DEUTSCHE NORM

Juni 2007

DIN EN ISO 19133

DIN

ICS 35.240.70

Geoinformation – Standortbezogene Dienste – Kursverfolgung und Navigation (ISO 19133:2005); Englische Fassung EN ISO 19133:2007

Geographic information –
Location-based services –
Tracking and navigation (ISO 19133:2005);
English version EN ISO 19133:2007

Information géographique –
Services basés sur la localisation –
Suivi et navigation (ISO 19133:2005);
Version anglaise EN ISO 19133:2007

Gesamtumfang 152 Seiten

Normenausschuss Bauwesen (NABau) im DIN

AVA Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

Nationales Vorwort

Der Text von ISO 19133:2005 wurde vom Technischen Komitee ISO/TC 211 „Geoinformation/Geomatik“ erarbeitet und als EN ISO 19133:2007 vom Technischen Komitee CEN/TC 287 „Geoinformation“ übernommen, dessen Sekretariat vom NEN (Niederlande) gehalten wird.

Der Text von ISO 19133:2005 wurde von CEN als EN ISO 19133:2007 ohne Änderungen angenommen.

Der für die deutsche Mitarbeit zuständige Arbeitsausschuss im DIN Deutsches Institut für Normung e. V. ist der als Spiegelausschuss zum CEN/TC 287 und ISO/TC 211 eingesetzte Arbeitsausschuss NA 005-03-03 AA „Kartographie und Geoinformation“ des Normenausschusses Bauwesen (NABau).

Das Präsidium des DIN hat mit seinem Beschluss 1/2004 festgelegt, dass von dem in den Regeln der europäischen Normungsarbeit von CEN/CENELEC verankerten Grundsatz, wonach Europäische Normen in den drei offiziellen Sprachen Deutsch, Englisch und Französisch veröffentlicht werden, in begründeten Ausnahmefällen abgewichen und auf die deutsche Sprachfassung verzichtet werden kann.

Die Genehmigung dafür hat die DIN-Geschäftsleitung entsprechend ihren in Anlage 1 zu dem DIN-Rundschreiben A 5/2004 festgelegten Kriterien für die vorliegende Norm auf Antrag des NABau-FB 03 „Vermessungswesen; Geoinformation“ erteilt.

Allgemeines

Standortbezogene Dienste unterstützen Anwendungen, bei denen die Position eines Akteurs, der mit einem mobilen Client ausgestattet ist, das Verhalten des Systems beeinflusst. So kann der Akteur Informationen zu seinem eigenen Standort erhalten oder ein anderer Nutzer kann Informationen in Abhängigkeit des Standortes des Akteurs erhalten. Wenn die Informationen dem Akteur zum Auffinden eines möglichst optimalen Weges zu seinem Ziel dienen, so handelt es sich um einen Navigationsdienst. Wenn die Informationen dazu dienen, die Änderung des Standortes eines Anderen zu verfolgen, so wird von einer Kursverfolgung gesprochen. Navigationssysteme sind in vielen Automobilen schon in Gebrauch. Kursverfolgungen werden z. B. im Flottenmanagement von Speditionen eingesetzt.

DIN EN ISO 19133 definiert Datentypen und Operationen, um die Implementierung von den beiden standortbezogenen Diensten Kursverfolgung und Navigation zu standardisieren. Ziel dieser Dienste ist, einen mobilen Client, der sich in einem Netz von Straßen, Wegen oder sonstigen Verbindungen befindet, an ein definiertes Ziel unter vorgegebenen Optimierungsbedingungen zu navigieren, oder den Kurs dieses Clients zu verfolgen. Der mobile Client kann dabei von einem Fußgänger oder verschiedenen Landfahrzeugen mitgeführt werden. Voraussetzung ist, dass die Position des mobilen Clients in diesem Netz jederzeit bekannt bzw. über den Dienst bestimmbar ist und dass er mit dem Dienst über einen drahtlosen, bidirektionalen Datentransfer verbunden ist.

Die Formulierung der Schnittstellen erfolgt auf konzeptioneller Ebene in UML. Das Design dieser Norm ist insbesondere auf Web-Dienste ausgelegt. Die Implementierungssprache der Klassen ist dabei nicht festgelegt.

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

Nationaler Anhang NA
(informativ)

Englisch-deutsche Fachwörterliste

cost function	Kostenfunktion (Gewichtung der Verbindungen zur Ermittlung der optimalen Route)
junction	Verbindungsstelle, von der mehrere Verbindungen abgehen
link	Verbindung zwischen zwei Verbindungsstellen
maneuver	Kombination von zusammenhängenden Abbiege- und Verbindungselementen, die ein komplexes Fahrmanöver bilden
navigation	Navigation (Kombination aus Ermittlung der optimalen Route, dem Durchfahren dieser Route und der Kursverfolgung)
network	Gerichteter Graph (Netz von Knoten und Kanten, die je mit genau einem Anfangs- und Endknoten inzidieren)
route	Route (Abfolge von Verbindungen in einem gerichteten Graphen)
routing	Ermittlung der optimalen Route
tracking	Überwachung und Weitergabe der aktuellen Position eines Fahrzeugs
traveller	Person, die navigiert oder deren Kurs verfolgt wird
turn	Abbiegestelle (besteht aus einer Verbindungsstelle und einer abzweigenden Verbindung)
vehicle	Fahrzeug, das navigiert oder dessen Kurs verfolgt wird (dies beinhaltet ohne Verletzung der Prinzipien dieser Norm auch Fußgänger)
waypoint	Potentielle Verbindungsstellen, die eine Route bilden können

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

– Leerseite –

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 19133

March 2007

ICS 35.240.70

English Version

Geographic information - Location-based services - Tracking and navigation (ISO 19133:2005)

Information géographique - Services basés sur la localisation - Suivi et navigation (ISO 19133:2005)

Geoinformation - Standortbezogene Dienste - Kursverfolgung und Navigation (ISO 19133:2005)

This European Standard was approved by CEN on 25 February 2007.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

© 2007 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members.

Ref. No. EN ISO 19133:2007: E

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

Contents

Page

Foreword ... 7

Introduction ... 8

1 Scope ... 9

2 Conformance ... 9

3 Normative references ... 10

4 Terms and definitions ... 10

5 Abbreviated terms and UML notation ... 14
5.1 Abbreviated terms ... 14
5.2 UML notation ... 14

6 Tracking ... 14
6.1 Semantics ... 14
6.2 Package: Tracking Service ... 15
6.3 Package: Point Estimates ... 29
6.4 Package: Location Transformation ... 34
6.5 Package: Measured Coordinates ... 35
6.6 Package: Linear Reference Systems ... 40

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

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

Page

Figures

Figure 1 — Tracking packages 15
Figure 2 — Context Diagram: TK_Position 16
Figure 3 — Context Diagram: TK_MobileSubscriber 17
Figure 4 — Context Diagram: TK_TrackingLocation 18
Figure 5 — Context Diagram: TK_TrackingService 19
Figure 6 — Context Diagram: TK_PositionType 20
Figure 7 — Context Diagram: TK_TrackingLocationSequence 21
Figure 8 — Context Diagram: TK_Trigger 22
Figure 9 — Context Diagram: TK_PeriodicTrigger 23
Figure 10 — Context Diagram: TK_TransitionTrigger 24
Figure 11 — Context Diagram: TK_TrackingLocationMetadata 25
Figure 12 — Context Diagram: TK_Transition 26
Figure 13 — Context Diagram: TK_QualityOfPosition 27
Figure 14 — Context Diagram: TK_Accuracy 28
Figure 15 — Context Diagram: TK_AccuracyStatement 28
Figure 16 — Point Estimate classes 29
Figure 17 — Geometric interpretations of point estimate types 30
Figure 18 — Context Diagram: EG_PointEstimateCircle 30
Figure 19 — Context Diagram: EG_PointEstimateEllipse 31
Figure 20 — Context Diagram: EG_PointEstimateArc 32
Figure 21 — Context Diagram: EG_PointEstimateSphere 33
Figure 22 — Context Diagram: EG_PointEstimateEllipsoid 34
Figure 23 — Context Diagram: LT_LocationTransformationService 35
Figure 24 — Measure Position 36
Figure 25 — Measured Coordinate Systems 37
Figure 26 — Context Diagram: MC_MeasurePosition 38
Figure 27 — Context Diagram: MC_CoordinateSystem 38
Figure 28 — Context Diagram: MC_CoordinateReferenceSystem 39
Figure 29 — LRS classes 40
Figure 30 — Context Diagram: LR_PositionExpression 41
Figure 31 — Context Diagram: LR_LinearReferenceMethod 43
Figure 32 — Context Diagram: LR_OffsetDirection 43
Figure 33 — Context Diagram: LR_ReferenceMarker 44
Figure 34 — Context Diagram: LR_Feature 45
Figure 35 — Context Diagram: LR_Element 45
Figure 36— Context Diagram: LR_OffsetExpression 46
Figure 37 — Navigation Packages 39

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

Page

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

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

Page

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

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

Page

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
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

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

Foreword

The text of ISO 19133:2005 has been prepared by Technical Committee ISO/TC 211 "Geographic information/Geomatics" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 19133:2007 by Technical Committee CEN/TC 287 "Geographic Information", the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2007, and conflicting national standards shall be withdrawn at the latest by September 2007.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Endorsement notice

The text of ISO 19133:2005 has been approved by CEN as EN ISO 19133:2007 without any modifications.

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

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.

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

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.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

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*

4 Terms and definitions

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

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.

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

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

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

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**

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**.

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

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

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.

4.29
vehicle classification
type of **vehicle**, based on the nature of its construction or intended purpose

NOTE Classifications based on construction include automobile, truck, bus, bicycle, etc. Classifications based on purpose include taxi, emergency vehicle, etc. Vehicle classification can be used to determine the application of **navigation** constraints.

4.30
waypoint
location on the **network** that plays a role in choosing **candidate routes** potentially satisfying a routing request

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

5 Abbreviated terms and UML notation

5.1 Abbreviated terms

CRS	Coordinate Reference System
CSL	Conceptual Schema Language
ECCMA	Electronic Commerce Code Management Association
GDF	Geographic Data Files
GML	Geography Markup Language
GPS	Global Positioning System
IAEC	International Address Element Code
LBS	Location Based Service
LDS	Location Dependent Service
LRM	Linear Referencing Method
LRS	Linear Reference System
OCL	Object Constraint Language
PDA	Personal Digital Assistant
UML	Unified Modeling language
XML	eXtensible Markup Language

5.2 UML notation

The UML notation used in this International Standard is described in ISO 19107, and differs from standard UML only in the existence and interpretation of some special stereotypes, in particular “CodeList” and “Union”.

The term “context diagram” used extensively in the naming of figures in this International Standard means a diagram that illustrates the context of a specified central type, meaning the types of it attributes, operations and association targets. This is the information most useful to the implementer of this central class.

