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Intelligent Transport Systems (ITS) - Facilities Layer function - Part 2: Position and Time management (PoTi) - Release 2

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Intelligent Transport Systems (ITS).

The present document is part 2 of a multi-part deliverable covering Facilities Layer function, as identified below:

Part 1: "Services Announcement (SA) specification";

Part 2: "Position and Time management (PoTi); Release 2".

The present document is based on inputs provided by various European projects including AutoNet, Concorda, Ensemble, Hights, PRoPART, Dutch-Germany-Austria Corridor, Scope@F, A58 (NL), PRE-DRIVE C2X, DRIVE C2X, SafeSpot, CVIS, CoVeL, SCOR@F, simTD, etc.

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Modal verbs terminology

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Introduction

Intelligent Transportation Systems Cooperative, Connected and Automated Mobility (CCAM) related use cases in the ITS environment as specified in the ETSI ITS architecture (ETSI EN 302 665 [i.1]) can be distributed over multiple ITS stations (ITS-Ss). ITS-Ss interact in the ITS system to exchange sensor data and traffic related information to make each other aware of traffic safety or traffic efficiency circumstances and situations by which each ITS-S equipped road user, whether automated or not, can improve their safety and efficiency related decisions.

1 Scope

The present document provides the specification of the Position and Time (PoTi) services. It includes functional and operational requirements for the position and time data to support ITS Applications. In addition, it includes the definition of syntax and semantics of messages exchanged between ITS Stations (ITS-Ss) to augment the position and time accuracy. Finally, it specifies the facilities layer protocol in support of such message exchanges.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI TS 103 301: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services".

[2] RTCM 10402.3: "Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service".

[3] RTCM 10403.3: "Differential GNSS (Global Navigation Satellite Systems) Services - Version 3".

[4] ETSI EN 302 663 (V1.3.1) (01-2020): "Intelligent Transport Systems (ITS); ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band".

[5] ETSI EN 302 890-1 (V1.2.1) (07-2019): "Intelligent Transport Systems (ITS); Facilities layer function; Part 1: Services Announcement (SA) specification".

[6] World Geodetic System 1984 (WGS84).

NOTE: Available at http://earth-info.nga.mil/GandG/update/index.php?dir=wgs84&action=wgs84#tab_wgs84-res.

[7] ISO 8855 (2011): "Road Vehicles -- Vehicle dynamics and road-holding ability -- Vocabulary".

[8] ETSI TS 103 248: "Intelligent Transport Systems (ITS); GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)".

[9] ISO 5725-1 (1994): "Accuracy (trueness and precision) of measurement methods and results -- Part 1: General principles and definitions".

[10] ETSI TS 102 894-2: "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary".

[11] ETSI EN 302 931 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Geographical Area Definition".

[12] ISO/TS 16460:2016: "Intelligent transport systems -- Communications access for land mobiles (CALM) -- Communication protocol messages for global usage".

[13] Recommendation ITU-T X.691/ISO/IEC 8825-2:2015: "Information technology - ASN.1 encoding rules: Specification of Packed Encoding Rules (PER)".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI EN 302 665: "Intelligent Transport Systems (ITS); Communications Architecture".

[i.2] ETSI TR 102 638 (V1.1.1): "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Definitions".

[i.3] ETSI EN 302 637-2: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service".

[i.4] ETSI EN 302 637-3: "Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service".

[i.5] ETSI TS 102 894-1 (V1.1.1): "Intelligent Transport Systems (ITS); Users and applications requirements; Part 1: Facility layer structure, functional requirements and specifications".

[i.6] ETSI TR 103 299: "Intelligent Transport System (ITS); Cooperative Adaptive Cruise Control (CACC); Pre-standardization study".

[i.7] ETSI TS 103 324: "Intelligent Transport Systems (ITS); Cooperative Perception Services".

[i.8] ETSI TS 103 246-1 (V1.2.1) (03-2017): "Satellite Earth Stations and Systems (SES); GNSS based location systems; Part 1: Functional requirements".

[i.9] EUREF: "European Terrestrial Reference System 89 (ETRS89)".

NOTE: Available at http://etrs89.ensg.ign.fr.

