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Geographic information — Positioning services

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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.

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

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 19116:2004), which has been technically revised.

The main changes compared to the previous edition are as follows.

— Device specific definitions have been removed from the model and normative body of the document. These have been clarified and reformatted in Annex D.

— Constructs from withdrawn standards ISO 19113, ISO 19114, and ISO 19115 have been updated where necessary to ISO 19115-1 and ISO 19157. References to these new standards are carried out using approved methods.

— Terminology entries from the first edition were updated and harmonized with other current standards in ISO/TC 211. As per ISO/IEC Directives, Part 2, 2018, unused terms have been removed from this edition.

— Constructs from ISO 19111 have been updated. References to the revised ISO 19111:2019 document are carried out using approved methods.

— A new, convenient yet unobtrusive, set of constructs for determining the reliability of a positioning result have been added to the model, in Clause 8.

— Based on the concepts related to the model, conformance with the other standards, and separation of the technology specific content from the abstract model, all UML models have been updated.

— Original requirements “drafted as normative *shall* statements” were rechecked for consistency with the model. Where necessary the requirements were revised or retained as regular text.

— Significant editorial revisions have been carried out, clarifying the structure of the document, correction of errors, and following current ISO/IEC Directives, Part 2 for drafting specifications.

In accordance with the ISO/IEC Directives, Part 2, 2018, *Rules for the structure and drafting of International Standards*, in International Standards the decimal sign is a comma on the line. However, the General Conference on Weights and Measures (Conférence Générale des Poids et Mesures) at its meeting in 2003 passed unanimously the following resolution:

“The decimal marker shall be either a point on the line or a comma on the line.”

In practice, the choice between these alternatives depends on customary use in the language concerned. In the technical areas of geodesy and geographic information it is customary for the decimal point always to be used, for all languages. That practice is used throughout this document.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Positioning services are among the processing services identified in ISO 19119:2016. Processing services include services that are computationally oriented and operate upon the elements from the model domain, rather than being directly integrated in the model domain itself. This document defines and describes the positioning service.

Positioning services employ a wide variety of technologies that provide position and related information to a similarly wide variety of applications, as depicted in Figure 1. Although these technologies differ in many respects, there are important items of information that are common among them and serve the needs of these application areas, such as the position data, time of observation and its accuracy. Also, there are items of information that apply only to specific technologies and are sometimes required in order to make correct use of the positioning results, such as signal strength, geometry factors, and raw measurements. Therefore, this document includes both general data elements that are applicable to a wide variety of positioning services and technology specific elements that are relevant to particular technologies.

