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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

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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.

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 (e.g. traffic lights, road tolls, variable message signs), control and services centres (e.g. traffic control centre, map providers), and other road users (e.g. pedestrians, cyclists).

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

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 (e.g. car-sharing, taxi ride booking, fleet management), 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), North America (e.g. Connected Vehicle Pilot Deployments) 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 PVT information is essential for some C-ITS services, notably for advanced driver assistance or automated driving (e.g. lane keeping, platooning).

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. 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, for example, 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.

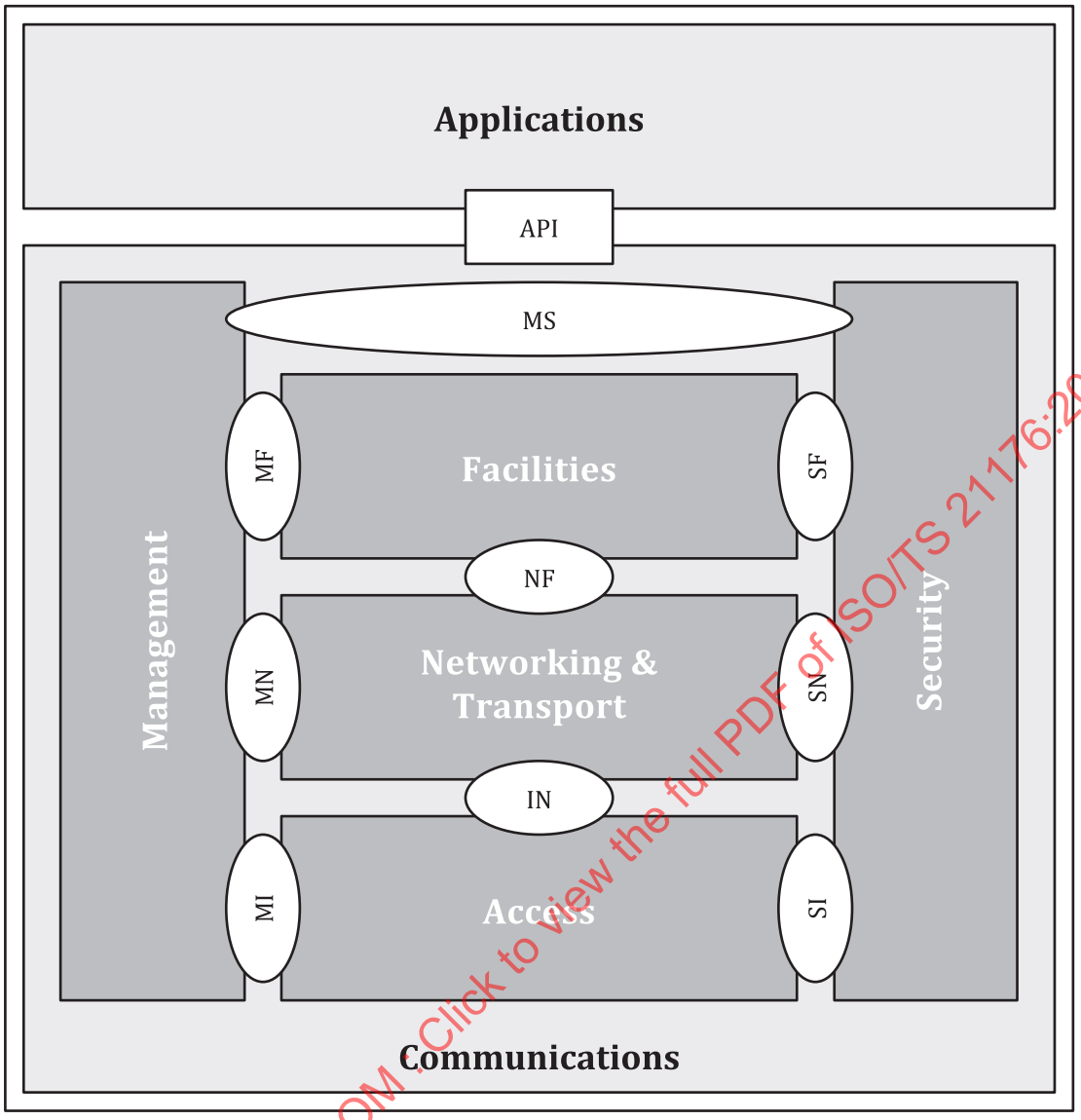

Figure 1 — Simplified ITS-S reference architecture according to ISO 21217

A physical implementation of an ITS station conformant with ISO 21217 is named ITS Station Unit (ITS-SU). According to ISO 21217, these C-ITS services are provided by ITS-S Application Processes (ITS-S-AP). An ITS-S-AP requests PVT information from the local PVT service, and may use this information locally and also in protocol data units (PDUs) exchanged with other stations. The exchange of information between ITS-SUs is performed using the set of functionalities and protocols supported by the ITS station and communication architecture.

6.2 ITS-S application processes (ITS-S-APs)

ITS station application processes (ITS-S-APs) are the entities of the ITS station that perform information processing and PDU exchanges with other stations for a particular ITS application in support of a particular ITS service.

6.3 ITS-S facilities layer services

The ITS-S facilities layer comprises functionalities that provide generic ITS-S facilities services to ITS-S-APs; see ISO 21217. Examples of such ITS-S facilities services are geo- and time stamping, local dynamic map and service announcement.

The functionalities providing such services are referred to as ITS-S capabilities as specified in ISO 24102-6.

Each ITS-S capability and each ITS-S facilities service is identified by a globally unique identifier; globally unique identifiers are specified in ISO 17419[4] and recorded in a global registry. New ITS-S facilities services and ITS-S capabilities compatible with the ITS station and communication architecture and its functionalities can thereby be added to meet the needs of all or a specific set of stakeholders.

NOTE Details of a registration mechanism of globally unique identifiers are out of scope of this document and are currently being developed in ISO/TC 204.

