
**Geographic information — Location-
based services — Tracking and
navigation**

*Information géographique — Services basés sur la localisation — Suivi
et navigation*

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Contents

Page

Foreword.....	viii
Introduction	ix
1 Scope	1
2 Conformance	1
3 Normative references	2
4 Terms and definitions.....	2
5 Abbreviated terms and UML notation.....	6
5.1 Abbreviated terms	6
5.2 UML notation	6
6 Tracking	7
6.1 Semantics	7
6.2 Package: Tracking Service	7
6.3 Package: Point Estimates	21
6.4 Package: Location Transformation.....	26
6.5 Package: Measured Coordinates.....	27
6.6 Package: Linear Reference Systems.....	32
7 Navigation.....	39
7.1 Semantics	39
7.2 Cost Functions and algorithms.....	41
7.3 Package: Navigation Service.....	42
7.4 Package: Cost Function	55
7.5 Package: Preferences.....	68
8 Address Model	70
8.1 Semantics	70
8.2 Package: Address.....	70
8.3 Package: Address Elements.....	74
9 Network.....	85
9.1 Semantics	85
9.2 Package: Network Model	85
9.3 Package: Turn and Junction.....	89
9.4 Package: Constraint and Advisory	95
9.5 Package: Link	108
9.6 Package: Network Position.....	111
9.7 Package: Route	112
9.8 Package: Combined Networks	117
10 Basic implementation packages	120
10.1 Package: Feature Data Model.....	120
10.2 Package: New Basic Types.....	124
Annex A (normative) Abstract test suite.....	127
Annex B (informative) Directed weighted graphs and their algorithms	134
Annex C (informative) View of Standard in terms of RM-ODP Services.....	137
Bibliography	139

