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Space systems — Requirements for global navigation satellite system (GNSS) positioning augmentation centers

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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).

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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 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

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

In the initial decades of the 21st century, several countries provide their constellations of global navigation satellite system (GNSS) such as U.S. GPS, Russian GLONASS, European Galileo, Chinese BDS, Indian NavIC, Japanese QZSS and SBASs; and they have been utilized as an international public service. GNSS positioning applications have been expanding in each region across the world.

In order to maximize the capability of these GNSS constellations, the respective regions have deployed GNSS positioning augmentation centres with continuously operating reference station (CORS) network. These facilities generate different types of corrections to mitigate atmospheric propagation errors and satellite errors, as well as providing integrity information. The application of these augmentation functions helps to achieve higher performance for GNSS positioning.

Along with the development of the GNSS constellations, GNSS reference stations have been established across populous and economic areas of the world. Industrialized countries have adopted precise positioning thanks to this integrated GNSS infrastructure in global, regional and national areas. Positioning users in other parts of the world require similar GNSS infrastructure.

This document is intended to resolve the issue that the users in other areas of the world need similar infrastructure and aims to provide high-performance GNSS standards for users around the world.

ISO TC 20 has published "ISO TC 20 business plan 2015" (https://www.iso.org/committee/46484. html). In 2.1.2 of the business plan, TC 20 has specified that “Space systems are defined as Space segments, Ground Segments and services (or applications)”; namely, space systems are defined to include the service or application.

In the past ten years, ISO TC 20/SC 14/WG 1 has discussed the standardization of space-based services based on "ISO TC 20 business plan 2015", because space systems provide a huge merit for the economy and society in each country today and space-based services contribute to people’s quality of life across the world. Space systems should be utilized furthermore in the world industry also after this time.

Today, the market has required precise navigation for automated craft and vehicles. One of the most important requirements is the safety of navigation. In response to this requirement, the space systems community is determined to take leadership of the use of space systems such as GNSS, for other downstream areas of application and service. ISO TC 20/SC 14 and its WG1 collaborate and cooperate with TC 20/SC 13, other ISO TCs, IEC TCs and harmonize the standards by international organizations in the GNSS-relevant area shown as Figure 1.

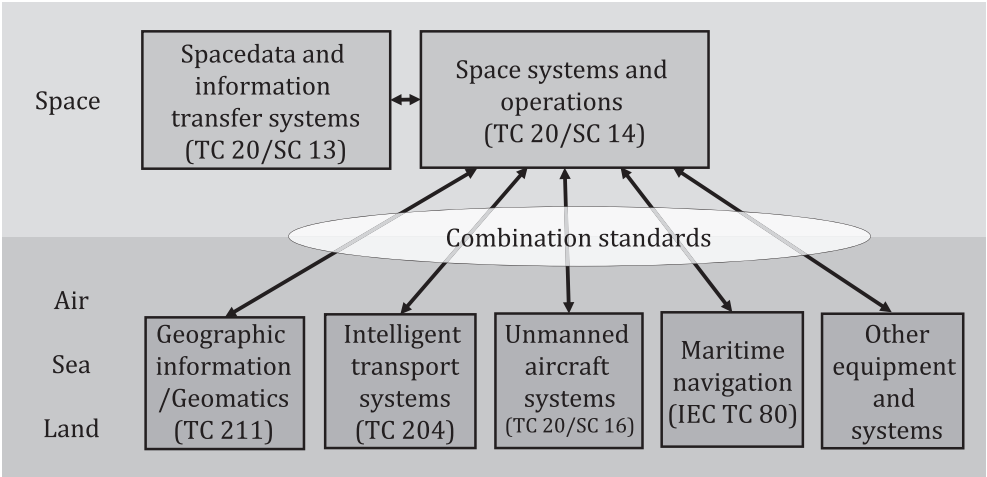

Figure 1 — Standardization of space-based services (GNSS-relevant area)

The GNSS project of ISO has respected the International Committee on Global Navigation Satellite Systems (ICG) and the Global Geospatial Information Management (GGIM) of the United Nations (UN) and its achievements. The UN's recommendations are reflected in this document.

