SLOVENSKI STANDARD
SIST EN 16803-1:2020

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Nadomešča:
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Vesolje - Uporaba sistemov globalne satelitske navigacije (GNSS) za ugotavljanje položaja pri inteligentnih transportnih sistemih (ITS) v cestnem prometu - 1. del: Definicije in sistemsko-tehnični postopki za določanje in ocenjevanje zmogljivosti

Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 1: Definitions and system engineering procedures for the establishment and assessment of performances

Raumfahrt - Anwendung von GNSS-basierter Ortung für Intelligente Transportsysteme im Straßenverkehr - Teil 1: Definitionen und Systemtechnikverfahren für die Festlegung und Überprüfung von Leistungsdaten

Espace - Utilisation de la localisation basée sur les GNSS pour les systèmes de transport routiers intelligents - Partie 1 : Définitions et procédure d'ingénierie système pour l'établissement et la vérification des performances

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ICS:

03.220.20	Cestni transport	Road transport
33.060.30	Radiorelejni in fiksni satelitski komunikacijski sistemi	Radio relay and fixed satellite communications systems
35.240.60	Uporabniške rešitve IT v prometu	IT applications in transport

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ICS 33.060.30; 35.240.60

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English version

Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) - Part 1: Definitions and system engineering procedures for the establishment and assessment of performances

Espace - Utilisation du positionnement GNSS pour les systèmes de transport routier intelligents (ITS) - Partie 1 : Définitions et procédures d'ingénierie système pour l'établissement et l'évaluation des performances

Raumfahrt - Anwendung von GNSS-basierter Ortung für Intelligente Transportsysteme (ITS) im Straßenverkehr - Teil 1: Definitionen und Systemtechnikverfahren für die Festlegung und Überprüfung von Leistungsdaten

This European Standard was approved by CEN on 12 July 2020.

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Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 16803-1:2020) has been prepared by Technical Committee CEN-CENELEC/TC 5 "Space", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2021, and conflicting national standards shall be withdrawn at the latest by March 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 16803-1:2016.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This revision of EN 16803-1 includes updates that are necessary to understand correctly the two next EN – Part 2 and Part 3. Some concepts and metrics not identified at the very beginning of EN 16803-1 definitively required to be aligned with last works of CEN/TC 5/WG 1 standardization group. Global architecture has not been modified, i.e. the table of content is unchanged. Among updates, the Introduction describes the LBS and ITS market for which these EN series are targeted. The GNSS Based Positioning Terminal (GBPT) is introduced later in the document, so that the "positioning system" concept can be developed and be included in the new set of ITS applications such as autonomous driving. The clause "Terms and Definitions" includes some new inputs now, like "Record&Replay", or "Reference Material". About metrics, a new one has been introduced: the continuity metric that is slightly different from the availability metric and could help to define how a service should be continuous. Definition of Time To First First (TTFF) is also proposed in this revision. It should help to share a common vision of what should be a hot/warn/cold start by using commonly accepted definitions. The concept of performances classes has also been refined with the new subclause "Introduction to Performance Requirements". Finally, the sensitivity analysis concept has been enlarged or adapted to cover the integrity assessment.

EN 16803, Space — *Use of GNSS-based positioning for road Intelligent Transport Systems (ITS)*, consists of the following parts:

— *Part 1: Definitions and system engineering procedures for the establishment and assessment of performances*;

— *Part 2: Assessment of basic performances of GNSS-based positioning terminals*;

— *Part 3: Assessment of security performances of GNSS-based positioning terminals*.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The civil applications of geopositioning are undergoing exponential development. The latest market analysis for the GNSS systems shows two major fields of application that, all together, practically share the whole of the market:

— intelligent Transport Systems (ITS), mainly in the Road ITS domain;

— location Based Services (LBS), accessible on smartphones and tablets.

