TECHNICAL SPECIFICATION

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Intelligent transport systems — Cooperative ITS — ITS station facilities for the transfer of information between ITS stations

Systèmes intelligents de transport — ITS coopératifs — Fonctionnalités des stations ITS pour le transfert d'information entre stations ITS

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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 on 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 the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 204, *Intelligent transport systems*.

Introduction

ITS station units compliant with the ITS station reference architecture specified in ISO 21217 may engage in Cooperative ITS (C-ITS) activities involving data exchanges between ITS stations in a variety of roles. Such data exchanges include, but are not limited to:

— data collected by the roadside infrastructure and transmitted to traffic control centers, possibly after aggregation,

— roadside equipment configured from the control centers to process a given set of data or issue messages to vehicles,

— roadside events reported to control centers, and

— broadcast transmission of vehicle status and event messages (e.g. CAM) to nearby ITS stations.

An example of an ITS station unit engaged in a C-ITS activity is a roadside ITS station unit collecting traffic-related information generated by road sensors and/or by vehicle ITS station units. The collected data can often serve other purposes than the originally intended one. For example, the cooperative awareness message (CAM) from the ETSI C-ITS message set generated for traffic-safety applications can be collected by roadside ITS station units for exploitation by traffic efficiency applications in traffic control centers (e.g. central ITS stations). The same information is thus used to improve road safety, as well as traffic efficiency and also to reduce greenhouse gas emissions.

The exploitation of such exchanges for purposes not initially intended is made possible once this exchange of information is performed in a standardized way through an ITS station facilities layer that is able to recognize messages from specific message sets (e.g. DATEX II, TPEG, C-ITS message sets) with data according to data object specifications from data dictionaries (e.g. the common ETSI data dictionary) and to forward them to applications which have an interest therein and have subscribed to the delivery of such message(s) and data. A Communication Profile Handler (CPH), a Facilities Services Handler (FSH*)* and a Content Subscription Handler (CSH) are defined in this Technical Specification to serve this purpose.

Outside of this Technical Specification, the commonly used term “message set” is used to indicate a collection of “messages” used in the exchange of information between peer ITS station units (see ISO/TS 17419). These messages are composed of structures sometime referred to as “data frames” and/or “data objects” which are in turn composed of objects called “data elements” (see SAE J2735). Herein, a slightly different lexicon is adopted. The term “data dictionary” is used to indicate a collection of “messages”, including “data object” from which the messages are composed. Thus, herein, “data objects” are synonymous with “data frames” and “data elements”. However, in this Technical Specification, the terms are used with the precise meaning to distinguish messages and data objects from which messages are constructed.

The functionalities specified in this Technical Specification include a Communication Profile Handler (CPH), a Facilities Services Handler (FSH), and a Content Subscription Handler (CSH). These functionalities are intended to enable, and be invoked by, technology-agnostic ITS applications and to facilitate the deployment of C-ITS applications that share information. In particular, these functionalities allow an application to

— specify a set of facilities layer services to be applied to its data units (ADUs),

— allow ITS station management to select the optimum communication profile (as a function of time) for any or all of its data flows, and

— publish information to and subscribe to information from a central repository (the CSH) in a standardized way that enables sharing of information between applications (the definition of C-ITS).

These functionalities provide a toolkit facilitating the specification of standards and the development of ITS applications [e.g. In-Vehicle Signage (ISO/TS 17425), Contextual Speed (ISO/TS 17426), Point of

Interest, Probe Data, IVI, LDM synchronization, remote ITS station configuration, and ITS applications for freight, logistics, public transportation, etc.] complying with the set of Cooperative ITS standards.

Intelligent transport systems — Cooperative ITS — ITS station facilities for the transfer of information between ITS stations

1 Scope

This Technical Specification specifies generic mechanisms enabling the exchange of information between ITS stations for applications related to Intelligent Transport Systems. It complies with the ITS station reference architecture (ISO 21217) and defines the following ITS station facilities layer functionalities:

— Communication Profile Handler (CPH);

— Content Subscription Handler (CSH);

— Facilities Services Handler (FSH).

These functionalities are used by ITS-S application processes (ITS-S-AP) to communicate with other ITS-S application processes and share information. These functionalities describe

— how lower-layer communication services assigned to a given data flow are applied to the service data units at the various layers in the communication protocol stack (CPH, see 6.2.3),

— how content from data dictionaries can be published and subscribed to by ITS-S application processes (CSH, see 6.2.5),

— how well-known ITS station facilities layer and management services can be applied to application process data units (FSH, see 6.2.4), relieving (ITS-S) application processes from having to implement these services on their own,

— how service access points (SAP) primitives specified in ISO 24102-3 are used,

— service primitives for the exchange of information between ITS-S application processes and the ITS station facilities layer (FA-SAP), and

— a set of communication requirements and objectives (profiles) using the methods defined in ISO/TS 17423 to select the level of performance (best effort or real-time, etc.), confidence and security (authentication, encryption, etc.) for information exchange between ITS stations, such as data provision, event notification, roadside configuration, map update.