6 Tracking

6.1 Semantics

The package “Tracking” contains other packages that are used in tracking services and related functions (see Figure 1).

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

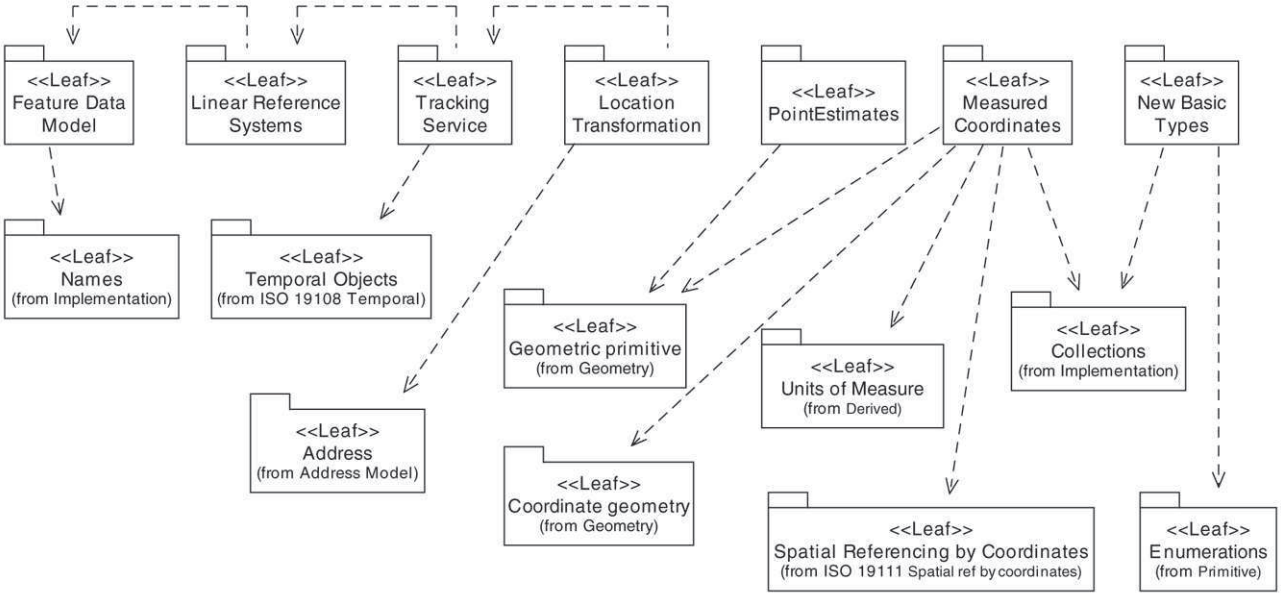

Figure 1 — Tracking packages

6.2 Package: Tracking Service

6.2.1 Semantics

The package “Tracking Service” contains types and classes useful in creating a tracking service. Since this is the core of many of the navigation functions described elsewhere in this International Standard, this package contains some important types universal to most if not all location-based services.

6.2.2 TK_Position

6.2.2.1 Semantics

The union class “TK_Position” is used to represent positions in tracking and associated applications. An instance of this class locates a position or place within the network. It should always be interpretable as a direct position (coordinate in a reference system), an address or as a network position. The discriminators for the union, and their associated types are as follows:

directPosition:	DirectPosition
placeName:	SI_LocationInstance
featureID:	FD_FeatureName
linearReference:	LR_PositionExpression
networkPosition:	NT_NetworkPosition
address:	AD_AbstractAddress
phone:	CharacterString

The operations on this type are all cast operators that allow the programmers to determine the position in the form most useful to them. The UML for TK_Position is given in Figure 2.

6.2.2.2 Operation: asPosition

The operator “asPosition” derives the coordinates in the CRS of the data of this location.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

```
TK_Position :: asPosition() : DirectPosition
```

6.2.2.3 Operation: asNetworkPosition

The operator “asNetworkPosition” derives the network position of this location.

```
TK_Position :: asNetworkPosition() : NT_NetworkPosition
```

6.2.2.4 Operation: asAddress

The operator “asAddress” derives the address of this location.

```
TK_Position :: asAddress() : AD_Address
```

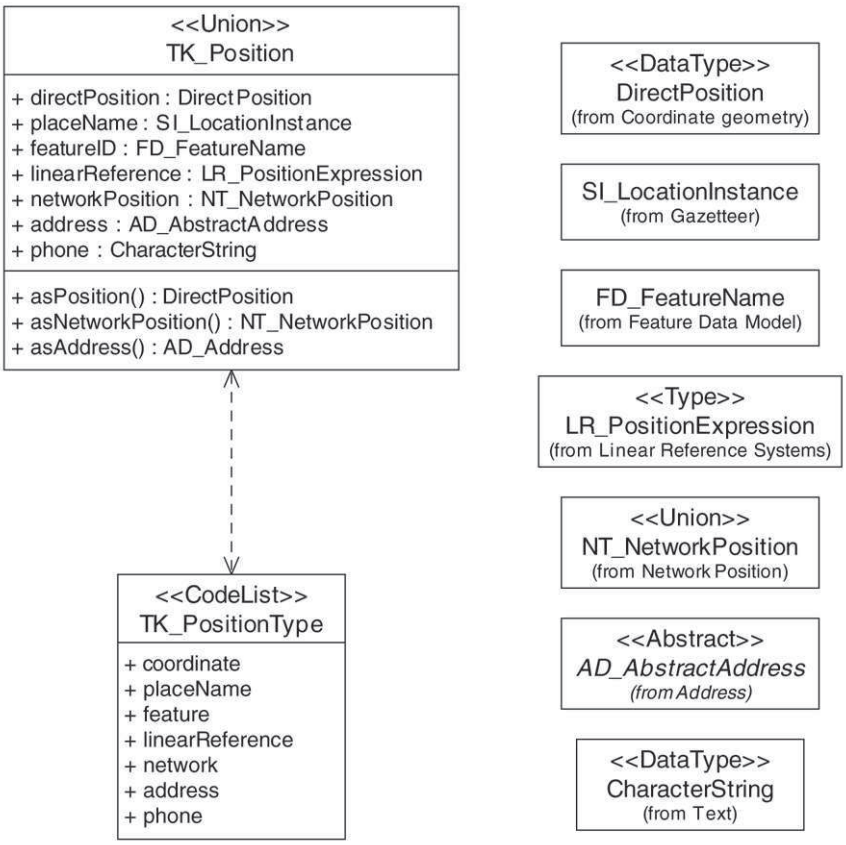

Figure 2 — Context Diagram: TK_Position

6.2.3 TK_MobileSubscriber

6.2.3.1 Semantics

The type “TK_MobileSubscriber” is used to model the items being tracked within the tracking service. The most common usage is the subscriber to a mobile service such as cell phone, where the service has the ability to determine the location of the device. The interfaces for the tracking services are also applicable to services that query the device for its location and would thus be applicable to GPS equipped devices as well. The service is a UML <<Type>> as opposed to a UML <<Interface>> because of the need to associate subscribers with their service.

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

There are deep issues of authentications between the service and the client, especially if the client is different from the mobile subscriber (in which case there are privacy issues). This International Standard assumes that those issues have been solved outside of the tracking interfaces (possible through a “verification” service, not dependent on geography, and therefore outside the scope of this International Standard). The UML for TK_MobileSubscriber is given in Figure 3.

6.2.3.2 Attribute: id : CharacterString

The attribute “id” is the identifier by which the associated tracking service knows this subscriber.

```
TK_MobileSubscriber :: id : CharacterString
```

6.2.3.3 Attribute: location : TK_TrackingLocation

The derived attribute “location” is the location of the subscriber at the time the attribute is accessed. This is essentially another access to the tracking service in many cases. In the case where the subscriber is a GPS equipped device, accessing this attribute would not necessarily activate the tracking service.

```
TK_MobileSubscriber :: location : TK_TrackingLocation
```

6.2.3.4 Role: trackingService[1..*] : TK_TrackingService

The association role “trackingService” links the subscribers to the tracking service that supports tracking them.

```
TK_MobileSubscriber :: trackingService[1..*]  : TK_TrackingService
```

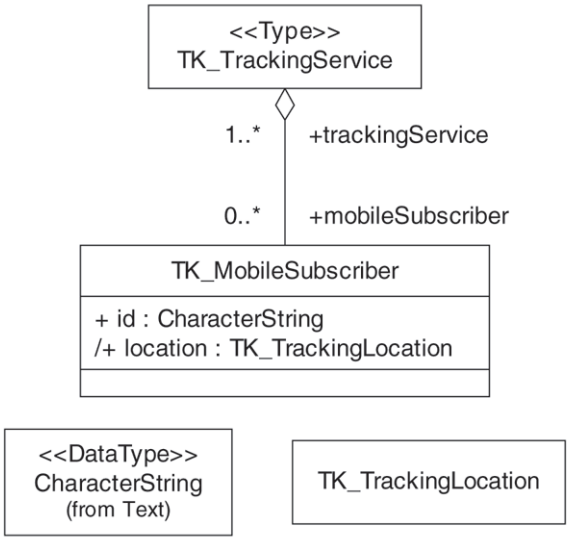

Figure 3 — Context Diagram: TK_MobileSubscriber

6.2.4 TK_TrackingLocation

6.2.4.1 Semantics

The type “TK_TrackingLocation” is used to represent objects describing a location and its associated metadata, such as time of measure, or direction of travel. The UML for TK_TrackingLocation is given in Figure 4.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.2.4.2 Attribute: position : TK_Position

The attribute “position” describes the measurements that represent the position of this object.

```
TK_TrackingLocation :: position : TK_Position
```

6.2.4.3 Attribute: time[0..1] : TM_Primitive

The optional attribute “time” describes the time of the measurements that represent the position of this object.

```
TK_TrackingLocation :: time[0..1] : TM_Primitive
```

6.2.4.4 Attribute: direction[0..1] : Bearing

The attribute “direction” describes the direction of travel of the subscriber being tracked.

```
TK_TrackingLocation :: direction[0..1] : Bearing
```

6.2.4.5 Attribute: speed[0..1] : Velocity

The attribute “speed” describes the velocity of travel of the subscriber being tracked.

```
TK_TrackingLocation :: speed[0..1] : Velocity
```

6.2.4.6 Role: metadata[0..*] : TK_TrackingLocationMetadata

The association role “metadata” aggregates optional metadata elements associated with this location.

```
TK_TrackingLocation :: metadata[0..*] : TK_TrackingLocationMetadata
```

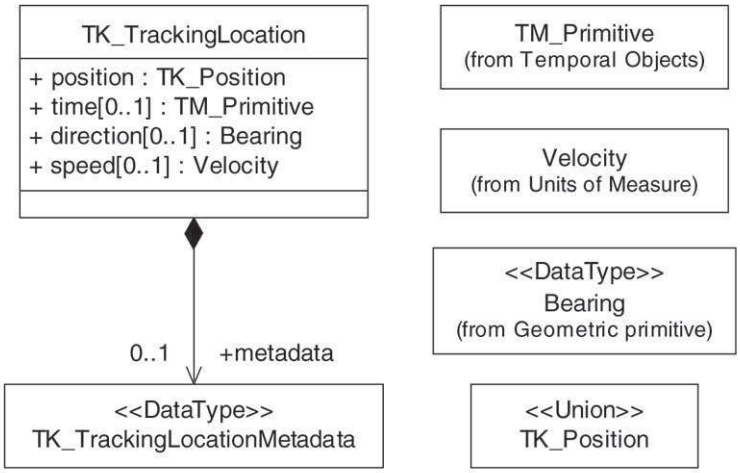

Figure 4 — Context Diagram: TK_TrackingLocation

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

6.2.5 TK_TrackingService

6.2.5.1 Semantics

The type “TK_TrackingService” defines interfaces and associations for tracking services. The UML for TK_TrackingService is given in Figure 5.