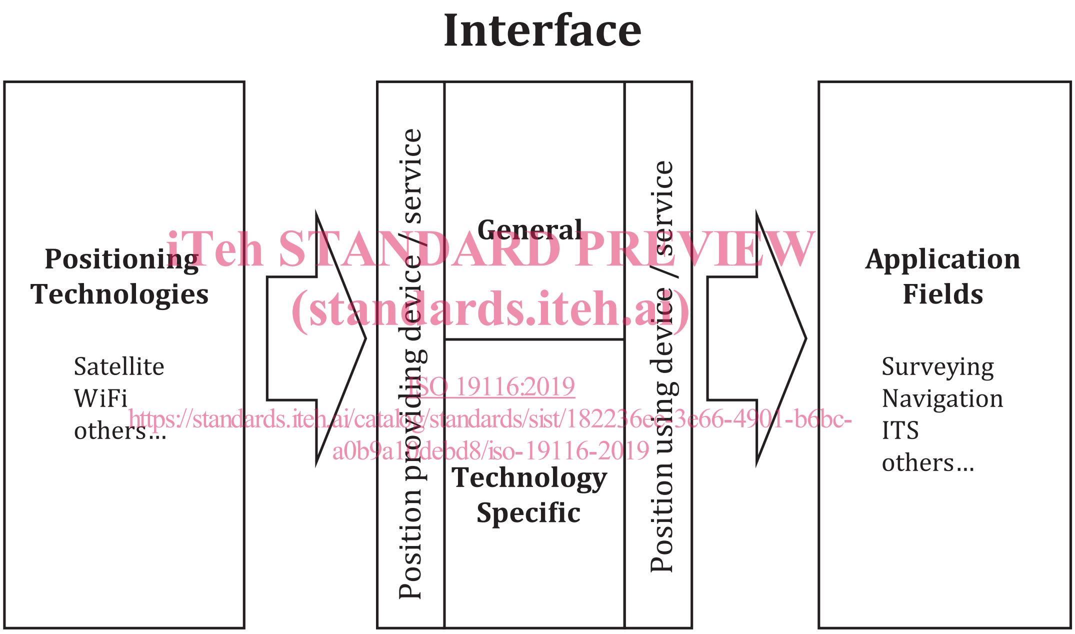

Figure 1 — Positioning services overview

Electronic positioning technology can measure the coordinates of a location on or near the Earth with great speed and accuracy, thereby allowing geographic information systems to be populated with any number of objects. However, the technologies for position determination have neither a common structure for expression of position information, nor common structures for expression of accuracy and reliability. The positioning services interface specified in this document provides data structures and operations that allow spatially oriented systems to employ positioning technologies with greater efficiency and interoperability.

Geographic information — Positioning services

1 Scope

This document specifies the data structure and content of an interface that permits communication between position-providing device(s) and position-using device(s) enabling the position-using device(s) to obtain and unambiguously interpret position information and determine, based on a measure of the degree of reliability, whether the resulting position information meets the requirements of the intended use.

A standardized interface for positioning allows the integration of reliable position information obtained from non-specific positioning technologies and is useful in various location-focused information applications, such as surveying, navigation, intelligent transportation systems (ITS), and location-based services (LBS).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19103, *Geographic information — Conceptual schema language*

ISO 19107, *Geographic information — Spatial schema*

ISO 19111, *Geographic information — Referencing by coordinates*

ISO 19115-1, *Geographic information — Metadata — Part 1: Fundamentals*

ISO 19157, *Geographic information — Data quality*

3 Terms and definitions

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

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

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

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

3.1
absolute accuracy
external accuracy
closeness of reported coordinate values to values accepted as or being true

Note 1 to entry: Where the true coordinate value may not be perfectly known, accuracy is normally tested by comparison to available values that can best be accepted as true.

[SOURCE: ISO/TS 19159-2:2016, 4.1 modified — NOTES 1 and 2 have been deleted and replaced by a new Note 1 to entry.]

3.2
accuracy
closeness of agreement between a test result or measurement result and the true value

Note 1 to entry: For positioning services, the test result is a measured value or set of values.

[SOURCE: ISO 3534-2:2006, 3.3.1, modified — NOTES 1, 2 and 3 have been deleted and replaced by a new Note 1 to entry.]

3.3
attitude
orientation of a body, described by the angles between the axes of that body's coordinate system and the axes of an external coordinate system

Note 1 to entry: In positioning services, this is usually the orientation of the user's platform, such as an aircraft, boat, or automobile.

3.4
coordinate
one of a sequence of numbers designating the position of a point

Note 1 to entry: In a spatial coordinate reference system, the coordinate numbers are qualified by units.

[SOURCE: ISO 19111:2019, 3.1.5]

3.5
coordinate conversion

coordinate operation that changes coordinates in a source coordinate reference system to coordinates in a target coordinate reference system in which both coordinate reference systems are based on the same datum

Note 1 to entry: A coordinate conversion uses parameters which have specified values.

EXAMPLE 1 A mapping of ellipsoidal coordinates to Cartesian coordinates using a map projection.

EXAMPLE 2 Change of units such as from radians to degrees or from feet to metres.

[SOURCE: ISO 19111:2019, 3.1.6]

3.6
coordinate operation
process using a mathematical model, based on a one-to-one relationship, that changes coordinates in a source coordinate reference system to coordinates in a target coordinate reference system, or that changes coordinates at a source coordinate epoch to coordinates at a target coordinate epoch within the same coordinate reference system

[SOURCE: ISO 19111:2019, 3.1.8]

3.7
coordinate reference system
coordinate system that is related to an object by a datum

Note 1 to entry: Geodetic and vertical datums are referred to as reference frames.

Note 2 to entry: For geodetic and vertical reference frames, the object will be the Earth. In planetary applications, geodetic and vertical reference frames may be applied to other celestial bodies.

[SOURCE: ISO 19111:2019, 3.1.9]

3.8
coordinate system
set of mathematical rules for specifying how coordinates are to be assigned to points

[SOURCE: ISO 19111:2019, 3.1.11]

3.9
coordinate transformation
coordinate operation that changes coordinates in a source coordinate reference system to coordinates in a target coordinate reference system in which the source and target coordinate reference systems are based on different datums

Note 1 to entry: A coordinate transformation uses parameters which are derived empirically. Any error in those coordinates will be embedded in the coordinate transformation and when the coordinate transformation is applied the embedded errors are transmitted to output coordinates.

