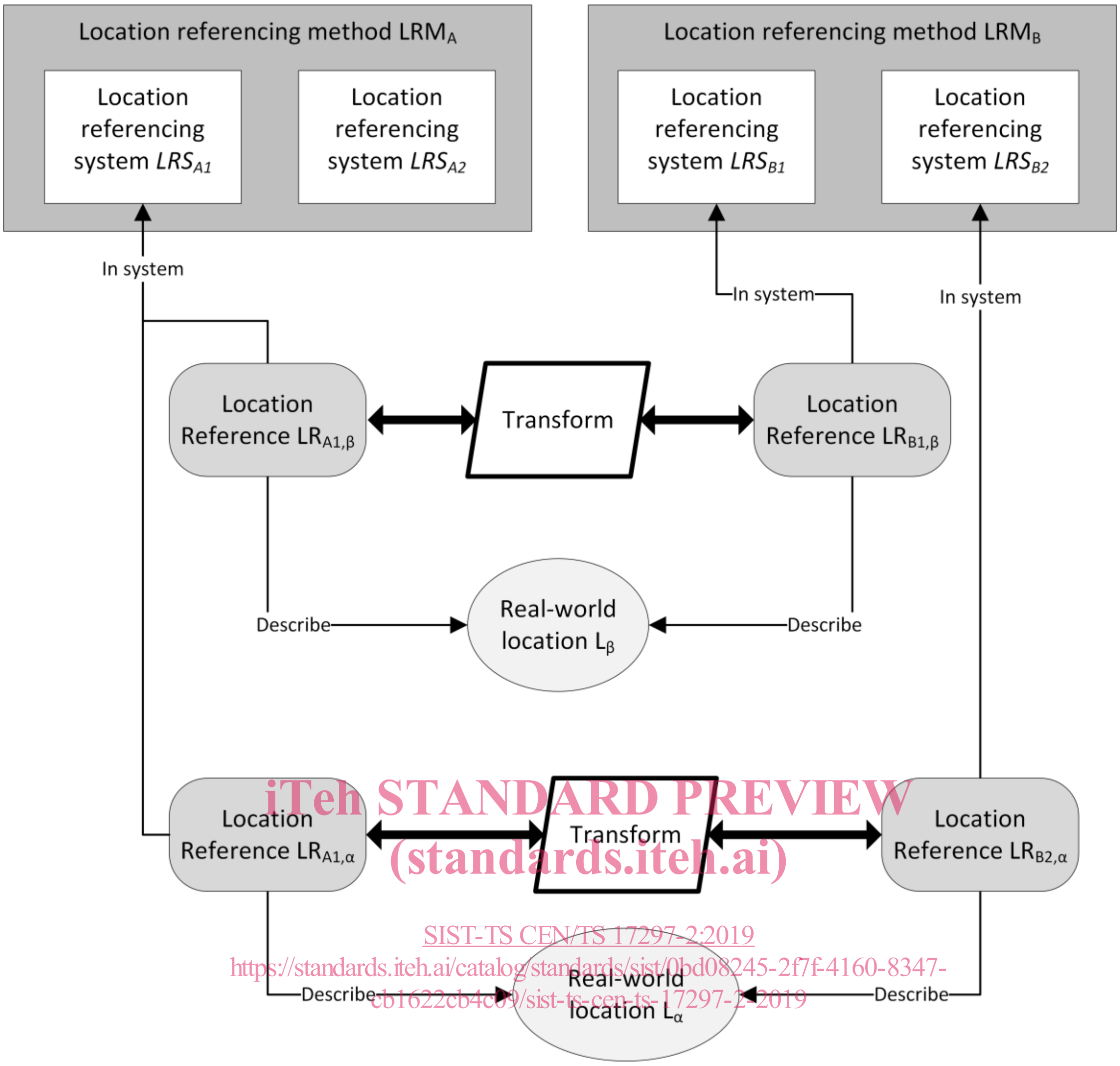

Figure 1 — Basic concepts of location referencing and transformation

There exist several commercial, free and open source tools for transformation of location references, mainly applications and libraries developed within the domain of geographic information (GIS). These are not referred to in this document, but the principles described will apply when using them.

5.2.2 Concept of preferred location referencing method

In theory, location references in one LRS can be transformed to become location references in any other LRS, based on any LRM. However, to be able to set up a transformation, common ground for the two LRSs in question is needed. This common ground can be parameters that describe the relation between location references in the two LRSs directly, but more likely, it will be a common LRS that both LRSs can refer to.

All LRMs have in common that they are methods for describing locations in the real world, and in the end, they depend on location referencing by coordinates. Location referencing by identifiers and ALERT-C depends on pre-coded locations described with coordinates, and both linear referencing systems and dynamic LRSs depend on linear networks described with coordinates. Due to this, location references in any LRS can be transformed to location referencing by coordinates. On the other hand, there is rarely any described direct connection between different LRSs.