6.2.5.2 Role mobileSubscriber[0..*] : TK_MobileSubscriber

The association role “mobileSubscriber” aggregates items (vehicle or traveller) that may be tracked by using this service.

```
TK_TrackingService :: mobileSubscriber[0..*] : TK_MobileSubscriber
```

6.2.5.3 Operation: locate

The operation “locate” returns a single location for a tracked item.

```
TK_TrackingService ::
      locate(ms : TK_MobileSubscriber, type : TK_PositionType) :
      TK_TrackingLocation
```

6.2.5.4 Operation: track

The operation “track” returns a sequence of locations for a tracked item. The trigger types that cause a new location to be placed in the sequence are specified in the operation protocol.

```
TK_TrackingService ::
      track(ms : TK_MobileSubscriber, triggerType[1..*] : TK_Trigger) :
      TK_TrackingLocationSequence
```

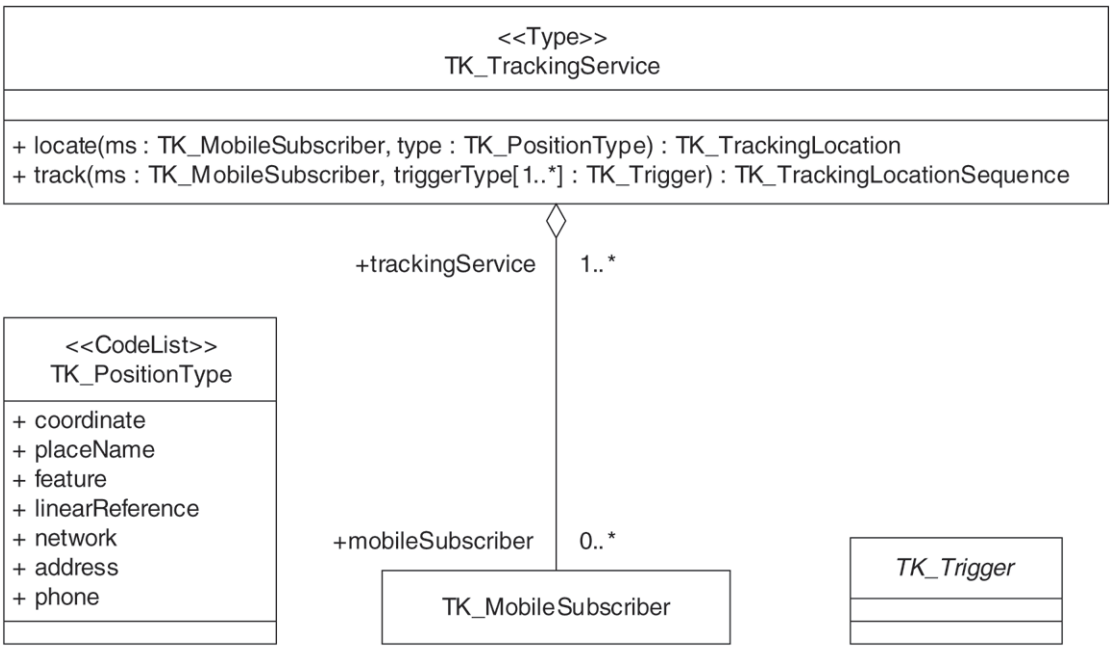

Figure 5 — Context Diagram: TK_TrackingService

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.2.6 TK_PositionType

The code list “TK_PositionType” lists the types of position available to the application. The initial members of this list include: “coordinate”, “placeName”, “feature”, “linearReference”, “network”, “address”, and “phone”. The UML for TK_PositionType is given in Figure 6.

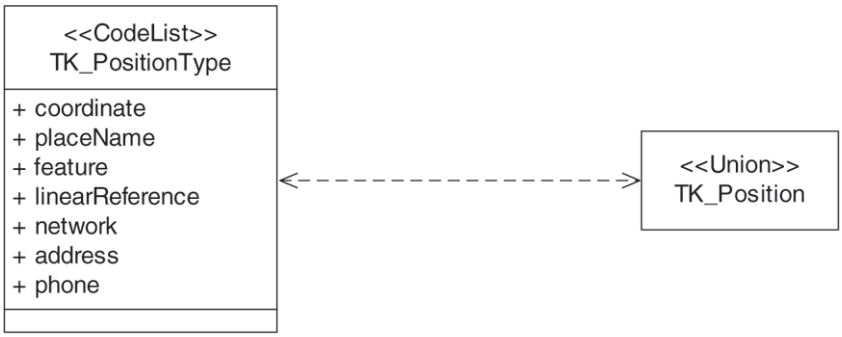

Figure 6 — Context Diagram: TK_PositionType

6.2.7 TK_TrackingLocationSequence

6.2.7.1 Semantics

The type “TK_TrackingLocationSequence” is an access mechanism for the return of a continuous tracking of an item. The UML for TK_TrackingLocationSequence is given in Figure 7.

6.2.7.2 Attribute: ms : TK_MobileSubscriber

The attribute “ms” gives the identity of the item being tracked.

```
TK_TrackingLocationSequence :: ms : TK_MobileSubscriber
```

6.2.7.3 Attribute: sequenceID : CharacterString

The attribute “sequenceID” gives the identity of the location sequence so that a client can repeatedly access the location sequence.

```
TK_TrackingLocationSequence :: sequenceID : CharacterString
```

6.2.7.4 Operation: next

The operation “next” returns the next location in the sequence.

```
TK_TrackingLocationSequence :: next() : TK_TrackingLocation
```

6.2.7.5 Operation: suspend

The operation “suspend” stops temporarily the stream of locations in the sequence.

```
TK_TrackingLocationSequence :: suspend() : Boolean
```


Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

6.2.7.6 Operation: restart

The operation “restart” restarts the stream of locations in the sequence that has been stopped by “suspend”.

```
TK_TrackingLocationSequence :: restart() : TK_TrackingLocation
```

6.2.7.7 Operation: terminate

The operation “terminate” stops permanently the stream of locations in the sequence.

```
TK_TrackingLocationSequence :: terminate() : Boolean
```

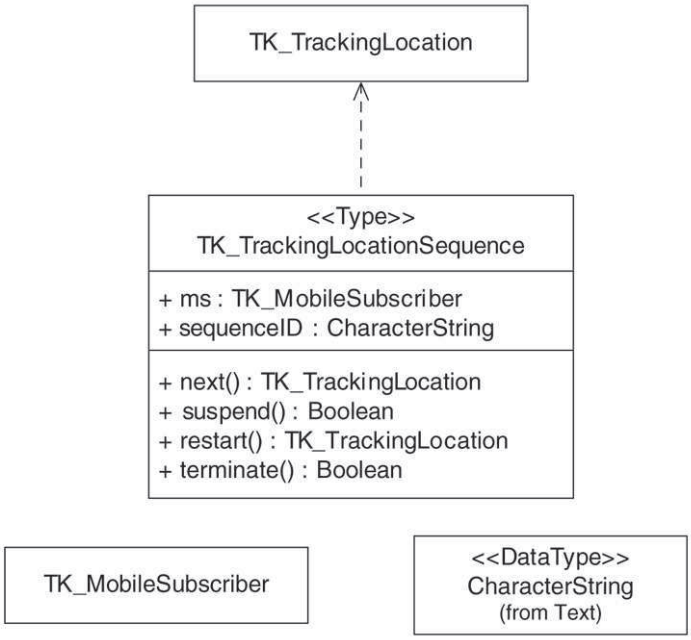

Figure 7 — Context Diagram: TK_TrackingLocationSequence

6.2.8 TK_Trigger

The abstract class “TK_Trigger” acts as a root class for trigger types to be used in controlling a location sequence. There are generally two types: triggered by an event, or triggered by the passage of time. The UML for TK_Trigger is given in Figure 8.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

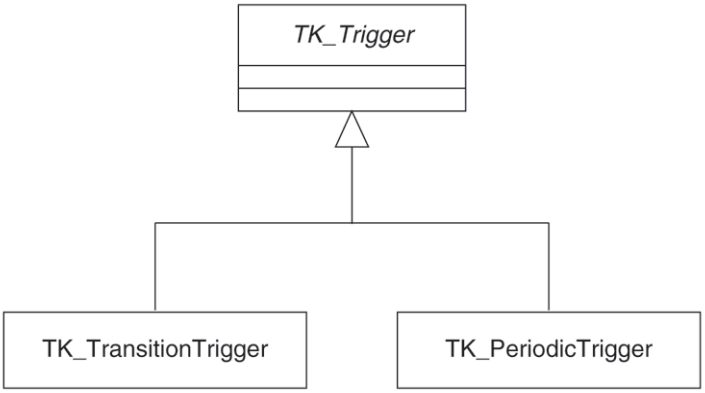

Figure 8 — Context Diagram: TK_Trigger

6.2.9 TK_PeriodicTrigger

6.2.9.1 Semantics

The class “TK_PeriodicTrigger” is used to control location sequences by setting up temporal limits on how far apart in time tracking samples are taken. Either minTime or maxTime shall be present for a valid TK_PeriodicTrigger. The UML for TK_PeriodicTrigger is given in Figure 9.

6.2.9.2 Attribute: minTime[0..1] : TM_Primitive

The attribute “minTime” is the minimum amount of time between tracking samples. In the absence of other criteria, the tracking service will begin the process to take a sample when the “minTime” has passed. Assuming no lag time is involved, the samples will be “minTime” apart.

```
TK_PeriodicTrigger :: minTime[0..1] : TM_Primitive
```

6.2.9.3 Attribute: maxTime[0..1] : TM_Primitive

The attribute “maxTime” is the maximum amount of time between tracking samples. In the absence of other criteria, the tracking service will attempt to assure that no two samples in the sequence are further apart than the “maxTime” parameter.

```
TK_PeriodicTrigger :: maxTime[0..1] : TM_Primitive
```


Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

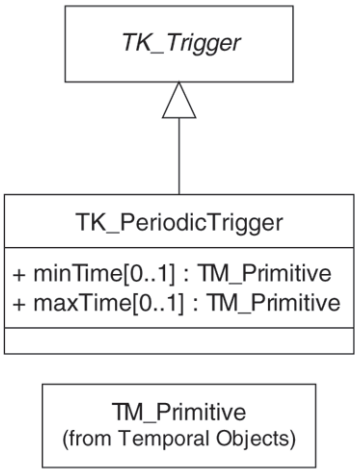

Figure 9 — Context Diagram: TK_PeriodicTrigger

6.2.10 TK_TransitionTrigger

6.2.10.1 Semantics

The class “TK_TransitionTrigger” models transitions relative to the item being tracked that will trigger the taking of a new location sample. In a TK_TransitionTrigger, at least one of the attributes shall be non-null. The UML for TK_TransitionTrigger is given in Figure10.