These ITS-S facilities services can be invoked either by other services in the ITS-S facilities layer or directly by ITS-S-APs:

— Performing a generic service by the ITS-S facilities layer (e.g. those specified in ISO/TS 17429 - see below) may add content to a PDU. E.g. the Facilities Services Handler (FSH), specified in ISO/TS 17429, may add a PVT stamp.

— Access to these services directly by the ITS-S-APs is e.g. made by usage of service primitives at the service access point between facilities and application layer (FA-SAP), as defined in ISO 21217 and ISO 24102-3.

ISO/TS 17429 defines a set of generic functionalities of the ITS-S facilities layer. Two of these functionalities are considered within the context of this document:

— **The Communication Profile Handler (CPH):** This ITS-S capability processes ITS-S facility layer service data units (ITS-FSDUs) transmitted by an ITS-S-AP. It checks whether there is a valid communication profile (ITS-SCP) corresponding to the ITS-S flow identifier associated with the ITS-FSDU. The CPH triggers the appropriate actions to be performed according to the given ITS-S-FlowID, including the processing by the FSH (see below).

— **The Facilities Services Handler (FSH):** This ITS-S capability provides a mechanism for applying generic ITS-S facilities services to ADUs transmitted by ITS-S-APs upon their request, made at the time of flow type registration (as per ISO 17423, ISO 24102-6 and ISO/TS 17429). This capability appends an ITS-S facilities header to the ADU whenever ITS-S facilities services are requested by the transmitting ITS-S-AP and require treatment of the ADU at both the sender and the recipient(s) of the packet containing the ADU.

Figure 2 illustrates the ITS stations facilities layer functionalities in the context of the ITS station and communication architecture; more details are presented in ISO/TS 17429.

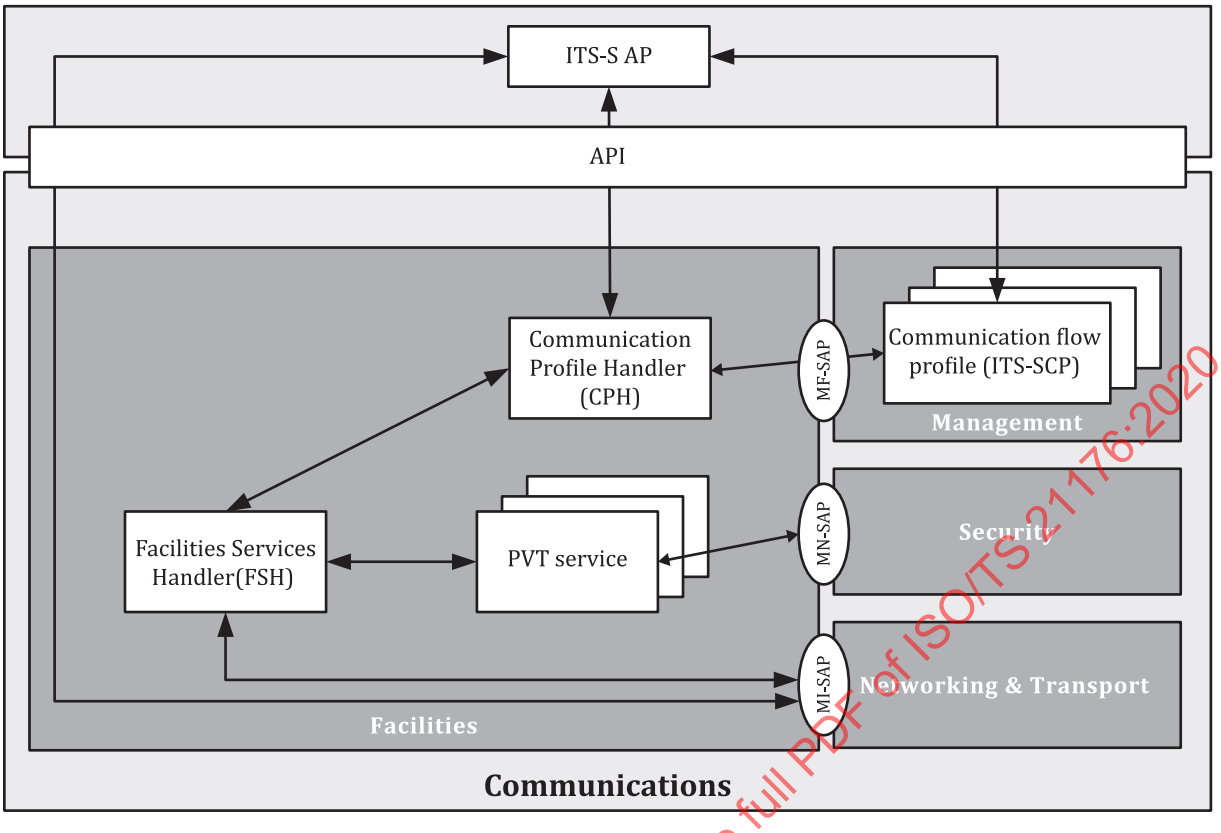

Figure 2 — PVT service as an ITS station facility based on ISO/TS 17429

6.4 PVT service provided by the ITS-S facilities layer

The PVT service is basically defined independently of any station architecture. In addition, PVT specifications are provided in accordance with the ITS station and communication architecture as defined in ISO 21217 and related standards.

In order that the PVT service can be used by ITS-S-APs relying on the path and flow management specified in ISO 24102-6, in accordance with the ITS station and communication architecture as specified in ISO 21217, the functionality providing PVT information (PVT service) is defined as an ITS-S capability.

NOTE 1 Facilities can also be defined as ITS-S-APs. In this case, such an ITS-S-AP is referred to as ITS-S facility application, as specified in ISO 21217.

NOTE 2 Defining the PVT service associated with an ITS-S capability simplifies its specification and use. The PVT functionality complies with the requirements that apply to ITS-S capabilities and ITS-S facilities services, as defined in ISO 17423, ISO 24102-6 and ISO/TS 17429. This does not preclude usage of the PVT service in a different station context, as the SAP of the PVT service is specified independently of any station architecture; a mapping of the PVT-SAP service primitives to SAPs of any station architecture can be achieved in the form of a non-standardized implementation.