Figures

Figure 1 — Tracking packages 7

Figure 2 — Context Diagram: TK_Position 8

Figure 3 — Context Diagram: TK_MobileSubscriber 9

Figure 4 — Context Diagram: TK_TrackingLocation..... 10

Figure 5 — Context Diagram: TK_TrackingService..... 11

Figure 6 — Context Diagram: TK_PositionType 12

Figure 7 — Context Diagram: TK_TrackingLocationSequence 13

Figure 8 — Context Diagram: TK_Trigger 14

Figure 9 — Context Diagram: TK_PeriodicTrigger 15

Figure 10 — Context Diagram: TK_TransitionTrigger..... 16

Figure 11 — Context Diagram: TK_TrackingLocationMetadata..... 17

Figure 12 — Context Diagram: TK_Transition 18

Figure 13 — Context Diagram: TK_QualityOfPosition 19

Figure 14 — Context Diagram: TK_Accuracy 20

Figure 15 — Context Diagram: TK_AccuracyStatement..... 20

Figure 16 — Point Estimate classes..... 21

Figure 17 — Geometric interpretations of point estimate types 22

Figure 18 — Context Diagram: EG_PointEstimateCircle 22

Figure 19 — Context Diagram: EG_PointEstimateEllipse 23

Figure 20 — Context Diagram: EG_PointEstimateArc 24

Figure 21 — Context Diagram: EG_PointEstimateSphere 25

Figure 22 — Context Diagram: EG_PointEstimateEllipsoid 26

Figure 23 — Context Diagram: LT_LocationTransformationService..... 27

Figure 24 — Measure Position 28

Figure 25 — Measured Coordinate Systems 29

Figure 26 — Context Diagram: MC_MeasurePosition 30

Figure 27 — Context Diagram: MC_CoordinateSystem 30

Figure 28 — Context Diagram: MC_CoordinateReferenceSystem 31

Figure 29 — LRS classes 32

Figure 30 — Context Diagram: LR_PositionExpression 33

Figure 31 — Context Diagram: LR_LinearReferenceMethod 35

Figure 32 — Context Diagram: LR_OffsetDirection..... 35

Figure 33 — Context Diagram: LR_ReferenceMarker 36

Figure 34 — Context Diagram: LR_Feature..... 37

Figure 35 — Context Diagram: LR_Element..... 37

Figure 36— Context Diagram: LR_OffsetExpression..... 38

Figure 37 — Navigation Packages..... 39

Figure 38 — Example of route from one link position to another..... 40

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6d1c5dcd551c/iso-19133-2005

Figure 39 — Services.....	42
Figure 40 — Context Diagram: NS_NavigationService.....	43
Figure 41 — Context Diagram: NS_RouteRequest.....	46
Figure 42 — Context Diagram: NS_Instruction.....	48
Figure 43 — Context Diagram: NS_InstructionList.....	49
Figure 44 — Context Diagram: NS_RouteResponse.....	50
Figure 45 — Context Diagram: NS_CostedTurn.....	51
Figure 46 — Context Diagram: NS_RenderingService.....	51
Figure 47 — Context Diagram: NS_RenderingRequest.....	52
Figure 48 — Context Diagram: NS_RenderingResponse.....	53
Figure 49 — Context Diagram: NS_RenderingType.....	53
Figure 50 — Context Diagram: NS_CostedLink.....	54
Figure 51 — Context Diagram: NS_CostFunctionCode.....	54
Figure 52 — Context Diagram: NS_RouteRequestType.....	55
Figure 53 — Context Diagram: NS_CostFunction.....	59
Figure 54 — Context Diagram: NS_CostElements.....	59
Figure 55 — Context Diagram: NS_MonetaryCost.....	60
Figure 56 — Context Diagram: NS_Tolls.....	61
Figure 57 — Context Diagram: NS_Fares.....	61
Figure 58 — Context Diagram: NS_Time.....	62
Figure 59 — Context Diagram: NS_TravelTime.....	62
Figure 60 — Context Diagram: NS_WaitingTime.....	63
Figure 61 — Context Diagram: NS_Counts.....	64
Figure 62 — Context Diagram: NS_NumberManeuvers.....	64
Figure 63 — Context Diagram: NS_NumberTurns.....	65
Figure 64 — Context Diagram: NS_NumberTransfers.....	65
Figure 65 — Context Diagram: NS_Distance.....	66
Figure 66 — Context Diagram: NS_WeightedCost.....	67
Figure 67 — Context Diagram: NS_CostFunctionTerm.....	68
Figure 68 — Context Diagram: NS_RoutePreferences.....	68
Figure 69 — Context Diagram: NS_AvoidList.....	69
Figure 70 — Leaf packages of the Address Model.....	70
Figure 71 — Basic Address classes.....	71
Figure 72 — Context Diagram: AD_Address.....	72
Figure 73 — Context Diagram: AD_AbstractAddress.....	72
Figure 74 — Context Diagram: AD_USAddress.....	74
Figure 75 — Context Diagram: AD_AddressElement.....	75
Figure 76 — Context Diagram: AD_Addressee.....	76
Figure 77 — Context Diagram: AD_StreetIntersection.....	76
Figure 78 — Context Diagram: AD_Street.....	78

