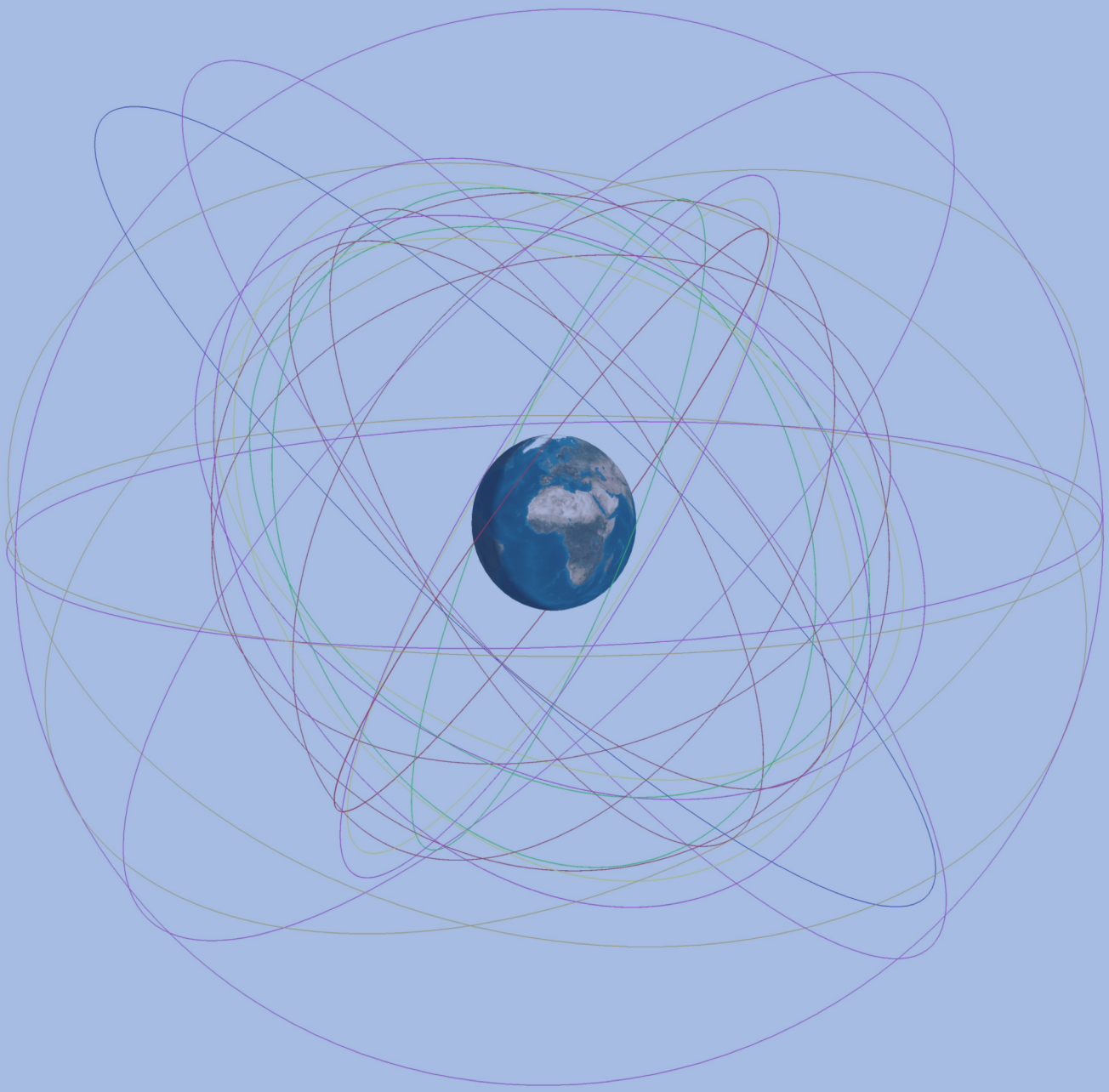
International Committee on
Global Navigation Satellite Systems

Guidelines for Developing Global and Regional Navigation Satellite Systems Performance Standards

(Version 2.0)



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Introduction

This document outlines guidance for creating open service performance standards for Global and Regional Navigation Satellite Systems (GNSS/RNSS). It was developed by the International Committee on GNSS, Working Group S (Systems, Signals, and Services), Subgroup for Interoperability and Service Standards, Performance Standards team. It is intended to be used by ICG member service providers.

