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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Contents

Page

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.

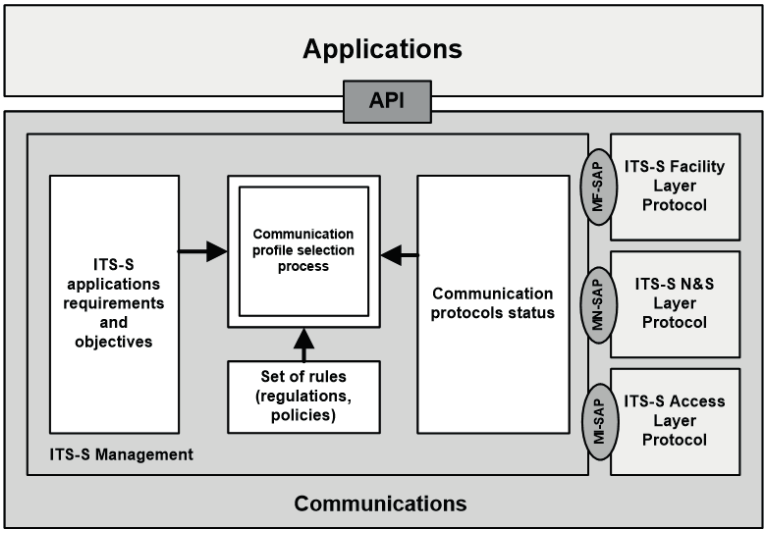


Figure 1 — ITS-S communication profile selection process (ISO/TS 17423)

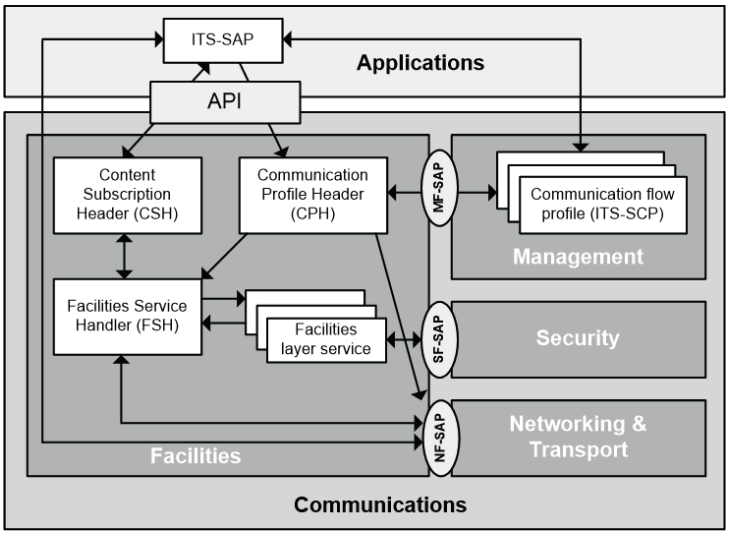


Figure 2 — ITS station facilities layer functionalities

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

indicating the quantity of data objects (ITS-S data container) from this data dictionary. This ITS-S facilities layer header is processed by the Facilities Services Handler (FSH) specified in Clause 10.

— Definition of a functionality allowing applications to publish data objects to and to subscribe to the reception of a specific data object from a given data dictionary. This functionality is provided by the Content Subscription Handler (CSH) specified in Clause 11.

The mechanisms defined in this Technical Specification allow information developed for specific services and purposes to be shared among applications that can make beneficial use of such information. The messages can contain data objects from well-known and publicly available data dictionaries or restricted proprietary data dictionaries to the condition data dictionaries are registered and identified by a globally unique data dictionary identifier.

These mechanisms allow the harmonization of the transmission and handling of messages defined for various use cases and fulfilling regional requirements, while preserving specific interests of all stakeholders. The number of means to use and combine data objects contained in messages is limitless and opens the door to innovative applications.

6.2 Technical specification overview

6.2.1 Architecture elements

This Technical Specification defines new functionalities of the ITS-S facilities layer of the ITS station reference architecture specified in ISO 21217, and the interaction of the ITS-S facilities layer with other layers and entities of the ITS station reference architecture.

— Clause 8 specifies additional requirements for ITS-S application processes (ITS-S-AP) in order to use the ITS-S facilities layer capabilities specified in this Technical Specification.

— Clause 9 specifies the Communication Profile Handler (CPH) capability within the ITS-S facilities layer. This capability simplifies the exchange of information between ITS station units or within an ITS station unit, i.e. between distinct nodes (ITS-SCUs) of the same ITS station unit.

— Clause 10 specifies the Facilities Services Handler (FSH) capability within the ITS-S facilities layer. This capability appends an ITS-S facilities layer header to the application data unit (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.

— Clause 11 specifies the Content Subscription Handler (CSH) capability of the ITS-S facilities layer. This capability is used to deliver content formatted according to the “ITS-S generic data container format” to all ITS-S application processes which have subscribed to the reception of data objects from a data dictionary.

— Clauses 12 and 13 specify the service access points (SAP) by means of which the ITS-S facilities layer interacts with ITS-S application processes (ITS-S-APs) and with the ITS-S networking and transport layer.

— Annex A provides ASN.1 definitions.

— Annex B provides an examples of communication profiles for which services specified in this Technical Specification are necessary.

ITS station architecture elements considered in this Technical Specification are illustrated in Figure 3.

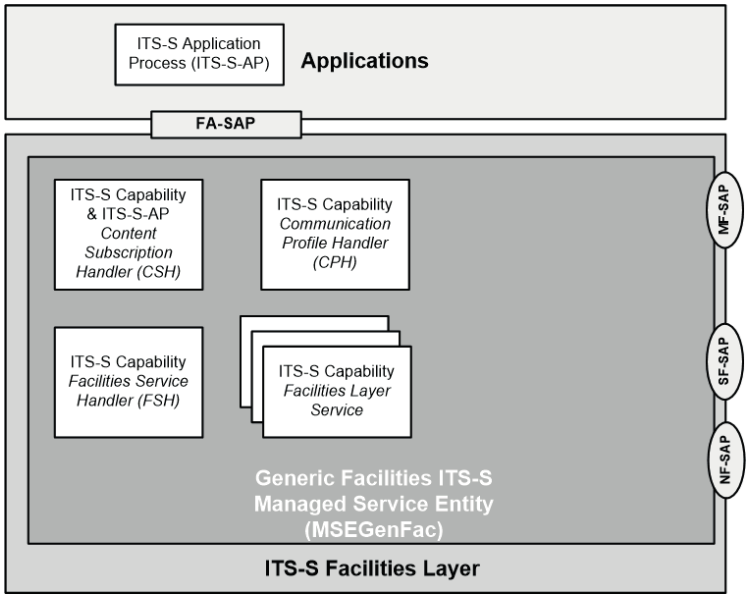


Figure 3 — ITS station architecture elements considered in this Technical Specification

6.2.2 ITS-S application processes

As indicated in ISO/TS 17423, an ITS-S application process (ITS-S-AP) may reside in the ITS-S application entity (above the communication stack), the ITS-S management entity or any of the ITS-S layers. Examples of ITS-S-APs include the following.

— ITS-S-APs located in the ITS-S application entity: e.g. Contextual Speed (ISO/TS 17425)[1], In-Vehicle Signage (ISO/TS 17426)[2], Point of Interest, Electric Vehicle Charging Spot.

— ITS-S-APs located in the ITS-S management entity: e.g. remote ITS station management (ISO 24102-2)[12], the ITS station internal management communication (ISO 24102-4)[13], the Fast Service Advertisement Protocol (ISO 24102-5)[14], or the ITS-S security entity (e.g. certificate collection).

— ITS-S-APs located in the ITS-S facilities layer: e.g. LDM,[4] and possibly CAM,[15], DENM[16] once ITS-FSDUs are presented to the ITS-S facilities layer in a manner complying with ISO/TS 17423 and ISO/TS 17419.

In order to use ITS-S facilities layer functionalities to communicate with peer ITS-S-APs, an ITS-S-AP shall first register its communication requirements to the ITS-S management entity (SME) using the procedures specified in ISO/TS 17423. This first-step registration must be performed for each "communication source" identified by an InterfaceNo (see ISO/TS 17423:2014, 5.1) and its ITS-S flow type. As a result of a successful communication requirements registration, the requesting ITS-S-AP obtains an ITS-S flow type identifier (FlowTypeID) from the ITS-S management entity for each registered communication source. This informs the ITS-S-AP that the ITS station has the necessary ITS-S capabilities to support ITS-S flows with characteristics of such ITS-S flow types.

Before transmitting, anITS-S-AP shall register its ITS-S flows corresponding to the registered ITS-S flow types and the communication sources using the methods specified in ISO 24102-6. This second step registration shall be performed for each destination to which ADUs are to be sent. As a result of each successful ITS-S flow registration, the requesting ITS-S-AP obtains an ITS-S flow identifier (ITS-S-FlowID) from the ITS-S management entity. The ITS-AP can now start transmitting ADUs.

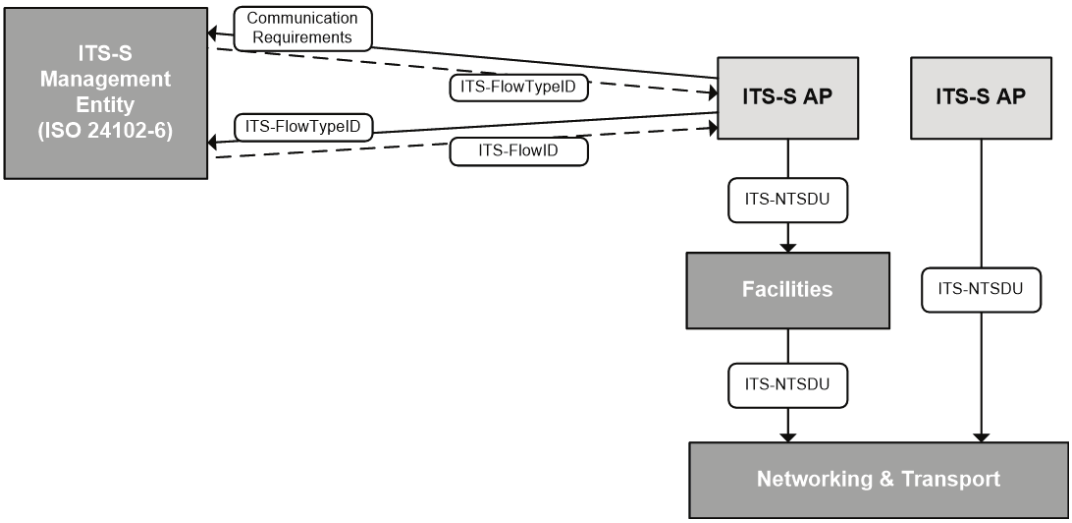
ITS-S-APs transmit their ADUs (ITS-FSDUs) and the corresponding ITS-S flow identifier (ITS-S-FlowID) to the underlying ITS station layer for further processing (see Figure 6). The ITS-S flow identifier points to the information necessary for each layer to properly form its PDUs for transmission to its peer(s).

This information is contained in the specific communication profile (ITS-SCP) selected by the ITS-S management entity.