Figure 79 — Context Diagram: AD_PostalCode	79
Figure 80 — Context Diagram: AD_StreetLocation	79
Figure 81 — Context Diagram: AD_PhoneNumber.....	80
Figure 82 — Context Diagram: AD_NamedPlace.....	81
Figure 83 — Context Diagram: AD_StreetAddress.....	82
Figure 84 — Context Diagram: AD_NamedPlaceClassification	82
Figure 85 — Context Diagram: AD_Building	83
Figure 86 — Context Diagram: AD_MuniQuadrant.....	83
Figure 87 — Context Diagram: AD_RegionCode	84
Figure 88 — Context Diagram: AD_NumberRange.....	85
Figure 89 — Context Diagram: AD_ListNamedPlaces	85
Figure 90 — Context Diagram: NT_Network	86
Figure 91 — Context Diagram: NT_WayPoint	87
Figure 92 — Context Diagram: NT_WayPointList.....	88
Figure 93 — Junction and turns	89
Figure 94 — Context Diagram: NT_Turn.....	92
Figure 95 — Context Diagram: NT_TurnDirection	92
Figure 96 — Context Diagram: NT_Junction.....	94
Figure 97 — Context Diagram: NT_JunctionType	95
Figure 98 — Context Diagram: NT_AngularDirection	95
Figure 99 — Context Diagram: NT_Constraint.....	96
Figure 100 — Context Diagram: NT_VehicleConstraint.....	98
Figure 101 — Context Diagram: NT_TemporalConstraint	99
Figure 102 — Context Diagram: NT_LaneConstraint	100
Figure 103 — Context Diagram: NT_Vehicle	101
Figure 104 — Context Diagram: NT_Advisory	102
Figure 105 — Context Diagram: NT_SpatialRelation.....	103
Figure 106 — Context Diagram: NT_AdvisoryCategory	104
Figure 107 — Context Diagram: NT_AdvisoryElement	104
Figure 108 — Context Diagram: NT_ExitAssociation.....	105
Figure 109 — Context Diagram: NT_AdvisoryDirection	106
Figure 110 — Context Diagram: NT_AdvisoryDistance	107
Figure 111 — Context Diagram: NT_AdvisorySpatialRelation	107
Figure 112 — Context Diagram: NT_Link	110
Figure 113 — Context Diagram: NT_RouteSegmentCategory	110
Figure 114 — Context Diagram: NT_LinkPosition	111
Figure 115 — Context Diagram: NT_NetworkPosition	112
Figure 116 — Context Diagram: NT_Route	114
Figure 117 — Context Diagram: NT_RouteSummary	115
Figure 118 — Context Diagram: NT_Maneuver.....	117

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Figure 119 — Combined Networks	117
Figure 120 — Context Diagram: NT_CombinedNetwork	118
Figure 121 — Context Diagram: NT_TransferNode	119
Figure 122 — Context Diagram: NT_Transfer	119
Figure 123 — Context Diagram: NT_TransferLink	120
Figure 124 — Feature data classes	120
Figure 125 — Context Diagram: FD_Feature	121
Figure 126 — Context Diagram: FD_FeatureCollection	122
Figure 127 — Context Diagram: FD_QueryFeatureCollection	123
Figure 128 — Context Diagram: FD_FeatureName	124
Figure 129 — Context Diagram: VoiceStream	125
Figure 130 — Context Diagram: BinaryData	125
Figure 131 — Context Diagram: Map	126
Figure 132 — Context Diagram: Image	126
Figure C.1 — Conceptual architecture equating mobile and non-mobile services	137

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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.

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.

ISO 19133 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

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Introduction

This International Standard is a description of the data and services needed to support tracking and navigation applications for mobile clients. The web services views of this International Standard are given in Annex C.

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Geographic information — Location-based services — Tracking and navigation

1 Scope

This International Standard describes the data types, and operations associated with those types, for the implementation of tracking and navigation services. This International Standard is designed to specify web services that can be made available to wireless devices through web-resident proxy applications, but is not restricted to that environment.

2 Conformance

Conformance to this International Standard takes on two meanings dependent on the type of entity declaring conformance.

Mechanisms for the transfer of data are conformant to this International Standard if they can be considered to consist of transfer record or type definitions that implement or extend a consistent subset of the object types described within this International Standard.

Web servers for tracking and navigation are conformant to this International Standard if their interfaces implement one or more of the subtypes of service defined in this International Standard and their communications and messaging are accomplished using a conformant transfer mechanism.