6.2.10.2 Attribute: type[0..*] : TK_TransitionType

The attribute “type” describes the type or types of transitions being watched. The various types of transitions are listed in the code list associated with the service.

```
TK_TransitionTrigger :: type[0..*] : TK_TransitionType
```

6.2.10.3 Attribute: deltaDirection[0..1] : Angle

The attribute “deltaDirection” describes the magnitude of the change of direction that triggers a new location sample.

```
TK_TransitionTrigger :: deltaDirection[0..1] : Angle
```

6.2.10.4 Attribute: deltaPosition[0..1] : Distance

The attribute “deltaPosition” describes the magnitude of the change of location (distance) that triggers a new location sample.

```
TK_TransitionTrigger :: deltaPosition[0..1] : Distance
```


Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

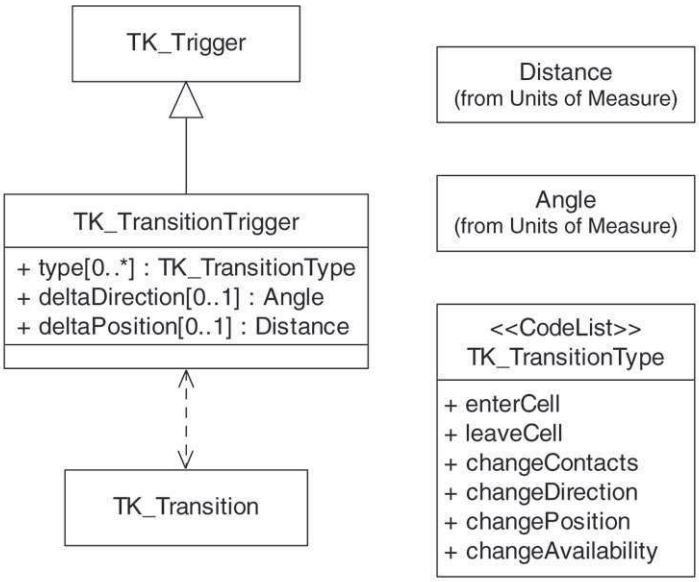

Figure 10 — Context Diagram: TK_TransitionTrigger

6.2.11 TK_TransitionType

The code list "TK_TransitionType" enumerates the types of transition tracked by this service. The initial values of the list include the following:

"enterCell"	mobile subscriber enters a cell associated with the network, e.g. cell phone network
"leaveCell"	mobile subscriber leaves a cell associated with the network
"changeContacts"	mobile subscriber changes the receivers with which it has contact
"changeDirection"	mobile subscriber changes the direction of its motion greater than the deltaDirection parameter specifies
"changePosition"	mobile subscriber changes its position greater than the deltaPosition parameter allows
"changeAvailability"	contact with the mobile subscriber is either lost or gained. If lost, the position just prior to loss is given. If gained, the first position calculated for the mobile subscriber after the new contact is given

6.2.12 TK_TrackingLocationMetadata

6.2.12.1 Semantics

The data type "TK_TrackingLocationMetadata" contains the metadata that is used to describe the position returned by the tracking service. As such, this data type shall always be contained in a TK_TrackingLocation, or other location type. The UML for TK_TrackingLocationMetadata is given in Figure 11.

6.2.12.2 Attribute: ms[0..1] : TK_MobileSubscriber

The attribute "ms" gives the identity of the item being tracked. If this attribute is not present, it should be derivable from context through the ownership of the containing TK_TrackingLocation.

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

```
TK_TrackingLocationSequence :: ms[0..1]: TK_MobileSubscriber
```

6.2.12.3 Attribute: quality : TK_QualityOfPosition

The attribute “quality” describes the quality of the position.

```
TK_TrackingLocationSequence :: quality : TK_QualityOfPosition
```

6.2.12.4 Attribute: time : TM_Primitive

The attribute “time” gives the time the position was measured.

```
TK_TrackingLocationSequence :: time : TM_Primitive
```

6.2.12.5 Attribute: clientID : CharacterString

The attribute “clientID” gives the identity of the client requesting the tracking service.

```
TK_TrackingLocationSequence :: clientID : CharacterString
```

6.2.12.6 Attribute: trigger[0..*] : TK_Transition

The attribute “trigger” gives the description of the transition that triggered this location measurement.

```
TK_TrackingLocationSequence :: trigger[0..*] : TK_Transition
```

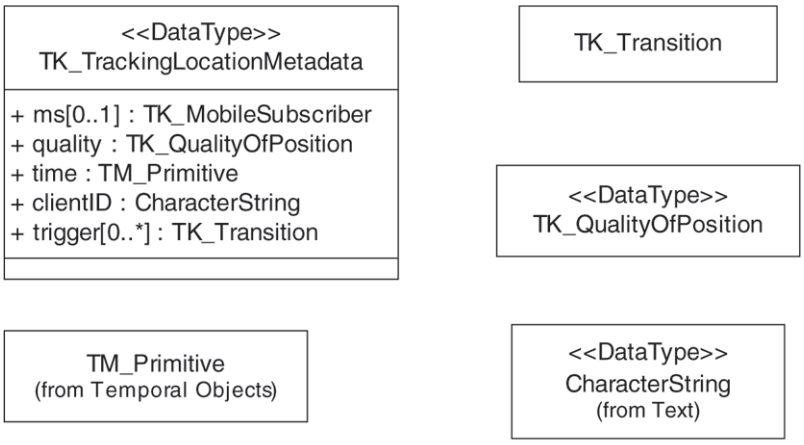

Figure 11 — Context Diagram: TK_TrackingLocationMetadata

6.2.13 TK_Transition

6.2.13.1 Semantics

The class “TK_Transition” describes a particular event or transition that triggered a location measure. The UML for TK_Transition is given in Figure 12.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.2.13.2 Attribute: type[1..*] : TK_TransitionType

The attribute “type” describes the type or types of transitions.

```
TK_Transition :: type[1..*] : TK_TransitionType
```

6.2.13.3 Attribute: time : TM_Primitive

The attribute “time” describes the time that the transition occurred. Normally, this should be approximately the same time as in the location metadata.

```
TK_Transition :: time : TM_Primitive
```

6.2.13.4 Attribute: deltaDirection[0..1] : Angle

The attribute “deltaDirection” describes the magnitude of the change of direction that triggered this new location sample.

```
TK_Transition :: deltaDirection[0..1] : Angle
```

6.2.13.5 Attribute: deltaPosition[0..1] : Distance

The attribute “deltaPosition” describes the magnitude of the change of location (distance) that triggered this location sample.

```
TK_Transition :: deltaPosition[0..1] : Distance
```

6.2.13.6 Attribute: availability[0..1] : Boolean

The attribute “availability” describes whether the location of the item being tracked is currently available to be measured.

```
TK_Transition :: availability[0..1] : Boolean
```

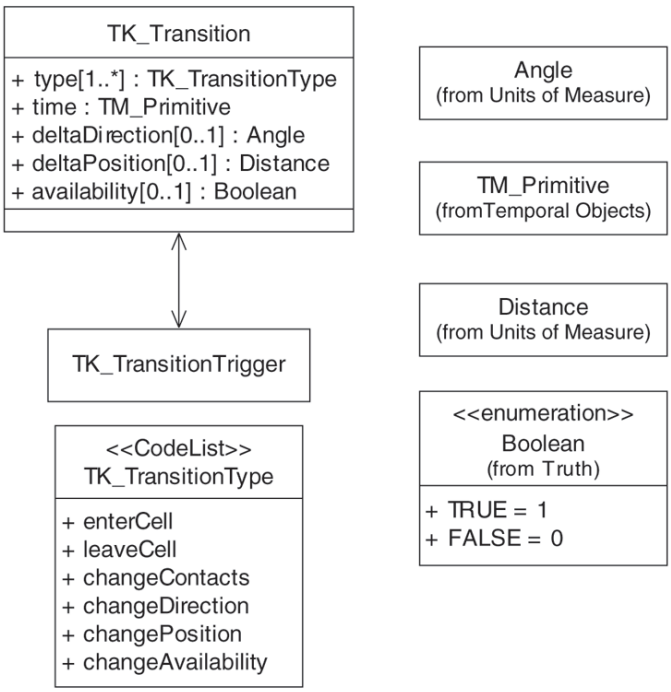

Figure 12 — Context Diagram: TK_Transition

Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06

6.2.14 TK_QualityOfPosition

6.2.14.1 Semantics

The data type “TK_QualityOfPosition” is used to describe the quality of position measurements. The UML for TK_QualityOfPosition is given in Figure 13.

6.2.14.2 Role: accuracyStatement[1..*] : TK_AccuracyStatement

The association role “accuracyStatement” aggregates statements about the accuracy of the position.

```
TK_QualityOfPosition :: accuracyStatement[1..*] : TK_AccuracyStatement
```

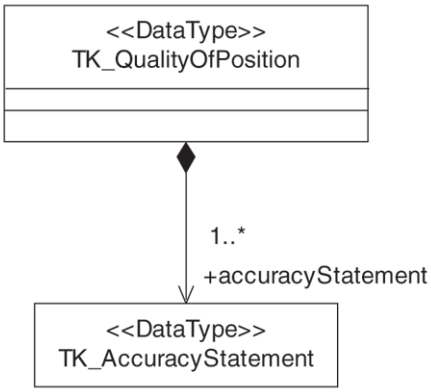

Figure 13 — Context Diagram: TK_QualityOfPosition

6.2.15 TK_Accuracy

6.2.15.1 Semantics

The class “TK_Accuracy” is used to describe accuracy of a measure. The numerical values are in the same units as the measure. The UML for TK_Accuracy is given in Figure 14.

