TECHNICAL SPECIFICATION

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First edition

Cooperative intelligent transport systems (C-ITS) — Position, velocity and time functionality in the ITS station

Systèmes de transport intelligents coopératifs (STI-C) – Fonctionnalités de position, de vitesse et de temps dans la station STI

PROOF/ÉPREUVE

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 278, *Intelligent transport systems,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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.

 PROOF/ÉPREUVE

Introduction

Context of C-ITS

This document is part of a family of deliverables from Standard Development Organizations (SDOs) for Cooperative Intelligent Transport Systems (C-ITS), a subset of standards for Intelligent Transport Systems (ITS).

ITS aims at improving surface transportation in terms of:

— **safety**, e.g. crash avoidance, obstacle detection, emergency call, dangerous goods;

— **efficiency**, e.g. navigation, green wave, priority, lane access control, contextual speed limits, car sharing;

— **comfort**, e.g. telematics, parking, electric vehicle charging, infotainment;

by applying information and communication technologies (ICT).

To support interoperability, C-ITS specifications are developed to exchange and share information within a given ITS application domain, or between ITS application domains.

C-ITS services are based on the exchange of data between vehicles of any category, the roadside and urban infrastructure (traffic lights, road tolls, variable message signs, etc.), control and services centres (traffic control centre, map providers, etc.), and other road users (pedestrians, cyclists, etc.).

Many ITS services require cooperation of vehicles with their surrounding environment (other vehicles, other road users, roadside and urban infrastructure, etc.) whilst other services require connectivity to remote service platforms (road traffic control centres, map providers, service providers, fleet managers, equipment manufacturers, etc.).

In order to support:

— a large variety of C-ITS services with diverging requirements, and

— efficient sharing of information maintained by individual service applications,

it is necessary to combine multiple access technologies and communication protocols with distinct performance characteristics (communication range, available bandwidth, end-to-end transmission delay, quality of service, security, etc.).

Combining multiple access technologies and communication protocols requires a common approach to the way communications and data are managed in a secure way. A functional architecture (the ITS station architecture) has therefore been specified to manage security, communications and data related to C-ITS services.

For more detail on C-ITS, see the ITS station and communication architecture specified in ISO 21217, and the multi-part technical report CEN/TR 21186 providing guidelines on the usage of C-ITS; see also https://www.itsstandards.eu/cits.

Need for position, velocity and time (PVT) information in C-ITS

Many ITS services, particularly those where vehicles or other mobile devices such as smartphones are involved, require position, velocity and time (PVT) information. Such PVT information is needed for various purposes. It is notably used by navigation systems, any related ITS service where position is needed (car-sharing, taxi ride booking, fleet management, etc.), advanced driver assistance or automated driving systems. The information transmitted between ITS stations or between components of an ITS station can be required to be marked with position or time information (geo- or time stamping).

PVT-related information can originate from various sources, such as a global navigation satellite system or systems (GNSSs). Accuracy and reliability can be improved by usage of serval sources, such as anti-spoofing flags used for GNSS signal authentication, inertial measurement units (IMUs), light detection

and ranging (LIDAR)-based sensors, video camera-based sensors, digital maps and differential correction systems. Input from the various sources needs to be properly merged and the output be associated with a defined accuracy.

The provision of PVT information in a standardized form that can be used by all types of C-ITS services (e.g. road safety, traffic efficiency, public transport, freight and logistics, emergency call and other value-added services) is urgently needed particularly in pilots and pre-deployment of C-ITS standards in Europe (e.g., ITS Corridor, ECo-AT, SCOOP@F, C-Roads, etc.), North America (e.g., Connected Vehicle Pilot Deployments, etc.) and Asia (e.g., Anting Project). In addition, PVT information is applicable to forthcoming deployments of the European emergency call (eCall) service. Further, high resolution and accurate PVT information is essential for automated driving.

High availability, precision and integrity of the PVT information is essential for some C-ITS services, notably for advanced driver assistance or automated driving (lane keeping, platooning, etc.).