6.5 Access to the PVT service

The PVT information can be accessed by an ITS-S-AP in two ways:

— directly upon request of PVT information ("pull method");

— directly upon subscription to the reception of PVT information ("subscription push method");

see the PVT services presented in Table 2.

NOTE 1 Another usage of the PVT service is specified in ISO/TS 17429, which defines an ITS-S facility service (FSH) that appends information to an ADU (e.g. geo- and time stamping) of a specific flow ("PVT-augmented ADUs push method"). See 6.6 for further details.

NOTE 2 ITS-S-APs include:

— ITS-S-APs located in the ITS-S application entity, also referred to as ITS-S application in ISO 21217;

— ITS-S-APs located in the ITS-S management entity: e.g. remote ITS station management [ISO 24102-2[8]], the ITS station internal management communication [ISO 24102-4[10]], also referred to as ITS-S management application in ISO 21217;

— ITS-S-APs located in the ITS-S facilities layer: e.g. LDM [ISO 18750[5]], CAM, also referred to as ITS-S facility applications in ISO 21217.

6.6 PVT-augmented ADUs

PVT-augmented ADUs ("PVT stamping"), i.e. appending PVT information to the ADUs, can be performed e.g. by the ITS-S facilities layer for each ITS-facilities protocol data unit (FPDU) of a given ITS-S flow (as defined in ISO 24102-6) for which the ITS-S-AP had requested to apply PVT stamping to its ADUs.

In order to perform PVT-augmented ADUs by the ITS-S facilities layer, one of the services presented in Table 2 and Table 11 is used.

7 PVT service

7.1 PVT service reference model

The PVT service reference model adheres to the GNSS-based positioning terminal model in accordance with EN 16803-1, which decomposes the generic architecture of intelligent road transport systems into two systems as illustrated in Figure 3:

— the positioning system, encompassing the sensors and the positioning module, provides the PVT information,

— the road ITS application system processes this PVT information, together with other data, to provide the final service to the end-user.

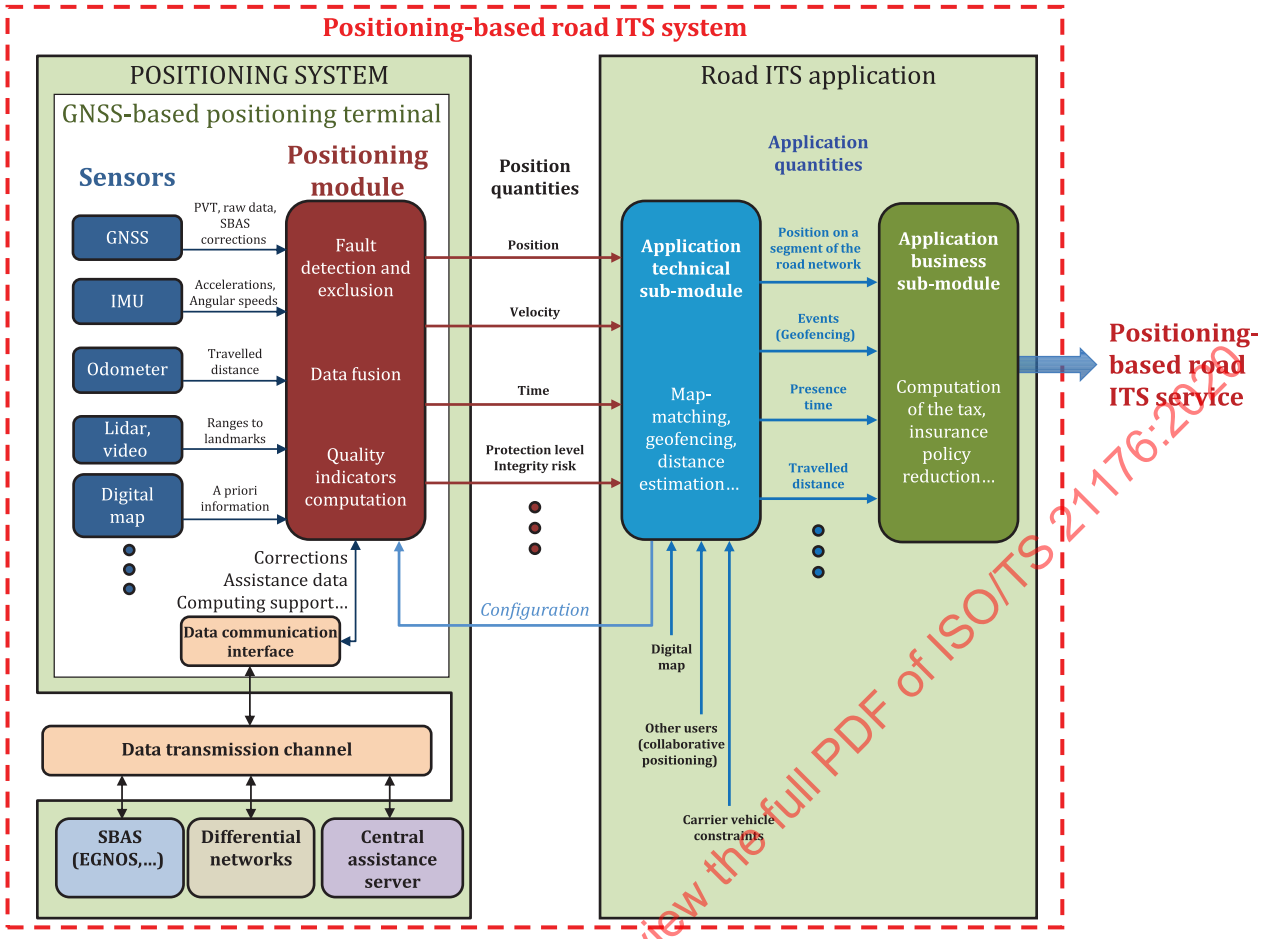

Figure 3 — GNSS-based positioning terminal model in its context according to EN 16803-1

NOTE 1 Adhering to the GNSS-based positioning terminal model does not preclude other PVT estimation technologies to be included in a sensor fusion process designed to provide accurate and trustable PVT information.

