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

Part 1: General information and use case definitions

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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

This document provides the framework guidelines to identify lane-level positioning technologies with the land transportation service requirements and related standards required to deploy, manage, and operate network-based precise positioning infrastructure for land transportation. The purpose of the system is to generate and transmit the GNSS correction and integrity information to land transportation users including drivers, pedestrians, riders, etc. in order to enable them to perform lane-level positioning with low-cost GNSS receivers on nomadic devices at a high confidence level. The system design following the requirements of ITS and automotive services that are closely related to traffic safety and traffic efficiency is defined.

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

Part 1: General information and use case definitions

1 Scope

This document provides the framework guidelines on technologies related to the network-based precise positioning infrastructure for land transportation (NETPPI-LT) that allows land transportation users or objects carrying nomadic devices, equipped with low-cost global navigation satellite systems (GNSS) receivers and wireless communication transceivers, to perform lane-level positioning and integrity monitoring. These technologies will unlock enhanced intelligent transport systems (ITS) services and applications and will increase traffic operation/management efficiencies and traffic safety by reducing economic and social costs from traffic jams, traffic accidents, and environmental pollution.

The framework described in this document includes:

— reference architecture for the NETPPI-LT enabling lane-level positioning and integrity monitoring on personal ITS devices;

— guidelines for providing a real-time lane-level positioning service based on GNSS with the aid of the NETPPI-LT;

— guidelines to facilitate the practical implementation of the NETPPI-LT for engineers including related use cases.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 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/

3.1.1
reference station
implementation of a NETPPI-LT subsystem which captures signals/data from visible GNSS satellites and monitoring information (pressure, temperature, humidity, image, etc.) at a known position with clear sky view and no radio interferences, and includes wired or wireless links to send the collected data to the control station

3.1.2
control station
implementation of a NETPPI-LT subsystem which generates the GNSS carrier phase measurement correction and integrity information based on the information received from multiple reference stations, and sends the correction and integrity information to wireless communication/broadcast systems (cellular networks, WAVE, DMB, etc.) for data transmission to drivers or pedestrians with nomadic devices

3.1.3
monitoring station
implementation of a NETPPI-LT subsystem which tests validity of the information, originated by the control station, and gives feedback to the control station for the system management

3.1.4
base station
implementation of a NETPPI-LT subsystem which is a part of wireless communication/broadcast systems and provides the correction and integrity information, originated by the control station, to drivers or pedestrians carrying nomadic devices

3.1.5
nomadic device
implementation of any type of nomadic device which captures carrier phase measurements for ranging to visible GNSS satellites, receives the correction and integrity information, originated by the control station, via wireless links including cellular networks (LTE families, 5G), WAVE, DSRC, DAB, DMB, etc., and determines its own position along with integrity by using the received data

3.2 Abbreviated terms

5G	fifth-generation mobile communications
C-ITS-S	central intelligent transportation system station
DAB	digital audio broadcasting
DMB	digital multimedia broadcasting
DSRC	dedicated short-range communications
GNSS	global navigation satellite systems
IMU	inertial measurement unit
ITS	intelligent transportation system
LTE	long term evolution
NETPPI-LT	network based precise positioning infrastructure for land transportation
R-ITS-S	roadside intelligent transportation system station
RTCA	Radio Technical Commission for Aeronautics
RTCM	Radio Technical Commission for Maritime Services
WAVE	wireless access for vehicular environment

V2I vehicle-to-infrastructure

V2V vehicle-to-vehicle

V2X vehicle-to-everything

4 Document overview and structure

This document provides all documents and references required to support the implementation of the requirements related to GNSS-based positioning with lane-level accuracy on nomadic devices. This series of standards consists of the following parts.

— Part 1: General information and use case definitions

This part provides an overview of the document set and structure along with the use case definitions and common set of resources (definitions, references), which are used for all subsequent parts.

— Part 2[1)]: Functional requirements and data interface

This part provides functional requirements of nomadic devices for the NETPPI-LT services and data interface between the infrastructure side and nomadic device.

5 General information

5.1 Purpose of this document

This document addresses three major areas:

— Identify the requirements of application level framework for the NETPPI-LT (lane-level positioning and integrity monitoring) services that can be frequently inserted, modified, and deleted;

— Identify the general information for all subjects related to the NETPPI-LT services from the perspectives of infrastructure and personal station (nomadic device);

— Specify the general use cases that should be included for the NETPPI-LT services.

5.2 Overview of NETPPI-LT

Existing ITS services and applications require road-level (meter) positioning accuracy, and commercial nomadic devices or ITS stations meet this requirement with low-cost standalone GNSS receivers that exploit code phase measurements for ranging to the satellites and may have the aid of mobile networks.

Emerging ITS services and vehicle technologies including autonomous vehicles, platooning, and collision avoidance demand lane-level (sub-meter) positioning accuracy, which cannot be achieved with the low-cost standalone GNSS receivers on the nomadic devices at a high level (95 % or more) of confidence. Integrity is another requirement to provide reliable services, but it cannot be provided on the standalone receivers.

The concept of the NETPPI-LT is to provide GNSS-based lane-level positioning and integrity monitoring services to land transportation users and objects carrying nomadic devices including cellular (smart) phones, navigators, etc. that are able to receive GNSS carrier phase measurements and to receive the GNSS correction and integrity information, originated by the control station, via wireless links (e.g. DAB, DMB, LTE, 5G, WAVE). The nomadic devices might be connected to external positioning personal stations that have the above functionalities. The correction information assists the nomadic devices to mitigate the effects of ionospheric and tropospheric delays, satellite clock errors, and ephemeris errors etc. in the range measurements. The integrity information provides reliability of the correction information and is used to determine integrity of the positioning result.

1) Under development. Current stage 0.00.

Figure 1 presents a reference architecture of the NETPPI-LT and an outline of data flow from the infrastructure to any type of nomadic device performing lane-level positioning and integrity monitoring using satellite navigation. The main components of the NETPPI-LT and their key roles are as follows:

— *Reference station* plays a role that collects GNSS range and quality measurements and senses the presence of intentional or unintentional threats to the GNSS measurements with different monitoring sensors including camera, weather sensors, and others. The collected data from GNSS and monitoring sensors is transmitted to the control station. The system may have a single reference station or multiple reference stations; the number of stations depends on the coverage of the NETPPI-LT service. Its functionalities may be implemented into the R-ITS-S.

— *Control station* generates the GNSS correction information used for ranging error removal on nomadic devices, with the combination of measurements from the reference stations. The integrity information, which describes the extent of belief on the correction information, is generated through a sequence of integrity tests. The control station offers the correction and integrity information via wireless links to land transportation users or objects carrying the nomadic devices to perform lane-level positioning and integrity monitoring. Its functionalities may be implemented into the C-ITS-S.

— *Monitoring station* tests if the information from the control station is valid for lane-level positioning and gives the feedback to the control station. Its installation is optional, but would be needed for the system operation and management. Its functionalities may be implemented into the R-ITS-S.

— *Base station* forwards the information, originated by the control station, to users over wireless links. The base station configuration follows the standards of the communication system used for data transfer. The link may indicate a data channel of one of the communications systems including cellular networks, WAVE, DSRC, DAB, DMB, etc.

— *Nomadic device* is capable of receiving GNSS carrier phase measurements for ranging and receiving the correction and integrity information from the control station. Based on the data, it determines its own position, along with integrity that gives how reliable the position estimate is.