A major challenge in defining and assessing the (GNSS) positioning performance, is that it is highly influenced by the environment and the operational scenario. Research projects, standardization activities and pilot projects are on-going to address open issues and to define a common and broadly adopted framework, including the definition of relevant quality parameters and associated test procedures for conformance assessment.

SaPPART, an Action under the European Cooperation in Science and Technology programme, brought together experts in GNSSs, ITS and mobility to address the open issues. SaPPART defined a framework for the assessment of the performances of GNSS-based positioning terminals[22][23][24], whose concepts have been integrated in leading ongoing research projects (e.g. such as inLANE and ESCAPE).

Context of use of this document

This document aims to define a functionality providing the PVT information and the interface between this new functionality and other existing functionalities of the ITS station so that it can be used in a uniform, flexible and future-proof extensible way by ITS-S application processes complying with the ITS station and communication architecture and related standards.

This document makes provision for any kind of quality parameter definitions, e.g. the accuracy levels for predefined confidence levels, associated with PVT information.

It is outside the scope of this document to define the associated conformance evaluation test procedures.

The EN 16803 series[11] defines a framework for assessing the performance of ITS GNSS-based terminals. It defines so-called protection levels of position and velocity (i.e. error bounds around the estimated position and velocity provided by the positioning module), of which each is associated with an integrity risk (i.e. probability that the actual error for a given position or velocity exceeds the associated protection level). EN 16803-2[11] defines a test methodology based on replay in the laboratory of real data sets recorded during fields tests. It may be used to assess the accuracy of the position and velocity of the positioning terminal and underpin the confidence levels of the position and the velocity as defined in this document.

Cooperative intelligent transport systems (C-ITS) — Position, velocity and time functionality in the ITS station

1 Scope

This document specifies a generic position, velocity and time (PVT) service. It further specifies the PVT service within the ITS station (ITS-S) facilities layer (ISO 21217) and its interface to other functionalities in an ITS-S such as:

— ITS-S application processes (ITS-S-APs), defined in ISO 21217;

— the generic facilities service handler (FSH) functionality of the ITS station facilities layer, defined in ISO/TS 17429.

This document specifies:

— a PVT service which, dependent on a specific implementation, uses a variety of positioning-related sources such as global navigation satellite systems (GNSSs, e.g. GALILEO, GLONASS and GPS), roadside infrastructure, cellular infrastructure, kinematic state sensors, vision sensors;

— a PVT service, which merges data from the above-mentioned positioning-related sources and provides the PVT output parameters (carrying the PVT information) including the associated quality (e.g. accuracy);

— how the PVT service is integrated as an ITS-S capability of the ITS station facilities layer;

— the interface function calls and responses (Service Access Point – service primitives) between the PVT ITS-S capability and other functionalities of the ITS station architecture;

— optionally, the PVT service as a capability of the ITS-S facilities layer; see ISO 24102-6;

— an ASN.1 module C-itsPvt, providing ASN.1 type and value definitions (in Annex A);

— an implementation conformance statement proforma (in Annex B), as a basis for assessment of conformity to this document.

NOTE It is outside the scope of this document to define the associated conformance evaluation test procedures.

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/IEC 8824-1, *Information technology — Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO 17423, *Intelligent transport systems — Cooperative systems — Application requirements and objectives*

ISO/TS 17429, *Intelligent transport systems — Cooperative ITS — ITS station facilities for the transfer of information between ITS stations*

ISO 17575-1:2016, *Electronic fee collection — Application interface definition for autonomous systems — Part 1: Charging*

ISO 21217, *Intelligent Transport Systems — Communications access for land mobiles (CALM — Architecture*

ISO 24102-6:2018, *Intelligent Transport Systems — Communications access for land mobiles (CALM) — ITS station management — Part 6: Path and flow management*

EN 16803-1, *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*

ETSI TS 102 894-2 V1.3.1 (2018-08), *Intelligent Transport Systems (ITS) — Users and applications requirements — Part 2: Applications and facilities layer common data dictionary*

ETSI prEN 302 890-2[1)], *Intelligent Transport Systems (ITS); Facilities Layer function Part 2: Facility Position and Time management (POTI)*

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 https://www.iso.org/obp

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

3.1
acceleration
rate of change of *velocity* (3.19) of an object with respect to time

Note 1 to entry: Acceleration is a physical vector quantity; both magnitude and direction are needed to define it. The unit of the scalar absolute value (magnitude) of acceleration is measured in the international system of units as metres per second squared (m/s^2).