ADUs may be transmitted down to the ITS-S networking and transport layer either directly without further processing by the ITS-S facilities layer or after invoking a set of requested services of the ITS-S facilities layer. In either case, the ITS-FSDU (the ADU after processing) or the ADU itself is transmitted to the ITS-S networking and transport layer (in the form of ITS-NTSDUs) where the ITS flow identifier is used to create the NPDU using the appropriate port numbers as transport layer source and destination addresses (ports). Note that dynamically assigned ports can be used to implement stateful services in the facilities layer.

In addition, an ITS-S-AP can publish or subscribe to the reception of data objects (identified by DataObjectIDs) from data dictionaries identified by DataDictionaryIDs. These dictionaries can be well-known, publicly available dictionaries, such as SAE J2735, ETSI Common Data Dictionary, DATEX II, TPEG and RDS-TMC, or proprietary dictionaries whose use is restricted to entities authorized by the owner of the dictionary. Publication and subscription are ITS-S internal processes, and are performed using the PublishContent and SubscribeContent requests, respectively (see 6.2.5). The ADUs exchanged between the CSH and an ITS-S-AP are formatted according to the "ITS-S generic data container format".

The flow of information between ITS-S-APs, the ITS-S management entity and the ITS-S facilities layer is shown in Figure 4.



NOTE Service primitive functions defined in ISO/TS 17423/ISO 24102-6.

Figure 4 — Relation between ITS-S application process and other elements of the ITS station

6.2.3 Communication Profile Handler (CPH)

The Communication Profile Handler (CPH) is a management ITS-S capability of the ITS-S facilities layer that is required to process ITS-FSDUs/ADUs (see Figure 6), transmitted by an ITS-S application process (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 causes the appropriate actions to be performed according to the parameters of the communication profile (ITS-SCP), including the transmission to the FSH if the ITS-S AP requested the use of ITS-S generic facility layer services.

The transmission of data from the ITS-S application process to the ITS-S networking and transport layer is illustrated in Figure 5. FSH services are invoked only when ITS-S facilities services are to be applied.

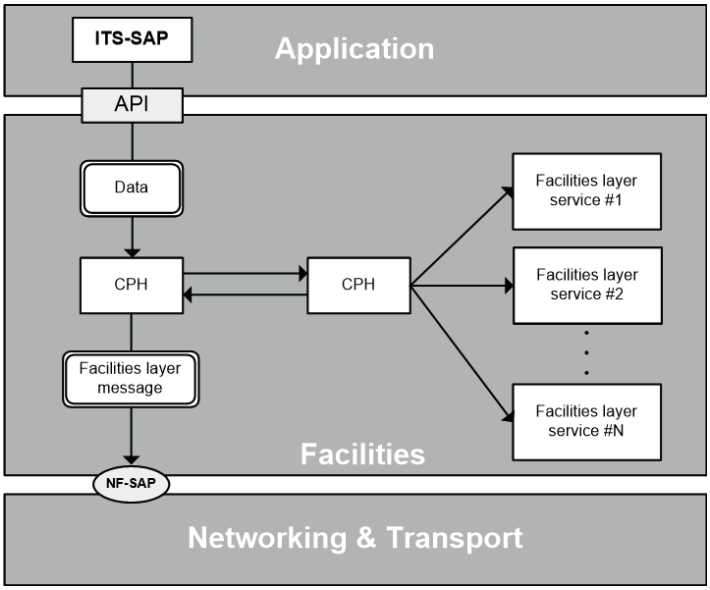


Figure 5 — Data transmission

The ITS-SCP is determined by the ITS-S management entity and is associated with an ITS-S flow identifier (ITS-S-FlowID). It provides the necessary information for the CPH to manage each ITS-S flow according to its specificities (which facilities services should be applied, which protocols must be used in the ITS station network and transport layer, etc.).

The list of active ITS-SCPs is maintained within the ITS-S facilities layer and can be updated or removed at any time upon request from the ITS-S management entity.

The CPH interacts with the ITS-S management entity, the ITS-S security entity, the ITS-S application entity and the ITS-S networking and transport layer of the ITS-S through SAPs as defined in ISO 24102-3 (MF-SAP and SF-SAP) using the procedures specified in ISO 24102-6 and in this Technical Specification.

6.2.4 Facilities Services Handler (FSH)

The Facilities Services Handler (FSH) is an ITS-S capability of the ITS-S facilities layer. It is used to apply "ITS-S facilities services" to ITS-FSDUs (see Figure 6). Examples of "ITS-S facilities services" include services related to security (encryption, authentication, non-repudiation, privacy), time stamping, geo-stamping, and compression. The specification of ITS-S facilities services is out of scope of this Technical Specification.

The list of "ITS-S facilities services" that must be applied onto the ITS-FSDU is negotiated between the ITS-S application process and the ITS-S management entity when the "ITS-S flow" is registered. Once an ITS-S flow identifier (ITS-S-FlowID) is allocated, the flow object pointed to by the assigned ITS-S-FlowID is provided by the ITS-S management entity to the ITS-S facilities layer. The flow object contains the list of ITS-S facilities services that must be applied to ITS-FSDU identified by the ITS-S-FlowID.

ITS-FSDUs transmitted by an ITS-S application process are initially handled by the Communication Profile Handler and then passed to the FSH whenever at least one of the "ITS-S facilities services" is listed in parameters pointed by the ITS-S-FlowID.

The FSH constructs the ITS-S facilities layer protocol data unit (ITS-FPDU) by appending an "ITS-S data header" in front of the ADU transmitted by the ITS-S application process in order to carry the information needed by the recipient(s) to perform the necessary operation(s) on the ITS-S facilities layer protocol data unit (e.g. decompressing when data are compressed, decrypting when the data are encrypted, authenticating when authentication data are provided). Each such message contains an ITS-S facilities header.

6.2.5 Content Subscription Handler (CSH)

The Content Subscription Handler (CSH) is an ITS-S capability of the ITS-S facilities layer. It is used to manage the subscription of instances of ITS-S application processes to the reception of published data objects. Data objects are identified by a DataObject identifier and are formatted according to the dictionary to which they belong.

As a result of a successful subscription, published data objects transmitted in messages processed by the ITS-S facilities layer are passed to all ITS-S-APs subscribed to the reception of such data objects.

6.2.6 Service access points (SAP)

The service access points (SAP) of the MF-SAP, the FA-SAP, the NF-SAP and the SF-SAP provide the mechanisms for the ITS-S facilities layer to interact with the ITS-S management entity, the ITS-S application entity, the ITS-S networking and transport later, and the ITS-S security entity, respectively. These services and related .request and .confirm service primitives are specified in ISO 24102-3.

— The services REQUEST and COMMAND of the MF-SAP are used by the Communication Profile Handler to obtain and update ITS-S communication profiles (ITS-SCP) from the ITS-S management entity and to provide the ITS-S management entity relevant information available at the ITS-S facilities layer (ITS-S capabilities, statistics on a given ITS-S flow, etc.).

— The services of the FA-SAP with some ASN.1 details specified in ISO 24102-3 are used by the Communication Profile Handler to transmit payload between the ITS-S facilities layer and the ITS-S application entity, and by the Content Subscription Handler (CSH) to manage the subscription of ITS-S-APs to the delivery of a certain data object.

This Technical Specification specifies functions carried in service primitives of the services introduced above.

6.2.7 Application data unit and protocol data unit

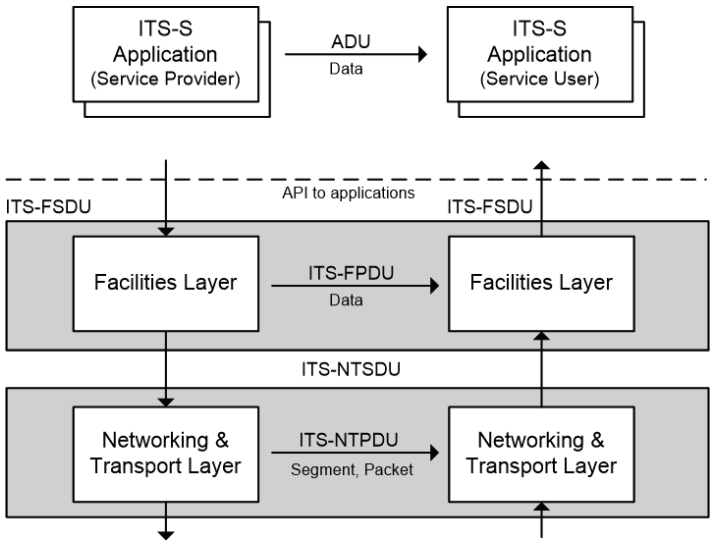


Figure 6 — ITS station application data units and protocol data units (ISO 21217)

Protocol data units (PDU) transmitted between peer ITS stations (ITS-FPDU, ITS-NTPU) and Service Data Units (SDU) exchanged locally in SAPs of ITS station (ITS-FSDU, ITS-NSDU) are defined in ISO 21217:2014, 7.2.3 and ISO 21217:2014, Figure 12 and illustrated in Figure 6.

7 General requirements

An authorized ITS-S application process or a permitted ITS-S application process certified for a BSME and identified by an ITS application identifier (ITS-AID) as specified in ISO/TS 17423 and ISO/TS 17419 shall implement the functions specified in Clause 8.

The functionalities of the ITS-S facilities layer specified in this Technical Specification shall be implemented as ITS-S capabilities of an ITS-S managed service entity (ITS-S MSE) at the ITS-S facilities layer ("Generic Facilities ITS-S MSE" — MSEGenFac in short). General procedures related to the management of ITS-S MSEs are specified in ISO 24102-6.

The "Generic Facilities ITS-S MSE" shall be allocated a globally unique identifier (MSEGenFacID).

NOTE ITS-S MSEs are identified by globally unique identifiers. Globally unique ITS identifiers are specified in ISO/TS 17419.

The "Generic ITS Station Facilities" ITS-S MSE has the following ITS-S capabilities:

— Communication Profile Handler (CPH);

— Facilities Services Handler (FSH);

— Content Subscription Handler (CSH).

An ITS station supporting ITS-S application processes compliant with ISO/TS 17423 shall implement the CPH ITS-S capability as specified in Clause 9.

An ITS station allowing ITS-S application processes to request the use of "ITS-S facilities services" shall implement the FSH ITS-S capability as specified in Clause 10.

An ITS station allowing ITS-S application processes to publish or subscribe data objects from a data dictionary shall implement the CSH ITS-S capability as specified in Clause 11.

Whenever necessary, the "Generic ITS Station Facilities" ITS-S MSE shall interact with the ITS-S management entity using services of the MF-SAP as specified in ISO/TS 17423 and ISO 24102-6.

Whenever necessary, the "Generic ITS Station Facilities" ITS-S MSE shall interact with the ITS-S application entity using services of the FA-SAP as specified in ISO 24102-3 and Clause 12.

Whenever necessary, the "Generic ITS Station Facilities" ITS-S MSE shall interact with the ITS-S networking and transport layer using services of the NF-SAP as specified in ISO 24102-3 and Clause 13.