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/TS 17419, *Intelligent transport systems — Cooperative systems — Classification and management of ITS applications in a global context*

ISO/TS 17423, *Intelligent transport systems — Cooperative systems — ITS application requirements and objectives for selection of communication profiles*

ISO 21217, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

ISO 24102-3, *Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management — Part 3: Service access points*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
ITS-S application
ITS-S application process residing in the ITS-S application entity

[SOURCE: ISO 21217:2014, 3.18]

3.2
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

Note 1 to entry: Examples of ITS-S application processes are contextual speed (ISO/TS 17426) and In-Vehicle Signage (ISO/TS 17425).

[SOURCE: ISO 21217:2014, 3.19]

3.3
ITS-S capability
ITS-S capabilities
uniquely addressable protocol functionality

Note 1 to entry: Examples of ITS-S capabilities are Content Subscription Handler (CSH), *Facilities Service Handler* (FSH), Communication Profile Handler (CPH).

[SOURCE: ISO 24102-6:2015, 3.6]

3.4
ITS-S facilities layer protocol data unit
ITS-FPDU
protocol data unit assembled by the Facilities Services Handler in the ITS-S facilities layer consisting of nested protocol data units exchanged between peer facilities layer services in ITS-S

3.5
ITS-S communication profile
parameterized ITS-S communication protocol stack

[SOURCE: ISO/TS 17423:2014, 3.7]

3.6
ITS-S data container
sequence of type-length-value (TLV) encoded data objects

3.7
ITS-S data header
header of the "ITS-S generic data container format" uniquely identifying the data contained in the ITS-S data containers by means of data dictionary identifiers unique in the ITS domain and the number of data objects from the data dictionary in the container

3.8
ITS-S flow
identifiable sequence of packets of a given ITS-S flow type transmitted between a source node and a destination node

[SOURCE: ISO 24102-6:2015, 3.6]

3.9
ITS-S flow identifier
ITS-S-FlowID
identifier, being unique within the ITS station, that identifies an ITS-S flow

[SOURCE: ISO 24102-6:2015, 3.6]

3.10
ITS-S flow type
set of characteristics describing a data flow

[SOURCE: ISO 24102-6:2015, 3.6]

3.11
ITS-S flow type identifier
ITS-S-FlowTypeID
identifier, being unique within the ITS station that identifies an ITS-S flow type

[SOURCE: ISO 24102-6:2015, 3.6]

3.12
ITS-S generic data container format
format of an ADU exchanged between an "ITS-S application process" and a Content Subscription Handler (CSH) or between two peer CSHs containing an "ITS-S data header" and followed by a number of "ITS-S data containers"

3.13
ITS-S facilities header
header used to form an "ITS-S facilities layer protocol data unit"

3.14
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".

3.15
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 & transport layer (IPv6, FNTP, GeoNetworking, 6LoWPAN, etc.), and MSEGenFac, the entity comprising the generic ITS-S facilities services specified in this Technical Specification (CPH, CSH, the FSH and possibly more).

[SOURCE: ISO 24102-6:2015, 3.14]

3.16
registered ITS-S flow
ITS-S flow that has been allocated an ITS-S-FlowID

4 Abbreviated terms

ADU	application data unit
BSMD	bounded secured managed domain (see ISO/TS 17419)
BSME	bounded secured managed entity (see ISO 21217)
C-ITS	cooperative ITS
CPH	Communication Profile Handler
CSH	Content Subscription Handler
FSH	Facilities Services Handler
ITS	intelligent transport systems (see ISO/TS 17419)
ITS-FlowTypeID	ITS flow type identifier (see ISO/TS 17423)
ITS-FPDU	ITS station facilities layer protocol data unit (see ISO 21217)
ITS-FSDU	ITS station facilities layer service data unit (see ISO 21217)
ITS-PN	ITS port number (see ISO/TS 17419)
ITS-S	ITS station (see ISO 21217)
ITS-S-AP	ITS-S application process (see ISO 24102-6)
ITS-S MSE	ITS-S managed service entity
ITS-SCP	ITS station communication profile (see ISO/TS 17423)
ITS-S-FlowID	ITS station flow identifier (see ISO 24102-6)
LDM	local dynamic map
MSEGenFac	generic facilities ITS-S MSE
MSEGenFacID	generic facilities ITS-S MSE identifier
SME	station management entity

5 Conformance

Details on conformity of equipment with this Technical Specification and on conformance tests are specified in the multipart ISO 20594[1)]:

— ISO 20594-1;

— ISO 20594-2;

— ISO 20594-3.

1) Under development.