3.2
confidence level
probability that the actual *PVT information* (3.15) is within the error bounds of the estimated PVT information

Note 1 to entry: Confidence level represents the confidence that the estimated position does not exceed the error bounds, referred to as *protection level* (3.13) in EN 16803-1.

Note 2 to entry: Confidence level, the term used in ETSI TS 102 894-2 V1.3.1 (2018-08), is the complementary probability of the *integrity risk* (3.3) (i.e. *confidence level* = 1 – *integrity risk*).

3.3
integrity risk
probability that, for positioning terminals providing a *protection level* (3.13) as integrity-related quantity, the actual error on a given output component exceeds its associated *protection level*

Note 1 to entry: *Integrity risk* is the complementary probability of the *confidence level* (3.2) (i.e. *integrity risk* = 1 – *confidence level*).

[SOURCE: EN 16803-1:2020, 3.2.8]

3.4
ITS-S application
ITS-S application process (3.5) residing in the ITS-S application entity

[SOURCE: ISO 21217:2014, 3.18]

1) Under preparation.

3.5
ITS-S application process
ITS-S-AP
element in an ITS station that performs information processing for a particular application and uses ITS-S services to transmit and receive information

[SOURCE: ISO 21217:2014, 3.19]

3.6
ITS-S capability
uniquely addressable protocol or functionality that is part of an *ITS-S managed service entity* (3.8)

Note 1 to entry: Examples of ITS-S capabilities in the ITS station facilities layer are generic ITS-S facilities layer services specified in ISO/TS 17429 (Communication Profile Handler, Facilities Services Handler, Content Subscription Handler), the position and time service defined in ISO/TS 21176, the security service defined in ISO/TS 21177; examples of ITS-S capabilities in the ITS-S networking and transport layer are IPv6 functionalities defined in ISO 21210 (IPv6 neighbour discovery, IPv6 forwarding, IPv6 mobility support, ...), the fast service announcement protocol defined in ISO 22418, etc.

[SOURCE: ISO 24102-6:2018, 3.6]

3.7
ITS-S facilities layer protocol data unit
ITS-FPDU
protocol data unit exchanged between peer ITS-S facility layers

[SOURCE: ISO 21217:2014, 3.23]

3.8
ITS-S managed service entity
ITS-S MSE
uniquely addressable entity in an ITS-S layer comprised of a set of related ITS-S capabilities

Note 1 to entry: Examples of ITS-S managed service entities are: a communication module in the ITS-S access technologies layer (M5, cellular, etc.), a protocol suite in the ITS-S networking and transport layer (IPv6, FNTP, GeoNetworking, 6LoWPAN, etc.), the generic facilities MSE at the ITS-S facilities layer.

[SOURCE: ISO 24102-6:2018, 3.14]

3.9
ITS-S facilities header
header used to form an "ITS-S facilities layer protocol data unit"

[SOURCE: ISO/TS 17429:2017, 3.13]

3.10
ITS-S facilities service
ITS-S capability of the ITS-S facilities layer providing a service that may be applied to ADUs at the request of the source ITS-S-AP

Note 1 to entry: Examples of ITS-S facilities services are "time stamping", "geo-stamping".

[SOURCE: ISO/TS 17429:2017, 3.14]

3.11
kinematics
motion of an object

Note 1 to entry: kinematics does not consider the forces that cause an object to move.