8 Requirements for the "ITS-S application Processes"

8.1 ITS-S-AP: Requirements for data transmission

In order to transmit data, the ITS-S-AP shall perform the following actions:

— ITS-S-AP shall register its communication flow requirements as specified in 8.3;

— ITS-S-AP shall register its ITS-S flows as specified in ISO 24102-6;

— ITS-S-AP shall transmit ADUs as specified in 8.4;

— ITS-S-AP shall listen for ADUs as specified in 8.5.

8.2 ITS-S-AP: Requirements for publishing and subscribing to data objects

In order to publish and subscribe to data formatted as data objects from a data dictionary using the publication/subscribe service described in 6.2.5 and specified in Clause 11, the ITS-S-AP shall perform the following actions:

— ITS-S-AP shall register its communication flow requirements as specified in 8.3.

— ITS-S-AP shall register its ITS-S flows as specified in ISO 24102-6.

— ITS-S-AP shall publish data objects as specified in 8.6.

— ITS-S-AP shall subscribe to the reception of data objects as specified in 8.7.

— ITS-S-AP shall cancel the subscription reception of data objects as specified in 8.8.

8.3 ITS-S-AP: Flow type registration

The ITS-S-AP shall register its communication flow requirements with the ITS-S management entity using the procedures specified in ISO/TS 17423 and ISO 24102-6. An ITS-S flow type identifier (ITS-FlowTypeID) is received from the ITS-S management entity for each successful registration of a communication interface and its "ITS-S flow type".

NOTE 1 Whenever ADUs are formatted according to the ITS-S generic data contained format (i.e. when ITS-S facilities services are applied), ITS-FPDUs are transmitted to the well-known port PORT_FSH.

NOTE 2 Packets from the ITS-S application process can either be sent to a well-known port corresponding to the Facilities Services Handler (PORT_FSH) or a dedicated port provided by the ITS-S application process. The former allows the application to benefit, at both the sending and receiving side, from ITS-S facilities services (security, compression, time-stamping, etc.) applied by the ITS-S facilities layer at the request of the ITS application processes. This requires the use of a short ITS-S facilities header, therefore handling by the ITS-S facilities layer (FSH) at reception. The ITS-S facilities layer will force the transmission of packets to PORT_FSH whenever any ITS-S facilities layer service is used. The latter allows applications to manage security and other services on their own and to ease the support of existing applications.

In order to apply distinct ITS-S facilities services onto distinct ITS-S flows of the same flow type, the ITS-S-AP must realize distinct communication flow requirement registrations.

8.4 ITS-S-AP: Transmitting data

The ITS-S-AP shall send ADUs to the ITS-S facilities layer using the service primitive function `TransmitFlowData` specified in 12.3.

NOTE This procedure applies to any type of data directly transmitted from an ITS-S-AP to peer ITS-S-APs. There are no requirements on the format and purpose of the data content. Transmission of published content is realized using the service primitive function `PublishContent` specified in 8.6.

8.5 ITS-S-AP: Receiving data

The instance ITS-S-AP identified by `.appID` shall process the `ReceiveFlowData` notification specified in 12.4 in order to receive ADUs using the generic services supported by the ITS-S facilities layer.

NOTE This procedure applies to any type of data directly transmitted from an ITS-S-AP to peer ITS-S-APs. There are no requirements on the format and purpose of the data content. Reception of published content is realized using the indication `ReceiveContent` specified in 8.9.

8.6 ITS-S-AP: Publishing data objects

The ITS-S AP can publish data objects on its own or using the content subscription mechanism (CSH) of the ITS-S facilities layer (specified in Clause 11).

The ADU shall be formatted using the "ITS-S data header" as specified in Table 6 followed by a sequence of "ITS-S data containers" containing type length value (TLV) encoded data objects as specified in Table 7. Every field is octet aligned.

In order to publish a data object (defined in a data dictionary) using the publication mechanism of the CSH, the source ITS-S-AP shall transmit the ADU using the service primitive function `PublishContent` as specified in 12.5.

Credentials shall be presented for data objects defined in a data dictionary for which access is restricted.

NOTE 1 Those credentials are required for the ITS-S facilities layer to assess publication rights of the ITS-S-AP.

Alternatively, the ITS-S-AP can also transmit the ADU on its own, without relying on the publication mechanism provided by the ITS-S facilities layer. In this situation, the `ITS-S-FlowID` used by the ITS-S-AP is provided by the ITS-S management entity as a result of the ITS-S flow registration with communication requirements parameters indicated in B.1. The ITS-S-AP shall then transmit the ADU using the service primitive function `TransmitFlowData` as specified in 12.3.

NOTE 2 This is required so that CSHs installed on other ITS stations or distinct ITS-SCUs of the same ITS station can forward the published content to ITS-S-AP interested in such data content. In particular, the communication requirements indicate that the data are processed by the entity listening on PORT_FSH.

Table 1 — ITS-FSDU transmitted directly by the ITS-S-AP

ITS-FSDU Parameters	ASN.1 Type	Description
`FlowID`	`FlowID`	ITS-flow identifier allocated to the ITS-S-AP for content publication
`ApplicationID`	`ApplicationID`	ApplicationID allocated to the ITS-S-AP
`ADU`	`AppProtDataUnit`	Concatenation of a ITS-S Data Header and subsequent ITS-S Data Containers containing data object published by an ITS-S application process.
`Options`	`SFoptions`	

8.7 ITS-S-AP: Subscribing to the reception of data objects

In order to subscribe to the reception of a data object (defined in a data dictionary) using the publication/subscribe mechanism described in 6.2.5 and specified in Clause 11, the sink ITS-S-AP instance shall inform the ITS-S facilities layer using the service primitive function `SubscribeContent` as specified in 12.6.

Credentials shall be presented for data objects defined in a data dictionary for which access is restricted.

NOTE Those credentials are required for the ITS-S facilities layer to assess access rights of the ITS-S-AP.

8.8 ITS-S-AP: Stopping the reception of data objects

In order to stop the reception of a data object (defined in a data dictionary) using the publication/subscribe mechanism described in 6.2.5 and specified in Clause 11, the sink ITS-S-AP instance shall inform the ITS-S facilities layer using the service primitive function `CancelContent` as specified in 12.7.

8.9 ITS-S-AP: Receiving data objects

Upon reception of a `ReceiveContent` notification from the ITS-S facilities layer, the instance ITS-S-AP identified by `.appID` shall process the ADU.

9 Requirements for the Communication Profile Handler

9.1 CPH: Initialization

The Communication Profile Handler (CPH) shall be implemented as an ITS-S capability of the “Generic Facilities ITS-MSE” (MSEGenFac) as specified in ISO 24102-6.

The CPH shall be allocated a globally unique ITS-S capability identifier recorded in a registry.

NOTE ITS-S capabilities are identified by globally unique identifiers. Globally unique ITS identifiers are specified in ISO/TS 17419.

Whenever the Communication Profile Handler is initialized, the ITS-S facilities layer shall

— report to the ITS-S management entity that the CPH is up and running using the request `NotifyCapa` with `.mseID` set to MSEGenFacID and `.capaList` containing details of the CPH ITS-S capability,

— request the ITS-S management entity to provide existing communication flow profiles using the request `GetCP`,

— perform the operations specified in 9.2 and 9.3.

9.2 CPH: Management of communication profiles

9.2.1 CPH: Communication flow profile parameters

The ITS-S management entity uses the command `SetCP` specified in ISO 24102-6 to provide communication flow profiles to the ITS-S facilities layer. Following the reception of the `SetCP` commands, the ITS-S facilities layer maintains information about communication flow profiles as illustrated in Table 2. Most of the parameters are filled up with the information directly provided from the ITS-S management entity; statistics about flows (cfpStats) may be inferred internally within the ITS-S facilities layer.

NOTE The parameters of the entries are defined in Table 2. The method used to record these communication flow profiles is implementation specific and is out of scope of this Technical Specification.

Table 2 — Communication flow profile parameters used by the Communication Profile Handler

Communication flow parameters	ASN.1 type	Description
cfpFlowID (key)	`FlowID`	Identifier of the ITS-S flow (see definition in ISO 21217 and ISO 24102-6)
cfpSrcAppID	`ApplicationID`	Identifier of the source (local) ITS-S application process
cfpDstAppID	`ApplicationID`	Identifier of the destination (remote) ITS-S application process
cfpPriority	`UserPriority`	Priority to be applied to this ITS-S flow
cfpPathAvailability	`CfpPathAvailability`	Indicates whether there is no path currently selected for this flow (NULL), or that there does not seem to be any path allowing transmission at full rate (CPH_PATHCONGESTED), or that there exists at least one clear path (CPH_OK)
cfpDstID	`DestinationID`	Identifier (address) of the destination
cfpDstType	`DestinationType`	Type of destination (single receiver, or a group of receivers) specified in ISO/TS 17423.
cfpDstNetAddr	`NprotAddress`	Network address of the destination (depends on cfpProtoNet)
cfpSrcPort	`TprotAddress`	Source port of the ITS-NTPDU
cfpDstPort	`TprotAddress`	Destination port of the ITS-NTPDU
cfpMaxFPDU	`CfpMaxFpdu`	The maximum ITS-FPDU size is indicated by the ITS-S management entity in order to avoid fragmentation of the packets given the protocols and services used for this flow.
cfpPriority	`UserPriority`	Priority to be applied to this ITS-S flow

Table 2 *(continued)*

Communication flow parameters	ASN.1 type	Description
cfpPathAvailability	`CfpPathAvailability`	Indicates whether there is no path currently selected for this flow (NULL), or that there does not seem to be any path allowing transmission at full rate (CPH_PATHCONGESTED), or that there exists at least one clear path (CPH_OK)
cfpServSec	`CapaInfos`	List of security services (supported by ITS-S capabilities) to be applied to ADUs of this ITS-S flow. These services require processing by the FSH (and the ITS-S security entity) and the addition of the ITS-S facilities header. Security services include source authentication, non-repudiation, data integrity, data confidentiality. The specification of these services is out of scope of the Technical Specification.
cfpServFac	`CapaInfos`	List of facilities services (supported by ITS-S capabilities) to be applied to ADUs of this ITS-S flow. These services may be executed once or on a per-packet basis (e.g. time stamping). These services require processing by the FSH and the addition of the ITS-S facilities header. The specification of these services is out of scope of the Technical Specification.
cfpStats	`FlowStatisticsList`	Set of statistics collected for each ITS-S flow specified in ISO 24102-6 (number of packets sent, number of acknowledgements received, number of negative acknowledgements received, transmission rate, etc.)

9.2.2 CPH: Updating communication flow profile parameters

The ITS-S management entity uses the command `SetCP` specified in ISO 24102-6 with `CfsCpsAction` set to “create” to instruct the ITS-S facilities layer that a new communication profile identified by an ITS-S flow identifier has been determined.

Upon reception of a command `SetCP` with `CfsCpsAction` set to “create”, the parameters of the communication profile provided by the ITS-S management entity shall be maintained internally as illustrated in Table 2. Upon success (successful addition of the entry), the error code `pfmOK` specified in ISO 24102-6 shall be returned to the ITS-S management entity.