Note 2 to entry: A coordinate transformation is colloquially sometimes referred to as a 'datum transformation'. This is erroneous. A coordinate transformation changes coordinate values. It does not change the definition of the datum. In this document coordinates are referenced to a coordinate reference system. A coordinate transformation operates between two coordinate reference systems, not between two datums.

[SOURCE: ISO 19111:2019, 3.1.12]

3.10
datum
reference frame
parameter or set of parameters that realize the position of the origin, the scale, and the orientation of a coordinate system

[SOURCE: ISO 19111:2019, 3.1.15]

3.11
height
distance of a point from a chosen reference surface positive upward along a line perpendicular to that surface

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

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

[SOURCE: ISO 19111:2019, 3.1.38]

3.12
inertial positioning system
positioning system employing accelerometers, gyroscopes, and computers as integral components to determine coordinates of points or objects relative to an initial known reference point

3.13
instant
0-dimensional geometric primitive representing position in time

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

[SOURCE: ISO 19108:2002, 4.1.17]

3.14
integrated positioning system
positioning system incorporating two or more positioning technologies

Note 1 to entry: The measurements produced by each positioning technology in an integrated system may be of any position, motion, or attitude. There may be redundant measurements. When combined, a unified position, motion, or attitude is determined.

3.15
linear positioning system
positioning system that measures distance from a reference point along a route (feature)

EXAMPLE An odometer used in conjunction with predefined mile or kilometre origin points along a route and provides a linear reference to a position.

3.16
map projection
coordinate conversion from an ellipsoidal coordinate system to a plane

[SOURCE: ISO 19111:2019, 3.1.40]

3.17
measurement precision
precision
closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions

Note 1 to entry: Measurement precision is usually expressed numerically by measures of imprecision, such as standard deviation, variance, or coefficient of variation under the specified conditions of measurement.

Note 2 to entry: The "specified conditions" can be, for example, repeatability conditions of measurement, intermediate precision conditions of measurement, or reproducibility conditions of measurement (see ISO 5725-3).

Note 3 to entry: Measurement precision is used to define measurement repeatability, intermediate measurement precision, and measurement reproducibility.

Note 4 to entry: Sometimes "measurement precision" is erroneously used to mean measurement accuracy.

[SOURCE: ISO/IEC Guide 99:2007, 2.15]

3.18
motion
change in the position of an object over time, represented by change of coordinate values with respect to a particular reference frame

EXAMPLE This may be motion of the position sensor mounted on a vehicle or other platform or motion of an object being tracked by a positioning system.

3.19
operating conditions
parameters influencing the determination of coordinate values by a positioning system

Note 1 to entry: Measurements acquired in the field are affected by many instrumental and environmental factors, including meteorological conditions, computational methods and constraints, imperfect instrument construction, incomplete instrument adjustment or calibration, and, in the case of optical measuring systems, the personal bias of the observer. Solutions for positions may be affected by the geometric relationships of the observed data and/or mathematical model employed in the processing software.

3.20
optical positioning system
positioning system that determines the position of an object by means of the properties of light

EXAMPLE Total Station: Commonly used term for an integrated optical positioning system incorporating an electronic theodolite and an electronic distance-measuring instrument into a single unit with an internal microprocessor for automatic computations.

3.21
performance indicator
internal parameters of positioning systems indicative of the level of performance achieved

Note 1 to entry: Performance indicators can be used as quality-control evidence of the positioning system and/or positioning solution. Internal quality control may include such factors as signal strength of received radio signals [signal-to-noise ratio (SNR)], figures indicating the dilution of precision (DOP) due to geometric constraints in radiolocation systems, and system-specific figure of merit (FOM).

3.22
positional accuracy
closeness of coordinate value to the true or accepted value in a specified reference system

Note 1 to entry: The phrase "absolute accuracy" is sometimes used for this concept to distinguish it from relative positional accuracy. Where the true coordinate value may not be perfectly known, accuracy is normally tested by comparison to available values that can best be accepted as true.

3.23
positional reliability
degree to which a positioning service provides agreed or expected absolute accuracy during a defined instant under specified conditions

Note 1 to entry: The wording of the definition has been adopted from ISO/IEC 16350:2015, 4.29.

3.24
positioning system
system of instrumental and computational components for determining position

EXAMPLE Inertial, integrated, linear, optical and satellite are examples of positioning systems.