In the context of this document, the positioning system provides the PVT service and is located in the ITS-S facilities layer. It includes a piece of software, referenced in Figure 3 as Positioning module, that uses PVT input parameters to determine the PVT output parameters. The PVT-related input (sensor data) and output parameters of the positioning module in Figure 3 are defined in 7.2 and 7.3, respectively.

NOTE 2 It is outside the scope of this document to define how the positioning system and which PVT sensors are implemented. The implementation of a positioning system in an ITS-SU generally includes a GNSS receiver as a primary PVT sensor, notably in a vehicle ITS-SU.

7.2 PVT-related input parameters

The PVT service may use various information sources. These sources can either be internal to the ITS-S, such as digital map information, or be external, such as differential corrections provided by the roadside infrastructure network.

Possible sources of PVT-related input information include:

— PVT input information provided by a GNSS receiver, for instance in the form of a standardized NMEA 0183[15] sentence (message), which provides 3D position, coordinated universal time and accuracy data (number of satellites being tracked and horizontal dilution of precision, HDOP). The position and velocity are provided in a global coordinate reference system (CRS) such as the World Geodetic System 84 (WGS84)[25] or the International Terrestrial Reference System (ITRS)[26].

— PVT-related input information provided by an inertial measurement unit (IMU), an electronic device that measures and reports the vehicle's specific force (typically along 3 axes), angular rate, and sometimes the magnetic field surrounding the vehicle, using a combination of accelerometers and gyroscopes, sometimes also magnetometers.

— The vehicle ground speed, or travelled distance provided by the odometer of the vehicle.

EXAMPLE 1 The number of pulses associated to the left and right wheels, available from the controller area network (CAN) bus, can be used to determine the vehicle's ground speed and its heading.

— Light detection and ranging (LIDAR)-based sensor data, providing distances to objects in the environment of the vehicle.

— Video camera-based sensor data, providing distances and directions between a given reference point of the vehicle and road markings, landmarks or points of interest in the environment of the vehicle.

— Any a priori information, such as a digital map, that can be used for data fusion purposes.

— Differential corrections for improving the accuracy of GNSS receivers, transmitted by any data transmission channel, for instance, the roadside infrastructure network or the cellular network.

EXAMPLE 2 RTCM 10403.3[17], designed specifically for the transmission of differential corrections coming from terrestrial networks of GNSS reference stations.

EXAMPLE 3 Corrections provided by a satellite-based augmentation system (SBAS), such as the European Geostationary Navigation Overlay Service (EGNOS) or the Wide Area Augmentation System (WAAS)[16]. These are generally provided by ground stations and geostationary satellites.

— PVT-related input information provided by the roadside and its environment (e.g. vehicles) or infrastructure, respectively.

EXAMPLE 4 PVT-related input information provided through V2X communications. For instance, the cooperative awareness message (CAM) generated by vehicles for traffic-safety applications, the SPaT information transmitted by the roadside infrastructure and LDM data as defined in ETSI EN 302 637-2[13], ISO/TS 19091[6], ISO 18750[5], respectively.

EXAMPLE 5 PVT-related input information provided by the cellular network as defined in ETSI TS 136 455[12].

EXAMPLE 6 Bluetooth® low energy beacon transmits a universally unique identifier, as defined in Bluetooth® Core Specification[27], which can be used by the ITS-SU to determine its position.

7.3 PVT output parameters

7.3.1 General

The PVT output parameters encompass part or all of the kinematics state vector of an ITS-SU providing the PVT service, e.g. the following parameters:

— `position`: the absolute geographical reference position of an object carrying an ITS-SU that provides the PVT service, where the reference position for different vehicles, roadside equipment and pedestrians shall be as defined in ETSI prEN 302 890-2[2)];

— `velocity`; the speed together with the heading associated with an ITS-SU;

— `acceleration`; the acceleration associated with an ITS-SU;

— `time`: the time associated with the position, velocity, acceleration or/and speed event of an ITS-SU.

2) Under preparation.

Table 1 provides an overview of the sets of PVT information specified in this document. Each set of PVT information, including provisions for the associated accuracy and PVT-related information, is specified in the subsequent subclauses. The complete associated ASN.1 type and value definitions to be used are specified in Annex A.

Table 1 — Sets of PVT information

PVT info set	PVT info set ID	Description
PvtInfoEcdd	1	Position, velocity, acceleration and time. Position and time according to ETSI TS 102 894-2 V1.3.1 (2018-08), also known as the ETSI Common Data Dictionary (ECDD). The definition of acceleration in this document is based on the definitions in the ECDD, the combination of lateral, longitudinal and vertical acceleration as defined in the ECDD, whilst noting that the ECDD does not explicitly define acceleration (with these three elements) as a data set. The definition of velocity in this document is based on definitions in the ECDD, the combination of speed together with heading as defined in the ECDD, whilst noting that the ECDD does not explicitly define velocity.
PvtInfoEcdd-PosVelocityTime	2	Position, velocity and time. It is a subset of pvtInfoEcdd.
PvtInfoEcdd-PosTime	3	Position and time according to ETSI TS 102 894-2 V1.3.1 (2018-08). It is a subset of pvtInfoEcdd.
PvtInfoEcdd-VelocityAccelerationTime	4	Velocity, acceleration and time. It is a subset of pvtInfoEcdd.
PvtInfoEcdd-VelocityTime	5	Velocity and time. It is a subset of pvtInfoEcdd.
PvtInfoEcdd-SpeedTime	6	Speed and time according to ETSI TS 102 894-2 V1.3.1 (2018-08). It is a subset of pvtInfoEcdd-VelocityTime, and consequently also of pvtInfoEcdd.
PvtInfoNmeaData	7	3-dimensional position, velocity and time and GNSS-receiver quality-related information as defined in ISO 17575-1, based on the NMEA 0183 Interface Standard[15].

The "PVT info set ID" of ASN.1 type `RefPvtInfo` (see the attached file identified in Annex A) presented in Table 1 is used in the service primitives specified in 8. The value zero identifies a Null-InfoSet, i.e. a non-existent PVT info set. The values 64 through 127 are dedicated to private (non-protected) use. All other values, i.e. 8 through 63 and larger than 127, are reserved for future CEN and ISO use.

