INTERNATIONAL STANDARD

ISO 19134

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Geographic information — Location-based services — Multimodal routing and navigation

Information géographique — Services basés sur la localisation — Routage et navigation multi-modes

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 19134 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

Introduction

In everyday life in metropolitan areas in the world, a typical traveller is involved in using various modes of transportation for daily activities: e.g. walking, driving, park-and-ride, mass transit and taxi. The traveller frequently faces the problem of finding the optimal or best route combining several modes, from the origin to the destination, passing through the locations (waypoints) where the traveller might want to engage in activities such as shopping and meeting people, possibly satisfying a set of constraints such as the sequence constraints like “activity 1 before activity 2”, “location 1 before location 2”, etc. A typical intercity traveller faces situations requiring decisions to be made such as which station (junction) and by which mode to travel in order to take which system among the available transportation modes between an origin and a destination. The decision will depend on the overall cost that includes the line-haul, parking, routing, stopping at stations (junctions), stopping at intermediate places, etc.

This International Standard provides a conceptual schema for describing the data and services needed to support routing and navigation application for mobile clients who intend to reach a target position using two or more modes of transportation. This conceptual schema is a standard schema such as the spatial schema (ISO 19107) or the temporal schema (ISO 19108). This International Standard provides a description of a service type to support routing and navigation for a mode that operates either on a fixed route or with a fixed schedule, a description of data type for transfers, and a description of data type for schedule information and route information of a mode with a fixed route and/or schedule.

Based upon ISO 19133:2005, this International Standard specifies additional classes as well as extensions to existing classes to be used for multimodal routing and navigation. As in ISO 19133:2005, this International Standard assumes that all requests for services will be encapsulated in a request/response pair between the mobile client and the client application or its on-web proxy application. Therefore, this International Standard describes service operation types and a set of request/response data types associated with some operations which are necessary for multimodal routing and navigation.

By way of adding and/or expanding ISO 19133:2005, standardized conceptual schemas for multimodal routing and navigation of mobile clients will increase the ability to share geographic information among multimodal location-based service applications. These schemas will be used by multimodal location-based service applications, mostly in metropolitan areas, and in all intercity travelling environments to provide consistently understandable spatial data structures.

Geographic information — Location-based services — Multimodal routing and navigation

1 Scope

This International Standard specifies the data types and their associated operations for the implementation of multimodal location-based services for routing and navigation. It is designed to specify web services that may be made available to wireless devices through web-resident proxy applications, but is not limited to that environment.

2 Conformance

Conformance to this International Standard depends on the type of entity declaring conformance.

Mechanisms for the data exchanges are conformant to this International Standard if they contain record implementations of the object types described within this International Standard, as specified in A.2.

Web services for routing and navigation are conformant to this International Standard if their interfaces implement one or both of the subtypes of service defined in this International Standard, as specified in A.3.

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 19101, *Geographic information — Reference model*

ISO 19107, *Geographic information — Spatial schema*

ISO 19108, *Geographic information — Temporal schema*

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

ISO 19133:2005, *Geographic information — Location-based services — Tracking and navigation*

4 Terms and definitions

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

4.1
application
manipulation and processing of data in support of user requirements

[ISO 19101]

4.2
application schema
conceptual schema for data required by one or more **applications**

[ISO 19101]

4.3
cost function
function that associates a measure (cost) to a **route**

[ISO 19133:2005]

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 latter criteria can be softened as long as it is not zero or less cost is associated to any loop in the network, as this will prevent the existence of a "minimal cost" route.

4.4
junction
single topological node in a **network** with its associated collection of **turns**, and incoming and outgoing **links**

[ISO 19133:2005]

NOTE Junction is an alias for node.

4.5
link
directed topological connection between two nodes (**junctions**), consisting of an edge and a direction

[ISO 19133:2005]

NOTE Link is an alias for directed edge.

4.6
location
identifiable geographic place

[ISO 19112]

NOTE A location is represented by one of a set of data types that describes 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) [ISO 19133:2005].

4.7
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

[ISO 19133:2005]

4.8
navigation
combination of **routing**, route traversal and **tracking**

[ISO 19133:2005]

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.