The ITS-S management entity uses the command `SetCP` specified in ISO 24102-6 with `CfsCpsAction` set to “update” to instruct the ITS-S facilities layer that the parameters of an existing communication profile identified by `FlowID` have been updated.

Upon reception of a command `SetCP` with `CfsCpsAction` set to “update”, the parameters maintained internally shall be updated for the communication profile identified by `FlowID`:

— Upon success (successful update of the entry), the error code `pfmOK` specified in ISO 24102-6 shall be returned to the ITS-S management entity.

— Upon failure, the error code `pfmFlowInvalid` specified in ISO 24102-6 shall be returned to the ITS-S management entity.

The ITS-S management entity uses the service primitive `SetCP` with `CfsCpsAction` set to “delete” to notify the ITS-S facilities layer that an existing communication profile identified by `FlowID` is no longer needed and has to be deleted.

Upon reception of a command SetCP with CfsCpsAction set to “delete”, all entries maintained internally corresponding to FlowID shall be deleted.

— Upon success (successful deletion of the entry), the error code pfmOK specified in ISO 24102-6 shall be returned to the ITS-S management entity.

— Upon failure, the error code pfmFail specified in ISO 24102-6 shall be returned to the ITS-S management entity.

NOTE If necessary to adapt to change of network conditions, the ITS-S management entity may update the communication profile for a given flow at any time even when packets of this flow have already been transmitted. This may result in the change of the network protocol or transport protocol indicated in the communication profile. The benefit of using generic ITS-S facilities layer services is that this change of the communication profile can be performed transparently to the ITS-S-AP (seamless handover). This is particularly useful when an access technology becomes unavailable or overloaded.

9.2.3 CPH: Reporting communication flow statistics

The ITS-S management entity uses the service primitive function CollectFlowStats to instruct the ITS-S facilities layer to collect statistics about a given ITS-S flow or the entire set of ITS-S flows. The requested actions are performed for all ITS-S flows if the value of FlowID is set to 0; otherwise, the requested action are performed only for the ITS_S flow identified by FlowID.

Upon reception of a CollectFlowStats instruction, the ITS-S facilities layer shall respond with an error using the service primitive function CollectFlowStatsConf if there is no known communication flow profile corresponding to FlowID, otherwise,

— if CfsCpsAction is set to “start”, the collection of statistics is initiated for the ITS-S flow identified by FlowID,

— if CfsCpsAction is set to “stop”, the collection of statistics is stopped and statistics are deleted for the ITS-S flow identified by FlowID,

— it CfsCpsAction is set to “suspend”, the collection of statistics is initiated for the ITS-S flow identified by FlowID,

— if CfsCpsAction is set to “resume”, the collection of statistics is resumed for the ITS-S flow identified by FlowID,

— if CfsCpsAction is set to “report”, statistics maintained internally shall be returned to the ITS-S management entity using the service primitive function CollectFlowStatsConf.

9.3 CPH: Processing data sent by ITS-S application processes

9.3.1 CPH: Processing TransmitFlowData instructions

The service primitive function TransmitFlowData is used by ITS-S-APs to transmit ITS-FSDUs using generic services supported by the ITS-S facilities layer. The field FlowID in the ITS-FSDU allows the ITS-S facilities layer to retrieve the communication profile mapped to the appropriate ITS-S flow.

Upon reception of a TransmitFlowData instruction from an ITS-S-AP, the actions specified in 9.3.2, 9.3.3, 9.3.4, 9.3.5 and 9.3.6 shall be executed, in this order.

NOTE The pre-requisite for the execution of these instructions is that the ITS-S-AP has previously registered its ITS-S flow communication requirements and objectives with the ITS-S management entity using the methods specified in ISO/TS 17423 and ISO/TS 17423. As a result of this registration, the ITS-S-AP has obtained an ITS-S-FlowID for each ITS-S flow. The ITS-S-FlowID is then included in each ITS-FSDU sent by the ITS-S-AP. In the meantime, the ITS-S management entity informed the Communication Profile Handler about the communication profiles used for each ITS-S flow.

9.3.2 CPH: Checking for a corresponding communication flow profile

The ITS-S facilities layer checks if it has recorded an ITS-S communication profile for the ITS-S flow identified by `FlowID`.

— If there is no ITS-S communication profile corresponding to `FlowID`, the ITS-FSDU is discarded and the error code `pfmFlowUnknown` shall be returned to the ITS-S-AP. The ITS-S facilities layer may inform the ITS-S management entity using the service primitive function `ReportFlowStats` with error code set to `pfmCpNotFound`.

NOTE The ITS-S management entity is in charge of determining the appropriate ITS-S communication profile for each ITS-S flow (transport protocol, network protocol, access technology, next hop, etc.) based on ITS-S flow communication requirements provided by ITS-S-AP and the feedback provided by all layers. Communication profiles are thus provided by the ITS-S management entity to the Communication Profile Handler while the Communication Profile Handler may be able to report packet loss, congestion, etc. to the ITS-S management entity.

— In all other conditions, the ITS-S communication profile to be used for the ITS-S flow is known and 9.3.3 is executed.

9.3.3 CPH: Checking for an available path

The ITS-S facilities layer checks for the availability of an ITS-S path for this ITS-S flow. Such information provided by the ITS-S management entity and recorded into the field `CfpPathAvailability` for the ITS-S communication profile identified by `FlowID`.

— If `CfpPathAvailability` is set `cphPAnoPathSelected`, the ITS-S facilities layer may return the error code `sfErrPATHUNAVAILABLE` to the originating ITS-S-AP and discard the ITS-FSDU. If this unavailability is inferred internally, the ITS-S facilities layer shall inform the ITS-S management entity using the service primitive function `ReportFlowStatsConf` specified in ISO 24102-6 with the error code set to `pfmPathUnavailable`.

NOTE 1 For instance, `CfpPathAvailability` could be set to `cphPAnoPathSelected` when the ITS-S management entity informs the ITS-S facilities layer that there is currently no ITS-S path corresponding to the flow requirements where the packet can be sent. This can be a temporary unavailability. Informing the ITS-S-AP about this transient unavailability allows the ITS-S-AP to take necessary actions.

— If `CfpPathAvailability` is set to `cphAPpathsCongested`, a path is available but may not allow the packet to reach its destination. The ITS-S facilities layer may return the value `sfErrOKPATHCONGESTED` to the originating ITS-S-AP and execute 9.3.4. If this congestion is inferred internally, the ITS-S facilities layer shall inform the ITS-S management entity using service primitive function `ReportFlowStatsConf` specified in ISO 24102-6 with the error code set to `pfmPathCongested`.

NOTE 2 As for the notification of the path unavailability above, informing the ITS-S-AP allows the ITS-S-AP to take necessary actions, e.g. reducing transmission rate.

— In all other conditions, an ITS-S path is available and 9.3.4 is executed.

9.3.4 CPH: Performing address resolution

The ITS-S facilities layer checks the value of the field `cfpDstNetAddr` corresponding to the ITS-S communication profile identified by `FlowID`.

— If `cfpDstNetAddr` is set to NULL, then no network address has been specified. Address resolution must be performed to determine the destination address corresponding to the network protocol indicated in the ITS-S communication flow profile. The error code `sfErrINVALID-DEST` shall be returned to the requesting ITS-S-AP if no network address can be determined and the ITS-FSDU shall be discarded.

— Otherwise, the result of the address resolution is recorded in the field `cfpDstNetAddr` for later use and 9.3.5 is executed.

NOTE The ITS-S facilities layer could be instructed by the ITS-S management entity to change the network protocol. A new address resolution is performed to determine the network address corresponding to the new network protocol in case the value of cfpDstNetAddr is reset to NULL upon reception of a service primitive function SetCP.

9.3.5 CPH: Checking for ITS-S facilities services

The ITS-S facilities layer checks if the ITS-S AP has requested the use of ITS-S facilities services for the ITS-S flow. Such information is provided by the ITS-S management entity and is recorded into the fields `cfpServFac` and `crpServSec`.

If `cfpServFac` or `cfpServSec` is not set to NULL, the procedures specified in 10.3 shall be executed. Otherwise, the procedures specified in 9.3.6 shall be executed.

9.3.6 CPH: Transmission to the NF-SAP

Whenever no error code other than `sfErrOKPATHCONGESTED` or `sfErrINVALID-DEST` is returned after performing the actions specified in 9.3.2, 9.3.3 and 9.3.4, the ITS-S facilities layer shall prepare the ITS-NTSDU as follows:

— `.fpdu` is set to the ADU received from the ITS-S-AP with no modification;

— socket.srcInfo is filled up with cfpSrcPort and cfpSrcNetAddr.;

— socket.destInfo is set with cfpDstPort and cfpDstNetAddr.;

— all other fields are filled up with the corresponding fields of the ITS-S communication profile.

The assembled message shall be forwarded to the ITS-S networking and transport layer using the NF-SAP service primitive function `TransmitNTSDU` specified in 13.2.

10 Requirements for the Facilities Services Handler

10.1 FSH: Initialization

The Facilities Services Handler (FSH) shall be implemented as an ITS-S capability of the “Generic Facilities ITS-S MSE” (MSEGenFac) as specified in ISO 24102-6.

The FSH shall be allocated a globally unique ITS-S capability identifier recorded in a registry.

NOTE 1 ITS-S capabilities are identified by globally unique identifiers. Globally unique ITS identifiers are specified in ISO/TS 17419.

Whenever the FSH is initialized:

— The ITS-S facilities layer shall report to the ITS-S management entity that the FSH is up and running using the request `NotifyCapa` with `.mseID` set to MSEGenFacID and `.capaList` containing details of the FSH ITS-S capability.

— It shall listen on transport port number PORT_FSH and perform the operations specified in 10.5 upon reception a service primitive function `ReceiveNTSDU`.

NOTE 2 PORT_FSH corresponds to a well-known port number. Port numbers will also be requested for ITS (FNTP: http://standards.iso.org/iso/ts/17419/TS17419%20Assigned%20Numbers/), UDP, TCP once this Technical Specification is published.

— Upon reception from the Communication Profile Handler (CPH), the ITS-FSDUs shall be processed as specified in 10.3.

10.2 FSH: ITS-S facilities layer protocol data unit format (ITS-FPDU)

The ITS-S facilities layer protocol data unit (ITS-FPDU) consists of the fields as specified in Table 3. ASN.1 details are specified in Annex A.

The well-known port number PORT_FSH shall be used as source and destination port in the transport protocols used to exchange these messages with peer entities.

Table 3 — ITS-S facilities layer protocol data unit format (ITS-FPDU)

Fields of ITS-FPDU (`Fpdu`)	ASN.1 type	Description
version	`INTEGER(0..7)`	FSH protocol version for the given frame structure
serviceNos	`INTEGER(0..31)`	Number N of subsequent serviceInfo fields
serviceInfo	`ServiceFacs`	Contains a globally unique service identifier (`ServFacID`) sub-field identifying the structure of the subsequent ServiceParameters sub-fields.
srcFacAddr	`FacAddr`	Identifier of the instance of ITS-S application process that sent the data (cfpSrcAppID).
dstFacAddr	`FacAddr`	Identifier of the instance of ITS-S application process for which the data are sent to (cfpDstAppID).
Data	`FpduData`	Contains the data preceded with a length indicator

10.3 FSH: Execution of facilities services

Upon reception of an ITS-FSDU from the Communication Profile Handler (CPH), the FSH shall execute the ITS-S facilities services listed in `cfpServFac` and `cfpServSec` in the order as being appropriate and by this it shall generate an updated ITS-S facilities layer protocol data unit (ITS-FPDU) in the format as specified in 10.2.