6.2.15.2 Attribute: accuracyType : TK_AccuracyType

The attribute “accuracyType” gives the type of accuracy measure.

```
TK_Accuracy :: accuracyType : TK_AccuracyType
```

6.2.15.3 Attribute: sigmaLevel[0..1] : Number

The attribute “sigmaLevel” describes the accuracy of the measure based on a multiple of the standard deviation.

```
TK_Accuracy :: sigmaLevel[0..1] : Number
```

6.2.15.4 Attribute: sigma[0..1] : Number

The attribute “sigma” describes the standard deviation.

```
TK_Accuracy :: sigma[0..1] : Number
```


Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.2.15.5 Attribute: units[0..1]: UnitOfMeasure

The attribute “units” gives the unit of measure for the accuracy for the measurement as needed.

```
TK_AccuracyStatement :: unit[0..1] : UnitOfMeasure
```

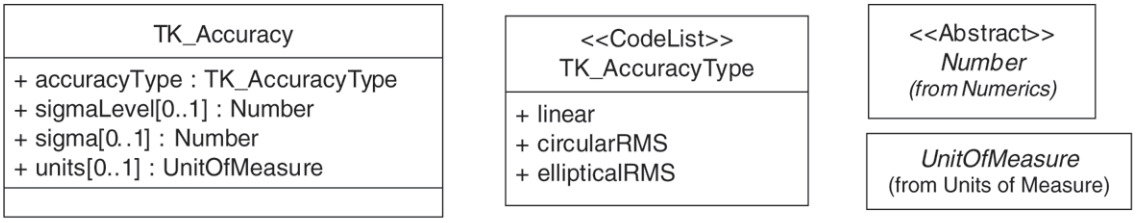

Figure 14 — Context Diagram: TK_Accuracy

6.2.16 TK_AccuracyType

The code list “TK_AccuracyType” lists the type of accuracy measure used by this service. The initial values in the value domain are “linear”, “circularRMS”, and “ellipticalRMS”.

6.2.17 TK_AccuracyStatement

6.2.17.1 Semantics

The data type “TK_AccuracyStatement” is used to make statements about metric accuracy of measurements. The UML for TK_AccuracyStatement is given in Figure 15.

6.2.17.2 Attribute: axis[1..*] : CharacterString

The attribute “axis” gives the axis or axes about which the statement applies. This name shall correspond to axes in a given coordinate reference system for the geometry of the given position.

```
TK_AccuracyStatement :: axis[1..*] : CharacterString
```

6.2.17.3 Attribute: accuracy : TK_Accuracy

The attribute “accuracy” gives accuracy for a measurement.

```
TK_AccuracyStatement :: accuracy : TK_Accuracy
```

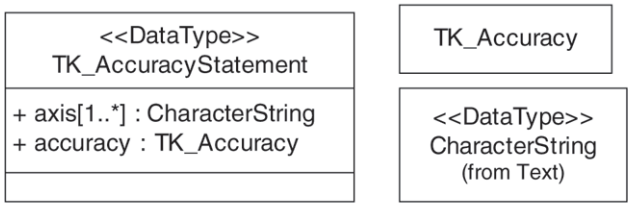

Figure 15 — Context Diagram: TK_AccuracyStatement

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.3 Package: Point Estimates

6.3.1 Semantics

The package “Point Estimates” contains geometry object types, all subclasses of “GM_Point", used in describing direct position estimates seen in tracking services. The UML for the inheritance hierarchy for the point estimate classes is given in Figure 16. A graphic of their form, showing the estimate with its error geometry, is given in Figure 17.

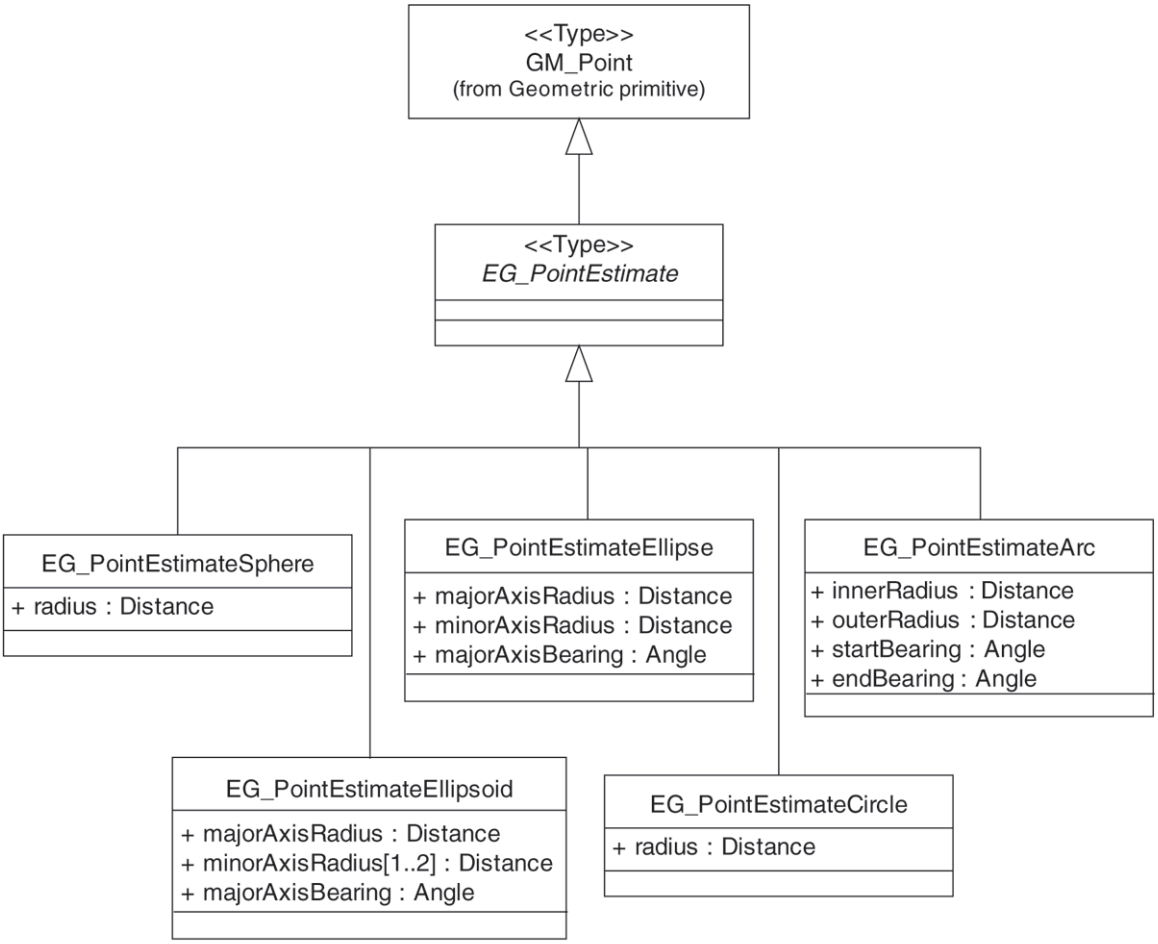

Figure 16 — Point Estimate classes

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

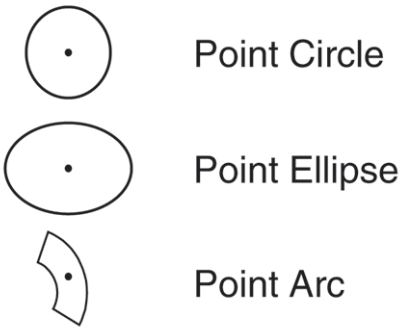

Figure 17 — Geometric interpretations of point estimate types

6.3.2 EG_PointEstimate

The type “EG_PointEstimate” is the abstract root of all the error estimate geometry objects. It is a subtype of point. The best estimate of the location is the centre of the given geometry. The coordinates of the point specify the primary constructive location of the geometry, and will be the best estimate of the location if and only if it is also the centre of the geometry specified. The UML for EG_PointEstimate is given in Figure 16.

6.3.3 EG_PointEstimateCircle

6.3.3.1 Semantics

The class “EG_PointEstimateCircle” is used to describe a point with an error estimate that is a metric circle of a given radius. It should be noted that this circle is not a circle in the coordinate reference system of the point unless the reference system is equivalent a local engineering one. The point coordinates (inherited from GM_Point) specify the centre of the circle, and the best estimate of position. The UML for EG_PointEstimateCircle is given in Figure 18.

6.3.3.2 Attribute: radius : Distance

The attribute “radius” is the radius of the error circle used in the point estimate. The usual semantics is to return a fixed “sigma” level that is a fixed multiple of the standard deviation of the measurement procedure. Unless otherwise specified by a profile, a 1,0-sigma level is given.

```
EG_PointEstimateCircle :: radius : Distance
```

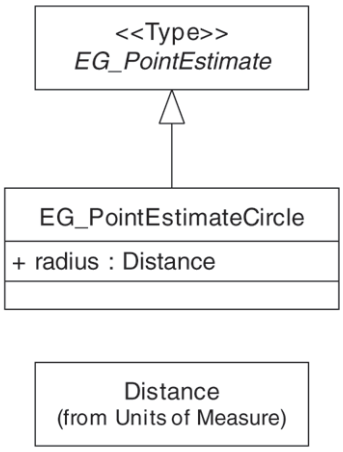

Figure 18 — Context Diagram: EG_PointEstimateCircle

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.3.4 EG_PointEstimateEllipse

6.3.4.1 Semantics

The point ellipse is the same as a point circle except that an ellipse defined by the parameters given specifies the error. The point coordinates (inherited from GM_Point) specify the centre of the ellipse, and the best estimate of position. The UML for EG_PointEstimateEllipse is given in Figure 19.

6.3.4.2 Attribute: majorAxisRadius : Distance

The attribute “majorAxisRadius” is half the length of the major axis of the ellipse.

```
EG_PointEstimateEllipse :: majorAxisRadius : Distance
```

6.3.4.3 Attribute: minorAxisRadius : Distance

The attribute “minorAxisRadius” is half the length of the minor axis of the ellipse.

```
EG_PointEstimateEllipse :: minorAxisRadius: Distance
```

6.3.4.4 Attribute: majorAxisBearing : Angle

The attribute “majorAxisBearing” is bearing of the major axis of the ellipse, given as an angle from true north. The minor axis is perpendicular to the major axis.

```
EG_PointEstimateEllipse :: majorAxisBearing : Angle
```

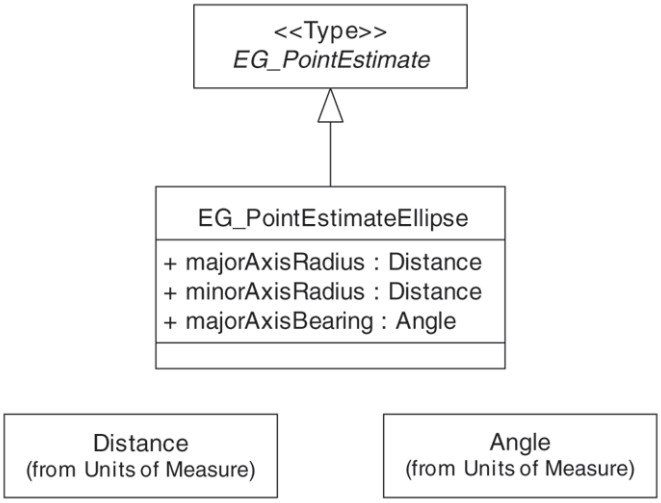

Figure 19 — Context Diagram: EG_PointEstimateEllipse

6.3.5 EG_PointEstimateArc

6.3.5.1 Semantics

The point arc is the same as a point circle except that a pair of arcs between two given radii and two given bearing angles gives the area estimate error. The point coordinates specify the centre of the two arcs. The best estimate of position is the along the centreline of the two arcs and halfway between the two radii. The UML for EG_PointEstimateArc is given in Figure 20.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.3.5.2 Attribute: innerRadius : Distance