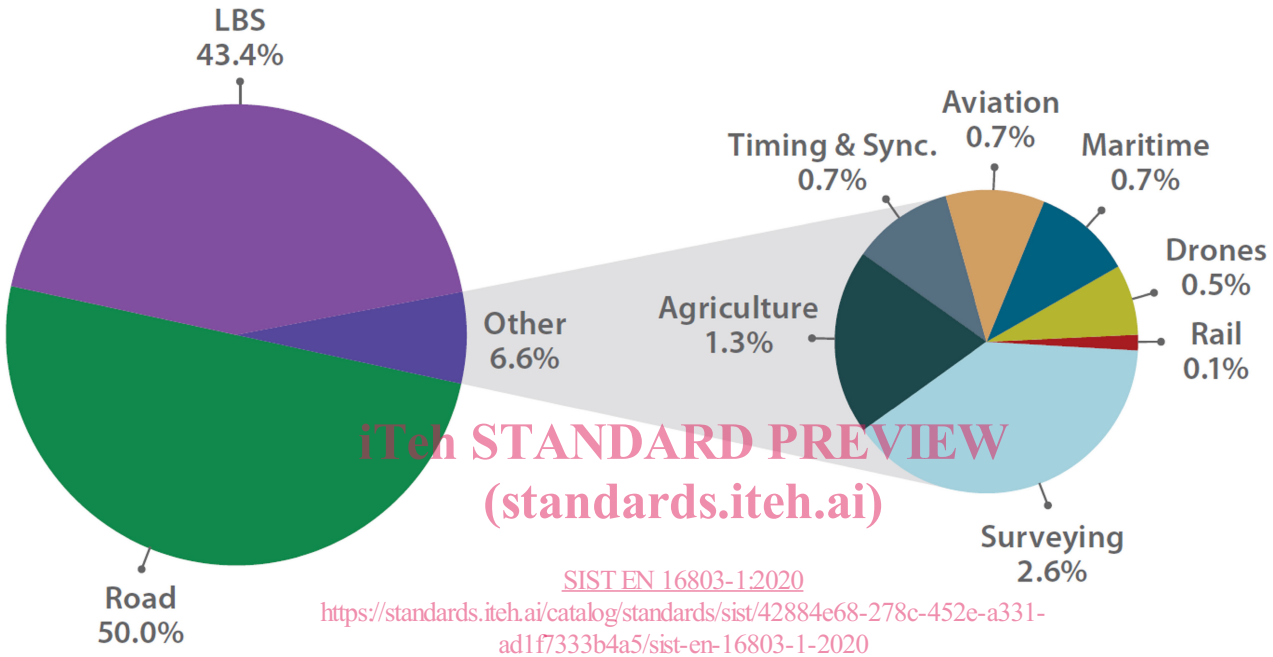

Figure 1 — Cumulative Revenue 2015-2025 by segment (Source: GNSS Market Report, Issue 5, copyright © European GNSS Agency, 2017)

When a *Road ITS system* needs GNSS positioning, which is the case for most of them, there is the question of the choice of the type of terminal or of its minimum performances that are necessary to satisfy the system's final requirements at user level. To meet these requirements, the system includes a processing module called *Road ITS application* which uses the outputs (*PVT* = Position-Velocity-Time) of a *positioning system* to provide the service with a given *End-to-end performance*. Consequently, this latter depends on the quality of the positioning outputs, which are highly variable with respect to the operational conditions of the system, but also on the performance of the *Road ITS application* itself.

Figure 2 represents the breakdown of a *Road ITS system* into its two main components.