3.11.1
kinematics state vector
set of parameters describing the *kinematics* (3.11) of an object, including its position

3.12
position
terrestrial absolute geographical location

Note 1 to entry: The absolute geographical location is defined according to a global coordinate reference system, such as the World Geodetic System 84 (WGS84)[25] or the International Terrestrial Reference System (ITRS)[26].

Note 2 to entry: The CEN/TR 17297 series presents a tutorial on location referencing methods, applicable location systems and translation methods between different system[12].

3.13
protection level
estimation of an upper bound for the error made on a *position* (3.12) or *velocity* (3.19) component (e.g. the plane position) associated with a given probability called i*ntegrity risk* (3.3)

[SOURCE: EN 16803-1:2020, 3.2.18]

3.14
PVT capability
ITS-S capability of the ITS-S facilities layer providing the PVT service

3.15
PVT information
information related to *kinematics* (3.11) of an ITS-SU

Note 1 to entry: Examples of such information are position, velocity, speed or acceleration as a function of time.

3.16
PVT service
station-internal service providing *PVT information* (3.15)

3.17
PVT stamp
addendum of *PVT information* (3.15) to the ADUs, by the ITS-S facilities layer, for each FPDU of a specific ITS-S flow

Note 1 to entry: This feature by which the ITS-S facilities layer augments ADUs by adding data to FPDUs is defined in ISO 24102-6.

3.18
speed
rate of change of an object's position with respect to a frame of reference

Note 1 to entry: Speed is a function of time.

3.19
velocity
an object's *speed* (3.18) and direction of motion

Note 1 to entry: Velocity is a physical vector quantity; both magnitude and direction are needed to define it. The scalar absolute value (magnitude) of velocity is called *speed* (3.18), a unit whose quantity is measured in the international system of units as metres per second (m/s).

4 Abbreviated terms

ADU	Application Data Unit (ISO 21217)
C-ITS	Cooperative ITS (ISO 21217)
CPH	Communication Profile Handler (ISO/TS 17429)

CSH	Content Subscription Handler (ISO/TS 17429)
FA-SAP	Service access point between facilities and application layer (ISO 21217)
ITS-FSDU	ITS Station Facility layer Service Data Unit (ISO 21217)
FSH	Facilities Service Handler (ISO/TS 17429)
Galileo	A Global Navigation Satellite System (GNSS) by the European Global Navigation Satellite Systems Agency (GSA)
GLONASS	Globalnaja nawigazionnaja sputnikowaja Sistema – a GNSS operated by the Russian Federal Space Agency
GNSS	Global Navigation Satellite System
GPS	Global Positioning System – a GNSS operated by the Air Force of the United States of America
LDM	Local Dynamic Map (ISO 18750)
ICS	Implementation Conformance Statement
ITS	Intelligent Transport Systems (ISO 21217)
ITS-S MSE	ITS-S Managed Service Entity (ISO/TS 17429)
ITS-S	ITS Station (ISO 21217)
ITS-S-AP	ITS Station Application Process (ISO 24102-6)
PVT	Position, Velocity and Time
SAP	Service Access Point (ISO 21217)
SBAS	Satellite-Based Augmentation System

5 Conformance

To evaluate conformance of an implementation to this document, it is necessary to have an implementation conformance statement (ICS), i.e. a statement of which capabilities and options have been implemented. Annex B provides an ICS proforma that shall be completed by an implementer or its representative that claims that its implementation conforms with requirements of this document.

The evaluation of an implementation for conformance to this document shall be based on the ICS and the execution of the associated conformance evaluation test procedures.

NOTE It is outside the scope of this document to define the associated conformance evaluation test procedures.

6 PVT service in the ITS station and communication architecture

6.1 ITS station and communication architecture

The PVT service is a station-internal service in support of C-ITS services that depend on the availability and accuracy of position, velocity, time or other kinematics characteristics of the station. A widely supported approach in C-ITS is to build on stations conformant with the station and communication reference architecture specified in ISO 21217 and illustrated in Figure 1.