
**Intelligent transport systems —
Communications access for land
mobiles (CALM) — ITS station
management —**

**Part 6:
Path and flow management**

*Systèmes intelligents de transport — Accès aux communications des
services mobiles terrestres (CALM) — Gestion des stations ITS —*

Partie 6: Titre manque



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

This document was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

A list of all parts in the ISO 24102 series can be found on the ISO website.

Introduction

This document is part of a series of International Standards for communications access for land mobiles (CALM). An introduction to this series of International Standards is provided in ISO 21217:2014.

This document is Part 6 of a series of International Standards that specifies path and flow management as part of the local ITS station management.

The ITS station management entity provides functionalities related to the management of communication protocol layers and the security entity presented in the ITS station reference architecture specified in ISO 21217:2014 and presented in [Figure 1](#) — ITS station reference architecture.

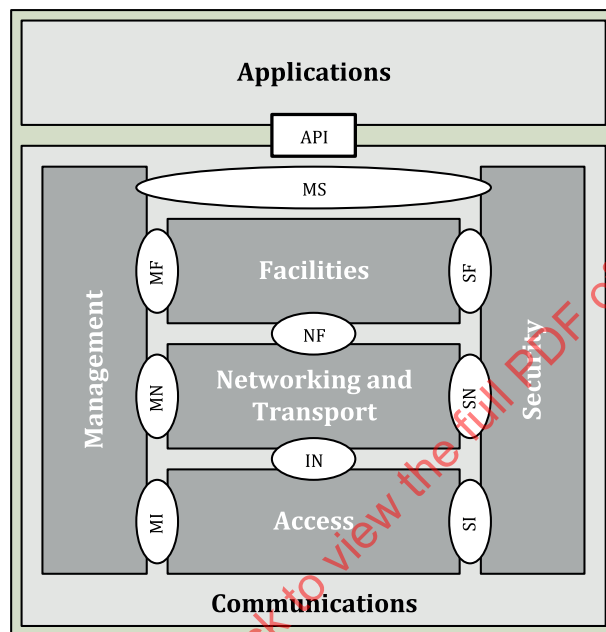


Figure 1 — ITS station reference architecture

The ITS station management entity is specified as a distributed process, where no supervisory entity is employed.

This document defines the functionalities of the ITS station that are used to collect the information necessary for path and flow management:

- the capabilities of all layers of the ITS station (functionalities, technologies and protocols) supported by the ITS station;
- the capabilities of neighbour ITS stations (functionalities, technologies and protocols) supported by the neighbour ITS stations;
- the current network conditions (availability and characteristics of a communication interface, availability of Internet access, etc.);
- the existing data flows and their communication requirements (identity of the destination node, security procedures applied to the data flow, end-to-end delay, packet size, etc);
- the available routing paths to a destination node;
- how a data flow is mapped to the selected routing path.

The information collected by the ITS station management entity is used to determine the most appropriate communication profile (facilities protocols, transport protocols, network protocols, access technologies and communication channels) and routing path indicating where to route packets of each

data flow, according to the communication requirements provided by the application and depending on the current network conditions. The method to perform this determination has competitive value and is out of scope of this document.

This document provides a detailed specification of the concept of paths and flows introduced in ISO 21217:2014. It complements ISO 17423:2018, ISO/TS 17429:2017, and ISO 24102-3[17]. The concept of paths and flows is essential for abstracting ITS station applications from the communications services available in the ITS station and for selecting the most appropriate communication profile (i.e. protocol stack).

The functionalities specified in this document apply to all types of ITS stations without distinction. They are useful for ITS stations equipped with various access technologies and/or various protocol stacks.

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Intelligent transport systems — Communications access for land mobiles (CALM) — ITS station management —

Part 6: Path and flow management

1 Scope

This document specifies parameters and procedures for the ITS station management entity to manage data flows and routing paths associated with available communication resources in an ITS station, and to map data flows to routing paths.

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 17423:2018, *Intelligent transport systems — Cooperative systems — ITS application requirements and objectives for selection of communication profiles*

ISO/TS 17429:2017, *Intelligent transport systems — Cooperative ITS — ITS station facilities for the transfer of information between ITS stations*

ISO 21217:2014, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 anchor node

logical node contained in an ITS-S path which, when instantiated, has a locator known by the source node

3.2 destination node

communication end point of an ITS-S path

Note 1 to entry: In multicast operation, there can be many distinct destination nodes.