NOTE It is possible that further sets of PVT information will be added in future editions of this document and in other standards.

7.3.2 PvtInfoEcdd

PvtInfoEcdd, which includes provisions for the associated accuracy for predefined confidence levels, is defined as follows:

— `position`: the geographical position as defined by `ReferencePosition` in ETSI TS 102 894-2 V1.3.1 (2018-08), A.124;

— `velocity`; the `Speed` together with the `Heading` of an ITS-S as defined in ETSI TS 102 894-2 V1.3.1 (2018-08), A.126 and A.112, respectively;

— `acceleration`; the combination of `LateralAcceleration`, `LongitudinalAcceleration` and `VerticalAcceleration` as defined in ETSI TS 102 894-2 V1.3.1 (2018-08) A.115, A.116 and A.129, respectively;

— `time`: the coordinated universal time associated with the position, velocity, acceleration or/and speed event of an ITS-S as defined by `TimestampIts` in A.82 in ETSI TS 102 894-2 V1.3.1 (2018-08).

NOTE 1 The defined parameters above conform to the definition of positioning and timing, as defined in 2.4 in Annex 2 to the draft Commission Delegated Regulation supplementing ITS Directive 2010/40/EU [18] of the European Parliament and of the Council with regard to the provision of the cooperative intelligent transport systems[19].

The ASN.1 type `ReferencePosition` specified in ETSI TS 102 894-2 V1.3.1 (2018-08) includes information related to the latitude, longitude, horizontal position accuracy and altitude (including accuracy). The WGS84[25] is used as the reference coordinate system for the geographical point. `ReferencePosition` is specified in ETSI TS 102 894-2 V1.3.1 (2018-08), A.124, and is given below in abbreviated form for the readability of this document:

```
ReferencePosition ::= SEQUENCE {
  latitude                    Latitude,
  longitude                   Longitude,
  positionConfidenceEllipse   PosConfidenceEllipse,
  altitude                    Altitude
}
```

where

— `Latitude`: latitude (in 0,1 micro degrees) of the geographical point, providing a range of 90 degrees in north or in south hemisphere. Positive values are used for latitude north of the Equator, negative values are used for latitude south of the Equator.

— `Longitude`: longitude (in 0,1 micro degrees) of the geographical point, providing a range of 180 degrees to the east or to the west of the prime meridian (which passes through the Royal Observatory, Greenwich, England). Negative values are used for longitudes to the west, positive values are used for longitudes to the east.

— `PositionConfidenceEllipse`: provides the absolute horizontal position accuracy (in centimetres) in a shape of ellipse with a predefined confidence level (e.g. 99,9 %). The centre of the ellipse shape corresponds to the reference position point for which the position accuracy is evaluated. The required confidence level of the position accuracy is defined by ITS message or ITS application applying this data frame.

— `Altitude`: ellipsoidal height (in 0,01 metre) above or below the ellipsoid of the geographical point and the associated absolute accuracy (e.g. 0,01, 0,02, 0,05, 0,1, ... 1, 5, 10, etc. greater than 200 metres or accuracy information is unavailable) for a predefined confidence level. The required confidence level is defined by the corresponding standards applying the usage of this data element.

NOTE 2 WGS84 represents a broadly adopted global geodetic reference system for the Earth for practical applications of mapping, geopositioning and navigation. Other terrestrial reference frames exist, notably the International Terrestrial Reference Frame (ITRF, the latest currently being ITRF2014, with ITRF2020 under preparation). It is possible to convert between the most commonly used terrestrial reference frames and the differences between them are typically in the order of centimetres. The international terrestrial reference frame is becoming increasingly recognized and used as the primary reference frame. All recent and up-to-date GNSS-specific terrestrial reference frames (WGS 84 for GPS, PZ-90 for GLONASS, the GTRF for Galileo, CGCS2000 for BeiDou, and the JGS for QZSS) are aligned to a primary ITRS realization, according to ISO 19161-1:2020, Annex C[7]. It would be beneficial for the next edition of the ECDD to refer to the International Terrestrial Reference System (ITRS)[26].

The ASN.1 type `Speed` includes information related to the speed and corresponding accuracy of the speed information for the moving object (e.g. vehicle), associated with the ITS-SU. `Speed` is specified in ETSI TS 102 894-2 V1.3.1 (2018-08), A.126, and is given below in abbreviated form for the readability of this document:

```
Speed ::= SEQUENCE {
  speedValue              SpeedValue,
  speedConfidence         SpeedConfidence
}
```

where

— `SpeedValue`: speed value (in 0,01 m/s).

— `SpeedConfidence`: the absolute accuracy (in cm/s) of a speed value information for a predefined confidence level.

The ASN.1 type `Heading` includes information related to the heading in a WGS84 coordinate system and the associated accuracy of the reported heading value, with a predefined confidence level. `Heading` is specified in ETSI TS 102 894-2 V1.3.1 (2018-08), A.112, and is given below in abbreviated form for the readability of this document:

```
Heading ::= SEQUENCE {
  headingValue                HeadingValue,
  headingConfidence           HeadingConfidence
}
```

where

— `HeadingValue`: orientation of a heading (in 0,1 degrees) with regards to the WGS84 north.

— `HeadingConfidence`: the accuracy (in 0,1 degrees) of the reported heading value with a predefined confidence level. The required confidence level is defined by the corresponding standards applying the data element.

The ASN.1 types `LateralAcceleration`, `LongitudinalAcceleration` and `VerticalAcceleration` as defined in ETSI TS 102 894-2 V1.3.1 (2018-08), A.115, A.116 and A.129, respectively, include information related to the vehicle acceleration at lateral, longitudinal acceleration and vertical direction and the associated accuracies. A brief description of these are provided below for the readability of this document.

```
LateralAcceleration ::= SEQUENCE {
  lateralAccelerationValue              LateralAccelerationValue,
  lateralAccelerationConfidence         AccelerationConfidence
}
LongitudinalAcceleration ::= SEQUENCE {
  longitudinalAccelerationValue         LongitudinalAccelerationValue,
  longitudinalAccelerationConfidence    AccelerationConfidence
}
VerticalAcceleration ::= SEQUENCE {
  verticalAccelerationValue             VerticalAccelerationValue,
  verticalAccelerationConfidence        AccelerationConfidence
}
```

where

— `LateralAccelerationValue`: lateral acceleration (in 0,1 m/s^2) and the associated accuracy for a predefined confidence level. Negative value indicates that the vehicle is accelerating towards the rights side, whereas positive value indicates that the vehicle is accelerating towards the left side, with regards to the vehicle orientation.

