INTERNATIONAL STANDARD

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Geographic information — Location-based services — Reference model

Information géographique — Services basés sur la localisation — Modèle de référence

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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.

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ISO 19132 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

Introduction

This International Standard establishes a framework supporting the development of location-based services (LBS). LBS are software services whose request and response pattern or values depend upon the location of some number of things, either real or conceptual. For example, tracking and navigation as defined in ISO 19133 are both location-based. Emergency response services are location-based since the requested assistance is invariably for a location fairly near the requestor at the time of the request. Environmental monitoring and remediation is dependent on the location and motion or other continuous change of the polluting agents. Even yellow-page directory services are dependent on the location, or tentative future location, of the requestor in search of a convenient business location for the acquisition of specific goods or services, either near his current location or his planned route.

A reference model is a conceptual framework consisting of a set of system decisions, both architectural and policy, which construct the logical environment for a set of applications and processes within a specific domain. A framework contains or references a taxonomy of terms and an ontology that defines the target domain. A framework can contain or reference other frameworks for related application sets or design paradigms. An LBS framework may relate to a framework of geographic information services, since much of its activity is associated to manipulation of location representations and the use of location as a key to other services. Models for frameworks exist at a variety of levels of abstraction, each of which is a generalization of the more detailed model, and a specialization of the more general ones. At the highest level, the only entities are the frameworks representing their respective reference models. This is illustrated in Figure 1.

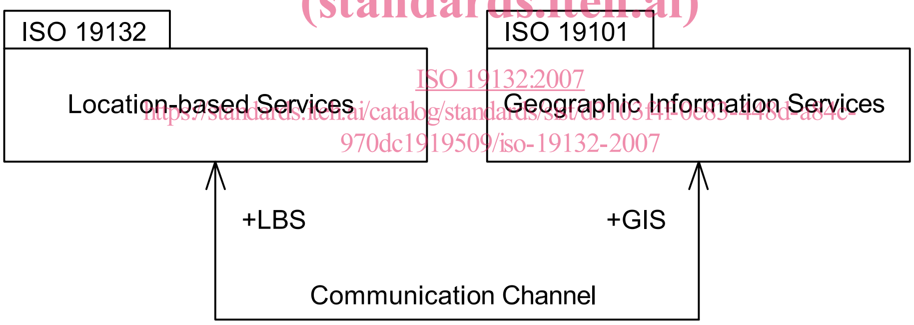

Figure 1 — Relation between LBS and GIS

What this says, in its simplest and most direct terms, is that the two frameworks are coupled and, depending on form more than on functionality, each will invoke services (functions) supplied by the other. This International Standard deals with the communication across the channel depicted in Figure 1. It does so by creating a reference model for the location-based services framework and linking it to the reference model defined in ISO 19101 and ISO/TS 19101-2.

A distinction between an LBS service [1)] and a GIS service [2)] is that LBS will normally have a larger granularity and significant non-spatial information component, and therefore is able to interact with both geographic data

1) The term “LBS” includes the word “service”, and so the phrase “LBS service” is logically redundant. When discussing LBSs in relation to other software components, the phrase “LBS service” can be used to maintain symmetry of expression. While logically inconsistent, this is grammatically and poetically acceptable.

2) It would be useful to redefine GIS as “geographic information service”, but past attempts to override the definition of “geographic information system” with “geographic information science” have not proven very fruitful. In this International Standard, all software components are viewed as services, and so mentions of “GIS” will be taken as “service implementation of GIS functionality”.

frameworks and with general information frameworks containing non-spatial data. Such data may be spatially linked in manners not traditionally used in geographic systems, such as by postal address or telephone number. Another distinction is that LBS services have to deal with the delivery mechanism at a finer level than GIS frameworks. LBS clients are likely to include mobile devices on a multitude of network types, and with a wide variety of capabilities. Thus, an LBS framework supports the same services through a variety of different interface protocols, each tailored for a class of client needs and capabilities. While the details of each client device's interface protocols are beyond the scope of this International Standard, it does address the common semantics of all of the LBS client classes by defining a set of common patterns that provide extensible templates for applications within this domain.