4.9
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 to a start (origin, source) **junction** and end (destination, sink) **junction**

[ISO 19133:2005]

NOTE The network is essentially the universe of discourse for the navigation problem. Networks are a variety of one-dimensional topological complexes. In this light, junction and topological nodes are synonyms, as are link and directed edges.

4.10
position
data type that describes a point or geometry potentially occupied by an object or person

[ISO 19133:2005]

NOTE A direct position is a semantic subtype of position. Direct position 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, but not a direct position.

4.11
route
sequence of links, and/or partial links, that describe a path, usually between two positions, within a network

[ISO 19133:2005]

4.12
routing
finding of optimal (minimal **cost function**) **routes** between **locations** in a **network**

[ISO 19133:2005]

4.13
tracking
monitoring and reporting the **location** of a **vehicle**

[ISO 19133:2005]

4.14
transportation mode
means that travellers can choose for transportation

4.15
turn
part of a **route** or **network** consisting of a **junction** location and an entry and exit **link** for that **junction**

[ISO 19133:2005]

4.16
traveller
person subject to being navigated, or tracked

cf. vehicle

[ISO 19133:2005]

4.17
vehicle
object subject to being navigated or tracked

cf. traveller

[ISO 19133:2005]

5 Symbols and abbreviated terms

5.1 Acronyms

BPR	Bureau of Public Roads
GDF	Geographic Data Format
GIS	Geographic Information System
GML	Geographic Markup Language
GPS	Global Positioning System
ITS	Intelligent Transportation System
LBS	Location-Based Service
LBMS	Location-Based Mobile Services
LP	Linear Programming
PCU	Passenger Car-equivalent Unit
UML	Unified Modeling 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”.

As in ISO 19133:2005, the term “context diagram”, as 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 its attributes, operations and association targets. This is the information most useful to the implementer of this central class.

5.3 Package abbreviations

Two-letter abbreviations are used to denote the package that contains a class. Those abbreviations precede class names, connected by a “_”. The International Standard in which those classes are located is indicated in parentheses. A list of those abbreviations follows.

MM	Multimodal Network (ISO 19134)
MN	Multimodal Navigation Service (ISO 19134)
NS	Navigation Service (ISO 19133:2005)
NT	Network (ISO 19133:2005)
TM	Temporal (ISO 19108)

6 Multimodal LBS for routing and navigation

6.1 Semantics

The model for multimodal LBS for routing and navigation consists of the ISO 19133:2005 package and five leaf packages: Multimodal Network, Multimodal Routing, Multimodal Constraint and Advisory, Multimodal Cost Function, and Multimodal Navigation Service. In addition to the appropriate types and classes of ISO 19133:2005, the five leaf packages contain types and classes which are necessary to create a multimodal LBS routing and navigation service. Figure 1 shows the dependencies among those leaf packages, including the ISO 19133:2005 package.

Multimodal location-based service utilizes networks of public transportation modes that operate on fixed and/or flexible schedule routes, using either road networks or guided networks. Preferable travel modes are decided and travel costs are calculated based on user preference and/or on cost functions.