The attribute “innerRadius” is the radius of the smaller of the two arcs.

```
EG_PointEstimateArc :: innerRadius : Distance
```

6.3.5.3 Attribute: outerRadius : Distance

The attribute “outerRadius” is the radius of the larger of the two arcs.

```
EG_PointEstimateArc :: outerRadius: Distance
```

6.3.5.4 Attribute: startBearing : Angle

The attribute “startBearing” is the bearing of one side of the arcs (left-hand end when viewed from the arc centre).

```
EG_PointEstimateArc :: startBearing : Angle
```

6.3.5.5 Attribute: endBearing : Angle

The attribute “endBearing” is the bearing of the other side of the arcs (right-hand end when viewed from the arc centre).

```
EG_PointEstimateArc :: endBearing: Angle
```

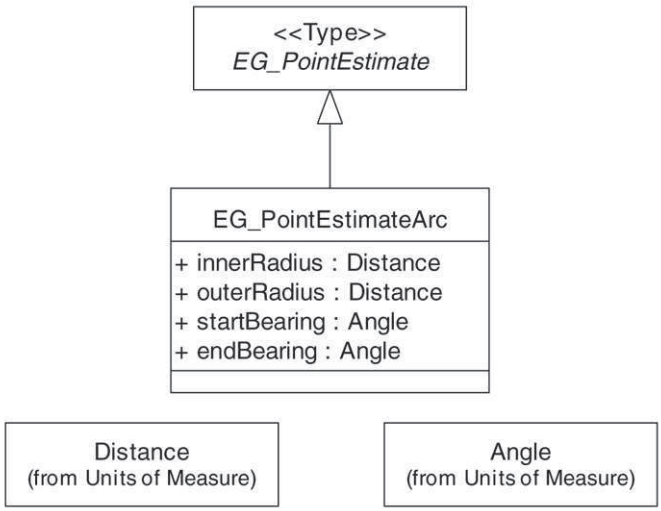

Figure 20 — Context Diagram: EG_PointEstimateArc

6.3.6 EG_PointEstimateSphere

6.3.6.1 Semantics

The class “EG_PointEstimateSphere” is used to describe a point with an error estimate that is a metric sphere of a given radius. It should be noted that this sphere is not a sphere in the coordinate reference system of the point unless the reference system is equivalent to a local engineering one. The point coordinates (inherited from GM_Point) specify the centre of the sphere, and the best estimate of position. The UML for EG_PointEstimateSphere is given in Figure 21.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.3.6.2 Attribute: radius : Distance

The attribute “radius” is the radius of the error sphere used in the point estimate. The usual semantics is to return a fixed “sigma” level that is a fixed multiple of the standard deviation of the measurement procedure. Unless otherwise specified by a profile, a 1,0-sigma level is given.

```
EG_PointEstimateSphere :: radius : Distance
```

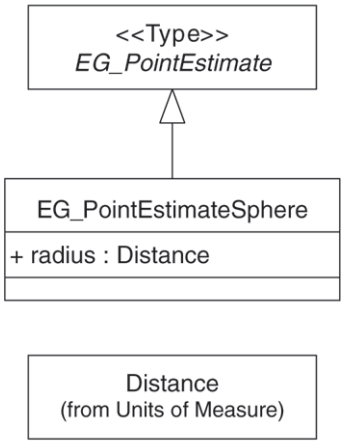

Figure 21 — Context Diagram: EG_PointEstimateSphere

6.3.7 EG_PointEstimateEllipsoid

6.3.7.1 Semantics

The point ellipsoid is the same as a point sphere except that an ellipsoid defined by the parameters given specifies the error. The point coordinates (inherited from GM_Point) specify the centre of the ellipsoid, and the best estimate of position. The UML for EG_PointEstimateEllipsoid is given in Figure 22.

6.3.7.2 Attribute: majorAxisRadius : Distance

The attribute “majorAxisRadius” is half the length of the major axis of the ellipsoid. In this case, major means “primary” or “central”. It may not necessarily be the longest of the three axes. It is the axis of rotation in the case where the remaining axes are equal.

```
EG_PointEstimateEllipsoid :: majorAxisRadius : Distance
```

6.3.7.3 Attribute: minorAxisRadius : Distance

The attribute “minorAxisRadius” is half the length of the minor axis of the ellipsoid. If one axis radius is given, the ellipsoid is a figure of rotation about the major axis, with this radius at the central “equator”. If two axes are given, then the figure is a fully general tri-axis ellipsoid.

```
EG_PointEstimateEllipsoid :: minorAxisRadius: Distance
```


Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.3.7.4 Attribute: majorAxisBearing : Angle

The attribute “majorAxisBearing” is bearing of the major axis of the ellipsoid, given as an angle from true north. The minor axis is perpendicular to the major axis. If a second angle is given, this is an elevation angle from the local horizontal.

```
EG_PointEstimateEllipsoid :: majorAxisBearing[1..2] : Angle
```

6.3.7.5 Attribute: minorAxisBearing : Angle

The attribute “minorAxisBearing” is bearing of the minor axis of the ellipsoid, given as an angle from true north. The minor axis is perpendicular to the major axis. If no angle is given, then the minor axis is in the horizontal plane, perpendicular to the major axis. If a second angle is given, this is an elevation angle from the local horizontal. The third axis (second minor axis, if needed) is perpendicular to both other axes and therefore its direction is fixed by the values already given. Its unit vector direction in 3D is the cross product of the unit vector directions of the other two axes.

```
EG_PointEstimateEllipsoid :: minorAxisBearing[0..2] : Angle
```

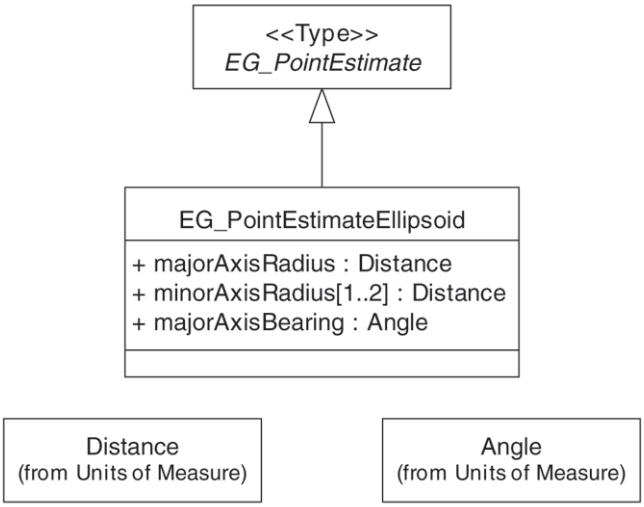

Figure 22 — Context Diagram: EG_PointEstimateEllipsoid

6.4 Package: Location Transformation

6.4.1 Semantics

The package “Location Transformation” contains classes to support the transformation of the various forms of location into one another.

6.4.2 LT_LocationTransformationService

6.4.2.1 Semantics

The abstract type “LT_LocationTransformationService” provides interfaces for services based upon the transformation of one form of location into another. The most common example of such a service is a geocoder, which maps addresses to geographic locations and vice versa. The UML for LT_LocationTransformationService is given in Figure 23.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.4.2.2 Operation: cast

The operation “cast” takes one form of location and creates another form of the same location.

```
LT_LocationTransformationService ::
      cast(p : TK_TrackingLocation, asType : TK_PositionType) :
      TK_TrackingLocation
```

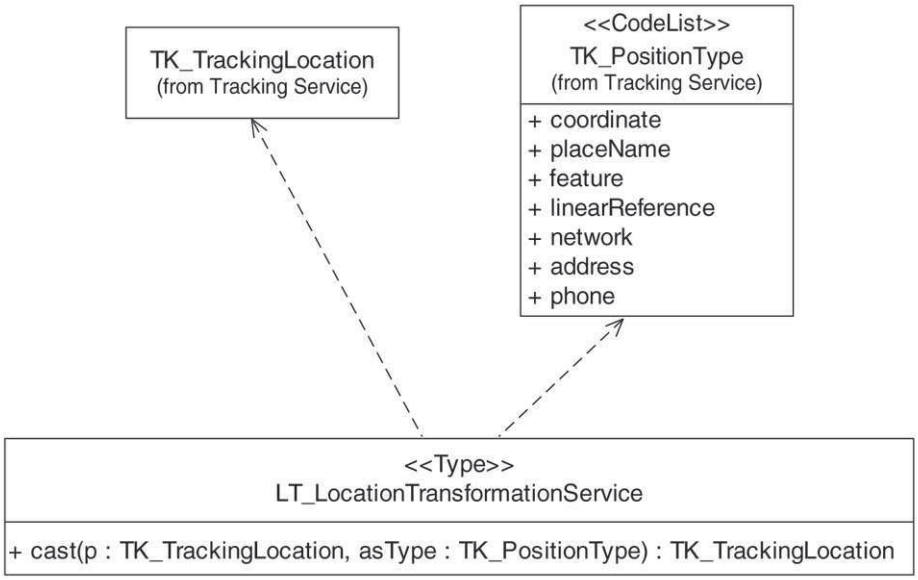

Figure 23 — Context Diagram: LT_LocationTransformationService

6.5 Package: Measured Coordinates

6.5.1 Semantics

The package “Measured Coordinates” contains classes for associating measures to coordinate positions. This is most commonly done in the creation of linear reference systems. This is done by modifying the coordinate reference systems defined in ISO 19111, by adding extra coordinate axes to the systems that allow for the storage of dependent coordinate measures, such as length measures.

