SLOVENSKI STANDARD
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Geografske informacije - Linearno georeferenciranje (ISO/DIS 19148:2020)

Geographic information - Linear referencing (ISO/DIS 19148:2020)

Geoinformation - Lineares Bezugssystem (ISO/DIS 19148:2020)

Information géographique - Référencement linéaire (ISO/DIS 19148:2020)

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Geographic information — Linear referencing

Information géographique — Référencement linéaire

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Foreword

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

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For an explanation 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.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

This second edition cancels and replaces the first edition (ISO 19148:2012), which has been technically revised.

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.

Introduction

This document is a description of the data and operations required to support linear referencing. This includes Linear Referencing Systems, linearly located events and linear segments.

Linear Referencing Systems enable the specification of positions along linear objects. The approach is based upon the Generalized Model for Linear Referencing[3] first standardized within ISO 19133:2005. This document extends that which was included in ISO 19133, both in functionality and explanation.

ISO 19109 supports features representing discrete objects with attributes having values which apply to the entire feature. ISO 19123 allows the attribute value to vary, depending upon the location within a feature, but does not support the assignment of attribute values to a single point or length along a linear feature. Linearly located events provide the mechanism for specifying attribution of linear objects when the attribute value varies along the length of a linear feature. A Linear Referencing System is used to specify where along the linear object each attribute value applies. The same mechanism can be used to specify where along a linear object another object is located, such as guardrail or a traffic accident.

It is common practice to segment a linear object having linearly located events, based upon one or more of its attributes. The resultant linear segments are attributed with just the attributes used in the segmentation process, insuring that the linear segments are homogeneous in value for these segmenting attributes.

Geographic information — Linear referencing

1 Scope

This document specifies a conceptual schema for locations relative to a one-dimensional object as measurement along (and optionally offset from) that object. It defines a description of the data and operations required to use and support linear referencing.

This document is applicable to transportation, utilities, environmental protection, location-based services and other applications which define locations relative to linear objects. Most examples discussed in this document come from the transportation domain for the ease of reading.

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 19103, *Geographic information — Conceptual schema language*

ISO 19107, *Geographic information — Spatial schema*

ISO 19108, *Geographic information — Temporal schema*

ISO 19111, *Geographic information — Referencing by coordinates*

3 Terms and definitions

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

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

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

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

3.1
attribute event
value of an attribute of a **feature** that may apply to only part of the feature

Note 1 to entry: to entry:An attribute event includes the **linearly referenced location** where the attribute value applies along the **attributed feature**.

Note 2 to entry: An attribute event may be qualified by the **instant** in which, or **period** during which, the attribute value applied.

3.2
attributed feature
feature along which an **attribute event** applies

3.3
direct position
position described by a single set of coordinates within a coordinate reference system

[SOURCE: ISO 19136-1:2020, 3.1.20]

3.4
feature
abstraction of real world phenomena

[SOURCE: ISO 19101-1:2014, 4.1.11]

3.5
feature event
information about the occurrence of a **located feature** along a **locating feature**

Note 1 to entry: A feature event includes the **linearly referenced location** of the located feature along the locating feature.

Note 2 to entry: A feature event may be qualified by the **instant** in which, or **period** during which, the feature event occurred.

3.6
geometric primitive
<geometry> geometric object representing a single, connected, homogeneous (isotropic) element of space

Note 1 to entry: Geometric primitives are non-decomposed objects that present information about geometric configuration. They include points, curves, surfaces, and solids. Many geometric objects behave like primitives (supporting the same interfaces defined for geometric primitives) but are actually composites composed of some number of other primitives. General collections may be aggregates and incapable of acting like a primitive (such as the lines of a complex network, which is not connected and thus incapable of being traceable as a single line). By this definition, a geometric primitive is topological open, since the boundary points are not isotropic to the interior points. Geometry is assumed to be closed. For points, the boundary is empty.

[SOURCE: ISO 19107:2019, 3.50]

3.7
height
h, H
distance of a point from a chosen reference surface positive upward along a line perpendicular to that surface

Note 1 to entry: A height below the reference surface will have a negative value.

Note 2 to entry: Generalization of ellipsoidal height (h) and gravity-related height (H).

[SOURCE: ISO 19111:2019, 3.1:38]

3.8
instant
zero-dimensional **geometric primitive** representing **position** in time

Note 1 to entry: The geometry of time is discussed in ISO 19108:2002, 5.2.

[SOURCE: ISO 19108:2002, 4.1.17]

3.9
linear element
one-dimensional object that serves as the axis along which measurements are made

Note 1 to entry: Also known as curvilinear element.

EXAMPLE **Feature**, such as “road”; curve geometry; directed edge topological primitive

3.10
linear referencing
specification of a **location** relative to a **linear element** as a measurement along (and optionally offset from) that element

Note 1 to entry: An alternative to specifying a location as a two- or three- dimensional **spatial position**.