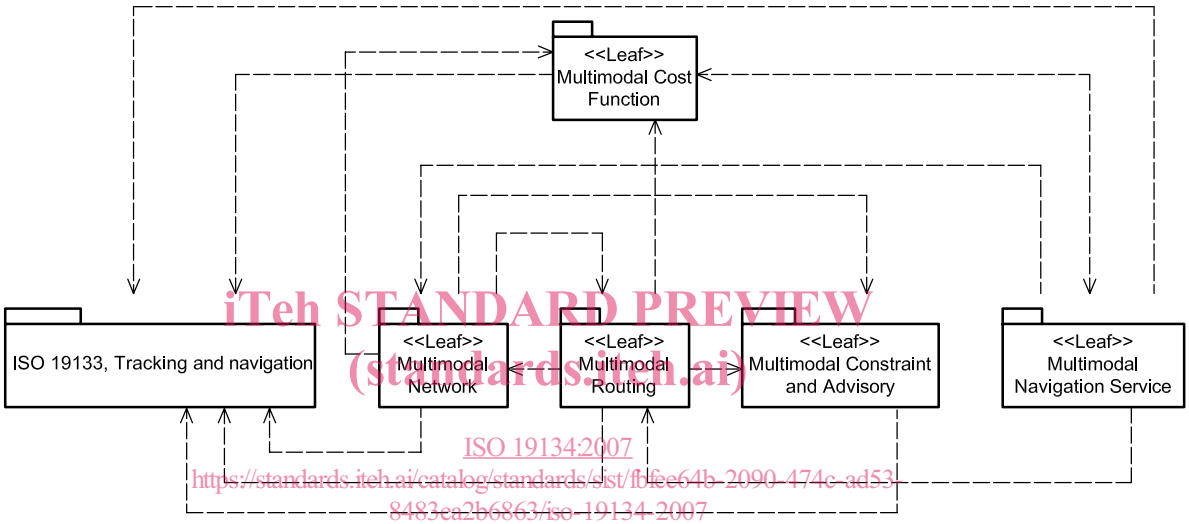

Figure 1 — Package dependencies

6.2 Multimodal Network

6.2.1 Semantics

The multimodal network model in this International Standard extends NT_CombinedNetwork and related classes from ISO 19133:2005, in order to specify multimodal LBS for routing and navigation. Multimodal network consists of component route segments and transfer nodes as shown in Figure 2. Modal transfer occurs only at a transfer node.

EXAMPLE One can transfer at NODE 112 from BUS # 2 to SUBWAY # 5. Transfers from walking or taxi to line-haul modes can be done at other nodes in Figure 2.

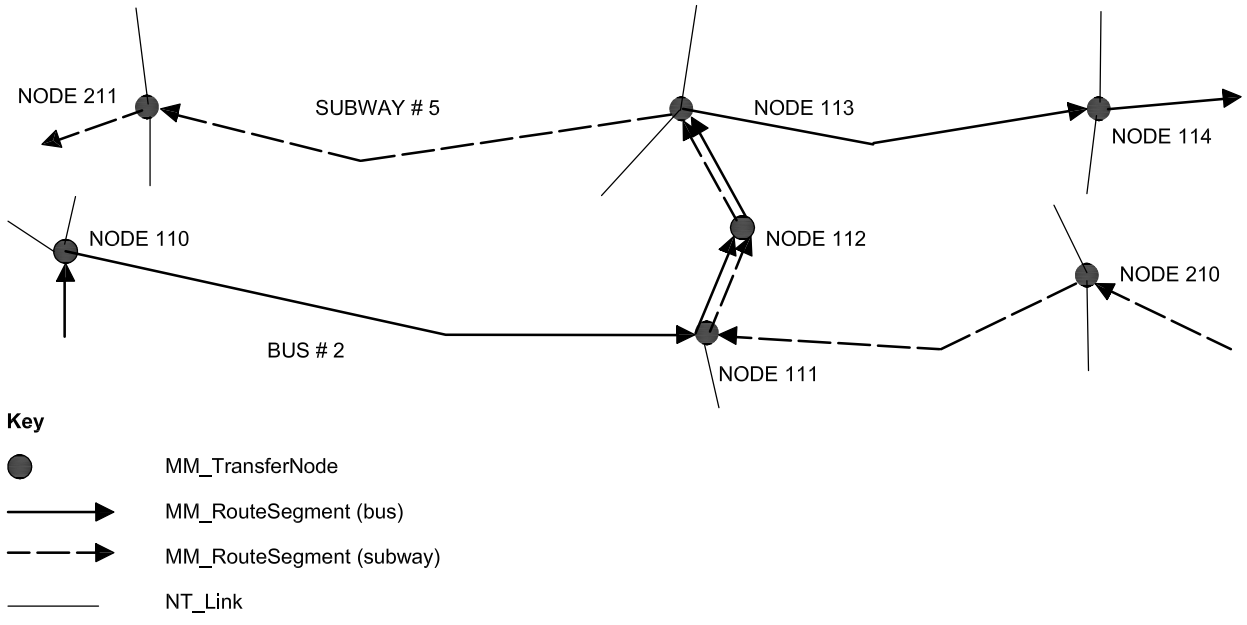

Figure 2 — MM_TransferNode and MM_RouteSegment in the MM_MultimodalNetwork

The route segment, MM_SingleModeLink, is a subtype of NT_Link specified in ISO 19133:2005.