3.25
relative position
position of a point with respect to the positions of other points

Note 1 to entry: The spatial relationship of one point relative to another may be one-, two- or three-dimensional.

3.26
relative accuracy
internal accuracy
closeness of the relative positions of features in a data set to their respective relative positions accepted as or being true

Note 1 to entry: Closely related terms, such as local accuracy, are employed in various countries, agencies and application groups. Where such terms are utilized, it is necessary to provide a description of the term.

Note 2 to entry: The wording of the definition is from ISO 19157: 2013, 7.3.4, and was later added as a terminology entry by ISO/TS 19159-2:2016, 4.32.

[SOURCE: ISO/TS 19159-2:2016, 4.23 modified — NOTE 1 has been deleted and replaced by a new Note 1 to entry, a new Note 2 to entry has been added.]

3.27
satellite positioning system
positioning system based upon receipt of signals broadcast from satellites

Note 1 to entry: In this context, satellite positioning implies the use of radio signals transmitted from "active" artificial objects orbiting the Earth and received by "passive" instruments on or near the Earth's surface to determine position, velocity, and/or attitude of an object.

EXAMPLE GPS and GLONASS are types of satellite positioning system platforms.

3.28
uncertainty
parameter, associated with the result of measurement, that characterizes the dispersion of values that could reasonably be attributed to the measurand

Note 1 to entry: When the quality of accuracy or precision of measured values, such as coordinates, is to be characterized quantitatively, the quality parameter is an estimate of the uncertainty of the measurement results. Because accuracy is a qualitative concept, one should not use it quantitatively, that is associate numbers with it; numbers should be associated with measures of uncertainty instead.

3.29
unit of measure
reference quantity chosen from a unit equivalence group

Note 1 to entry: In positioning services, the usual units of measurement are either angular units or linear units. Implementations of positioning services shall clearly distinguish between SI units and non-SI units. When non-SI units are employed, their relation to SI units shall be specified.

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

4.1 Symbols and abbreviated terms

BDS	BeiDou Navigation Satellite System
C/A	Coarse/Acquisition code transmissions of the GPS and GLONASS
CRS	Coordinate Reference System
DOP	Dilution of Precision
DGPS	Differential GPS
FOM	Figure of Merit
Galileo	Galileo GNSS
GDOP	Geometric Dilution of Precision
GIS	Geographic Information System
GLONASS	GLObal NAvigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HDOP	Horizontal Dilution of Precision
L*n*	Signal transmission in a specified portion of the L band of the radio spectrum; suffix “*n*” indicates portion of the band for a defined frequency such as GPS L1 or GLONASS L1
LORAN-C	LOcation and RANging radiolocation system
NAD*yy*	North American Datum; suffix “*yy*” indicates last two digits of year
NAVIC	Indian Regional Navigation Satellite System
NFC	Near Field Communication

NMEA	National Marine Electronics Association
PDOP	Positional Dilution of Precision
PPS	Precise Positioning Service of a Global Navigation Satellite System
QZSS	Quasi-Zenith Satellite System (Japan)
RAIM	Receiver Autonomous Integrity Monitoring
RINEX	Receiver INdependent EXchange Format
RMS	Root Mean Square
RMSE	Root Mean Square Error
RSSI	Received Signal Strength Indicator
SI	Système International d'unités (International System of Units)
SNR	Signal to Noise Ratio
SV	Space Vehicle
TDOP	Time Dilution of Precision
UML	Unified Modeling Language
UTC	Coordinated Universal Time
VDOP	Vertical Dilution of Precision

4.2 Backwards compatibility

Backwards compatibility issues were carefully considered during the revision process. However, due to the age of the document and the significant revisions of related standards, various technical revisions were necessary in carrying out the revision work.

Following ISO/TC 211 guidelines for modular standards development, requirements that were written directly into the clause paragraphs of ISO 19116:2004 were identified and then reformatted into independent requirements text and formatted as such. Later, as the models were updated, these requirements were rechecked for consistency with the model. Where necessary the requirements were revised or retained as regular text.

4.3 UML notation

In this document, conceptual schemas are presented in the Unified Modeling Language (UML). The user shall refer to ISO 19103 for the specific profile of UML used in this document.

4.4 UML packages

UML packages used in this document are shown in Table 1. Like the original version of ISO 19116:2004, this revised version retains the two letter prefixes used to denote the package that contains a class. These prefixes precede class names, connected by a "_". A list of these prefixes is shown in Table 1, together with a reference to the reference standard in which these classes are located.