3.11
linear referencing method
manner in which measurements are made along (and optionally offset from) a **linear element**

3.12
linear referencing system
set of **linear referencing methods** and the policies, records and procedures for implementing them[1]

3.13
linear segment
part of a linear **feature** that is distinguished from the remainder of that feature by a subset of attributes, each having a single value for the entire part

Note 1 to entry: A linear segment is a one-dimensional object without explicit geometry.

Note 2 to entry: The implicit geometry of the linear segment can be derived from the geometry of the parent feature.

3.14
linearly located
located using a **Linear Referencing System**

3.15
linearly located event
occurrence along a **feature** of an attribute value or another feature

Note 1 to entry: The event **location** is specified using **linearly referenced locations**.

Note 2 to entry: A linearly located event may be qualified by the **instant** in which, or **period** during which, the linearly located event occurred.

Note 3 to entry: ISO 19108 limits events to a single instant in time and does not include the specification of a location.

3.16
linearly referenced location
location whose **position** is specified using **linear referencing**

3.17
located feature
linearly located feature
feature that is **linearly located** along an associated (locating) feature

EXAMPLE A feature “bridge” may be a located feature along the feature “railway” [a **locating feature**].

3.18
locating feature
linearly locating feature
feature that is used to identify the **location** of **linearly located** features

EXAMPLE A feature “road” may be the locating feature for a feature “pedestrian crossing” [a **located feature**].

3.19
location
a particular place or position

Note 1 to entry: A location identifies a geographic place.

Note 2 to entry: Additionally, in this document, a location is represented by one of a set of data types that describe a **position**, along with metadata about that data, including coordinates (from a coordinate reference system), a measure (from a **Linear Referencing System**), or an address (from an address system).

[SOURCE: ISO 19112:2019, 3.1.3]

3.20
period
one-dimensional **geometric primitive** representing extent in time

Note 1 to entry: A period is bounded by two different **temporal positions**.

[SOURCE: ISO 19108:2002, 4.1.27]

3.21
position
data type that describes a point or geometry potentially occupied by an object or person

Note 1 to entry: A **direct position** is a semantic subtype of position. Direct positions as described can define only a point and, therefore, not all positions can be represented by a direct position. That is consistent with the "is type of" relation. An ISO 19107 geometry is also a position, just not a direct position.

[SOURCE: ISO 19133:2005, 4.18]

3.22
spatial position
direct position that is referenced to a two- or three-dimensional coordinate reference system

Note 1 to entry: An alternative to specifying a **location** as a **linearly referenced location**.

3.23
temporal position
location relative to a **temporal reference system**

[SOURCE: ISO 19108:2002, 4.1.34]

3.24
temporal reference system
reference system against which time is measured

[SOURCE: ISO 19108:2002, 4.1.35]

3.25
valid time
time when a fact is true in the abstracted reality

[SOURCE: ISO 19108:2002, 4.1.39]

4 Symbols, abbreviated terms, backwards compatibility, and UML notation

4.1 Symbols and abbreviated terms

CRS Coordinate Reference System

LRM Linear Referencing Method

LRS Linear Referencing System

RDF Resource Description Framework

REST Representational State Transfer

SOAP Single Object Access Protocol

SPARQL	SPARQL Protocol and RDF Query Language
SQL	Structured Query Language
UML	Unified Modelling Language
XSP	Cross-Sectional Positioning

4.2 Backwards compatibility

The changes in this edition compared to the previous edition are:

— revision of the definition of the term linear element, removing a circular reference with the definition for the term linear referencing;

— revision of the conceptual schema to meet current standards and harmonize with other ISO/TC 211 standards;

— refactoring of the core Linear Referencing System package, abstracting implementation classes into a new Application Schema package that is now presented as an example in Annex D;

— introduction of an approach addressing broken-chainage;

— introduction of an enumeration addressing directionality of measurements;

— introduction of an approach addressing Cross-Sectional Positioning conventions;

— introduction of an approach addressing Measures with Uneven Distribution.

— refactoring of the Linearly Located Event package dropping the previous assumption that the Linear Element was always of a Feature type;

— introduction of simplifications of the conceptual schema;

— additional example illustrating Measures with Uneven Distribution in Annex C;

— introduction of information about some standards implementing the conceptual schema described in this document in Annex C.

— additional example illustrating Secondary Linear Referencing Systems in Annex E;

— the correction of minor errors.

The changes are elaborated in Annex F.

4.3 UML notation

In this document, conceptual schemas are presented in the Unified Modelling Language (UML). ISO 19103 Conceptual schema language presents the specific profile of UML used in this document.

5 Conformance

5.1 Conformance overview

Clause 6 of this document uses the Unified Modelling Language (UML) to present conceptual schemas for describing the constructs required for Linear Referencing. These schemas define conceptual classes that shall be used in application schemas, profiles and implementation specifications. This document concerns only externally visible interfaces and places no restriction on the underlying implementations other than what is required to satisfy the interface specifications in the actual situation, such as

— interfaces to software services using techniques such as SOAP, REST and SPARQL end points;

— interfaces to databases using techniques such as SQL;

— data interchange using encoding as defined in ISO 19118.