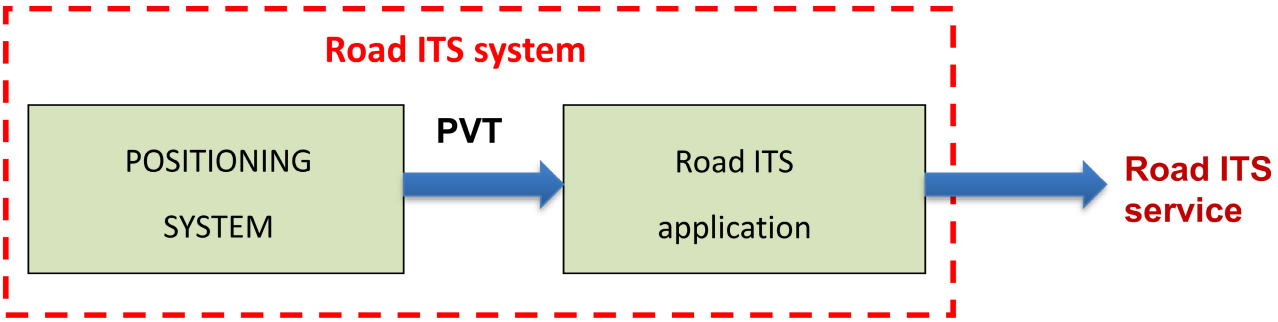

Figure 2 — The two main components of a Road ITS system

The main *Road ITS systems* concerned by this issue are:

— autonomous driving;

— GNSS-based Road User Charging systems (road, parking zone, urban…);

— localized emergency calls (eCall);

— electronic tachograph;

— taximeter;

— regulated freight transport systems (hazardous substances, livestock, etc.);

— "Pay-as-you-drive" insurance;

— road management systems, traffic information systems;

— advanced Driver Assistance Systems (ADAS);

— etc.

Some *Road ITS systems* are considered as "safety critical", because their failure may cause human death or injury and others are "liability critical", because they include financial or regulatory aspects. In some cases, their development is subject to an official certification/homologation process.

Particularly for those systems, there exists a strong need to be able to prove they do meet their *End-to-end performance* requirements related to positioning, but presently there is no standard that supports such certification process.

The performance management approach proposed in this document is based on a classical system engineering approach and is a support for engineers facing the problem of handling the performances of a *Positioning-based road ITS system* all along the system development.

This overall performance management approach can be summarized as follow:

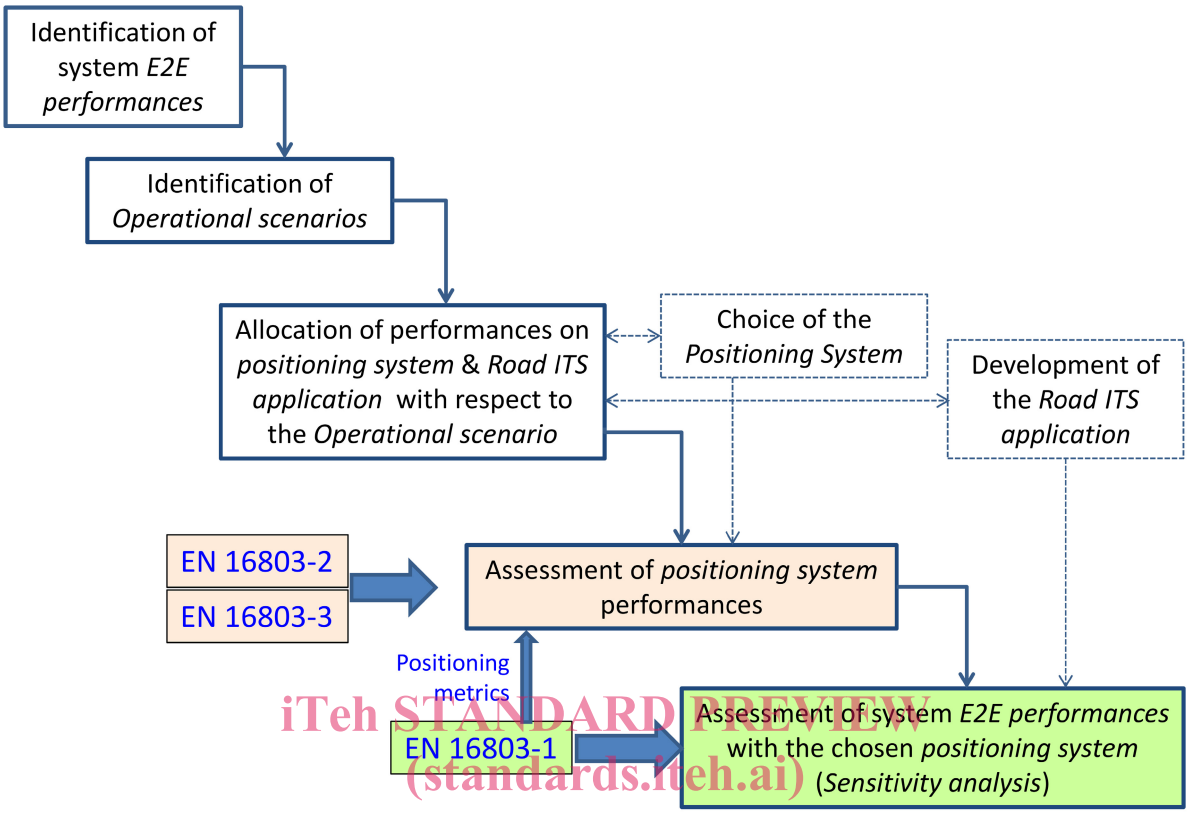

Figure 3 — Logic of the overall performance management approach

The starting point of any performance management of a *Positioning-based road ITS system* **should** be the definition and clear statement of the *E2E performances* which are targeted by the system to design and/or test, as expressed by the customer.

In the context of this document, the system breakdown into components is the one that has been introduced above:

— Positioning System;

— The Road ITS application.

The interface between these two components is assumed to be the *PVT* information, together with some auxiliary information, for instance *Integrity* information if the *Positioning System* is designed to support this kind of feature.

Performance requirements are generally stated as requirements on the outputs of a given system component, assuming that the other components feeding it with input information do respect their own performance requirements.

Hence, the performance allocation of the *E2E performances* between the system components **should** follow the general scheme below.