EXAMPLE Figure 3 shows a base network for a multimodal network of which NT_SingleModeLink and its associated NT_SingleModeJunction are composed.

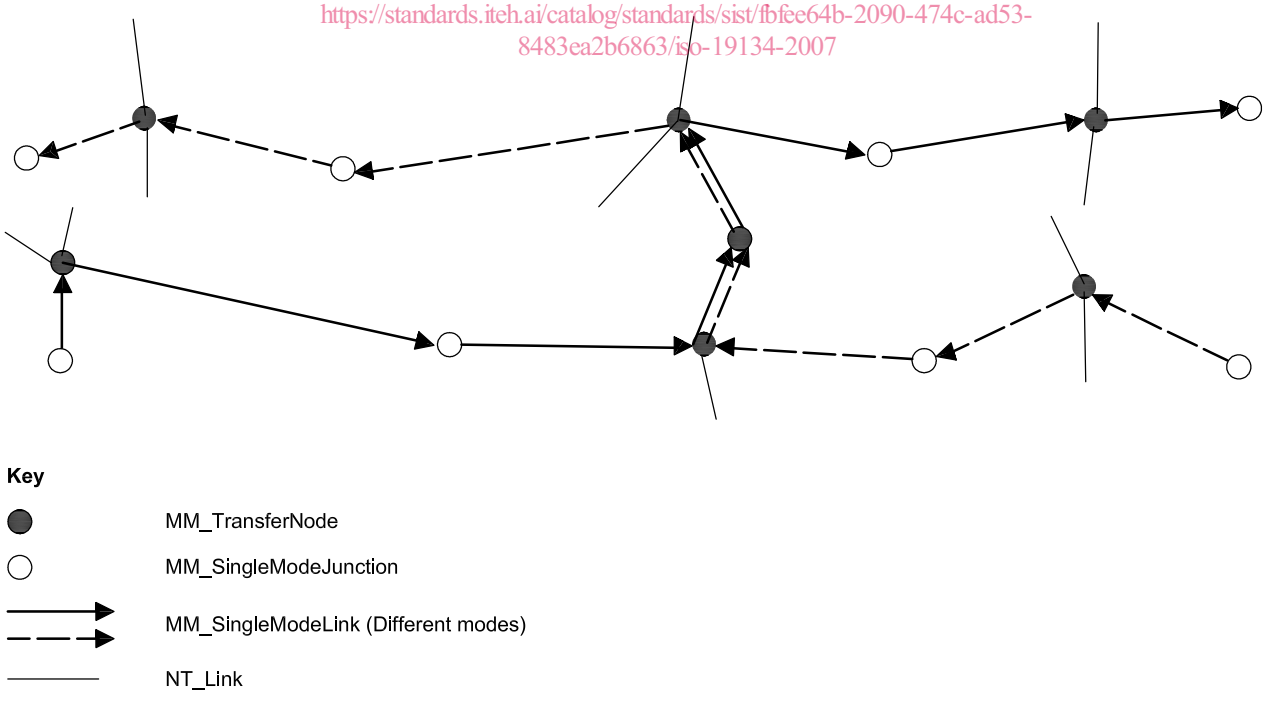

Figure 3 — NT_SingleModeLinks and NT_SingleModeJunctions in the MM_MultimodalNetwork

Figure 4 shows how the principal classes defined in this package are related to classes defined in ISO 19133:2005.