This document is applicable in the civil and commercial market. Because these markets increasingly require high accuracy positioning utilized in automated flight, driving and navigation, it is necessary to standardize GNSS positioning augmentation centres in this document.

ISO TC 20/SC 14 already published ISO 18197, which specified the total matters of system engineering, On the other hand, this document has focused on GNSS positioning augmentation centres as one element of GNSS centimetre class positioning. For the realization of the actual infrastructure, both ISO 18197 and this document should be used.

GNSS applications are emerging industry. Space systems appears to be reaching to incorporated other activities beyond space and aircraft platform for navigation. High performance positioning which is described in this document contributes the safety of navigation after this time.

Space systems — Requirements for global navigation satellite system (GNSS) positioning augmentation centers

1 Scope

This document specifies requirements for GNSS positioning augmentation centres that distribute correction data to provide higher accuracy and integrity information for positioning users in the civil and commercial market.

The GNSS positioning augmentation centres cover the following types of positioning:

a) real-time sub-meter to decimetre-level positioning;

b) real-time centimetre-level positioning;

c) post-processed geodetic positioning.

This document also specifies roles of the following stakeholders and functions of the software present at GNSS positioning augmentation centres:

— role of planner;

— role of designer;

— role of administrator;

— function of software.

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 18197, *Space systems — Space based services requirements for centimetre class positioning*

ISO 19161-1:2020, *Geographic information — Geodetic references — Part 1: International terrestrial reference system (ITRS)*

Annex ICAO, 10 – Aeronautical Telecommunications – Volume I – Radio Navigation Aids.

3 Terms and definitions

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

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

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

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

3.1 Space-based positioning and navigation

3.1.1
radiodetermination
determination of the position, velocity, timing and/or other characteristics of an object, or the obtaining of information relating to these characteristics, by means of radio waves

[SOURCE: IEC 60050-725:1994, 725-12-48, modified — “timing” has been added.]

3.1.2
satellite radiodetermination
radiodetermination (3.1.1) which makes use of a satellite system

[SOURCE: IEC 60050-725:1994, 725-12-49]

3.1.3
radionavigation
radiodetermination (3.1.1) used for the purpose of navigation, including obstruction warning

[SOURCE: IEC 60050-725:1994, 725-12-50]

3.1.4
satellite radionavigation
satellite radiodetermination (3.1.2) used for *radionavigation* (3.1.3)

[SOURCE: IEC 60050-725:1994, 725-12-51]

3.1.5
universe of discourse
view of the real or hypothetical world that includes everything of interest

[SOURCE: ISO 19101-1:2014, 4.1.38]

3.1.6
positioning augmentation centre
centring system that augments the function of another infrastructural positioning system

Note 1 to entry: An administrator of positioning augmentation centre is a person or a organization who operates, maintains, and responds to users on the service of the above centre.

3.2 Positioning quality

3.2.1
accuracy
closeness of agreement between a test result or measurement result and the *true value* (3.2.5)

Note 1 to entry: In practice, the *accepted true value* (3.2.6) is substituted for the true value.

Note 2 to entry: The term “accuracy”, when applied to a set of test or measurement result, involves a combination of random components and a common systematic error or *bias* (3.2.2) component.

Note 3 to entry: Accuracy refers to a combination of bias and *precision* (3.2.3).

[SOURCE: ISO 3534-2:2006, 3.3.1, modified — In Note 1 to entry, "accepted reference value" has been changed to "accepted true value"; in Note 3 to entry, “trueness” has been changed to “bias”.]

3.2.2
bias
difference between the expectation of a test result or measurement result and a *true value* (3.2.5)

Note 1 to entry: Bias is the total systematic error as contrasted to random error. There may be one or more systematic error components contributing to the bias. A larger systematic difference from the true value is reflected by a larger bias value.