Two of the annexes included in this International Standard are there to highlight the harmonization issue as the LBS domain develops. Organizations that develop standards in LBS need to be aware of other activities. Annex D lists some of the important standards development organizations. Annex E is a crosswalk between common terminology in the geographic information and the intelligent transport system domains. Crosswalks between common terminologies of differing domains are important for semantic interoperability. ITS is used only as an example of one crosswalk.

Geographic information — Location-based services — Reference model

1 Scope

This International Standard defines a reference model and a conceptual framework for location-based services (LBS), and describes the basic principles by which LBS applications may interoperate. This framework references or contains an ontology, a taxonomy, a set of design patterns and a core set of LBS service abstract specifications in UML. This International Standard further specifies the framework's relationship to other frameworks, applications and services for geographic information and to client applications.

This International Standard addresses, for an LBS system, the first three basic viewpoints as defined in the Reference Model for Open Distributed Processing (RM-ODP, see ISO/IEC 10746-1). These viewpoints are the

a) Enterprise Viewpoint – detailing the purpose, scope, and policies of the system,

b) Information Viewpoint – detailing the semantics of information and processing within the system,

c) Computational Viewpoint – detailing the functional decomposition of the system.

The fourth and fifth viewpoints are addressed only in requirements or examples. These are the

d) Engineering Viewpoint – detailing the infrastructure for distribution,

e) Technology Viewpoint – detailing the technology for implementation.

Reference models and frameworks can be defined at a variety of levels, from conceptual design to software documentation. This International Standard

- defines the conceptual framework for, and the type of applications included within, LBS,
- establishes general principles for LBS for both mobile and fixed clients,
- specifies the interface for data access while roaming,
- defines the architectural relationship with other ISO geographic information standards,
- identifies areas in which further standards for LBS are required.

This International Standard does not address the following issues:

- rules by which LBS are developed;
- general principles for roaming agreements for mobile clients and tracking targets.

2 Conformance

Conformance to this International Standard takes on several meanings depending on the type of entity declaring conformance.

— **Semantic conformance** shall imply that the terminology used by the candidate corresponds explicitly to this International Standard where possible.

— **Data conformance** shall imply the usage of data types within application schemas or design specifications that are mappable into types in this International Standard, as in a UML realization of a type by a class.

— **Service conformance** shall imply both the consistent use of message-based request-response interfaces and data conformance for the message packages used by those interfaces.

Conformance may be claimed by a standard, a data structure or schema (such as an encoding definition) or a software module. In all cases, semantics and data conformance are possible. Service conformance is limited to either software or interface specification based on a service-oriented architecture. In service conformance, a data structure may claim this conformance only as part of a larger operational structure (such as the role of XML in SOAP-based SOA applications).

Details for conformance tests are given 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 19107, *Geographic information — Spatial schema*

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

ISO 19110, *Geographic information — Methodology for feature cataloguing*

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

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

ISO 19136, *Geographic information — Geography Markup Language (GML)*

4 Terms and definitions

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

4.1
active object
object which is capable of independent actions, and therefore capable of initiating interactions between itself and other objects without immediate prior external stimulation

cf. **passive object** (4.35)

NOTE An active object can represent a **user** or an active **service** that depends on internal (and therefore not visible) triggers to start actions. **Active** and **passive** states can exist for the same object, and such a service can transition between these two states depending on invocation of an activation or deactivation operation protocol.

4.2
basic service
service providing a basic function to other services or applications in a functional manner

cf. **interoperate** (4.18)

NOTE **Basic services** lack any persistent, user-specific state information between invocations and are not meant for direct access by users. Because they act in a functional manner, they are readily replaceable at runtime by other **services** using the same interfaces.

4.3
candidate route
any route that satisfies all constraints of the routing request, with the possible exception of optimality of the cost function

[ISO 19133]

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

4.4
cluster
collection of **targets** potentially heterogeneous (each satisfying a different query criteria) whose locations fall within a small neighbourhood

4.5
constraint
restriction on how a **link** or **turn** may be traversed by a **vehicle**, such as **vehicle** classification, or a physical or temporal constraint

[ISO 19133]

4.6
continuous change
change in an attribute whose type has a **distance measure** such that its value can be assumed to take on intermediate values between two known measurements

NOTE The interpolation of continuous change is usually done by taking into consideration constraints on the “curve” joining the two data points (time1, value1) and (time2, value2), looking at the value as a function of time. For example, if the continuous change is for the motion of a vehicle, then the constraints of physics and of the paths appropriate for that vehicle must be taken into consideration.