Clauses 6 and 7 of this International Standard use the Unified Modeling Language (UML) to present conceptual schemas for describing the information and services for tracking and navigation. Clause 8 further describes a general schema for addresses to be used as location equivalents in three types of services. Clause 9 describes network data appropriate for these services. This International Standard concerns only externally visible interfaces and places no restriction on the underlying implementations other than what is needed to satisfy the interface specifications in the actual situation, such as

- interfaces to software services using techniques such as COM or CORBA;
- interfaces to databases using techniques such as SQL;
- data interchange using encoding as defined in ISO 19118.

Few applications will require the full range of capabilities described by this conceptual schema. This clause, therefore, defines a set of conformance classes that will 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 types 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. Implementations that choose to depend on external “free functions” for some or all operations, or forgo them altogether, need not support all operations, but shall always support a data type sufficient to record the state of each of the chosen UML types as defined by its member variables. Common names for “metaphorically identical” but technically different entities are acceptable. The UML model in this International Standard 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.

Details of the conformance classes are given in the abstract test suite in Annex A.

3 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 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

ISO 19107, *Geographic information — Spatial schema*

ISO 19108, *Geographic information — Temporal schema*

ISO 19109, *Geographic information — Rules for application schema*

ISO 19111, *Geographic information — Spatial referencing by coordinates*

ISO 19112, *Geographic information — Spatial referencing by geographic identifiers*

ISO 19118, *Geographic information — Encoding*

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4 Terms and definitions

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For the purposes of this document, the following terms and definitions apply.
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4.1 candidate route
any **route** that satisfies all constraints of the routing request with the possible exception of optimality of the **cost function**

NOTE Navigation is the process of finding the candidate route that optimizes a chosen cost function.

4.2 cost function
function that associates a measure (cost) to a **route**

NOTE The normal mechanism is to apply a cost to each part of a **route**, and to define the total **route** cost as the sum of the cost of the parts. This is necessary for the operation of the most common navigation algorithms. The units of cost functions are not limited to monetary costs and values only, but include such measures as time, distance, and possibly others. The only requirement is that the function be additive and at least non-negative. This last criteria can be softened as long as no zero or less cost is associated with any loop in the network, as this will prevent the existence of a “minimal cost” **route**.

4.3 Dijkstra graph
positively weighted directed graph appropriately configured to execute a shortest path search

NOTE The term comes from the most commonly known algorithm for finding a shortest path in a positively weighted graph, from E. Dijkstra’s paper [7]. Although this algorithm is not the only one in use, the requirements for the graph are common to most. The most common relaxation of the requirement is the “positive weights”, which are not needed in the Bellman–Ford algorithm [4], [8].

4.4 geocoding

translation of one form of **location** into another

NOTE Geocoding usually refers to the translation of “address” or “intersection” to “direct position”. Many service providers also include a “reverse geocoding” interface to their geocoder, thus extending the definition of the service as a general translator of **location**. Because routing services use internal **location** encodings not usually available to others, a geocoder is an integral part of the internals of such a service.

4.5 instantiate

to represent (an abstraction) by the creation of a concrete instance or to create the ability to create an instance

NOTE A class or data element definition instantiates a type if it creates the ability to create objects or data elements, respectively, that can represent the concepts (instance data and/or operations) defined by that type. A class is instantiated by an object if the class defines that object’s structure and function. A data schema is instantiated by a data element if the data schema defines that element’s structure.

4.6 junction

single topological node in a **network** with its associated collection of **turns**, incoming and outgoing **links**

NOTE Junction is an alias for node.

4.7 linear referencing system linear positioning system [ISO 19116] positioning system

that measures distance from a reference point along a route (feature)

NOTE The system includes the complete set of procedures for determining and retaining a record of specific points along a linear feature such as the **location** reference method(s) together with the procedures for storing, maintaining, and retrieving **location** information about points and segments on the highways. [NCHRP Synthesis 21, 1974]

4.8 link

directed topological connection between two nodes (**junctions**), consisting of an edge and a direction

NOTE Link is an alias for directed edge.