— `LongitudinalAcceleration`: longitudinal acceleration (in 0,1 m/s^2) and the associated accuracy for a predefined confidence level. Negative values indicate that the vehicle is breaking, whereas positive values indicate that the vehicle is accelerating.

— `VerticalAcceleration`: vertical acceleration (in 0,1 m/s^2) and the associated accuracy for a predefined confidence level. Negative values indicate that the vehicle is accelerating downwards, whereas positive values indicate that the vehicle is accelerating upwards.

The ASN.1 type `TimestampIts` carries the number of milliseconds since 2004-01-01T00:00:00.000Z, as specified in ISO 8601-1[1].

NOTE 3 It is outside the scope of this document to define the required accuracies of the PVT output parameters. In line with the approach adopted in ETSI TS 102 894-2 V.1.3.1 (2018-08), the required accuracy of the PVT parameters can be defined by the corresponding standards or specifications applying the usage of these (e.g. related to a specific C-ITS application or use case).

NOTE 4 The EN 16803 series[11] defines a framework for assessment of the performance of ITS GNSS-based terminals. It defines so-called protection levels of position and velocity in terms of their size (i.e. error bounds around the values provided by the positioning module), each of which is associated with an integrity risk (i.e. probability that the actual error for a given position or velocity exceeds the associated protection level). Integrity risk is the complementary probability of the confidence level (i.e. integrity risk = 1 – confidence level). EN 16803-2[11] can 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.

NOTE 5 The Commission Delegated Regulation (EU) 2017/79[20] defines technical requirements for compatibility of eCall in-vehicle systems with the positioning services provided by the Galileo and the EGNOS systems. These requirements are verifiable through application of the test procedures specified in the implementation guidelines for EGNOS/Galileo conformance testing associated with European regulation related to eCall in-vehicle systems[21]. The documents can be used as a source of inspiration or a blueprint by other C-ITS applications when formulating technical requirements for positioning services and the associated test procedures.

PvtInfoEcdd shall be associated with the ASN.1 type `PvtInfoEcdd` as specified in Annex A.

7.3.3 PvtInfoEcdd-PosVelocityTime

PvtInfoEcdd-PosVelocityTime is defined as follows:

— `position`: the geographical position as defined in 7.3.2;

— `velocity`: the velocity as defined in 7.3.2;

— `time`: the coordinated universal time as associated with the position and velocity event as defined in 7.3.2.

PvtInfoEcdd-PosVelocityTime shall be associated with the ASN.1 type `PvtInfoEcdd-PosVelocityTime` as specified in Annex A.

7.3.4 PvtInfoEcdd-PosTime

PvtInfoEcdd-PosTime is defined as follows:

— `position`: the geographical position as defined in 7.3.2;

— `time`: the coordinated universal time associated with the position event as defined in 7.3.2.

PvtInfoEcdd-PosTime shall be associated with the ASN.1 type `PvtInfoEcdd-PosTime` as specified in Annex A.

7.3.5 PvtInfoEcdd-VelocityAccelerationTime

PvtInfoEcdd-VelocityAccelerationTime is defined as follows:

— `velocity`: the velocity as defined in 7.3.2;

— `acceleration`: the acceleration as defined in 7.3.2;

— `time`: the coordinated universal time associated with the velocity and acceleration as defined in 7.3.2.

PvtInfoEcdd-VelocityAccelerationTime shall be associated with the ASN.1 type `PvtInfoEcdd-VelocityAccelerationTime` as specified in Annex A.

7.3.6 PvtInfoEcdd-VelocityTime

PvtInfoEcdd-VelocityTime is defined as follows:

— `velocity`: the `Speed` together with the `Heading` as defined in 7.3.2;

— `time`: the coordinated universal time associated with the velocity event as defined in 7.3.2.

PvtInfoEcdd-VelocityTime shall be associated with the ASN.1 type `PvtInfoEcdd-VelocityTime` as specified in Annex A.

7.3.7 PvtInfoEcdd-SpeedTime

PvtInfoEcdd-SpeedTime is defined as follows:

— `speed`: as defined in 7.3.2;

— `time`: the coordinated universal time associated with the speed event as defined in 7.3.2.

PvtInfoEcdd-SpeedTime shall be associated with the ASN.1 type `PvtInfoEcdd-SpeedTime` as specified in Annex A.

7.3.8 PvtInfoNmeaData

PvtInfoNmeaData contains a selection of data elements in the NMEA 0183 Interface Standard[15] as defined by NmeaData in ISO 17575-1. This selection represents the Recommended Minimum Sentence C (RMC), but leaving out data about magnetic variation, and extended with additional data (altitude, usedSatellites, HDOP) from other NMEA sentences.

The semantics of the elements of NmeaData shall be as defined in ISO 17575-1:2016, 7.6.11.

NOTE The data elements of NmeaData are specified in ISO 17575-1 with the following components:

— `time`: in hours, minutes, seconds and milliseconds;

— `status`: status indicator (ok or warning) of the GNSS receiver;

— `latitude`: latitude coordinate to the corresponding real position in WGS84, per default unless mutually otherwise agreed;

— `latNS`: direction of latitude, indicates whether north or south of equator;

— `longitude`: longitude coordinate to the corresponding real position in WGS84, per default unless mutually otherwise agreed;

— `longEW`: direction of longitude, indicates whether east or west of prime meridian

— `speed`: speed in km/h

— `heading`: track angle in degrees

— `date`: in day, month and year (year 2000 AD coded as 00)

— `signalIntegrity`: mode of operation (autonomous, differential, estimated (dead reckoning), manual input or simulated mode; data not valid)

— `altitude`: altitude above WGS84 in metres

— `usedSatellite`: number of satellites used to calculate the position

— `hdop`: horizontal dilution of precision. It is an indication of the effect of satellite geometry on the accuracy of the positioning-related data. It is a unitless number where smaller is better. When visible navigation satellites are close together in the sky, the geometry is said to be weak and the HDOP value is high; when far apart, the geometry is strong and the HDOP value is low.