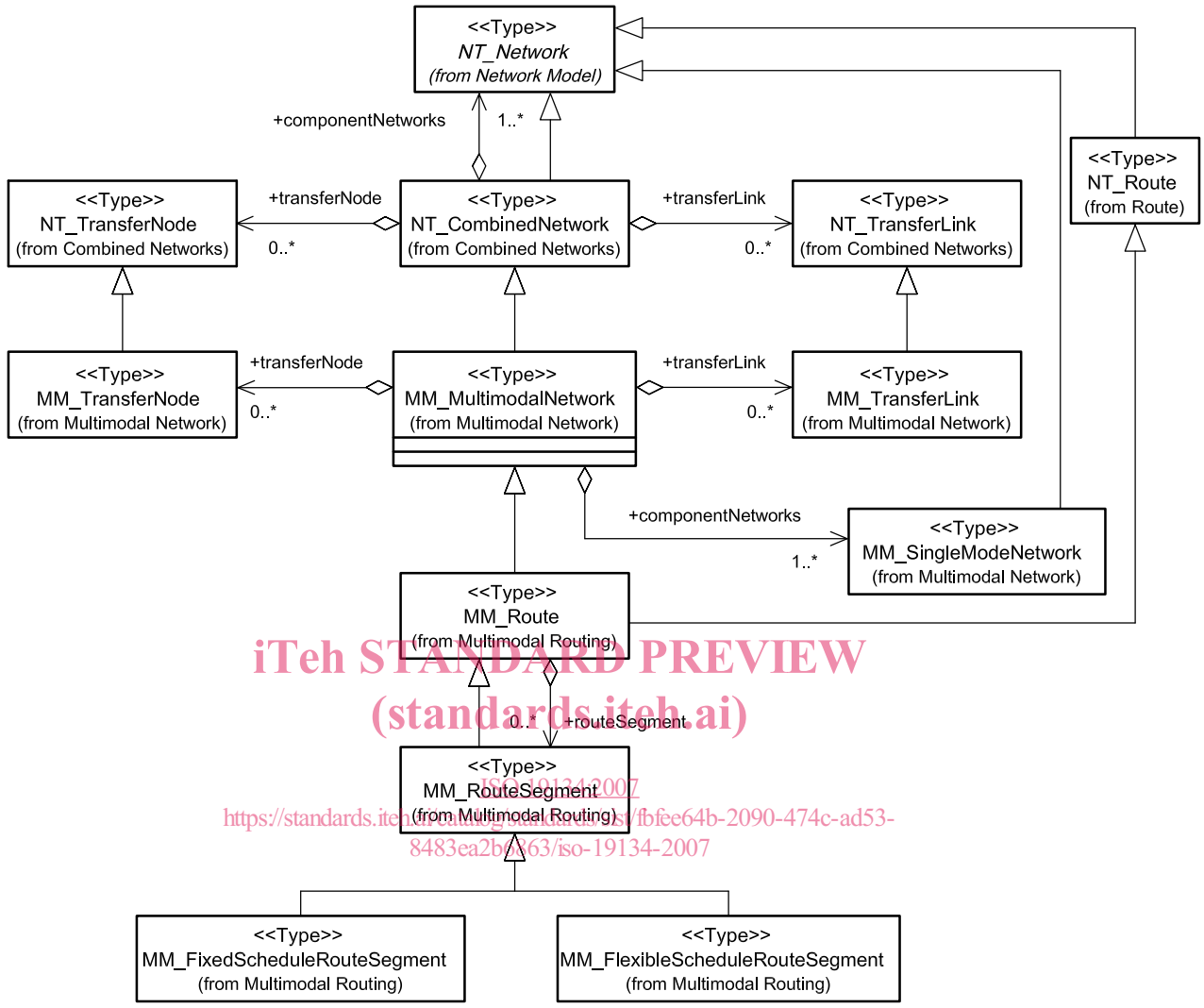

Figure 4 — ISO 19133:2005 and ISO 19134

6.2.2 MM_MultimodalNetwork

6.2.2.1 Semantics

The type MM_MultimodalNetwork is a type which aggregates MM_SingleModeNetworks into NT_CombinedNetwork for multimodal routing and navigation. Using MM_TransferNodes or MM_TransferLinks, a MM_MultimodalNetwork merges a set of single mode networks (MM_SingleModeNetwork) into a larger multimodal network. The UML diagram for MM_MultimodalNetwork is given in Figure 5.

6.2.2.2 Role: componentNetworks : MM_SingleModeNetwork

The association role componentNetworks is the inherited association role from NT_CombinedNetwork in ISO 19133:2005, which specifies the single mode networks from which this multimodal network is created:

```
MM_MultimodalNetwork :: componentNetworks : MM_SingleModeNetwork
```