This concept is illustrated in Figure 24. This illustrates how direct positions, the foundation of coordinate geometries in ISO 19107, are modified to carry measure information. Figure 25 shows the mechanism for altering a coordinate reference system to allow for the additional axes to be added allowing for the measure. Normally, only one measure is added (usually a nominal arc distance), and other measures are given as functions of this basic one.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

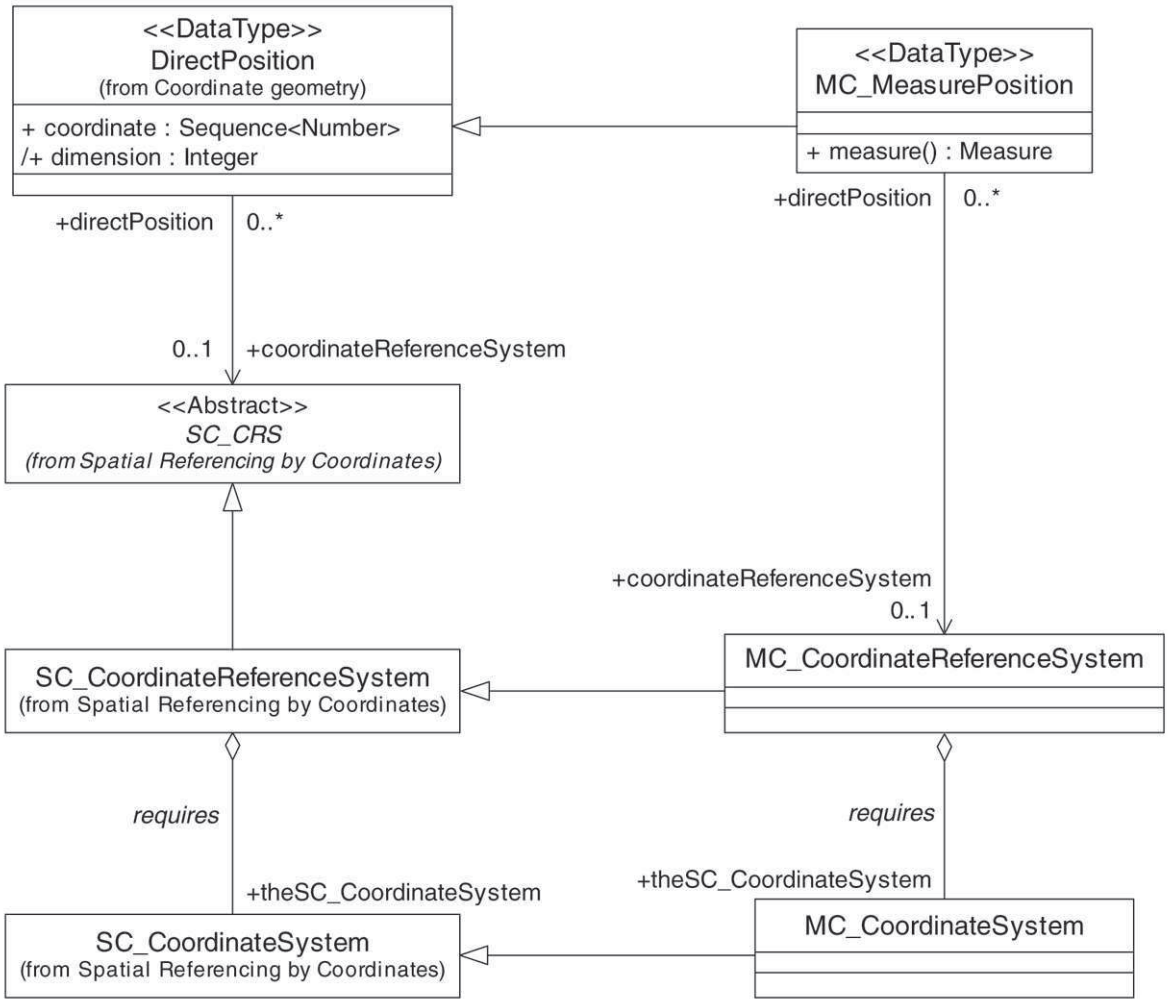

Figure 24 — Measure Position

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

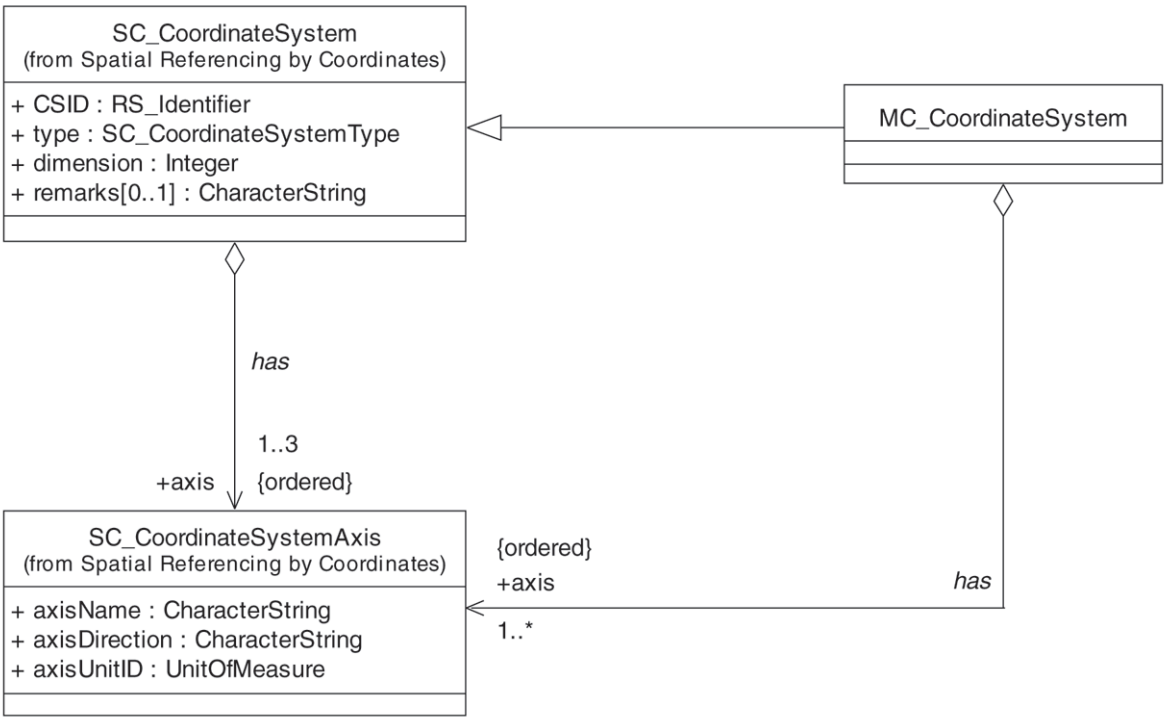

Figure 25 — Measured Coordinate Systems

6.5.2 MC_MeasurePosition

6.5.2.1 Semantics

The data type “MC_MeasurePosition” extends the concept of a DirectPosition to include additional measures as ordinates. The UML for MC_MeasurePosition is given in Figure 26.

6.5.2.2 Role: coordinateReferenceSystem[0..1] : MC_CoordinateReferenceSystem

The optional association role “CoordinateReferenceSystem” inherited from DirectPosition, will now reference a measured coordinate system. If this role is empty, then, as in the case of direct position, there shall be a larger context that implies the coordinate reference system.

```
MC_MeasurePosition :: CoordinateReferenceSystem[0..1] :
      MC_CoordinateReferenceSystem
```

6.5.2.3 Operation: measure

The operation “measure” gives the measured position of a projection onto its measure component.

```
MC_MeasurePosition :: measure() : Measure
```


Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

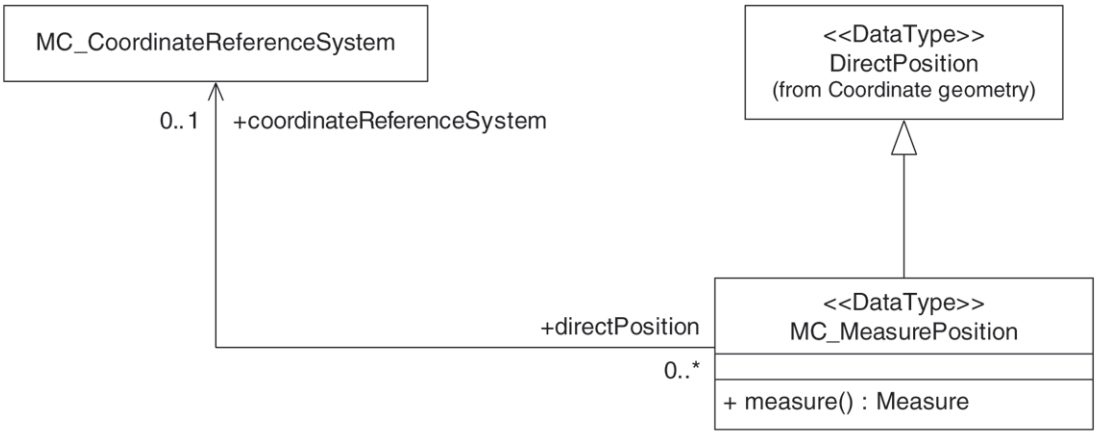

Figure 26 — Context Diagram: MC_MeasurePosition

6.5.3 MC_CoordinateSystem

6.5.3.1 Semantics

The class “MC_CoordinateSystem” describes coordinate systems that have been augmented with measures. The UML for MC_CoordinateSystem is given in Figure 27.

6.5.3.2 Role: axis[1..*] : SC_CoordinateSystemAxis

The role “axis” aggregates the axes for the coordinate reference system. This association is inherited form ISO 19111, but is modified here to accommodate additional axes for the measures. Normally, only one strictly monotonic measure axis is needed, as other measures can be implemented as functions of this one. The most common measure for this is some version of arc length for curves.

```
MC_CoordinateSystem :: axis[1..*]: SC_CoordinateSystemAxis
```

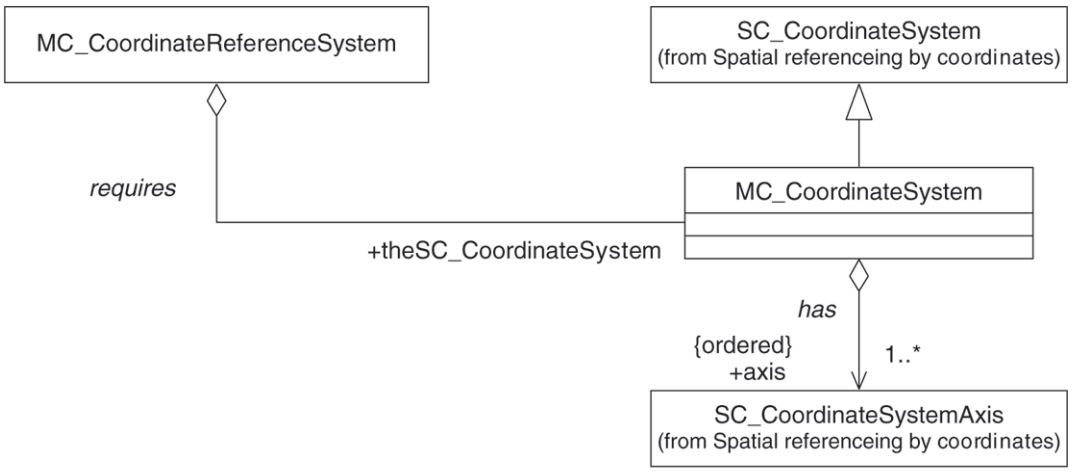

Figure 27 — Context Diagram: MC_CoordinateSystem

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.5.4 MC_CoordinateReferenceSystem

6.5.4.1 Semantics

The class “MC_CoordinateReferenceSystem” extends the class “SC_CoordinateReferenceSystem” defined in ISO 19111 to allow for additional coordinate axes to accommodate measures. The UML for MC_CoordinateReferenceSystem is given in Figure 28.