The preferred location referencing method considered in this document is location referencing by coordinates.

Table 1 describes the possible direct transformations.

Table 1 — Common direct transformations

to / from	Coordinates	Identifier	Linear	ALERT-C	AGORA-C™	OpenLR™
Coordinates (coordinates)	**yes**	yes	yes	yes	yes	yes
Identifier (pre-coded)	yes					
Linear (pre-coded)	yes		**yes**			
ALERT-C (pre-coded)	yes					
AGORA-C™ (dynamic)	yes					
OpenLR™ (dynamic)	yes					

5.2.3 Preferred method for transformations

This document describes transformations between different LRSs by transforming from the source LRS to a preferred method, and then transforming to the target LRS from the preferred method. As location referencing by coordinates is a LRM that all LRMs can relate to, this is the preferred location referencing method. Requirements for the preferred location referencing method are described in 6.1.

6.1 indicates CRSs that are acknowledged as the common basis for reference and transformation in conjunction with the INSPIRE Directive, and regulations which for application in the European context are considered in this document to form the acceptable baseline of preferred location referencing method. These systems will be called "preferred CRSs".

The preferred method of transformation of source location reference S to a target location reference T consists of either one or two steps.

If the target CRS is coordinate-based, the transformation consists only of Step 1:

Step 1: The source location reference S is transformed to a location reference in the preferred location referencing method (i.e. by coordinates), in particular using the CRS as recommended by the Directive 2007/2/EU.

If the target CRS is not coordinate-based, the transformation consists of two steps:

Step 1: As above.

Step 2: Location reference from Step 1 (T_1) is transformed to the target location reference T in the target system (T_2).