[i.10] ETSI TR 101 607 (V1.1.1) (05-2013): "Intelligent Transport Systems (ITS); Cooperative ITS (C-ITS); Release 1".

[i.11] ISO 3534-1 (10-2009): "Statistics - Vocabulary and symbols - Part 1: General statistical terms and terms".

[i.12] ETSI TS 136 305 (V11.2.0): "LTE; Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Stage 2 functional specification of User Equipment (UE) positioning in E-UTRAN (3GPP TS 36.305 version 11.2.0 Release 11)".

[i.13] IETF RFC 5905 (June 2010): "Network Time Protocol Version 4: Protocol and Algorithms Specification".

[i.14] IEC 60050: "International Electrotechnical Vocabulary", 113-01-08 (instant), 113-01-10 (time interval), 113-01-13 (duration).

[i.15] IS-QZSS-L6-001: "Quasi-Zenith Satellite System Interface Specification Centimeter Level Augmentation Service".

NOTE: Available at https://qzss.go.jp/en/technical/download/pdf/ps-is-qzss/is-qzss-l6-001.pdf.

[i.16] IETF RFC 8173 (June 2017): "Precision Time Protocol Version 2 (PTPv2) Management Information Base".

[i.17] EN ISO 22418: "Intelligent transport systems - Fast service announcement protocol (FSAP) for general purposes in ITS" (produced by CEN).

[i.18] IEEE™ 1609.3: "IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Networking Services".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

accuracy: closeness of a measured value to a standard or known value

heading: orientation of the horizontal velocity vector with respect to the WGS84 [6] North (clockwise), unless otherwise noted

horizontal speed: magnitude of horizontal velocity-vector of the reference position point

horizontal velocity vector: projection of the 3D velocity vector on the WGS84 [6] ellipsoid

integrity risk: probability, per unit of time, of having a Parameter Failure without issuing an alert within the Time-to-Alert

ITS constellation: group of ITS-Ss which are exchanging ITS data among themselves

ITS time: time based on TAI

NOTE: Epoch of this time is set to 2004-01-01T00:00:00Z, that is 0 seconds on 1st of January 2004 UTC.

parameter failure: failure occurring when the position and time entity is unable to estimate parameters with an error less than the maximum tolerable error (err > err_max)

position integrity: measure of the trust that can be placed in the correctness of the estimated Parameters supplied by the Position and Time entity

NOTE: Integrity includes the ability of the equipment (at the Position and Time entity and/or User level) to compute timely and valid alerts when the estimated Parameters do not need to be used for the operation of interest.

protection level: estimated bound on the Parameter Error from the Position and Time entity at a defined confidence level such as 50 %, 75 %, 95 %, 99 %, etc., delivered with the Parameters

station clock: clock representing ITS time in an ITS Station

Time-to-Alert: maximum allowable elapsed time from the onset of a Parameter Failure until the equipment annunciates the alert

velocity: vector indicating speed in a particular direction

vertical velocity vector: projection of the 3D velocity vector on the normal vector of the WGS84 [6] Ellipsoid