8 PVT-SAP service primitives

8.1 General

8.1.1 Overview

The PVT services specified in this document can be implemented either in the context of C-ITS services deployed in accordance with the ITS station and communication architecture specified in ISO 21217 and ISO 24102-6 or in the context of other deployments.

Table 2 lists the defined PVT services, which are subsequently defined in more details in 8.2 and 8.3. An implementation of the PVT service(s) compliant with this document shall provide at least one of the services listed in Table 2.

Table 2 — PVT Services

Service name	Description
PVTquery	Provides PVT information immediately upon request from an ITS-S-AP. See Get-PVT-related service primitives in 8.2.
PVTinfoSubscription	Provides PVT information periodically to the ITS-S-AP subscriber. See Subscribe-PVT-related service primitives in 8.3.

The requirements defined in the following subclauses relate to a PVT-Service Access Point (PVT-SAP) with service primitives that can be mapped to the SAPs specified in ISO 21217 and ISO 24102-3[2], i.e. the PVT-SAP service primitives can show up as service functions in the respective service primitives specified in ISO 24102-3[9].

The following subclauses define the details of the PVT-SAP used to provide information between the PVT service located in the ITS-S facilities layer and the user of the PVT service. The corresponding ASN.1 type and value definitions are provided in Annex A.

8.1.2 PVTinit

Whenever the PVT service is initialized, it shall report its presence and the provided services presented in Table 2, using the PVT-SAP service primitives of ASN.1 types `PvtSapRegMngtRq` and `PvtSapRegMngtCf` as defined in Annex A, to the ITS station management entity.

Based on this information, the ITS station management entity can interact with the path and flow management as specified in ISO 24102-6.

8.1.3 Return codes

The ASN.1 type and values for the PVT-SAP return code applicable to this document shall be as specified in Table 3.

Table 3 — PVT-SAP return codes of ASN.1 type `PvtSapReturnCode`

Return Code	ASN.1 value	Description
pvtReturnCode-OK	0	Request is correctly processed
pvtReturnCode-Unavailable	1	PVT facilities service not available
pvtReturnCode-InfoUnavailable	2	Service available, but the requested information not provided
pvtReturnCode-NoSubscription	3	Only used in CancelCf
pvtReturnCode-PFMnotSupported	4	ISO 24102-6 not supported

8.2 Get-PVT

The PVT-SAP service primitive `Get-PVT-Rq` shall be used by an ITS-S-AP to request immediate provision of PVT information. ASN.1 types and values for `Get-PVT-Rq` shall be in accordance with Table 4.

Table 4 — PVT-SAP service primitive Get-PVT-Rq of ASN.1 type `PvtSapGetRq`

Component name	ASN.1 Type	Description
`appId`	`ITSsapiid`	Identifier of the requesting ITS-S-AP
`pvtInfoOption`	`RefPvtInfo`	Reference to the specific requested set of PVT information

Upon reception of a service primitive `Get-PVT-Rq` the PVT service shall check the validity of the parameters provided by the requesting ITS-S-AP.

If the request is valid, then the PVT service shall return the requested PVT information using `Get-PVT-Cf` as specified in Table 5 and with the return codes as specified in Table 3.

If the request is not valid, then the PVT service shall report an error in accordance with 8.1.3.

Table 5 — PVT-SAP service primitive Get—PVT-Cf of ASN.1 type `PvtSapGetCf`

Component name	ASN.1 Type	Description
`appId`	`ITSsapiid`	Identifier of the requesting ITS-S-AP
`returnCode`	`PvtSapReturnCode`	Applicable return codes are specified in Table 3.
`Pvtinfo`	`PVTinfo`	PVT information. In case of error return `PvtInfoNull`

NOTE `Get-PVT-Rq` is also used e.g. by the FSH (see ISO/TS 17429) to obtain PVT information used for PVT-stamping of ITS-FPDUs.

8.3 Subscribe-PVT-related service primitives

8.3.1 Subscribe-PVT

The PVTinfoSubscription service maintains information on instances of ITS-S-APs (identified by `ITSsapiid`, see also Table 6) that subscribe to the reception of PVT information. The method to maintain this information is implementation-specific and outside the scope of this document.

The PVT-SAP service primitive `Subscribe-PVT-Rq` shall be used by an ITS-S-AP to subscribe to the provision of PVT information. ASN.1 types and values for `Subscribe-PVT-Rq` shall be in accordance with Table 6.

Table 6 — PVT-SAP service primitive Subscribe-PVT-Rq of ASN.1 type `PvtSapSubscribeRq`

Component name	ASN.1 Type	Description
`appId`	`ITSsapiid`	Identifier of the ITS-S-AP requesting subscription to PVT information
`subscriptionId`	`PvtSubscriptionId`	Identifier of a specific subscription within the ITS-S-AP
`trigger`	`RefPvtTrigger`	Reference to the requested specific triggering mechanism of a PVT subscription notification
`pvtInfoOption`	`RefPvtInfo`	Reference to the specific requested set of PVT information

Upon reception of a PVT service primitive `Subscribe-PVT-Rq` the PVT service shall check the validity of the parameters provided by the requesting ITS-S-AP.

If the subscription request is valid, then `ITSsapiid` and related parameters shall be noted and maintained until the subscription is cancelled by the requesting ITS-S-AP; see 8.3.3. Further, the PVT service shall then confirm `Subscribe-PVT-Rq` with `Subscribe-PVT-Cf`, which shall only carry the return codes as specified in Table 7.

If the subscription request is not valid, then the PVT service shall report an error in accordance with 8.1.3.