Note 2 to entry: The bias of a measuring instrument is normally estimated by averaging the error of indication over an appropriate number of repeated measurements. The error of indication is the: "indication of a measuring instrument minus a true value of the corresponding input quantity".

Note 3 to entry: In practice, the *accepted true value* (3.2.6) is substituted for the true value.

[SOURCE: ISO 3534-2:2006, 3.3.2 modified — In Note 3 to entry, "accepted reference value" has been changed to "accepted true value".]

3.2.3
precision
closeness of agreement between independent test/measurement results obtained under stipulated conditions

Note 1 to entry: Precision depends only on the distribution of random errors and does not relate to the *true value* (3.2.5) or the specified value.

Note 2 to entry: The measure of precision is usually expressed in terms and imprecision and computed as a standard deviation of the test results or measurement results. Less precision is reflected by a larger standard deviation.

Note 3 to entry: Quantitative measures of precision depend critically on the stipulated conditions. Repeatability conditions and reproducibility conditions are particular sets of extreme stipulated conditions.

[SOURCE: ISO 3534-2:2006, 3.3.4]

3.2.4
integrity
measure of the trust that can be placed in the correctness of the information supplied by a navigation system and that includes the ability of the system to provide timely warnings to users when the system should not be used for navigation

[SOURCE: 2019 Federal Radionavigation Plan,[36] DOT-VNTSC-OST-R-15-01, A.1.10]

3.2.5
true value
value which characterizes a quantity or quantitative characteristic perfectly defined in the conditions which exist when that quantity or quantitative characteristic is considered

Note 1 to entry: The true value of a quantity or quantitative characteristic is a theoretical concept and, in general, cannot be known exactly.

[SOURCE: ISO 3534-2:2006, 3.2.5, modified — Note 2 to entry has been deleted.]

3.2.6
accepted true value
value that serves as an agreed-upon reference for comparison

Note 1 to entry: The accepted true value is derived as:

a) a theoretical or established value, based on scientific principles;

b) an assigned or certified value, based on experimental work of some national or international organization;

c) a consensus or certified value, based on collaborative experimental work under the auspices of a scientific or technical group;

d) the expectation, i.e. the mean of a specified set of measurements, when a), b) and c) are not available.

[SOURCE: ISO 3534-2:2006, 3.2.7, modified — The term has been changed from "accepted reference value" to "accepted true value".]

3.2.7
state space
space defined by the state variables as axes of a vector space, in which every vector represents a state of the system

Note 1 to entry: A vector space is defined in IEC 60050-102:2017, 102-03-01.

Note 2 to entry: "space" is this term is a mathematical vector space, and if different from "space" of a physical universe.

[SOURCE: IEC 60050-351:2013, 351-41-09, modified — Notes 1 and 2 to entry have been added.]

3.3 Terrestrial reference system

3.3.1
coordinate
one of a sequence of numbers designating the position of a point

Note 1 to entry: In a spatial *coordinate reference system* (3.3.3), the coordinate numbers are qualified by units.

[SOURCE: ISO 19111:2019, 3.1.5]

3.3.2
coordinate system
set of mathematical rules for specifying how *coordinates* (3.3.1) are to be assigned to points

[SOURCE: ISO 19111:2019, 3.1.11]

3.3.3
coordinate reference system
coordinate system (3.3.2) that is related to an object by a *datum* (3.3.4)

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]

3.3.4
datum
parameter or set of parameters that realize the position of the origin, the scale, and the orientation of a *coordinate system* (3.3.2)

Note 1 to entry: "Reference frame" is an alias of "datum" in the field of geodesy (see SOURCE). But in space systems area, "reference frame" means a platform-fixed coordinate system of a spacecraft or a space station. Therefore, "reference frame" is not used as an alias of "datum" in this document.

[SOURCE: ISO 19111:2019, 3.1.15, modified — The alternative preferred term "reference frame" has bee deleted; note 1 to entry has been added]

3.3.5
coordinate operation
process using a mathematical model, based on a one-to-one relationship, that changes *coordinates* (3.3.1) in a source *coordinate reference system* (3.3.3) 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]