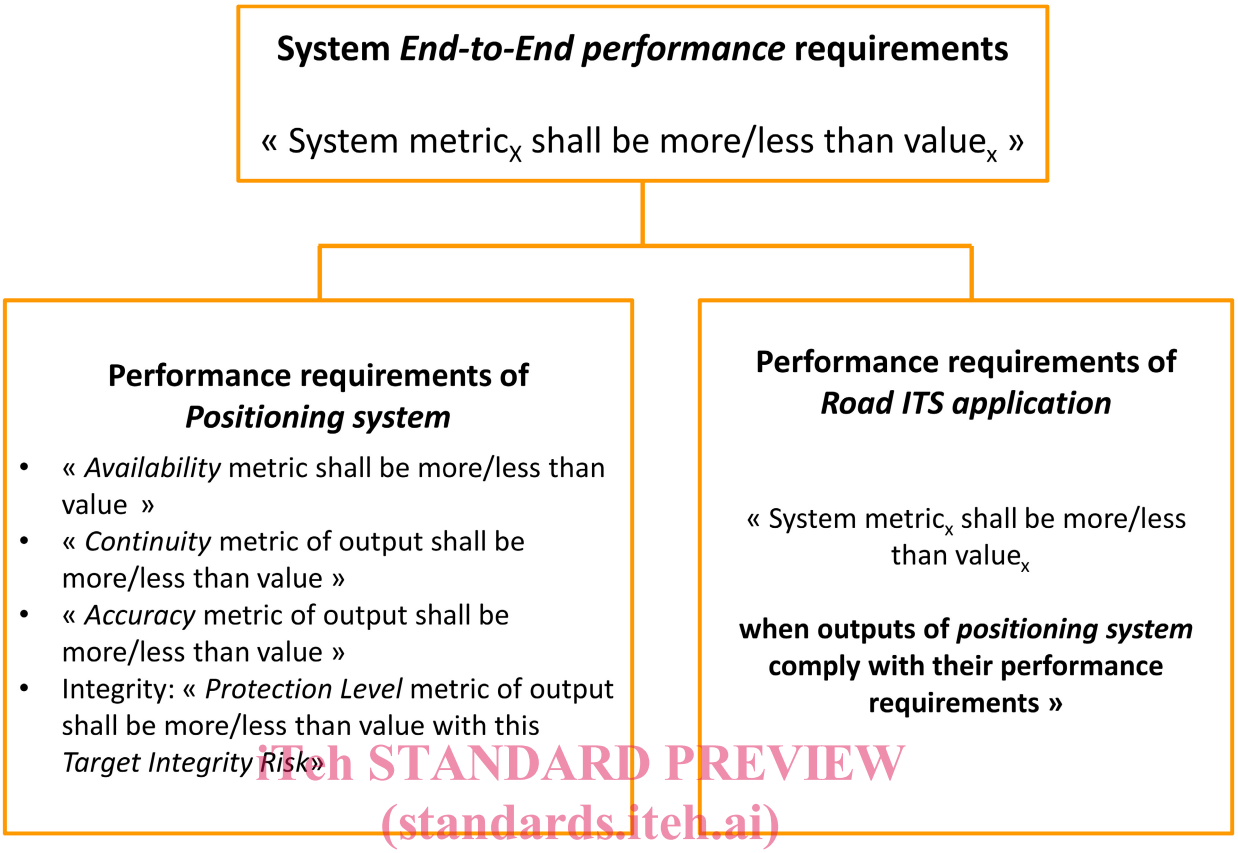

Figure 4 — Generic performance allocation process

The performance requirements of the *Road ITS application* are actually the same ones as the system *E2E performance* requirements but expressed under the condition that the *Positioning System* respects certain performances requirements.

NOTE Depending on the application, performance requirements may need to be put only on the position output or only on the velocity output by the *Positioning System*.

Due to the specificities of GNSS performances, which are due to be defined statistically and which are highly dependent on the operational conditions, margins should be planned in the performance allocations, in order to allow the system to meet its performance requirements, even when, in certain conditions, one of its component does not strictly meet its own requirements. This is the objective of what is called “Sensitivity Analysis”.

1 Scope

EN 16803-1 addresses the final stage of the performance management approach, i.e. the assessment of the whole *Road ITS system* performance equipped with a given *Positioning System*, using the *Sensitivity analysis* method.

EN 16803-1 addresses the identification and the definition the positioning performance features and metrics required for Positioning System assessment.

This document gives definitions of the various items to be considered when specifying an *Operational scenario* and provides a method to compare finely two environments with respect to their effects on GNSS positioning performance.

This document gives definition of the most important terms used all along the document and describes the architecture of a *Road ITS system* based on GNSS as it is intended in this standard.

This document **does not** address:

— the performance metrics to be used to define the *Road ITS system* performance requirements, highly depending on the use case and the will of the owner of the system;

— the performance requirements of the various kinds of *Road ITS systems*;

— the tests that are necessary to assess *Positioning System* performances (Record and Replay tests for this purpose will be addressed by EN 16803-2 and EN 16803-3.

2 Normative references

There are no normative references in this document.

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 http://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

3.1 General terms

3.1.1
digital map
digital description of the road network and of a certain number of attributes assigned to the elements of this network

Note 1 to entry: Takes the form of a geo-referenced database at the data processing level.