6.5.4.2 Role: theSC_CoordinateSystem : MC_CoordinateSystem

The association role “theSC_CoordinateSystem” inherited from ISO 19111 is extended here to allow for target class changes.

```
MC_CoordinateReferenceSystem ::
      theSC_CoordinateSystem : MC_CoordinateSystem
```

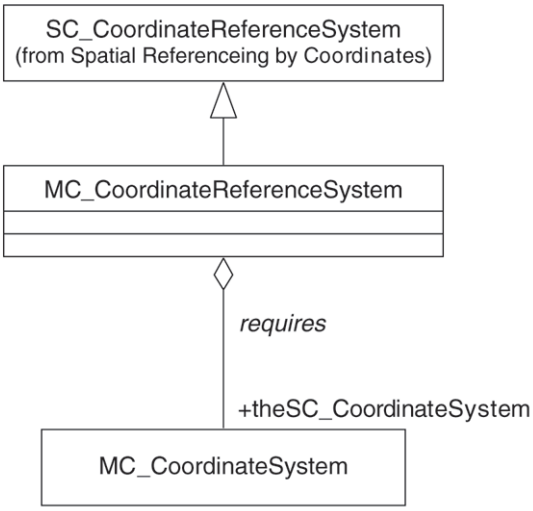

Figure 28 — Context Diagram: MC_CoordinateReferenceSystem

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.6 Package: Linear Reference Systems

6.6.1 Semantics

The package “Linear Reference Systems” supplies classes and types to the definition of linear reference systems. Linear reference systems are in wide use in transportation. They allow for the specification of positions along curvilinear features by using measured distances from known positions, usually represented by physical markers along the right-of-way of the transportation feature. The classes for this system and their relationships are depicted in Figure 29.

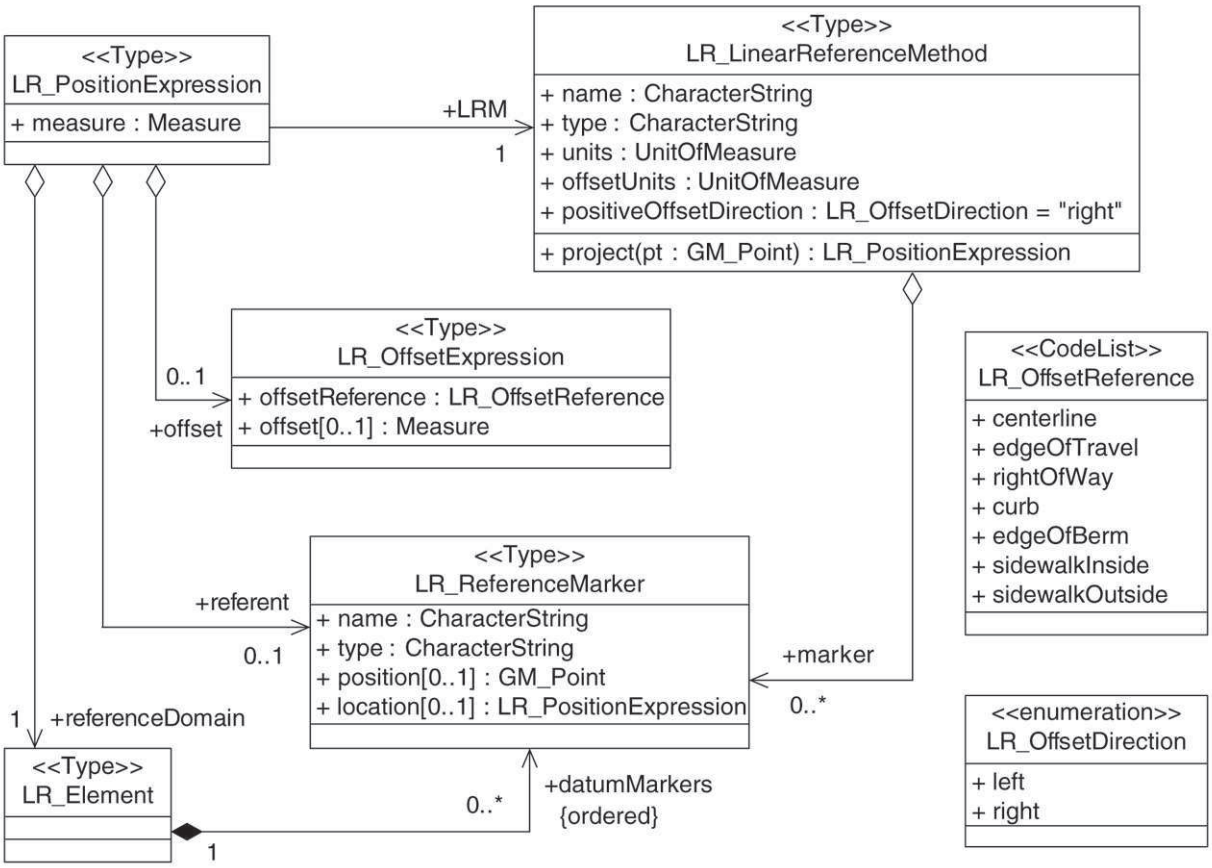

Figure 29 — LRS classes

6.6.2 LR_PositionExpression

6.6.2.1 Semantics

The class “LR_PositionExpression” is used to describe position given by a measure value, a curvilinear element being measured, and the method of measurement. The UML for LR_PositionExpression is given in Figure 30.

6.6.2.2 Attribute: measure : Measure

The attribute “measure” gives the measure (usually a distance) of this position expression.

```
LR_PositionExpression :: measure : Measure
```


Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.6.2.3 Role: LRM : LR_LinearReferenceMethod

The role “LRM” gives the linear reference method used for this position expression.

```
LR_PositionExpression :: LRM : LR_LinearReferenceMethod
```

6.6.2.4 Role: referent [0..1] : LR_ReferenceMarker

The optional association role “referent” gives the marker or known position from which the measure is taken for the linear reference method used for this position expression. If the referent is absent, the measurement is made from the start of the LR_element.

```
LR_PositionExpression :: referent [0..1]: LR_ReferenceMarker
```

6.6.2.5 Role: referenceDomain : LR_Element

The role “referenceDomain” gives the linear object upon which the measure is taken for the linear reference method used for this position expression.

```
LR_PositionExpression :: referenceDomain : LR_Element
```

6.6.2.6 Role: offset[0..1] : LR_OffsetExpression

The optional association role “offset” gives perpendicular distance offset of this position expression. If the offset is absent, then the position is on the LR_element.

```
LR_PositionExpression :: offset[0..1] : LR_OffsetExpression
```

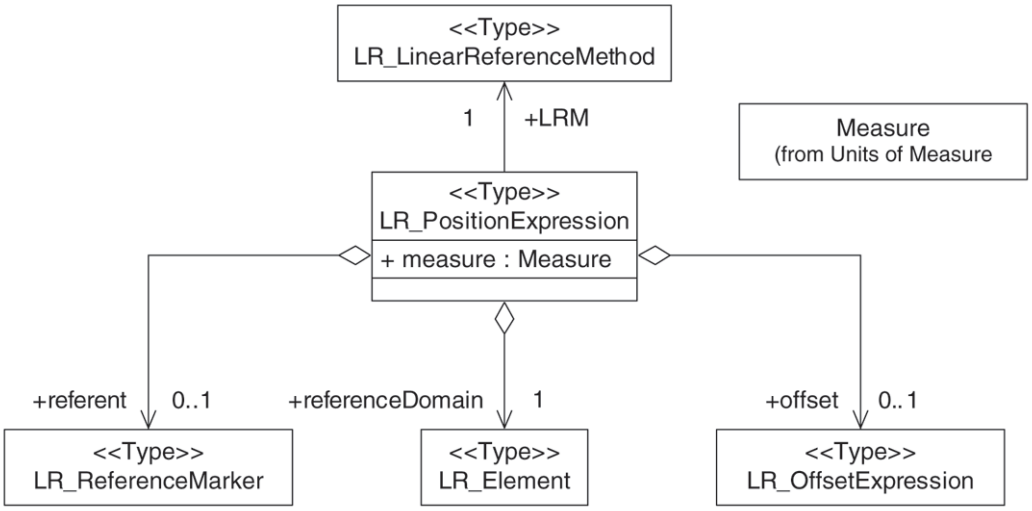

Figure 30 — Context Diagram: LR_PositionExpression

6.6.3 LR_LinearReferenceMethod

6.6.3.1 Semantics

The type “LR_LinearReferenceMethod” describes the manner in which measurements are made along (and optionally laterally offset from) a curvilinear element. The UML for LR_LinearReferenceMethod is given in Figure 31.

Documents
Document Sharing Hub
Full document details: DIN EN ISO 19133:2007-06

6.6.3.2 Attribute: name : CharacterString

The attribute: “name” gives the name of this linear reference method.

```
LR_LinearReferenceMethod :: name : CharacterString
```

6.6.3.3 Attribute: type : CharacterString

The attribute: “type” gives the type of this linear reference method.

```
LR_LinearReferenceMethod :: type : CharacterString
```

6.6.3.4 Attribute: units : UnitOfMeasure

The attribute: “units” gives the units of measure used for this linear reference method for measures along the base elements.

```
LR_LinearReferenceMethod :: units : UnitOfMeasure
```

6.6.3.5 Attribute: offsetUnits : UnitOfMeasure

The attribute: “offsetUnits” gives the units of measure used for this linear reference method for measures perpendicular to the base elements.

```
LR_LinearReferenceMethod :: offsetUnits : UnitOfMeasure
```

6.6.3.6 Attribute: positiveOffsetDirection : LR_OffsetDirection = "right"

The attribute: “positiveOffsetDirection” gives the direction used as positive for this linear reference method for measures perpendicular to the base elements. The default value is right for positive, left for negative.

```
LR_LinearReferenceMethod ::
      positiveOffsetDirection : LR_OffsetDirection = "right”
```

6.6.3.7 Role: marker[1..*] : LR_ReferenceMarker

The association role “marker” aggregates all reference markers used by the linear reference methods. Normally, this will be grouped by linear element.

```
LR_LinearReferenceMethod :: marker[0..*] : LR_ReferenceMarker
```

6.6.3.8 Role: referenceElement[1..*] : LR_Element

The role: “referenceElement” aggregates all the linear elements along which this method is supported.

```
LR_LinearReferenceMethod :: referenceElement[1..*] : LR_Element
```

6.6.3.9 Operation: project

The operation “project” will find the measure of the point on a base element closest to the given point, and then express the point as a position expression for the linear reference method. If the point is precisely on one of the linear elements, then the offset will be zero there is no offset expression.

```
LR_LinearReferenceMethod ::
      project(pt : GM_Point) : LR_PositionExpression
```


Documents
Document Sharing Hub

Full document details: DIN EN ISO 19133:2007-06