Few applications require the full range of capabilities described by this conceptual schema. Clause 6, therefore, defines a set of conformance classes that support applications whose requirements range from the minimum necessary to define data structures to full object implementation. This flexibility is controlled by a set of UML concepts that can be implemented in a variety of manners. Implementations that define full object functionality shall implement all operations defined by the types of the chosen conformance class, as is common for UML designed object implementations. It is not necessary for implementations that choose to depend on external "free functions" for some or all operations, or forgo them altogether, to support all operations, but they shall always support a data type sufficient to record the state of each of the chosen UML types as defined by its member variables. It is acceptable to use common names for concepts that are the same but have technically different implementations. The UML model in this document defines abstract types, application schemas define conceptual classes, various software systems define implementation classes or data structures, and the XML from the encoding standard (ISO 19118) defines entity tags. All of these reference the same information content. There is no difficulty in allowing the use of the same name to represent the same information content even though at a deeper level there are significant technical differences in the digital entities being implemented. This "allows" types defined in the UML model to be used directly in application schemas.

5.2 Conformance classes

5.2.1 General

Conformance to this document shall consist of either data type conformance or both data type and operation conformance.

5.2.2 Data type conformance

Data type conformance includes the usage of data types in application schemas or profiles that instantiate types in this document. In this context, "instantiate" means that there is a correspondence between the types in the appropriate part of this document, and the data types of the application schema or profile in such a way that each standard type can be considered as a supertype of the application schema data type. This means that an application schema or profile data type corresponding to a standard type contains sufficient data to recreate that standard type's information content.

Table 1 assigns conformance tests, detailed in Annex A, to each of the packages in Clause 6. Each row in the table represents one conformance class. A specification claiming data type conformance to a package in the first column of the table shall satisfy the requirements specified by the tests given in the remaining columns to the right.

Table 1 — Data type conformance tests

Package	Conformance test					
	A.1.1	A.1.2	A.1.3	A.1.4	A.1.5	A.1.6
Linear Referencing System	X	—	—	—	—	—
Linear Referencing Towards Referent	X	X	—	—	—	—
Linear Referencing Offset	X	—	X	—	—	—
Linear Referencing Offset Vector	X	—	X	X	—	—
Linearly Located Event	X	—	—	—	X	—
Linear Segmentation	X	—	—	—	X	X

5.2.3 Operation conformance

Operation conformance includes both the consistent use of operation interfaces and data type conformance for the parameters, and return values used by those operations. Operation conformance also includes get and set operations for attributes.

Table 2 assigns conformance tests, detailed in Annex A, to each of the packages in Clause 6. Each row in the table represents one conformance class. A specification claiming operation conformance to a package in the first column of the table shall satisfy the requirements specified by the tests given in the remaining columns to the right.

Table 2 — Operation conformance tests

Package	Conformance test					
	A.1.1 A.2.1	A.1.2 A.2.2	A.1.3 A.2.3	A.1.4 A.2.4	A.1.5 A.2.5	A.1.6 A.2.6
Linear Referencing System	X	—	—	—	—	—
Linear Referencing Towards Referent	X	X	—	—	—	—
Linear Referencing Offset	X	—	X	—	—	—
Linear Referencing Offset Vector	X	—	X	X	—	—
Linearly Located Event	X	—	—	—	X	—
Linear Segmentation	X	—	—	—	X	X

6 Linear referencing

6.1 Background

6.1.1 Linear referencing concepts

6.1.1.1 General

Linear Referencing Systems are in wide use in transportation but are also appropriate in other areas such as utilities. They allow for the specification of positions along linear elements by using measured distances along (and optionally offset from) the element. This is in contrast to using spatial positions that use two- or three- dimensional coordinates, consistent with a particular Coordinate Reference System (CRS).

Linearly referenced locations are significant for several reasons. First, a significant amount of information is currently held in huge databases from legacy systems that pre-date Geographic Information Systems (GIS). Many useful applications can and have been built on these data with no understanding of where on the earth's surface the data are located. Knowing where they are located relative to a linear element such as a roadway route or pipeline is sufficient to support these applications and can be used as a means of integrating data from multiple, disparate sources.

In some situations, having a linearly referenced location along a known linear element is more advantageous than knowing its spatial position. Consider a crash in need of emergency assistance. Knowing the linear element (e.g. Northbound I-95) and the approximate linear location is superior to having a potentially more precise spatial GPS location that is not of significant accuracy to determine whether it is northbound or southbound I-95, especially if an impassable barrier separates the two carriageways.

The linearly referenced location as specified in this document as a position expression, therefore, has many uses. It can be used to tie information about a linear facility to a specific location along that facility. It can also be used to find a position on the face of the earth by specifying how far along the position is (and optionally offset from) on a particular linear element.