3.1.2
epoch
time at which a GNSS measurement is made

3.1.3
GNSS
Global Navigation Satellite Systems
general acronym designating satellite positioning systems

3.1.4
GPS
Global Positioning System
GPS-Navstar American satellite positioning system

3.1.5
ITS
Intelligent Transport Systems
systems applying information, communication and positioning technologies to the transport domain

3.1.6
navigation
action of leading a vehicle or pedestrian to a given destination, by calculating the optimal trajectory and giving guidance with reference to this trajectory and its real time position

3.1.7
navigation message
data transmitted by the GNSS satellites and necessary for the position computation

3.1.8
performance
global characterization of the quality of the service provided by a system

Note 1 to entry: The performance is generally composed of several given performance features of given outputs of the system and measured by using given metrics.

3.1.9
performance class
domain delimited by 2 boundaries for a given performance metric

3.1.10
performance feature
given characteristic used to qualify and quantify the service provided by a system

EXAMPLE *Accuracy* for a *Positioning system*.

3.1.11
performance metric
precise definition of the means of measuring a given performance feature of a given output of a system

EXAMPLE An *Accuracy* metric can be the median value of an error sample acquired during a given test following a given protocol.

3.1.12
positioning
action of determining the position of a mobile object or a person

3.1.13
pseudo-range
measurement, by the GNSS receiver, of the distance between a satellite antenna and the receiver antenna, biased by the error due to the difference between the satellite clock and the receiver clock

Note 1 to entry: Belongs to the category of *Raw measurements*.

3.1.14
RM
reference material
material, sufficiently homogeneous and stable with reference to specified properties, which has been established to be fit for its intended use in measurement or in examination of nominal properties

[SOURCE: International vocabulary of metrology – Basic and general concepts and associated terms (IVM)]

EXAMPLE

- Reference trajectory (or Ground Truth);
- Data set consisting of the selected test scenario.

3.1.15
SBAS
Satellite Based Augmentation System
regional augmentation system of complete satellite systems

EXAMPLE GPS WAAS, EGNOS, QZSS MSAS and GLONASS SDCM are examples for regional augmentation systems.

3.1.16
trajectory

series of time-stamped positions (and possibly speeds) of a mobile object

3.1.17
Timestamp Resolution

size of the smallest time lapse which would result in different consecutive timestamps

Note 1 to entry: It can be understood as the value of the least significant bit within the word used to encode the timestamp.

3.2 Specific terms

3.2.1
application quantity
quantity produced by the *Road ITS application*, from which an *End-to-end performance* can be calculated

Note 1 to entry: This quantity is normally deducted from a set of positions (and/or speeds) produced by the *Positioning system*.

EXAMPLE The time of presence of a vehicle inside a given zone is an *Application quantity* for a *Geofencing* application.

3.2.2
assisted GNSS
technique consisting in assisting the positioning calculation performed by the GNSS terminal by providing it, via a telecommunication system, with partial or full navigation data as borne by the GNSS signal transmitted by the satellites

Note 1 to entry: This technique reduces the *Time To First Fix*, and lowers the acquisition sensitivity threshold.

3.2.3
benchmark GNSS receiver
off-the-shelf, low-cost and high sensitivity GNSS receiver capable of providing pseudo-range measurements

Note 1 to entry: This kind of receiver is proposed in this document as a benchmark sensor of the environmental constraints that affect the GNSS signals propagation for fine comparison of environments between themselves.

3.2.4
E2E performance - end-to-end performance
performance of the service provided by a *Road ITS system*

Note 1 to entry: *E2E performance* is measured by applying a performance metric to an *Application quantity*.

EXAMPLE For a Taximeter, the accuracy of the travelled distance is an *E2E performance*.

3.2.5
geofencing
function consisting in determining the presence of certain persons or of certain moving objects within a certain geographical zone

Note 1 to entry: This zone can be defined in several ways.

3.2.6
geo-object
geographic entity, having the form of a virtual polygon, framing a point of interest or delimiting a zone of interest

3.2.7
integrity
general performance feature referring to the trust a user can have in the delivered value of a given *Position* or *Velocity* component

Note 1 to entry: This feature is expressed by 2 quantities: the *Protection level* and the associated *Integrity risk*.