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Tsys ITS Station Time

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3D	3 Dimensional
ACC	Automatic Crouse Control
ACK	Acknowledgement
ASN	Abstract Syntax Notation
BSA	Basic Set of Applications
CA	Cooperative Awareness (service)
CACC	Cooperative Adaptive Cruise Control
CAM	Cooperative Awareness Message
CCAM	Cooperative, Connected and Automated Mobility
CDD	Common Data Dictionary
CP	Collective Perception (service)
CVIS	Cooperative Vehicle-Infrastructure Systems
DEN	Decentralized Environmental Notification
DENM	Decentralized Environmental Notification Message
D-GNSS	Differential Global Navigation Satellite System
ECU	Electronic Control Unit
EDAS	EGNOS Data Access Service
EGNOS	European Geostationary Navigation Overlay Service
EU	European Union
FA-SAP	Facilities to Applications Service Access Point
GLONASS	GLObal NAvigation Satellite System
GNSS	Global Navigation Satellite Systems
GPC	GNSS Positioning Correction
GPS	Global Positioning System
GRM	GPS Raw data Message
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
ISO	International Organization for Standardization
ITRF	International Terrestrial Reference Frame
ITS	Intelligent Transport Systems
ITS-C	ITS Constellation
ITS-S	ITS Station
ITU-T	International Telecommunication Union - Telecommunication standardization sector
MAC	Media Access Control
NA	Not Applicable
NF-SAP	Network to Facilities Service Access Point
NGA	National Geospatial-intelligence Agency
NRTK	Network Real Time Kinematic
NTP	Network Time Protocol
PDU	Protocol Data Unit
PoTi	Position and Time
PPP	Precise Point Positioning
PSID	Provider Service Identifier
RAN	Radio Access Network
RF	Radio Frequency
RFC	Request For Comment
R-ITS-S	Roadside ITS Station
RTCM	Radio Technical Commission for Maritime services
RTCMEM	Radio Technical Commission for Maritime services Environmental Message
RTK	Real Time Kinematic
SA	Service Announcement
SAM	Service Announcement Message
SF-SAP	Security to Facilities Service Access Point
SI	Standard International
SIFS	Short InterFrame Space
SLR	Satellite Laser Ranging
SPATEM	Signal Phase And Timing Extended Message

SSR	Sirius Satellite Radio
TAI	International Atomic Time scale
TCU	Transmission Control Unit
ToF	Time-of-Flight
UE	User Equipment
UPER	Unaligned Packet Encoding Rules
UTC	Coordinated Universal Time
UWB	Ultra Wide Band
VLBI	Very-Long-Baseline Interferometry
VRU	Vulnerable Road User
WGS	World Geodetic System
WGS84	World Geodetic System 1984

4 Position and Time entity introduction

4.1 Introduction

ITS applications such as specified in the Basic Set of Applications specification (BSA) ETSI TR 102 638 [i.2] require the exchange of position and time information as part of the information exchange among ITS-Ss. As initial ITS location based services, the Cooperative Awareness (CA) basic service ETSI EN 302 637-2 [i.3] and similar, the road traffic event Decentralized Environmental Notification (DEN) basic service ETSI EN 302 637-3 [i.4] are developed. These services and their data exchanges are dependent on position and time information. In this and the following clauses it is understood that "position" means **kinematic and attitude state** as defined in clause 5.4.1 which includes attitude and movement parameters including velocity, heading, horizontal speed and optionally others.

In order to realize road ITS safety related applications, ITS-Ss need to have an absolute knowledge about their position and have a common synchronized knowledge about time to be able to value information received from another ITS-Ss. To realize this absolute knowledge about position and time, an ITS-S may be equipped with a Global Navigation Satellite Systems (GNSS) making use of Galileo or GPS and/or other satellite navigation technologies, providing satellite positioning information to the PoTi entity.

Depending on the applications supported by an ITS-S, the qualitive requirements on the accuracy, integrity and reliability of the position and time references may vary. As the CA basic service (ETSI EN 302 637-2 [i.3]) specifies, road safety applications may require the ITS-S to transmit position and time information at intervals of about 10 times a second, while new applications such as Platooning requires intervals of ≥ 20 times a second.

ITS applications are based on the exchange of information among ITS-Ss and therefore ITS applications operating in one ITS-S are depending on the information provided by other ITS-Ss, a set of minimum requirements to be supported by all ITS-Ss needs to be agreed. As new ITS applications are constantly being developed these minimum requirements need to be set for a selective set of (grouped) ITS applications. At the current state an ETSI Release 1 set of ITS standards (ETSI TR 101 607 [i.10]) is the reference for the Release 1 equipment and therefore it provides the requirements for the Release 1 PoTi requirements.

Based on the current developments of new services and related analyses by EU projects further optional requirements are included.

The position and time (PoTi) service as identified in ETSI TS 102 894-1 [i.5] residing in the facility layer is an essential part of the ITS; it provides time and position information to all ITS applications and services.

In order to satisfy the application requirements and different Releases of application sets, the PoTi entity may include various methods to ensure the accuracy, integrity and reliability of the position and time references as required by the ITS applications supported by the ITS-S.