NOTE The list of services is provided to the ITS-S management entity by the requesting ITS-S-AP at the time of flow type registration, using the methods specified in ISO/TS 17423 and ISO 24102-6. This list of services is later passed from the ITS-S management entity to the ITS-S facilities layer along with the ITS-S communication profile in the fields cfpServFac and cfpServSec as specified in 9.2.

The services that can be performed using the functionalities specified in this Technical Specification shall be registered in a global service registry (dynamic updates to this Technical Specification). These services can either be publicly available (a specification defining the service is therefore needed) or proprietary. In both cases, a globally unique number shall be allocated. This method ensures that new services can be made available anytime with no need to revise this Technical Specification.

The ADU contained in the ITS-FSDU provided by the CPH is first processed by the ITS-S capability implementing the first ITS-S facilities service indicated in `cfpServFac` and `cfpServSec` until all requested services are performed on the data field.

If the requested service does not exist or its execution is not successful, the ITS-FSDU is discarded the error code `sfErrINVALID-SERV` or `sfErrUNAVAILABLE-SERV` shall respectively be returned to the requesting ITS-S-AP together with the `ServFacID` identifying the service.

Otherwise, the result of this service process is the first `serviceInfo` field, and potentially a modified version of the `data` field.

This potentially modified version of the `data` field is provided as the input to the ITS-S capability implementing the next requested ITS-S facilities service.

If successful, the potentially modified version of the `data` field is input for the ITS-S capability implementing the next ITS-S facilities service indicated in `cfpServFac` and `cfpServSec` until all requested services are performed on the data field.

The order of execution of services is important but is not subject to standardization except for the service to encrypt or sign the message; this service shall be executed as the last service in transmit mode. Details on such security services are subject to a future standard.

Once all requested ITS-S facilities services are executed, the ITS-FPDU shall be assembled as indicated in Table 3. The sequence of `ServiceInfo` fields shall start with the field related to the service that was executed last.

Then 10.4 is executed.

10.4 FSH: Transmission to the NF-SAP

Whenever no error code other than `sfErrOKPATHCONGESTED` or `sfErrINVALID-DEST` is returned after performing the actions specified in 9.3.2, 9.3.3 and 9.3.4, the ITS-S facilities layer shall prepare the ITS-NTSDU as follows.

— `fpdu` is set to the ITS-FPDU assembled by the FSH as described in 10.3.

— `.socket.srcInfo` is filled up with PORT_FSH and `cf`pSrcNetAddr.

— `.socket.destInfo` is set with PORT_FSH and `cfpDstNetAddr`.

— all other fields are filled up with the corresponding fields of the ITS-S communication profile.

The assembled message shall be forwarded to the ITS-S networking and transport layer using the NF-SAP service primitive function `TransmitNTSDU` specified in 13.2.

10.5 FSH: Reception of messages

Upon reception notification from the ITS-S networking and transport layer with NF-SAP service primitive `ReceiveNTSDU`, the FSH checks the protocol version contained in the ITS-FSDU:

— In case the protocol version is supported, it executes the ITS-S facilities services (in the reverse order compared to the transmit mode) in the order as given by the sequence of ServiceInfo fields. The data field resulting from the application of the last ITS-S facilities service is forwarded to the final destination identified by the `dstFacAddr` field using the service primitive function `ReceiveFlowData`.

NOTE For data objects from a data dictionary transmitted using the Content Subscription Handler, `srcFacAddr` and `dstFacAddr` are filled up with the well-known ApplicationID of the CSH.

— In case the protocol version is not supported, the received message is discarded, and the ITS-S management entity is informed using the service primitive function `NotifyCapa` so that it can get an update of the Facilities Service Handler functionality; see ISO 24102-2.

This procedure also applies to the situation in which there is no treatment at the ITS-S facilities layer (i.e. no ITS-S facilities service has been applied by the source besides ITS-S facilities service 0).

11 Requirements for the Content Subscription Handler

11.1 CSH: Initialization

The Content Subscription Handler (CSH) shall be implemented as an ITS-S capability of the “Generic Facilities ITS-S MSE” (MSEGenFac) as specified in ISO 24102-6.

The CSH shall be allocated a globally unique ITS-S capability identifier recorded in a registry.

NOTE 1 ITS-S capabilities are identified by globally unique identifiers. Globally unique ITS identifiers are specified in ISO/TS 17419.

Whenever the CSH is initialized, the ITS-S facilities layer shall report to the ITS-S management entity that the CSH is up and running using the request `NotifyCapa` with `.mseID` set to MSEGenFacID and `.capaList` containing details of the CSH ITS-S capability.

The CSH maintains a list of instances of ITS-S-APs (identified by `ApplicationID`) that have subscribed to the reception of a data object from a data dictionary. This is illustrated in Table 4. The method to maintain this information is implementation-specific and is thus out of scope of this Technical Specification.

NOTE 2 The CSH does not need to understand the content nor structure of the data objects.

Table 4 — Information maintained by the CSH

Content parameters	ASN.1 type	Description
`DataDictionaryID`	`DataDictID`	Identifier of the data dictionary
`DataObjectID`	`DOidentifier`	Identifier of the data object from the data dictionary
`ApplicationIDs`	`SEQUENCE OF ApplicationID`	List of all instances of ITS-S-APs which have subscribed to the reception of a data object from a data dictionary identified by {DataDictionaryID, DataObjectID}, e.g. an instance of the In-Vehicle Signage application (ISO/TS 17425), Contextual Speed application (ISO/TS 17426)
`Credentials`	`PubContCredentials`	List of access credentials used to validate the access rights claimed by the ITS-S-APs.
`Options`	`SFoptions`	TBD: time stamps, source info, etc.

11.2 CSH: processing content publication from ITS-S-AP

In order to publish content on behalf of an ITS-S-AP (i.e. the CSH is the source of such ADUs, not the ITS-S-AP itself), the CSH shall be implemented (in addition to an ITS-S capability) as an ITS-S application process (ITS-S AP) as specified in ISO 21217 and ISO/TS 17423.

The `ApplicationID` used by the CSH shall be a well-known globally unique `ApplicationID` recorded in a registry.

The `FlowID` used by the CSH is provided by the ITS-S management entity as a result of the ITS-S flow registration with communication requirements parameters indicated in Annex B.

Upon reception of a service primitive function `PublishContent` from an ITS-S-AP, the CSH shall verify that the ITS-S-AP is authorized to transmit the data object from the data dictionary.

NOTE 1 It is assumed that the actions specified in 8.1 have been performed by the ITS-S-APs prior to requesting the use of the publication mechanism provided by CSH in the ITS-S facilities layer. The ITS-FSDU received by the ITS-S-AP is thus formatted as indicated in Tables 6 and 7 and sent to PORT_FSH for processing on the receiver side (see 8.6).

If the ITS-S-AP is authorized, the CSH shall prepare the ITS-FSDU as specified in Table 5 and transmit it using the service primitive function `TransmitFlowData`.

NOTE 2 The CSH sends data objects on behalf of the ITS-S application process that generated it. Alternatively, the ITS-S application process can also send the data directly as long as the data are formatted as indicated in Tables 6 and 7 and sent to PORT_FSH for processing on the receiver side (see 8.6).

NOTE 3 The method of authentication is out of scope of this Technical Specification. Atomic security operations defined in other standards can be applied.

Table 5 — ITS-FSDU transmitted by the CSH on behalf of ITS-S-AP

ITS-FSDU Parameters	ASN.1 Type	Description
FlowID	FlowID	ITS-flow identifier allocated to the CSH
ApplicationID	ApplicationID	ApplicationID allocated to the CSH
ADU	AppProtDataUnit	Concatenation of ITS-S Data Header and subsequent ITS-S Data Containers containing data object published by an ITS-S application process.
Options	SFoptions	

11.3 CSH: processing content subscription from ITS-S-AP

Upon reception of a service primitive function SubscribeContent from an ITS-S-AP, the CSH shall verify that the ITS-S-AP is authorized to receive the requested data identified by {DataDictionatyID, DataObjectID}.

NOTE The method of authentication is out of scope of this Technical Specification. Atomic security operations defined in other standards can be applied.

If the ITS-S-AP is authorized, the ApplicationID and related information of the requesting ITS-S-AP instance is added for the reception of the requested data identified by {DataDictionatyID, DataObjectID} as illustrated in Table 4.

11.4 CSH: processing content subscription cancellation from ITS-S-AP

Upon reception of a service primitive function CancelContent from an ITS-S-AP, its ApplicationID is removed from the list of recipients for the data identified by {DataDictionatyID, DataObjectID}.

NOTE Access credentials are not needed to cancel the subscription.

11.5 CSH: transmitting content to ITS-S-AP

Upon reception of a service primitive function ReceiveFlowData from the FSH, the CSH determines what are the subscribed ITS-S-APs for the data identified by {DataDictionatyID, DataObjectID}.

If DataDictionaryID corresponds to a registered dictionary, the CSH shall then deliver the received data to all instances of ITS-S-APs which have subscribed to the reception of the data identified by {DataDictionatyID, DataObjectID} using the service primitive function ReceiveContent.

11.6 ITS-S generic data container format

Data objects published by an ITS-S-AP shall be formatted using the “ITS-S data header” as specified in Table 6 followed by a sequence of “ITS-S data containers” containing type length value (TLV) encoded data objects as specified in Table 7. Every field is octet aligned.

Table 6 — ITS-S data header format

Fields	ASN.1 Type	Description
DataDictionaryID	DataDictID	Globally unique identifier of the data dictionary. Examples of such data dictionaries are ITS message sets such as the CEN dictionary, the ETSI dictionary, and data dictionaries associated with DATEX II, TPEG, SAE and RDS-TMC. Proprietary data dictionaries can be registered, and would be allocated a globally unique data dictionary identifier from a specific range of identifiers.
DataObjNum	INTEGER(0..255)	Number of "ITS-S data containers" following the "ITS-S data header". The length of this field is 1 byte (i.e. there could be up to 255 "ITS-S data containers" sent in the same packet).

Table 7 — ITS-S data container format

Fields	ASN.1 Type	Description
DataObjectID	DOidentifier	Identifier of the data object, unique in the related data dictionary. The length of this field is variable. Examples of data objects are the Cooperative Awareness Message (CAM), the Signal Phase And Timing message (SPAT).
Length	variable	Number of bytes of the payload
Payload	variable	Data object, structured in many different ways and possibly hierarchized
Credentials	PubContCredentials	Security material to assess the source ITS-S application process is authorized to transmit such data object

12 FA-SAP service primitive functions

12.1 Overview

The following sub-clauses define details of the service access point between the ITS-S application entity and the ITS-S facilities layer (FA-SAP). FA-SAP primitives are used by ITS-S-AP to transmit data of any type and subscribe to the reception of data objects.