GNSS/RNSS Service Providers in the ICG have agreed each to provide a performance standard document describing the level of service of the GNSS/RNSS for its stage of operation. This service applies only to the signal in space and not to actual receiver, atmospheric, or local environmental effects. The Standard will incorporate the parameters identified in this guidance document, although the document format, definitions, and textual content are at the discretion of the service provider.

In this document, the term “performance standard” is used, although other terms are used, such as service standard, open service standard, or service definition document. For the purpose of this document these terms are considered synonymous.

Document Sections

At a minimum, the Performance Standard should contain sections for each of the following:

Purpose. Description of the purpose of the document, describing why it is being produced and what it is intended to provide.

Scope. Description of the scope of the document and what it is intended to cover given the state of the existing GNSS/RNSS service. Examples are range accuracy and availability, positioning and timing accuracy and availability, and continuity.

Service Definition. Definition of the service that is being provided, such as open service or standard positioning service.

GNSS/RNSS System Overview. Description of the GNSS/RNSS system from a high-level view, its components and capabilities.

Service Characteristics and Minimum Usage Assumptions. Description of the characteristics of the signal in space service, including signal interface specification with reference to where this information can be found, performance characteristics (including signal health settings), and user equipment assumptions.

Key Terms and Definitions. Identification and definitions for the key terms and parameters used in the Standard.

References. Detailed references to any of the documents mentioned in the Standard.

Performance Standards & Service Definition.

The Performance Standard should describe the system service levels for the following parameters, grouped by categories. Parameters identified as [Key] are required to be included in the Standard. Those identified as [Optional] are recommendations for consideration, and may or may not be included. For each parameter, the Standard shall provide a definition that is unambiguous and testable.

Satellite domain

Slot Availability (maintenance of satellites to orbital slot parameters) [Key]
Terrestrial Service Volume Coverage [Key]
Space Service Volume Coverage [Optional]

Range domain

Signal in space (SIS) Range Accuracy (all signals) [Key]
SIS Range Accuracy (by Age of Data) [Optional]
SIS Range Integrity [Optional]
SIS Range Rate Accuracy [Optional]
SIS Range Acceleration Accuracy [Optional]
SIS Range Rate Integrity [Optional]
SIS Range Acceleration Integrity [Optional]

Position domain

This section applies if position is provided as a service. This section requires a statement of receiver assumptions, such as elevation mask angle, ability to track all in view, single or dual frequency.

DOP Availability [Key]
Position Accuracy (Global Average & Worst Site)[Optional]
Position Availability [Key]

Time domain

Time transfer accuracy [Optional]
UTC time dissemination accuracy [Key]

Continuity

Signal in Space Continuity [Optional]
Note: Continuity standard could be implemented after sufficient period for data collection following declaration of full operational capability of the system.

Definition of Terms.

Each of the terms used in the Performance Standards Guidelines are defined in this section.

Satellite Domain

Per-slot Terrestrial Service Volume for each Satellite. Comprises the portion of the near-Earth region that extends from the surface of the Earth up to an altitude of X1 km above the surface of the Earth, where the signal is visible from a single satellite's orbital position.

Constellation Terrestrial Service Volume. Comprises the portion of the near-Earth region that extends from the surface of the Earth up to an altitude of X1 km above the surface of the Earth.

Per-slot Space Service Volume for each Satellite. The portion of the near-Earth region that extends from the upper bound of the terrestrial service volume (X1) up to an altitude of X2 km above the surface of the Earth that is visible from a single satellite's orbital position.

Constellation Space Service Volume. Comprises the portion of the near-Earth region that extends from the upper bound of the terrestrial service volume (X1) up to an altitude of X2 km above the surface of the Earth.

Slot Availability. The fraction of time over a specified period that a constellation slot is occupied by a satellite broadcasting healthy SIS defined in corresponding ICD.

Constellation Slot. A defined geometric location in the defined orbit that contains at least one operational satellite. Different constellations may have different definitions for the geometrical spacing of their slots.

Note. Slot Availability could be normalized over the constellation but should not be interpreted as constellation availability.

Constellation Availability. The probability that N slots in the baseline constellation are occupied by a satellite broadcasting a healthy signal in space.

