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Intelligent transport systems (ITS) — Network-based precise positioning infrastructure for land transportation —

Part 2: Functional requirements and data sets for nomadic devices

Systèmes de transport intelligents — Infrastructure de positionnement précis en réseau pour les transports terrestres — Partie 2: Exigences fonctionnelles et ensembles de données pour les dispositifs nomades

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

A list of all parts in the ISO 22086 series can be found on the ISO website.

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

Lane-level positioning is deemed as a critical function to facilitate emerging applications of intelligent transport systems (ITS) for safety and traffic efficiency. Another critical issue for applications with safety concerns is to guarantee or monitor integrity of the positioning result. Global navigation satellite systems (GNSS) have led the provision of position along with velocity and time information in the ITS domain, but lane-level accuracy cannot be achieved and integrity monitoring functionalities are not supported with commercial low-cost GNSS receivers operating in standalone mode.

The ISO 22086 series deals with standard issues on a nomadic device for lane-level positioning and integrity monitoring with a GNSS-based lane-level positioning system, referred to as network-based precise positioning infrastructure for land transportation (NETPPI-LT). NETPPLI-LT provides additional information to enhance positioning accuracy and to monitor integrity over wireless links.

Intelligent transport systems (ITS) — Network-based precise positioning infrastructure for land transportation —

Part 2:
Functional requirements and data sets for nomadic devices

1 Scope

This document specifies the functional requirements of nomadic devices for lane-level positioning and integrity monitoring with the network-based precise positioning infrastructure for land transportation (NETPPI-LT), a lane-level positioning system based on global navigation satellite systems (GNSS) described in ISO/TR 22086-1. This document identifies the GNNS threats to monitor and the errors to remove or mitigate to achieve lane-level accuracy and integrity. It also specifies the data sets to be contained in messages between the nomadic device and the control station providing GNSS correction and integrity information. This specification enables the nomadic device to support lane-level positioning and integrity monitoring. Enabling techniques and methods, which can be different for each provider or vendor, are not addressed in this document.

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/TR 22086-1, *Intelligent transport systems (ITS) — Network based precise positioning infrastructure for land transportation — Part 1: General information and use case definitions*

ETSI EN 302 890-2:2020, *Intelligent transport systems (ITS); Facilities layer function; Part 2: Position and time management (PoTi); Release 2*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 22086-1 and the following 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
alert limit
error tolerance not to be exceeded without issuing an alert

3.2
augmentation information
correction and *integrity information* (3.7) for global navigation satellite systems (GNSS) measurements

3.3
auxiliary reference station
reference station within a set of the reference networks, which captures global navigation satellite systems (GNSS) *raw measurements* (3.14) at a known position and sends them to the control stations of the network-based precise positioning infrastructure for land transportation (NETPPI-LT) to produce correction differences of the *range measurements* (3.12) relative to the ones of the *master reference station* (3.8)

3.4
carrier-phase measurement
measure of range between a navigation satellite and a nomadic device or a global navigation satellite systems (GNSS) receiver embedded within the nomadic device, based on the phase measurements of the carrier frequency

Note 1 to entry: Carrier-phase measurement is expressed in metres.

3.5
pseudorange (code) measurement
measure of range between a navigation satellite and a nomadic device or a global navigation satellite systems (GNSS) receiver embedded within the nomadic device, based on the phase delay of the pseudorandom noise code

Note 1 to entry: Pseudorange measurement is expressed in metres.

3.6
correction information
information including *raw measurements* (3.14) of a master or virtual reference station and correction differences for pairs of reference stations to remove common errors in global navigation satellite systems (GNSS) *range measurement* (3.12) of a nomadic device

3.7
integrity information
information used to determine either the occurrence of failures or uncertainties (e.g. one-sigma) in the position domain

3.8
master reference station
reference station within a set of the reference networks, for which *raw measurements* (3.14) and coordinate information are transmitted to a nomadic device via the control stations of the NETPPI-LT

3.9
navigation message
message containing ephemeris data, used to calculate the position of each global navigation satellite systems (GNSS) satellite in orbit, and information on time and status of entire satellites in the constellation

3.10
network RTK
network real-time kinematic
RTK (3.13) technique based on multiple reference stations to support an extended service coverage by provisioning correction differences of the *range measurements* (3.12) for pairs of master and *auxiliary reference stations* (3.3) in addition to *raw measurements* (3.14) of the *master reference station* (3.8)

3.11
protection level
upper bound for the positioning error, which is an instantaneous estimate based on different measurements related to the quality of the received signal, *range measurements* (3.12), and *navigation message* (3.9)

3.12
range measurement
pseudorange and *carrier-phase measurements* (3.4) between a navigation satellite and a nomadic device or a global navigation satellite systems (GNSS) receiver embedded within the nomadic device

3.13
real-time kinematic
RTK
differential global navigation satellite systems (GNSS) technique that provides, in real time, highly accurate positioning for a nomadic device based on *carrier-phase measurements* (3.4), which are corrected by referring *raw measurements* (3.14) of a single reference station

3.14
raw measurement
measurement available in a global navigation satellite systems (GNSS) receiver after the signal processing stage before the positioning stage including *code measurements* (3.5), *carrier-phase measurements* (3.4), *navigation messages* (3.9), and signal quality indicators

4 Abbreviated terms

5G	fifth-generation mobile communications
CCD	code carrier divergence
CS	control station
DMB	digital multimedia broadcasting
DSRC	dedicated short-range communications
FDI	fault detection and isolation
GNSS	global navigation satellite systems
ITS	intelligent transportation system
LTE	long term evolution
MQM	measurement quality monitoring
ND	nomadic device
NRTK	network real-time kinematic
NETPPI-LT	network based precise positioning infrastructure for land transportation
OSR	observation space representation
PL	protection level
PoTi	position and time management
PPP	precise point positioning
PPP-RTK	precise point positioning-real time kinematic
PRN	pseudorandom noise
RF	radio frequency
RTCM	radio technical commission for maritime services
RTK	real-time kinematic
SSR	state space representation

WAVE wireless access for vehicular environment

YE-TE yesterday-minus-today ephemeris

5 Functional requirements

5.1 Overview

This document conforms to the GNSS-based positioning terminal model specified in EN 16803-1 for the reference model of nomadic devices in which the output to safety-related applications includes the positioning result and the protection level. Such output is used for providing warnings to the users or the systems and services based on GNSS when exceeding a given alert limit, i.e. the largest positioning error acceptable for the operation.

The nomadic device shall support the PoTi (position and time management) service at the facilities layer specified in accordance with ETSI EN 302 890-2. The functions described in this document are implemented as part of the position augmentation, which is a function of the PoTi entity.

The nomadic device performs a series of functions to ensure lane-level accuracy and integrity with the NETPPI-LT. Its functional architecture is illustrated in Figure 1. The nomadic device can include multiple positioning modules in addition to GNSS and can integrate all the data from the modules for positioning as specified in EN 16803-1. As those methods are beyond the scope of this document, relevant architectures are not depicted in Figure 1.