4.7
cost function
function that associates a measure (cost) to a **route**

[ISO 19133]

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

4.8
coupling
linkage of two or more software systems through information transfer or messaging

NOTE 1 Compare with **integration**. While the conceptual schema of the information transferred shall be agreed upon to some level, **coupling** applications can be and are usually flexible in the data representation of that information as long as the semantics content is correct and mappable to some canonical representation of the conceptual schema. The most common mapping technology used for XML messages is XSLT, and the transformation stylesheet can be supplied either by the service broker or by the service provider. It is considered a best practice for a service provider to supply his functionality through several logically equivalent messaging APIs, each represented by a different URI linked to an XSLT transformation bridge, and implemented by the same internal code.

NOTE 2 Loose coupling and tight coupling are not at present well-defined terms in the literature. Generally, “tight” coupling means that there is some sort of incurred dependency between requester and responder in the use of the interface, while “loose” means no such dependency. The nature of that dependency is not consistently defined between authors. In that light, “tight” coupling or “tight” integration are both bad practices, and have been viewed as such since the inception of the terms. Some literature refers to **integration** as “tight coupling”, but that is a less accurate description.

4.9
digital item
structured digital object [asset, work, service, data or information] with a standard representation, identification and metadata framework

[ISO 21000-1]

4.10
discrete change
change in an attribute value such that it can be assumed to have changed without having taken intermediate values between two known measurements

NOTE Legal changes of parcel changes are discrete, having occurred at a specific time.

4.11
discrete spatiotemporal object
temporal sequence of object representations depicting the same spatial feature at different times

NOTE See Theodoridis, 1999 [31].

4.12
distance measure
distance metric
measure of the pairs of values of an attribute type that assigns a numeric value that is positive, symmetric and satisfies the triangular inequality

NOTE A measure “*d*” is positive if $d(x, y) > 0$ for every x, y where $x \neq y$ and $d(x,x) = 0$. A measure “*d*” is symmetric if $d(x, y) = d(y, x)$ for every x, y. A measure “*d*” satisfies the triangular inequality if $d(x, y) \leqslant d(x, a) + d(a, y)$ for every a, x and y. All numeric or vector valued attributes have such a metric, the most common being the Euclidean metric based on the square root of the sum of the squares of the differences in each dimension. Other non-Euclidean metrics take “curvature of space” into account (such as along the surface of the spheroid).

4.13
geocoding
translation of one form of location into another

[ISO 19133]

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.

4.14
identity
data sufficient to identify an object over time, independent of its state

NOTE An **identity** is usually a persistent and constant key member attribute value of the **object**. Since it is temporally constant and unique, it will be the same in any **state** associated to the **object** regardless of its **timestamp**. A moving **object's identity** is independent of both time and **location**.

4.15
instantiate
represent (an abstraction) by the creation of a concrete instance or to create the ability to create an instance

[ISO 19133]

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.

4.16
integration
linkage of two or more software systems by the use of a common data and method base

cf. **coupling** (4.8)

NOTE **Integration** and **coupling** are the two major mechanisms for the interoperation of systems.

4.17
interoperability
capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

[ISO/IEC 2382-1]

4.18
interoperate
communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

cf. **interoperability** (4.17)

4.19
junction
single topological node in a **network** with its associated collection of **turns** and incoming and outgoing **links**

[ISO 19133]

NOTE Junction is an alias for node.

4.20
license
permission or proof of permission granted to a system participant by a competent authority to exercise a **right** which would otherwise be disallowed or unlawful

4.21
linear referencing system
linear positioning system (ISO 19116)
positioning system that measures distance from a reference point along a route (feature)

[ISO 19133]

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. See *NCHRP Synthesis 21*, 1974 [25].