12.2 Error codes

ASN.1 types and values for the FA-SAP error codes applicable to this Technical Specification shall be as specified in Table 8.

Table 8 — Error codes of ASN.1 type SFerror used in the FA-SAP

Error codes	ASN.1 Value	Description
FA_OK	sfErrOK	Success of the operation
FA_OKPATHCONGESTED	sfErrOKPATHCONGESTED	Success — A communication path is available but appears to be congested. The ITS-FSDU is transmitted but reception at the destination cannot be guaranteed.
FA_FLOWNOTREGISTERED	sfErrFLOWNOTREGISTERED	Failure — ITS-FSDU cannot be transmitted because it cannot be mapped to a valid flow instance identifier (CPH_FlowID).
FA_PATHUNAVAILABLE	sfErrPATHUNAVAILABLE	Failure — ITS-FSDU cannot be transmitted because no communication path currently available.

Table 8 *(continued)*

Error codes	ASN.1 Value	Description
FA_NOTAUTHORIZED	sfErrNOTAUTHORIZED	Failure — The requesting ITS-S-AP is not authorized to perform such action (the authorization material presented is not correct).
FA_NOSECU	sfErrNOSECU	Failure — ITS-FSDU cannot be transmitted because the requested security operation cannot be performed on the ADU.
FA_INVALID_PORT	sfErrINVALID-PORT	Failure — ITS-FSDU cannot be transmitted because the port provided at flow instance registration is not corresponding to a known port.
FA_INVALID_DEST	sfErrINVALID-DEST	Failure — ITS-FSDU cannot be transmitted because the port provided at flow instance registration cannot be determined.
FA_INVALID_SERV	sfErrINVALID-SERV	Failure — ITS-FSDU cannot be transmitted because the generic facilities services requested at flow instance registration is not supported.
FA_UNAVAILABLE_SERV	sfErrUNAVAILABLE-SERV	Failure — ITS-FSDU cannot be transmitted because the generic facilities services requested at flow instance registration cannot be performed.
FA_INVALID	sfErrINVALID	Failure — ITS-FSDU cannot be transmitted due to other invalid parameter.

12.3 TransmitFlowData

The service primitive function `TransmitFlowData` is used by an ITS-S-AP to transmit data of any type. ASN.1 types and values for the applicable function shall be as specified in Table 9 with ASN.1 details specified in Annex A.

Table 9 — `TransmitFlowData`

ITS-FSDU Parameters	ASN.1 Type	Description
.flowID	FlowID	Identifier of the flow.
.appID	ApplicationID	Identifier of the instance of the ITS-S-AP.
.adu	AppProtDataUnit	Any type of ADU (no restriction on the type of ADU nor its format).
.options	SFoptions	Options may be defined as dynamic updates.

Table 10 — `TransmitFlowDataConf`

Error codes	ASN.1 Type	Description
.error	SFerror	Applicable error codes (FA_OK, FA_OKPATHCONGESTED, FA_FLOWNOTREGISTERED, FA_PATHUNAVAILABLE, FA_NOSECU, FA_INVALID_PORT, FA_INVALID_DEST, FA_INVALID_SERV, FA_UNAVAILABLE_SERV, FA_INVALID) are specified in Table 8.
.options	SFoptions	For error codes FA_INVALID_SERV and FA_UNAVAILABLE_SERV, the relevant `ServFacID` shall be provided.

12.4 ReceiveFlowData

The service primitive function `ReceiveFlowData` is used by the ITS-S facilities layer to notify the instance of ITS-S-AP identified by `ApplicationID` that data has been received. ASN.1 types and values for the applicable function shall be as specified in Table 11 with ASN.1 details specified in Annex A.

Table 11 — `ReceiveFlowData`

ITS-FSDU Parameters	ASN.1 Type	Description
`.appID`	`ApplicationID`	Identifier of the instance of the ITS-S-AP where this ITS-FSDU shall be received. May be set to NULL (has the same format and meaning as a port number).
`.adu`	`AppProtDataUnit`	Any type of ADU (no restriction on the type of ADU nor its format).
`.srcPort`	`PortNumber`	Source port contained in the ITS-NTSDU. May be set to NULL (needed for the reply).
`.dstPort`	`PortNumber`	Destination port contained in the ITS-NTSDU. May be set to NULL (can be used to map the received ADU to a FlowID used for transmission of ADUs).
`.servFac`	`CapaInfos`	A sequence of identifiers of ITS-S facilities services (supported by ITS-S capabilities) and their related content. This information is obtained as a result of processing the ITS-S facilities layer header contained in the ITS-FPDU obtained by the ITS-S network and transport layer.
`.servSec`	`CapaInfos`	A sequence of identifiers of security services (supported by ITS-S capabilities) and their related content. This information is obtained as a result of processing the ITS-S facilities layer header contained in the ITS-FPDU obtained by the ITS-S network and transport layer.
`.options`	`SFoptions`	

12.5 PublishContent

The service primitive function `PublishContent` is used by an ITS-S-AP to publish data according to the "ITS-S generic data container format". ASN.1 types and values for the applicable function shall be as specified in Table 12 with ASN.1 details specified in Annex A.

Table 12 — PublishContent

ITS-FSDU Parameters	ASN.1 Type	Description
.flowID	FlowID	Identifier of the ITS-S flow.
.appID	ApplicationID	Identifier of the instance of the ITS-S-AP.
.data	DataFromDDs	
.data.dictID	DataDictID	Identifier of the data dictionary (public or proprietary; all identifiers are globally unique and registered).
.data.objectID	DOidentifier	Identifier of the data object from the dictionary.
.data.content	several	Data object content.
.options	SFoptions	Options
.credentials	PubContCredentials	Access credentials used to validate the access rights claimed by the ITS-S-APs.

Table 13 — PublishContentConf

Error codes	ASN.1 Type	Description
.error	SFerror	Applicable error codes (FA_OK, FA_OKPATHCONGESTED, FA_NOTAUTHORIZED, FA_FLOWNOTREGISTERED, FA_PATHUNAVAILABLE, FA_NOSECU, FA_INVALID_PORT, FA_INVALID_DEST, FA_INVALID_SERV, FA_UNAVAILABLE_SERV, FA_INVALID) are specified in Table 8.

12.6 SubscribeContent

The service primitive function SubscribeContent is used by an ITS-S-AP to subscribe to the reception of a data object from a data dictionary identified by {DataDictionaryID, DataObjectID}. ASN.1 types and values for the applicable function shall be as specified in Table 14 with ASN.1 details specified in Annex A.

Table 14 — SubscribeContent

ITS-FSDU Parameters	ASN.1 Type	Description
.appID	ApplicationID	Identifier of the instance of the ITS-S-AP.
.ddID	DataDictID	Identifier of the data dictionary (public or proprietary; all identifiers are globally unique and registered).
.doID	DOidentifier	Identifier of the data object from the data dictionary.
Credentials	PubContCredentials	Access credentials used to validate the access rights claimed by the ITS-S-APs.

Table 15 — SubscribeContentConf

Error codes	ASN.1 Type	Description
.error	SFerror	Applicable error codes (FA_OK, FA_NOTAUTHORIZED, FA_INVALID) are specified in Table 8.

12.7 CancelContent

The service primitive function CancelContent is used by an ITS-S-AP to cancel an existing subscription for the reception of a data object from a data dictionary identified by {DataDictionaryID, DataObjectID}. ASN.1 types and values for the applicable function shall be as specified in Table 16 with ASN.1 details specified in Annex A.

Table 16 — CancelContent

ITS-FSDU Parameters	ASN.1 Type	Description
.appID	ApplicationID	Identifier of the instance of the ITS-S-AP.
.ddID	ASN-ID_DD	Identifier of the data dictionary (public or proprietary; all identifiers are globally unique and registered).
.doID	ASN-ID_DO	Identifier of the data object from the data dictionary.

Table 17 — CancelContentConf

Error codes	ASN.1 Type	Description
.error	SFerror	Applicable error codes (FA_OK, FA_NOTAUTHORIZED, FA_INVALID) are specified in Table 8.

12.8 ReceiveContent

The service primitive function ReceiveContent is used by the ITS-S facilities layer to notify the instance of ITS-S-AP identified by appID that data object from a data dictionary identified by {DataDictionaryID, DataObjectID} for which the ITS-S-AP has subscribed to has been received. ASN.1 types and values for the applicable function shall be as specified in Table 18 with ASN.1 details specified in Annex A.

Table 18 — ReceiveContent

ITS-FSDU Parameters	ASN.1 Type	Description
.appID	ApplicationID	Identifier of the instance of the ITS-S-AP where this packet shall be received. May be set to NULL (has the same format and meaning as a port number).
.data	DataFromDDs	
.data.dictID	DataDictID	Identifier of the data dictionary (public or proprietary; all identifiers are globally unique and registered).
.data.objectID	DOidentifier	Identifier of the data object from the dictionary.
.data.content	several	Data object content
.options	SFoptions	Options

13 NF-SAP service primitive functions

13.1 ReceiveNTSDU

The service primitive function ReceiveNTSDU is used by the ITS-S networking and transport layer to notify the ITS-S facilities layer that data has been received. ASN.1 types and values for the parameters of the ReceiveNTSDU function shall be as specified in Table 19 with ASN.1 details specified in Annex A.

Table 19 — NF-UP.indicate(ReceiveNTSDU)

ITS-NTSDU Parameters	ASN.1 Type	Description
.adu	AppProtDataUnit	
.socket.srcInfo	Socket	Identifier of the source where this packet came from in case a reply must be sent (concatenation of port number and network address).
.socket.destInfo	Socket	Identifier of the destination where this packet must be received (concatenation of port number and network address).

13.2 TransmitNTSDU

The service primitive function `TransmitNTSDU` is used by the ITS-S facilities layer to transmit data (ITS-NTSDU, see Figure 6) to the ITS-S networking and transport layer (i.e. for the purpose of transmission to another node). ASN.1 types and for the parameters of the `TransmitNTSDU` function shall be as specified in Table 20 with ASN.1 details specified in Annex A.

NOTE The NF-SAP service primitive functions depend on the protocols (FNTP, IP, GN/BTP).

Table 20 — NF-DOWN.request(TransmitNTSDU)

ITS-NTSDU Parameters	ASN.1 Type	Description
`FlowID`	`FlowID`	Identifier of the ITS-S flow the packet belongs to.
`.socket.srcInfo`	`Socket`	Port number and network address of the source where this packet came from in case a reply must be sent. This includes notification of the transport protocol and network protocol to be used.
`.socket.destInfo`	`Socket`	Port number and network address of the destination where this packet must be received. This includes notification of the transport protocol and network protocol to be used.
`.fpdu`	`FlProtDataUnit`	Data object transmitted by the ITS-S-AP and possibly modified by the ITS-S facilities layer.
`.priority`	`UserPriority`	Priority of the transmission request.
`.options`	`SFoptions`	Various per-packet options (TBD) including per packet priority.