6 Overview

6.1 Motivations

6.1.1 Communication services

Abstracting applications from the communications services used to exchange information between peer entities is a useful basic architectural principle of intelligent transport systems (ITS) embodied in the ITS station and communication architecture presented in ISO 21217. Applications and the communications services they use are linked together using the concepts of paths and flows and communication profiles described in ISO 21217 with related path and flow management procedures specified in ISO 24102-6. The ITS station management entity (SME) uses communication requirements and objectives provided by the ITS station application processes (ITS-S-AP) as specified in ISO/TS 17423 together with the "ITS-S capabilities" of each layer, dynamic information provided by each layer (computed internally or collected from neighbour ITS stations) and sets of decision rules (regulations and policies) to select the most suitable ITS-S communication protocol stack, also referred to as ITS-S communication profiles (ITS-SCP), for each source of a potential flow as illustrated in Figure 1.

A set of communication requirements is referred to as a flow type (ITS-FlowType) in ISO 24102-6. There are well-known registered Flow Types as specified in ISO/TS 17419. A flow identifier (ITS-S-FlowID) which is unique within the ITS station is provided to the requesting ITS station application process and the decision rules are communicated by the ITS station management entity to the relevant ITS station layers in the ITS station. The procedures for the management of paths and flows are out of scope of this Technical Specification and are defined in ISO 24102-6.

The flow identifier is used by the Communication Profile Handler (CPH) (see 6.2.3) to determine the actions to be applied to each application data unit (ADU) (see Figure 6), presented by an ITS station application process for transmission using lower layer communication services. From this flow identifier pointing to the ITS-S communication profile selected by the ITS station management entity, the Communication Profile Handler determines, amongst other things, how to perform address resolution, whether security actions have to be performed (by the ITS station security entity), and how to prepare the service data units (ITS-SDUs) for processing by the next lower layer. As shown in Figure 4, at the facilities layer, the CPH passes the ADU to the facilities service handler (FSH) for applying well-known facilities layer services to the ADU, if requested by the ITS station application process, to form an ITS-FSDU for transmission to the ITS station networking and transport layer.

The mechanisms presented in this Technical Specification and in ISO 24102-6 allow dynamic selection of the best protocol stack at any given time and location according to the current resources (available access technologies, available communication capabilities of the destination, etc.). For example, an ITS station implementing such capabilities could transmit data using an IP communication stack in one situation and a non-IP communication stack in another situation (network protocol agnostic). Similarly, data could be transmitted using a long-range communication technology (e.g. 3G[8]) in one situation and a short-range communication technology (e.g. 802.11[9]) in another situation, transparently to the application (access technology agnostic). This eases deployment as applications can function properly in different deployment scenarios and in situations where different communication technologies are available. Such applications would also easily cope with the deployment of new communication technologies.

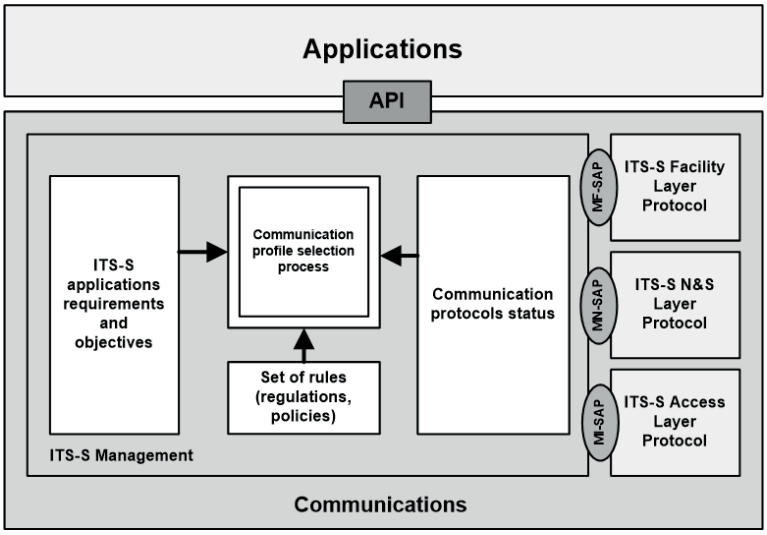

Figure 1 — ITS-S communication profile selection process (ISO/TS 17423)