Table 7 — PVT-SAP service primitive Subscribe-PVT-Cf of ASN.1 type `PvtSapSubscribeCf`

Component name	ASN.1 Type	Description
`appId`	`ITSsapiid`	Identifier of the requesting ITS-S-AP
`subscriptionId`	`PvtSubscriptionId`	Identifier of a specific subscription within the ITS-S-AP
`returnCode`	`PvtSapReturnCode`	Applicable return codes are specified in Table 3.

PVT information shall be provided to the requesting ITS-S-AP as indicated in 8.3.2

8.3.2 Notify-PVT

Whenever new PVT information corresponding to the subscription request of an ITS-S-AP AP is available, this new PVT information shall be provided to the ITS-S-AP using the PVT service primitive `Notify-PVT-Rq`. ASN.1 types and values for `Notify-PVT-Rq` shall be in accordance with Table 8.

Table 8 — PVT-SAP service primitive Notify-PVT-Rq of ASN.1 type `PvtSapNotifyRq`

Component name	ASN.1 Type	Description
appId	ITSsapiid	Identifier of the ITS-S-AP that requested subscription to PVT information
subscriptionId	PvtSubscriptionId	Identifier of a specific subscription within the ITS-S-AP
pvtinfo	PVTinfo	PVT information. In case of error return `PvtInfoNull`

`Notify-PVT-Rq` shall not be confirmed.

8.3.3 Cancel-PVT

The PVT-SAP service primitive `Cancel-PVT-Rq` shall be used by an ITS-S-AP to cancel the subscribed provision of PVT information. ASN.1 types and values for `Cancel-PVT-Rq` shall be in accordance with Table 9.

Table 9 — PVT-SAP service primitive Cancel-PVT-Rq of ASN.1 type `PvtSapCancelRq`

Component name	ASN.1 Type	Description
appId	ITSsapiid	Identifier of the ITS-S-AP requesting subscription to PVT information
subscriptionId	PvtSubscriptionId	Identifier of a specific subscription within the ITS-S-AP

Upon reception of a PVT service primitive `Cancel-PVT-Rq` the PVT service shall check the validity of the request.

If the request originated from a valid previously noted ITS-S-AP, all information related to the ITS-S-AP, identified by `ITSsapiid` shall be invalidated by the PVT service.

If the request is valid, then the PVT service may acknowledge the request using `Cancel-PVT-Cf` as defined in Table 10.

Table 10 — PVT-SAP service primitive Cancel-Cf of ASN.1 type `PvtSapCancelCf`

Component name	ASN.1 Type	Description
appId	ITSsapiid	Identifier of the requesting ITS-S-AP
subscriptionId	PvtSubscriptionId	Identifier of a specific subscription within the ITS-S-AP
returnCode	PvtSapReturnCode	Applicable return codes are specified in Table 3.

9 PVT capability

The PVT service specified in this document can be implemented either:

1. in the context of C-ITS services deployed in conformance with the ITS station architecture specified in ISO 21217 and related standards, or
2. in the context of other architectures.

The requirements in this clause only apply to implementations in the above-mentioned context 1.

The PVT service shall be provided as an ITS-S capability (hereinafter referred to as a PVT capability) as specified in ISO 24102-6.

General requirements applying to all ITS-S capabilities shall apply to the PVT capability:

— The PVT capability is identified by the globally unique ITS-S capability identifier equal to 1.

NOTE 1 ITS-S capabilities are identified by globally unique identifiers. Management of such numbers is the task of the ISO ITS registration authority.

— The PVT capability can provide several ITS-S facilities layer services. Each service provided by the ITS-S capability is identified by the globally unique ITS-S facilities service identifier. Table 11 lists the PVT facilities services, and the associated ITS-facilities layer identifiers, that can be provided by the PVT capability.

Table 11 — Services provided by the PVT capability

Service name	ITS-S facilities layer service identifier	Description
PVTquery	1	Provides PVT information immediately upon request from an ITS-S-AP. See 8.2 for details.
PVTinfoSubscription	2	Provides PVT information periodically to subscribed ITS-S-AP. See 8.3 for details.

NOTE 2 ITS-S facilities services are identified by globally unique identifiers. Management of such numbers is the task of the ISO ITS registration authority.

— The PVT capability shall interact with the ITS station management entity using the service functions of the MF-SAP with ASN.1 code defined in ISO 24102-6:2018, Annex A.

Annex A
(normative)

PVT data type specifications

This annex presents the abstract syntax notation one (ASN.1) type and value definitions related to

— the PVT output parameters specified in 7.3,

— the PVT-SAP service primitives specified in Clause 8,

to be used in accordance with the ASN.1 technique specified in ISO/IEC 8824-1. Applicable encoding rules, e.g., unaligned packed encoding rules specified in ISO/IEC 8825-2[2], depend on the usage of the PVT service as specified elsewhere.

The actual ASN.1 module is contained in the attached file "ISO21176(2020)C-itsPvtV1.asn", which can be directly imported in a compiler.

The syntax and semantics of the data types in the ASN.1 types in the attached file "ISO21176(2020) C-itsPvtV1.asn" that are imported shall comply with ETSI TS 102 894-2 V.1.3.1 (2019-08), ISO 17575-1, ISO/TS 17429 and ISO 24102-6, respectively.

NOTE 1 The above referenced file (i.e. "ISO21176(2020)C-itsPvtV1.asn") is available for download via a hyperlink at https://www.itsstandards.eu/cits and https://standards.iso.org/iso/ts/21176/.

Table A.1 provides the SHA-256 cryptographic hash digest for the referenced file, offering a means to verify the integrity of the referenced file. The SHA-256 algorithm is specified in NIST 180-4[14].

Table A.1 — SHA-256 cryptographic hash digest

File Name	SHA-256 cryptographic hash digest
`ISO21176(2020)C-itsPvtV1.asn`	BAA7C3E3B39860E12E83FE8AC58AE011A0EDC18DFDAECC9CFD32A5437437C22E

NOTE 2 Pasting the text of the file into one of the hash digest computation pages available on the web can result in a non-matching hash digest due to changes in the underlying coding.