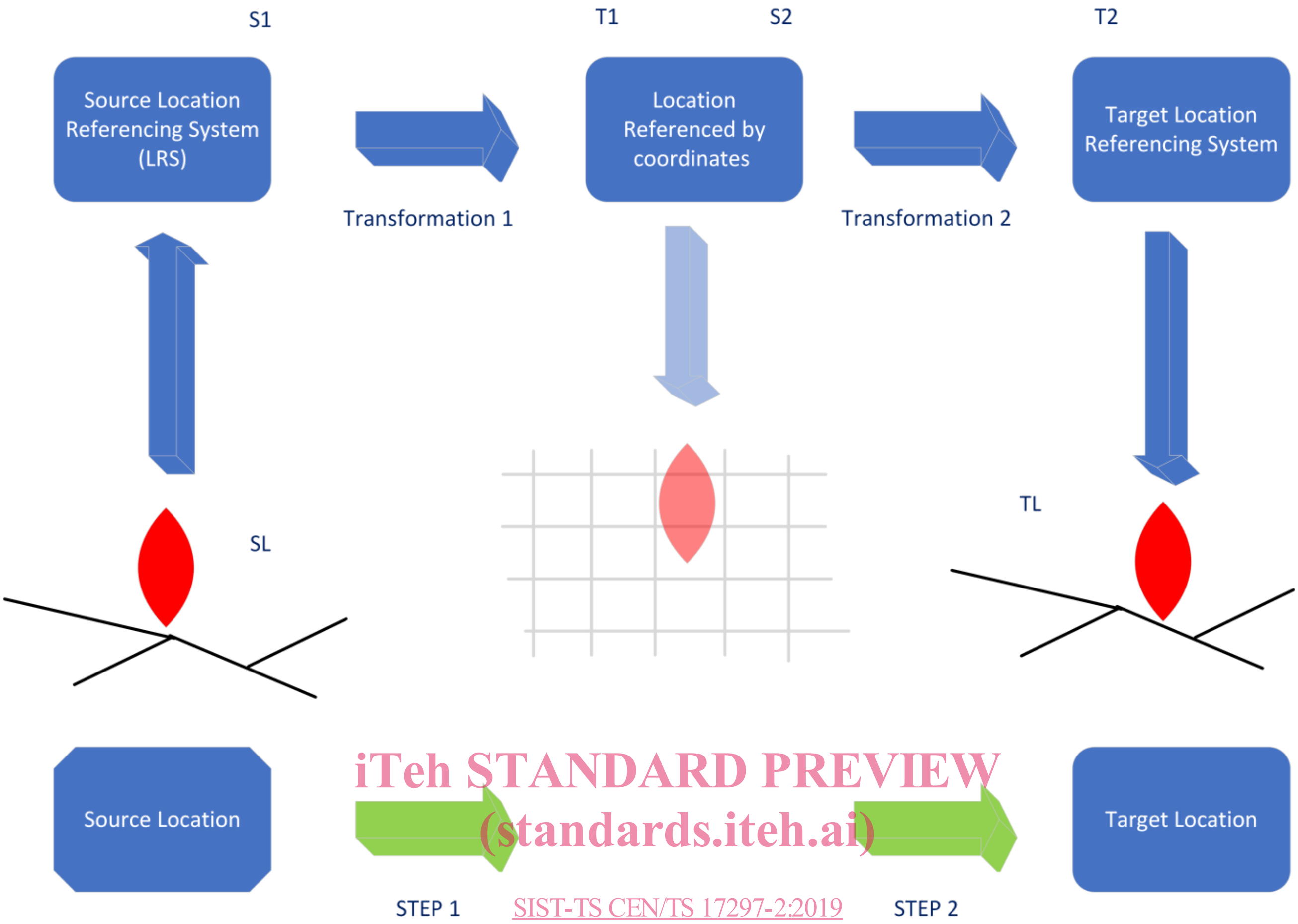

Figure 2 — Illustration of the *Preferred Transformation Method* with two steps

5.2.4 Legislation concerning technical aspects

5.2.4.1 The INSPIRE Directive

To solve problems of interoperability, quality, accessibility and sharing of spatial information, measures have been taken by the European Commission and expressed in the Directive 2007/2/EC of the European Parliament and of the Council, called INSPIRE (Infrastructure for Spatial Information in the European Community).

INSPIRE developed two types of documents: INSPIRE Implementing Rules (IR, legally binding), describing “what Member States must implement” and INSPIRE Technical Guidelines, specifying “how Member States might implement the legally binding requirements”. Even if the Technical Guidelines are not technically binding, they propose specific technical implementation for satisfying the legally binding requirements.

5.2.4.2 Coordinate reference systems

Whilst INSPIRE concerns a whole range of data domains, i.e. the INSPIRE “data themes”, such as Addresses, Transport Networks Cadastral Parcels, and Coordinate Reference Systems, the latter play a special role in INSPIRE; they are considered reference data, i.e. data that represent a link to information belonging to the different data themes. The CRSs allow for a harmonized and interoperable geographic localization of spatial features in the different data domains.

Among of a range of CRS, INSPIRE identifies a short list of CRSs to be used to guarantee a common basis for the geographical harmonization between all the other themes defined in the Annexes of the Directive.

The general legally binding document is the COMMISSION REGULATION (EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards interoperability of spatial data sets and services, in particular its ANNEX II entitled "Requirements for spatial data themes listed in Annex I to Directive 2007/2/EC". The requirements concerning the CRS are based on the ISO 19100 series of standards, essentially on ISO 19111.

This legally binding document above requires the use of a specific datum and of at least one out of a list of CRSs (or, by exception, of another CRS, but defined by parameters allowing for conversion operations); in particular:

a) *"(…) the datum shall be the datum of the European Terrestrial Reference System 1989 (ETRS89) in areas within its geographical scope, or the datum of the International Terrestrial Reference System (ITRS) or other geodetic coordinate reference systems compliant with ITRS in areas that are outside the geographical scope of ETRS89. Compliant with the ITRS means that the system definition is based on the definition of the ITRS and there is a well-documented relationship between both systems, according to EN ISO 19111 (…)*".

b) "*At least one of the following CRSs shall be used for the spatial data sets:*

- *Three-dimensional CRS:*
  - *three-dimensional Cartesian coordinates based on a datum specified as in a) above and using the parameters of the Geodetic Reference System 1980 (GRS80) ellipsoid,*
  - *three-dimensional geodetic coordinates (latitude, longitude and ellipsoidal height) based on a datum based on a datum specified as in a) above and using the parameters of the GRS80 ellipsoid.*

- *Two-dimensional CRS:*
  - *two-dimensional geodetic coordinates (latitude and longitude) based on a datum specified as in a) above and using the parameters of the GRS80 ellipsoid,*
  - *plane coordinates using the ETRS89 Lambert Azimuthal Equal Area coordinate reference system,*
  - *plane coordinates using the ETRS89 Lambert Conformal Conic coordinate reference system,*
  - *plane coordinates using the ETRS89 Transverse Mercator coordinate reference system,"*
- "*Compound CRS where the horizontal component of the compound coordinate reference system is one of the coordinate reference systems above. For the vertical component on land, the European Vertical Reference System (EVRS) shall be used to express gravity-related heights (within its geographical scope).*"

The related INSPIRE Technical Guidelines provide practical guidance for implementation based on all relevant requirements for the CRS, in particular, as regards "map projections"; it requires, beyond others, "*Lambert Azimuthal Equal Area (ETRS89-LAEA) for pan-European spatial analysis and reporting, where true area representation is required*", which is of particular interest for this document.

The INSPIRE Technical Guidelines contain also the identifiers for the different types of coordinate reference systems that "*shall*" be used according to it.