4.9 link position

position within a network on a **link** defined by some strictly monotonic measure associated with that **link**

NOTE Link positions are often associated with a target feature that is not part of the network. The most common link measures used for this are the distance from start node or address. The most common use of a link position is to geolocate an “address”.

4.10 location

identifiable geographic place

[ISO 19112]

NOTE 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).

4.11
location-based service
LBS

service whose return or other property is dependent on the **location** of the client requesting the service or of some other thing, object or person

4.12
location-dependent service
LDS

service whose availability is dependent upon the **location** of the client

4.13
main-road rule

set of criteria used at a **turn** in lieu of a **route instruction**; default instruction used at a node

NOTE This rule represents what is “most natural” to do at a node (intersection), given the entry link used. The most common version is “as straight as possible”, or to exit a **turn** on the most obvious extension of the entry street, which is usually, but not always, the same named street that was the entry. Every node in a route is either associated with an instruction or can be navigated by the main-road rule.

4.14
maneuver
manœuvre

collection of related **links** and **turns** used in a route in combination

NOTE Maneuvers are used to cluster **turns** into convenient and legal combinations. They may be as simple as a single **turn**, a combination of quick **turns** (“jogs” in the American mid-west consisting of a **turn** followed immediately by a **turn** in the opposite direction) or very complex combinations consisting of entry, exit, and connecting roadways (“magic roundabouts” in the UK).

4.15
navigation

combination of **routing**, **route transversal** and **tracking**

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NOTE This is essentially the common term navigation, but the definition decomposes the process in terms used in the packages defined in this International Standard.

4.16
navigation constraint
constraint

restriction on how a **link** or **turn** may be traversed by a **vehicle**, such as **vehicle** classification, physical or temporal constraint

4.17
network

abstract structure consisting of a set of 0-dimensional objects called **junctions**, and a set of 1-dimensional objects called **links** that connect the **junctions**, each **link** being associated with a start (origin, source) **junction** and end (destination, sink) **junction**

NOTE The **network** is essentially the universe of discourse for the **navigation** problem. **Networks** are a variety of 1-dimensional topological complex. In this light, **junction** and topological node are synonyms, as are **link** and directed edge.

4.18
position

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

NOTE A direct position is a semantic subtype of position. Direct positions as described can only define 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.

4.19**route**

sequence of **links** and/or partial **links** that describe a path, usually between two **positions**, within a **network**

4.20**route instruction**

information needed at a point along a **route** in a **network** that allows that **route** to be traversed

NOTE To minimize the number of **instructions** needed to complete a **route traversal**, a default instruction can be assumed at **junctions** without specifically associated **instructions**. This default is called the **main-road rule**.

4.21**route traversal**

process of following a **route**

4.22**routing**

finding of optimal (minimal **cost function**) **routes** between **locations** in a **network**

4.23**slope**

rate of change of elevation with respect to curve length

4.24**tracking**

monitoring and reporting the **location** of a **vehicle**

4.25**traveller**

person subject to being navigated or tracked

cf. vehicle

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NOTE Includes pedestrians. See ISO 14825. In this International Standard, traveller can be replaced by **vehicle** without any change of intent.

4.26**traversable**

condition of a **link** or **turn** that allows or restricts all traffic's traversal, as opposed to a more detailed **navigation constraint**

NOTE Traversability is usually a function of physical, cultural, or legal conditions. If traversable is false, then the object cannot be navigated. This effectively removes a **link** from the usable network. In the case of a node, it effectively removes the node and all associated **links** from the useable network. In the case of a **turn**, it simply removes it from any viable **route**. Non-traversable entities are not included in **maneuvers** or **routes**.

4.27**turn**

part of a **route** or **network** consisting of a **junction** location and an entry and exit **link** for that **junction**

4.28**vehicle**

object subject to being navigated or tracked

cf. traveller

NOTE Includes pedestrians. See ISO 14825. In this International Standard, vehicle can be replaced by **traveller** without any change of intent.