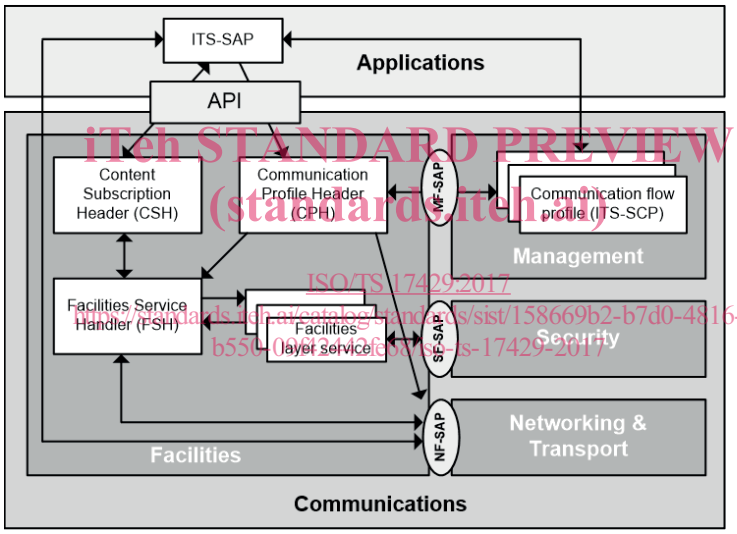

Figure 2 — ITS station facilities layer functionalities

6.1.2 General purpose ITS station facilities layer services

ITS stations generally host a number of applications that instantiate various ITS-related services. These applications, in turn, make use of ITS-S services to perform their functions. A number of these ITS-S services reside in OSI layers 5 through 7 (session, presentation, and application layers respectively) and are invoked by many applications. Examples of actions that are commonly performed include:

— determination of a network address of the destination(s) identified by e.g. a name (group name), a URL or a geographic location;

— determination of a communication protocol stack to be used to reach the destination(s);

— addition of a time-stamp to the payload at the source;

— addition of a geo-stamp to the payload at the source;

— addition of non-repudiation material to the payload at the source and assessing the correctness of the payload at the destination;

— addition of authentication material (a certificate) to the payload at the source and authentication of the source at the destination;

— encryption of the payload at the source and decryption at the destination;

— compression of the payload at the source and decompression at the destination.

Once generic services that perform these and similar common actions are standardized and instantiated in the ITS-S facilities layer, they are available to all applications. The availability of such services can simplify, the development of applications thereby decreasing development costs and application complexity. Furthermore, it allows applications to make use of upgrades to such services seamlessly.

The Facilities Services Handler (FSH) described in 6.2.4 and specified in Clause 10 provides a mechanism for applying generic services (ITS-S facilities services) to payloads (ADUs) transmitted by applications (ITS-S APs) upon their request. Performing any of these generic services requires the definition of an ITS-S facilities layer header carrying the information necessary to perform the reverse action associated with each service at the destination of the data (encryption/decryption, compression/decompression, etc.).

The number of ITS-S facilities services supported by the Facilities Services Handler is extensible by means of a generic services registry. New services can be installed in the ITS-S facilities layer at any time, without requiring modifications to this Technical Specification. The registration mechanism supports global, regional, or local services, as well as well-known and proprietary services.

In order for successful exchange of ADUs between peer ITS-S-APs to occur, the services applied on transmission generally must be available at the receiver so the reverse actions can be performed. Mechanisms for ensuring service availability at both transmitting ITS-S-APs and peer receiving ITS-S-APs are outside the scope of this Technical Specification. Such mechanisms can include application level negotiation, inclusion of appropriate information in service advertisements, and system configuration requirements on ITS-Ss with service push and update functionality.

6.1.3 Information sharing services

Messages exchanged between ITS stations contain information that is often useful to a number of applications, not only the peer application receiving the message, and not only ITS applications. For instance, the speed of vehicles contained in messages collected by the roadside infrastructure could be used by an application to assess traffic congestion and at the same time be used by another application to estimate pollution levels. While the information being processed is the same, the services are quite different.

Different applications would indeed compute new information based on the aggregation of different pieces of data. This can be done to the condition the type of data can easily be identified and can easily be divided into atomic pieces.

Messages sent by vehicles, the roadside infrastructure and control centers generally contain data formatted differently according to the purpose of the messages, the organization in charge of defining the format, and the region where they are used. For instance the cooperative awareness message (CAM) specified in ETSI 102 637-2 [15] and the decentralized environmental notification message (DENM) specified in ETSI 102 637-3 [16] have been defined by ETSI; ISO and CEN have defined messages for In-Vehicle Signage (ISO/TS 17425)[1], Contextual Speed (ISO/TS 17426)[2], and signal phase and timing (SPAT) (ISO/TS 19091)[5]. DATEX II, TPEG, SAE J2735 [18] are other messages sets that are heavily used.

Several of the defined messages contain similar basic pieces of information (e.g. vehicle speed or type, time, geographic position, road identification) and each message or set of messages contains a variety of these basic pieces of information. This results in redundancies and inefficiencies unless the data contained in these messages is presented according to a harmonized reference model.

This Technical Specification provides specifications for a generic means for the sharing of information from well-known message sets. These include:

— Specification of a generic data container (message) format (ITS-S generic data container format) made of a header (ITS-S data header) containing an identifier of the data dictionary and a number