Annex A
(normative)

ASN.1 modules

A.1 Overview

The ASN.1 basic notation is specified in ISO/IEC 8824-1:2008. The following ASN.1 modules are specified in this Annex:

— ITSitssf { iso (1) standard (0) itssf (17429) asnm-1 (1) version1(1)}.

In case the ASN.1 specifications given in this Annex are not compliant with illustrations or specifications provided elsewhere in this Technical Specification, the specifications given in this Annex shall prevail.

Dynamic updates of this annex will be published on http://standards.iso.org/iso/ts/17419/ and become an integral part of this Technical Specification.

A.2 Module ITSitssf

This module specifies ASN.1 type definitions together with useful ASN.1 value definitions.

It imports ASN.1 definitions from modules specified in ISO 17419, ISO 21218, ISO 24102-3, SO 24102-6, ISO 17423.

NOTE ASN.1 definitions and definitions contained in these standards are currently being aligned in order to ensure consistency. Please refer to the latest revisions (2017).

Unaligned packed coding rules (PER) as specified in ISO/IEC 8825-2 shall be applied for this ASN.1 module.

```
ITSitssf { iso (1) standard (0) itssf (17429) asnm-1 (1) version1(1) }

DEFINITIONS AUTOMATIC TAGS::=BEGIN

IMPORTS
EUI64, UserPriority, MACaddress FROM CALMllsap {iso(1) standard(0) calm-ll-sap(21218)
asnm-1 (1) version1 (1)}

ApplicationID FROM CALMmanagement { iso (1) standard (0) calm-management (24102) local (1)
asnm-1 (1) version1 (1)}

FlowID, FlowStatisticsList, DestinationID, CapaInfos FROM ITSpfm { iso (1) standard (0)
calm-management (24102) pfm (6) asnm-1 (1) version1(1) }

PortNumber FROM CALMfntp { iso (1) standard (0) calm-nonip(29281) fntp(1) asnm-1 (1)
version1 (1)}

DestinationType FROM CITSapplReq {iso(1) standard(0) cits-applReq (17423) asnm-1 (1)
version1 (1)}

ITSaid FROM CITSapplMgmtApplReg {iso(1) standard(0) cits-applMgmt (17419) applRegistry (2)
version1 (1)}

;


-- End of IMPORTS

-- Types
```

```
-- TransmitFlowData
TransmitFlowData ::= SEQUENCE{
     flowID          FlowID,
     appID           ApplicationID,
     adu             AppProtDataUnit,
     options         SFoptions
     }

AppProtDataUnit ::= OCTET STRING

SFoptions ::= SEQUENCE SIZE(1..256) OF SFoption

TransmitFlowDataConf ::= SEQUENCE{
     error           SFerror,
     options         SFoptions
     }

SFerror ::= INTEGER{
     sfErrOK                 (0),
     sfErrOKPATHCONGESTED    (1),
     sfErrFLOWNOTREGISTERED  (2),
     sfErrPATHUNAVAILABLE    (3),
     sfErrNOTAUTHORIZED      (4),
     sfErrNOSECU             (5),
     sfErrINVALID-PORT       (6),
     sfErrINVALID-DEST       (7),
     sfErrINVALID-SERV       (8),
     sfErrUNAVAILABLE-SERV   (9),
     sfErrINVALID            (10)
     } (0..255)

-- ReceiveFlowData
ReceiveFlowData ::= SEQUENCE{
     appID           ApplicationID,
     adu             AppProtDataUnit,
     srcPort         PortNumber,
     destPort        PortNumber,
     servFac         CapaInfos,
     servSec         CapaInfos,
     options         SFoptions
     }

-- PublishContent
PublishContent ::= SEQUENCE{
     flowID          FlowID,
     appID           ApplicationID,
     data            DataFromDDs,
     options         SFoptions,
     credentials     PubContCredentials
     }

PubContCredentials ::= OCTET STRING

PublishContentConf ::= SEQUENCE{
   error             SFerror
   }


-- SubscribeContent
SubscribeContent ::= SEQUENCE{
     appID           ApplicationID,
     ddID            DataDictID,
     doID            INTEGER,
     credentials     PubContCredentials
     }

SubscribeContentConf ::= SEQUENCE{
   error             SFerror
   }
```

```
-- CancelContent
CancelContent ::= SEQUENCE{
     appID          ApplicationID,
     ddID           DataDictID,
     doID           INTEGER
     }

CancelContentConf ::= SEQUENCE{
   error            SFerror
   }


-- ReceiveContent
ReceiveContent ::= SEQUENCE {
     appID          ApplicationID,
     data           DataFromDDs,
     options        SFoptions
     }


-- ReceiveNTSDU
ReceiveNTSDU ::= SEQUENCE{
     adu            AppProtDataUnit,
     socket         ItsSocket
     }

ItsSocket ::= SEQUENCE{
    srcInfo        Socket, -- source port number and network address
    destInfo       Socket  -- destination port number and network address
    }

Socket ::= SEQUENCE{
     tProtAddress   TprotAddress,
     nProtAddress   NprotAddress
     }


-- TransmitNTSDU
TransmitNTSDU ::= SEQUENCE{
     flowID         FlowID,
     socket         ItsSocket,
     fpdu           FlProtDataUnit,
     priority       UserPriority,
     options        SFoptions
     }

FlProtDataUnit ::= OCTET STRING



-- ITS facilities layer protocol data unit
Fpdu ::= SEQUENCE{
     version        INTEGER(0..7),
     serviceNos     INTEGER(0..31),
     services       ServiceFacs,
     srcFacAddr     FacAddr,
     dstFacAddr     FacAddr,
     data           FpduData
     }

FacAddr ::= ApplicationID

FpduData ::= OCTET STRING


-- Other types
CfpPathAvailability:: = INTEGER{
     cphPAnoPathSelected     (0),
     cphAPpathsCongested     (1),
     cphAPathLeastOne         (255)
```

```
     } (0..255)


CfpMaxFpdu ::= INTEGER(0..65535)

-- Dynamic Updates
-- Instantiations of CLASS objects

-- SF-OPTION CLASS

SFoptionID ::= INTEGER{
     sFoptNone      (0)
     }

SF-OPTION ::= CLASS{
     &id            SFoptionID UNIQUE,
     &Type
     }
     WITH SYNTAX {&Type SELECTED BY &id}

SFoption ::= SEQUENCE{
     sfOptID        SF-OPTION.&id({SFoptionTypes}),
     option         SF-OPTION.&Type({SFoptionTypes}{@.sfOptID})
     }

-- Dynamic elements of SF-OPTION

SFoptionTypes SF-OPTION ::= {
     {SFoptionNone  SELECTED BY sFoptNone},
     ...
     }

SFoptionNone ::= NULL


-- SERV-FAC CLASS
ServFacID ::= INTEGER{
     servFacNone    (0),
     servFacCSH     (1)
     } (0..255)

SERV-FAC ::= CLASS{
     &id             ServFacID UNIQUE,
     &Type
     }
     WITH SYNTAX {&Type SELECTED BY &id}

ServiceFacs ::= SEQUENCE SIZE(0..63) OF ServFac

ServFac ::= SEQUENCE{
     serfFacID      SERV-FAC.&id({ServFacTypes}),
     serfFac        SERV-FAC.&Type({ServFacTypes}{@.serfFacID})
     }

-- Dynamic elements of SERV-FAC

ServFacTypes SERV-FAC:: = {
     {ServFacNone   SELECTED BY servFacNone} |
     {ServFacCSH    SELECTED BY servFacCSH},
     ...
     }

ServFacNone ::= NULL -- this is the empty service header

ServFacCSH ::= DataFromDDs

-- DATA-DICT CLASS
DataDictID ::= INTEGER{
     dataDictLdm18750   (0)
     } -- is size constraint needed?
```

```
DATA-DICT ::= CLASS{
     &id            DataDictID UNIQUE,
     &Type
     }
     WITH SYNTAX {&Type SELECTED BY &id}

DataFromDDs ::= SEQUENCE SIZE(1..256) OF DataFromDD

DataFromDD ::= SEQUENCE{
     dataDictID     DATA-DICT.&id({DataDictionaryTypes}),
     dataFromDict   DATA-DICT.&Type({DataDictionaryTypes}{@.dataDictID})
     }

DataDictionaryTypes DATA-DICT:: = {
     {DataObjectsLDM18750  SELECTED BY dataDictLdm18750},
     ...
     }

/*
DOidentifier ::= INTEGER
*/

DOldm18750ID ::= INTEGER {
     doLdm18750NullType (0) -- this is a dummy value not to be used!
     } -- data object ID for all data dictionaries must be of type INTEGER

DO-LDM18750 ::= CLASS{
     &id            DOldm18750ID UNIQUE,
     &Type
     }
     WITH SYNTAX {&Type SELECTED BY &id}

DataObjectsLDM18750 ::= SEQUENCE SIZE(1..256) OF DataObjectLDM18750

DataObjectLDM18750 ::= SEQUENCE{
     dataObjID      DO-LDM18750.&id({DOldm18750Types}),
     dataFromDict   DO-LDM18750.&Type({DOldm18750Types}{@.dataObjID})
     }

DOldm18750Types DO-LDM18750 ::= {
     {NullTypeDO    SELECTED BY doLdm18750NullType},
     ...
     }

NullTypeDO ::= NULL



-- TPROT CLASS
TprotID ::= INTEGER{
     tProtFntpPort    (0),
     tProtFntpItsaid  (1),
     tProtTcp         (2),
     tProtUdp         (3)
     } (0..255)

TPROT ::= CLASS{
     &id              TprotID UNIQUE,
     &Type
     }
     WITH SYNTAX {&Type SELECTED BY &id}

TprotAddress ::= SEQUENCE{
     protID         TPROT.&id({TprotTypes}),
     protAddress    TPROT.&Type({TprotTypes}{@.protID})
     }

-- Dynamic elements of TPROT

TprotTypes TPROT ::= {
     {FntpPort      SELECTED BY tProtFntpPort} |
```

```
     {FntpItsaid    SELECTED BY tProtFntpItsaid} |
     {TcpPort       SELECTED BY tProtTcp} |
     {UdpPort       SELECTED BY tProtUdp},
     ...
     }

FntpPort ::= PortNumber
FntpItsaid ::= ITSaid
TcpPort ::= INTEGER (0..65535)
UdpPort ::= INTEGER (0..65535)


-- NPROT CLASS
NprotID ::= INTEGER{
     nProtFntpMac   (0),
     nProtIPv6      (2)
     } (0..255)

NPROT ::= CLASS{
     &id            NprotID UNIQUE,
     &Type
     }
     WITH SYNTAX {&Type SELECTED BY &id}

NprotAddress ::= SEQUENCE{
     protID         NPROT.&id({NprotTypes}),
     protAddress    NPROT.&Type({NprotTypes}{@.protID})
     }

- Dynamic elements of NPROT

NprotTypes NPROT ::= {
     {NProtFntpMac  SELECTED BY nProtFntpMac} |
     {NProtIPv6     SELECTED BY nProtIPv6},
     ...
     }

NProtFntpMac ::= MACaddress
NProtIPv6 ::= EUI64


END
```

Annex B
(informative)

Profiles

This Annex illustrates the communication requirements parameters presented by different types of ITS-S application processes and provided to the ITS station management entity at time of flow type registration as defined in ISO 24102-6. The set of parameters is as defined in ISO/TS 17423:2014.