Note 2 to entry: In this document, the definition of integrity is inspired by, but significantly simpler than, the definition of the same concept for the civil aviation community.

Note 3 to entry: For other domains than GNSS positioning, *Integrity* may have other definitions.

3.2.8
integrity risk
IR
probability that, for *Positioning terminals* providing a *Protection level* as integrity-related quantity, the actual error on a given output component exceeds its associated *Protection level*

3.2.9
misleading information rate
MIR
observed rate, for *Positioning terminals* providing a *Protection level* as integrity-related quantity, at which the actual error on a given output component exceeds its associated *Protection level*

Note 1 to entry: The MIR differs from the IR in that the MIR is a purely empirical quantity (e.g. based on observations obtained through field testis) whereas the IR determination comprises also a complete and rational analysis of the system design, its potential weaknesses, threats, etc. (RAMS analysis). The MIR is an empirical first approximation of the IR, and usually an optimistic one.

3.2.10
map-matching
processing operation consisting in determining the position of the mobile on a map representing the road network

Note 1 to entry: Requires a digital map.

3.2.11
operational scenario
description of the conditions in which the *GNSS-based road ITS system* is operating and particularly affecting the *GNSS-based positioning terminal*

3.2.12
position
location of the positioning terminal or, more specifically, of some reference point attached to it, such as the antenna phase centre

3.2.13
positioning system
set of hardware and software components, which can be in different locations, but interconnected, which contribute to estimating the position, velocity and associated timestamp of a mobile object

3.2.14
positioning terminal
equipment (unit) carried by a vehicle or a person delivering a position solution to a *Road ITS application*

Note 1 to entry: The *Positioning terminal* is the component of the *Positioning system* which is directly interfaced with the position data user (in this document the *Road ITS application*).

Note 2 to entry: The *Positioning terminal* uses a GNSS receiver which may be hybridized or assisted.

3.2.15
positioning module
software component of the *Positioning terminal* processing the *PVT* from the data of different sensors

3.2.16
positioning-based road ITS system
system consisting of one or several *Positioning terminals* and of a *Road ITS application* providing a *Positioning-based Road ITS service*

3.2.17
positioning-based road ITS service
main function(s) of a *Positioning-based Road ITS system*, making use of the *Application quantities*

EXAMPLE Computation and secure storage of charge events for a road charging system.

3.2.18
protection level
estimation of an upper bound for the error made on a *Position* or *Velocity* component (e.g. the plane position) associated with a given probability called *Integrity risk*

Note 1 to entry: Like the actual error, this quantity can be characterized by its distribution function.

3.2.19
PVT error model
parametric mathematical model representing the errors affecting a *PVT* component, composed with noise and biases observed on this component, output by a *Positioning terminal* operating in a certain environment

Note 1 to entry: The *PVT error model* is used to draw pseudo-random trajectories representative of real trajectories.

3.2.20
Position, Velocity and Time
PVT
data related with the position, the velocity and the time which is available at the output of a GNSS receiver or of a *Positioning terminal* in general

3.2.21
Record and Replay
R&R
test techniques consisting to digitize GNSS signals and sensor measurements in the real world campaigns so that they can be repeated later on suitable laboratory test benches

3.2.22
raw measurements
quantities available in a GNSS receiver after the signal processing stage from which the *PVT* will be calculated

Note 1 to entry: The *Pseudo-ranges* for each tracked satellite are essential components of the *Raw measurements*.

3.2.23
reference trajectory
series of time-stamped positions of a reference point on a mobile object (test vehicle), produced by a *Reference trajectory measurement system*

Note 1 to entry: This reference trajectory may be called “Ground truth” in some other documents.

3.2.24
RTMeS
reference trajectory measurement system
measurement means capable of accuracy performances better of at least one order of magnitude than those of the required performance of the *Positioning terminal* being tested