Range domain

Range Accuracy for each satellite over All AOD. The statistical value of the global average SIS User Range Error (URE) over a specified interval for any healthy SIS across all ages of data (AOD).

Range Accuracy for each satellite at Zero AOD. The statistical value of the global average SIS User Range Error (URE) over a specified interval for any healthy SIS at zero

age of data (AOD).

Range Accuracy for each satellite at Any AOD. The statistical value of the global average SIS User Range Error (URE) over a specified interval for any healthy SIS at the worst age of data (AOD).

Global Average SIS URE. The root-mean-square (rms) value of instantaneous SIS URE, across the portion of the globe in view of a single satellite at a particular instant in time.

Note. Global Average SIS URE could be also calculated from the satellite's alongtrack, crosstrack, and radial orbit error components and timing error.

Instantaneous SIS URE. The difference between the measured line-of-sight SIS range and the expected range obtained from the NAV message parameters, excluding the user receiver clock offsets or measurement errors. The instantaneous SIS URE only considers the errors associated with the GNSS space segment and the ground control segment (excluding ionospheric delay errors, tropospheric delay errors, multipath and receiver noise, etc.）

Range Integrity. This includes the probability of a single failure and probability of constellation fault.

Probability of a single failure is defined as a percentage of time over the specified interval when a single healthy satellite's instantaneous SIS URE exceeds the specified not-to-exceed (NTE) tolerance without a timely alert.

Probability of constellation fault is defined as a percentage of time over the specified interval when more than one healthy satellite's instantaneous SIS URE exceeds the specified not-to-exceed (NTE) tolerance without a timely alert.

Range Rate Accuracy for each satellite. The statistical value of the global average of the SIS User Range Rate Error (URRE), which is the first time derivative of SIS URE over a specified interval for any healthy SIS.

Range Acceleration Accuracy for each satellite. The statistical value of the global average of the SIS User Range Acceleration Error (URAE), which is the second time derivative of SIS URE over a specified interval for any healthy SIS.

Position domain

DOP Availability Global. The average DOP Availability over all points of the globe/region.

DOP Availability Worst Site. The lowest DOP Availability over all points of the globe/region.

DOP Availability. The percentage of specified time when the specified DOP is below a threshold, where the DOP is calculated for all healthy SIS above a specified mask angle at a particular point in the globe/region.

Average Location Position Availability. The average position availability over all points of the globe/region.

Worst-case Location Position Availability. The lowest Position Availability over all points of the globe/region_

Position Availability. The percentage of specified time that a predicted position error is below a specified threshold, where the position is calculated for all healthy signals in space (SIS) above a specified mask angle at a particular point of the globe/region.

Note. Predicted position error is usually calculated as daily 95% SIS URE multiplied by instantaneous VDOP/HDOP.

Position Accuracy Global Average. The statistical difference between the calculated user position and a true reference user position over a specified time interval averaged over the globe/region. Position Accuracy considers only signal in space errors and can be represented by the horizontal and the vertical positioning error components.

Position Accuracy Worst Site. The maximum (worst) statistical value of instantaneous differences over the globe/region between the estimated user position and true reference user position over a specified interval of time.

Time domain

Time transfer accuracy. The statistical value of the instantaneous differences between the estimated receiver time scale offset from a reference realization of UTC and the true offset over a specified time interval, averaged over the globe/region and considering both UTC offset error and timing accuracy.

UTC Time Dissemination Accuracy (UTC Offset Error). The statistical value of the instantaneous differences between the broadcast GNSS time scale offset from a reference realization of UTC and the actual value of that offset over a specified interval of time averaged over the globe/region.

Timing accuracy. The statistical value of the instantaneous differences between the time determined by users from received GNSS signals and the actual system time for that GNSS system, averaged over the globe/region.

Note. In this context, the "reference realization of UTC" refers to the actual realization/prediction of UTC that is used by a specific GNSS to steer, in real time, the actual system time (of that GNSS system) to the UTC.

Continuity

The Signal In Space continuity for a healthy SIS. The probability that the SIS will continue to be healthy without unscheduled interruption over a specified time interval. Interruption is defined as loss of availability of healthy SIS, as defined in the corresponding ICD. Interruptions notified in advance through official notifications of

GNSS service providers are scheduled and can be removed from the computation of continuity statistics. Continuity should be specified and assessed over any hour, normalized annually and averaged over all slots in the baseline constellation.