NOTE The published version of ISO/TS 17423:2014 is under revision in order to be aligned with ISO 24102-6 and this Technical Specification so there are discrepancies between the content of Tables B.1 to B.3 and the content of the tables in ISO/TS 17423:2014; once the revision of ISO/TS 17423:2014 is achieved, the parameters presented in Tables B.1 to B.3 will be slightly modified and new fields will probably be added.

B.1 Transmission of broadcast safety message from the CSH or an application

Table B.1 presents the parameters used for the ITS-S flow corresponding to broadcast messages sent either from the Content Subscription Handler or an ITS-S application process installed on a roadside ITS station to nearby vehicle ITS stations.

The intended usage in this example is the 5,9 GHz access technology using the communication channel reserved for safety messages. Examples include messages defined for In-Vehicle Signage (ISO/TS 17425), Contextual Speed (ISO/TS 17426), Signal Phase and Timing (SPAT) (ISO/TS 19091).

The data content is formatted as defined in 11.6. The content of the *payload* field of the ITS-S data container is defined in relevant standards, as for instance the ones indicated above. The ITS-FPDU is formatted as indicated in 10.2.

Table B.1 — Communication parameters for a safety broadcast message

Communication flow requirements (ASN.1 type)	Value	Comment
Identifiers for the ITS-S flow type registration		
`ApplicationID`	ID of CSH or ID of the application	Identifier of the ITS-S application process realizing the ITS-S flow type registration request.
`FlowTypeID`	N/A	Not presented unless ITS-S flow type parameters are registered in a global registry (not the case for the time being).
Operational communication service parameters		
`LogicalChannelType`	SfCH	Safety channel.
`ContConnect`	N/A	No continuous connectivity needed for a broadcast.
`NxRepeat`	255, 0,5 s	A transmission is expected once every half second (0,5) until the ITS-S flow is cancelled (255).
`StoreAndForward`	N/A	No store and forward capability needed.
`Priority`	Maximum	Maximum since safety-related message.
`PortNo`	Rx: **PORT_FSH** Tx: **PORT_FSH**	PORT_FSH is used because ITS-S facilities services are requested by the ITS-S application process. The message is thus formatted using the ITS-S data header and the ITS-S data container.

Table B.1 *(continued)*

Communication flow requirements (ASN.1 type)	Value	Comment
Destination communication service parameters		
DestType	1 (GeoLocationBasedType) 4 (geoBroadcast)/	Broadcast to geographical area.
DestDomain	2 (siteLocal)	Messages are transmitted to a limited geographic area limited by the coverage range of the source.
CommDistance	500 m	Minimum distance at which vehicles are supposed to receive the message.
Multihop	N/A	Not needed since recipients are not expected to relay the message.
Directivity	Omnidirectional	
Performance communication service parameters		
Resilience	N/A	Requesting increase of likelihood of proper delivery is not needed for a broadcast message sent over of safety channel.
MinThP	MaxADU × NxRepeat	Meaningless for repeated broadcast services.
MaxLat	4 (ms100)	Maximum acceptable latency of 100 ms, parameter not necessarily needed as the message is a broadcast and is known as high priority anyway.
MaxADU	1 (multiples of 100 byte)	100 is an example. Value depends on the exact content of the message but should be short for a safety message.
ITS-S facilities services to be applied by the Facilities Services Handler (FSH)		
CapaInfos (security services)	DataIntegrity/NonRepudiation /SourceAuthentication	Security services provided by the ITS-S security layer are called by the FSH
CapaInfos (facilities services)	TimeStamping (this is just an example of service; CapaInfos allows to provide a list)	Generic security services provided by ITS-S capabilities in the ITS-S facilities layer are called by the FSH.
Protocol communication service parameters		
Protocol	N/A	The choice of the protocol stack (transport, network, access technology) is left to the ITS-S management entity so that this Technical Specification is generically applicable to road-side ITS-S implemented with distinct protocol stacks according to regional decisions.

B.2 Transmission of data from a proprietary application to a server

Table B.2 below presents the communication requirements corresponding to a large point-to-point data exchange between a proprietary client application installed on a vehicle and the corresponding proprietary server application reachable through the Internet (for instance, a software update, map update, etc.). Among other requirements, this data exchange requires session continuity and confidentiality.

As a result of providing such communication requirements, the ITS-S management entity will determine the appropriate communication profile and inform the ITS-S facilities layer (CPH). The ITS-S management entity will ensure session continuity is maintained between the vehicle and the server while the vehicle is moving using any available access technology (urban WiFi, vehicular WiFi, cellular, etc.), possibly combined so that the loss of connectivity using one access technology is recovered by the use of another access technology, without breaking up the ongoing data transfer. Session continuity will

effectively be maintained by the ITS-S network and transport layer (IPv6, as specified in ISO 21210) following the instructions of the ITS-S management entity as specified in ISO 24120-6.

The data content format is proprietary to the application, and none of the ITS-S facilities services are requested, even for security which is implemented directly in the application (thereof, the security services are marked as "not requested"). The FSH is thus not used, and the ADU is not modified in the ITS-S facilities layer (no need to create an ITS-FPDU as indicated in 10.2. Packets are thus not transferred via the port PORT_FSH.

Table B.2 — Communication parameters for a proprietary data transfer

Communication flow requirements (ASN.1 type)	Value	Comment
Identifiers for the flow type registration		
`ApplicationID`	ID of the application	Identifier of the ITS-S application process realizing the flow type registration request.
`FlowTypeID`	N/A	Not presented unless flow parameters are registered in a global registry (not the case for the time being).
Operational communication service parameters		
`LogicalChannelType`	GPCH	General purpose channel.
`ContConnect`	10 min (just an example of maximum estimated duration)	Continuous connectivity needed/an estimated duration of the transmission is given as an indication for better selection of the communication profile by the ITS station management.
`NxRepeat`	0	No repetition of data for file transfer.
`StoreAndForward`	N/A	No store and forward capability needed.
`Priority`	N/A	Best effort is sufficient.
`PortNo`	Rx: any Tx: any	Port requested by the application.
Destination communication service parameters		
`DestType`	0 (AddressBasedType)/ 2 (unicast)	Unicast address in the Internet.
`DestDomain`	8 (global)	Server reachable in the Internet.
`CommDistance`	N/A	N/A as server reachable in the Internet.
`Multihop`	N/A	Not needed since recipients are not expected to relay the message.
`Directivity`	Omnidirectional	
Performance communication service parameters		
`Resilience`	N/A	Requesting increase of likelihood of proper delivery is not necessary.
`MinThP`	0	No specify transmission rate is needed.
`MaxLat`	1 (any)	Any latency is acceptable.
`MaxADU`	65535 (multiples of 100 byte)	Maximum size of the data exchanged (maximum file size, etc.).
ITS-S facilities services to applied by the Facilities Services Handler (FSH)		
`CapaInfos` (security services)	None	The application uses directly the security services offered by the ITS-S security entity.

Table B.2 *(continued)*

Communication flow requirements (ASN.1 type)	Value	Comment
`CapaInfos` (facilities services)	None	The application does not use any ITS-S facilities service.
Protocol communication service parameters		
`Protocol`	N/A	Choice of the protocol stack (transport, network, access technology) is left to the ITS-S management entity so that the International Standard is generically applicable to roadside ITS-S implemented with distinct protocol stacks according to regional decisions. In a regional deployment, the ITS station management entity can be statically configured to select a given communication profile (e.g. FNTP/M5, GeoNet/G5, WSMP/11p).

B.3 Transmission of probe data from a proprietary application to a server

Table B.3 presents the communication requirements corresponding to a continuous point-to-point small data exchange between a proprietary client application installed in ITS station (roadside or vehicle ITS station) and the corresponding proprietary server application reachable through the Internet (for instance, probe data, etc.). Among other requirements, this data exchange requires confidentiality, time stamping, geo-stamping. Session continuity is not necessary, but connectivity is expected to be relatively continuous.

As a result of providing such communication requirements, the ITS-S management entity will determine the appropriate communication profile and inform the ITS-S facilities layer (CPH). The ITS-S management entity will ensure the data are transferred to the server using any available access technology (urban WiFi, vehicular WiFi, cellular, etc.), possibly combined so that the loss of connectivity using one access technology is recovered by the use of another access technology. Connectivity will effectively be managed by the ITS-S network and transport layer (IPv6, as specified in ISO 21210) following the instructions of the ITS-S management entity as specified in ISO 24120-6.

The data content format is proprietary to the application, but the application requests the use of ITS-S facilities services simplifying the design of the application. In this example, the application relies on the ITS-S facilities layer to apply security services and for time stamping and geo-stamping each probe data. The ITS-FPDU is formatted as indicated in 10.2.

Table B.3 — Communication parameters for a proprietary probe data

Communication flow requirements (ASN.1 type)	Value	Comment
Identifiers for the flow type registration		
`ApplicationID`	ID of the application	Identifier of the ITS-S application process realizing the flow type registration request.
`FlowTypeID`	N/A	Not presented unless flow parameters are registered in a global registry (not the case for the time being).
Operational communication service parameters		
`LogicalChannelType`	GPCH	General purpose channel.

Table B.3 *(continued)*

Communication flow requirements (ASN.1 type)	Value	Comment
ContConnect	10 min (just an example of maximum estimated duration)	Continuous connectivity not needed/an estimated duration of the transmission is given as an indication for better selection of the communication profile by the ITS station management.
NxRepeat	0	No repetition of data for probe data.
StoreAndForward	N/A	No store and forward capability needed.
Priority	N/A	Best effort is sufficient.
PortNo	Rx: any Tx: any	Port requested by the application.
Destination communication service parameters		
DestType	0 (AddressBasedType)/ 2 (unicast)	Unicast address in the Internet.
DestDomain	8 (global)	Server reachable in the Internet.
CommDistance	N/A	N/A as server reachable in the Internet.
Multihop	N/A	Not needed since recipients are not expected to relay the message.
Directivity	Omnidirectional	
Performance communication service parameters		
Resilience	N/A	Requesting increase of likelihood of proper delivery is not necessary.
MinThP	0	No specify transmission rate is needed.
MaxLat	1 (any)	Any latency is acceptable.
MaxADU	10 (multiples of 100 byte)	Maximum size of the data exchanged (maximum file size, etc).
ITS-S facilities services to applied by the Facilities Services Handler (FSH)		
CapaInfos (security services)	DataIntegrity/NonRepudiation /SourceAuthentication	Security services provided by the ITS-S security layer are called by the FSH.
CapaInfos (facilities services)	TimeStamping/GeoStamping (this is just an example of service; CapaInfos allows to provide a list)	Generic security services provided by ITS-S capabilities in the ITS-S facilities layer are called by the FSH.
Protocol communication service parameters		
Protocol	N/A	Choice of the protocol stack (transport, network, access technology) is left to the ITS-S management entity so that the International Standard is generically applicable to roadside ITS-S implemented with distinct protocol stacks according to regional decisions.

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