3.3 ITS-S egress anchor node

second (last) anchor node contained in an ITS-S path

3.4 ITS-S ingress anchor node

first anchor node contained in an ITS-S path

3.5

ITS-S anchor segment

segment of an ITS-S path that starts at an ITS-S ingress anchor node and ends up at an ITS-S egress anchor node

3.6

ITS-S capability

uniquely addressable protocol or functionality that is part of an ITS-S Managed Service Entity

Note 1 to entry: Examples of ITS-S capabilities in the ITS station facilities layer are generic ITS-S facilities layer services specified in ISO/TS 17429 (Communication Profile Handler, Facilities Services Handler, Content Subscription Handler), the position and time service defined in ISO/TS 21176¹⁾, the security service defined in ISO/TS 21177²⁾; examples of ITS-S capabilities in the ITS-S networking and transport layer are IPv6 functionalities defined in ISO 21210 (IPv6 neighbour discovery, IPv6 forwarding, IPv6 mobility support, ...), the fast service announcement protocol defined in ISO 22418³⁾, etc.

3.7

ITS-S communication profile

ITS-SCP

parameterized ITS-S communication protocol stack (set of protocols composing all the ITS station layers) that allows communication end points to communicate with one another

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

3.9

ITS-S flow identifier

FlowID

identifier, being unique within an ITS station unit, that identifies an ITS-S flow

3.10

ITS-S flow type

set of characteristics describing a data flow

Note 1 to entry: Flow types could be pre-assigned, well known and recorded with some authority registry or defined by the applications following a number of conventions

3.11

ITS-S flow type identifier

FlowTypeID

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

3.12

ITS-S path

directed sequence of nodes connected by links starting at a source node, traversing a communication interface of the source ITS-S, an ITS-S ingress anchor node and an ITS-S egress anchor node, ending at a destination node

Note 1 to entry: In some circumstances, the ITS-S ingress anchor node and the ITS-S egress anchor nodes might be collapsed with the destination node (i.e. the roles of the ITS-S ingress anchor node and the ITS-S egress anchor node are played by the destination node).

Note 2 to entry: For bidirectional communications, two such ITS-S paths exist, i.e. one starting at each communication end point. Note further that there could be multiple ITS-S paths between a source and its destination.

-
- 1) Under development.
 - 2) Under development.
 - 3) To be published.

3.13**ITS-S path identifier****PathID**

identifier of a given ITS-S path being unique within an ITS station

3.14**ITS-S managed service entity****MSE**

uniquely addressable entity in an ITS-S layer comprised of a set of related ITS-S capabilities

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

3.15**locator**

identifier of the topological location of a node in a communication network

Note 1 to entry: A locator of an ITS station is the identifier of an ITS-S ingress anchor node (an ITS station has as many locators as there are ITS-S ingress anchor nodes to which it is attached).

3.16**registered ITS-S flow**

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

3.17**source node**

communication end point that creates packets for transmission to peer entities

4 Symbols and abbreviated terms

CI	Communication Interface, see ISO 21218 [14]
ITS-S-FlowID	ITS Station Flow Identifier
ITS-S-FlowTypeID	ITS Flow Type Identifier
ITS-S	ITS station, see ISO 21217:2014
ITS-S-AP	ITS Station Application Process
ITS-S-APID	ITS Station Application Process Identifier
ITS-SCP	ITS station communication profile
ITS-SCU-CMC	ITS-SCU Communication Management Centre, see ISO 24102-2 [16]
MSE	ITS station Managed Service Entity
PathID	ITS station Path Identifier
PFM, pfm	Path and Flow Management
SAL	ITS Station Access Layer
SFL	ITS Station Facilities Layer

SME	ITS Station Management Entity
SNTL	ITS Station Networking and Transport Layer
VCI	Virtual Communication Interface, see ISO 21218[14]

5 Overview

5.1 Relation with the ITS station reference architecture

This document specifies functionalities of the ITS “Station Management Entity” (SME) of the communication architecture specified in ISO 21217:2014. The layered ITS station communication architecture is illustrated in [Figure 1](#) — ITS station reference architecture. The ITS “Station Facilities Layer” (SFL), the ITS “Station Networking & Transport Layer” (SNTL), and the ITS “Station Access Layer” (SAL) are each capable of containing multiple managed service entities (ITS-S Managed Service Entity) running simultaneously as detailed in ISO 21217:2014.

5.2 ITS-S flows

In general, an ITS station supports multiple ITS-S applications of different types such as applications for road safety, traffic efficiency, value added services and infotainment. Each application that needs to send and receive data is most often either engaged in a bidirectional exchange with known communication peers, or is repetitively broadcasting data to unidentified receivers. The nature of the transmitted information is known and communication requirements are typically specific to the type of data flow (road safety, traffic efficiency, infotainment). These communication requirements can be expressed in terms of bandwidth, end-to-end delay, security, packet size, etc. for each type of data flow. A list of requirements is provided in ISO 17423:2018.

The ITS-S flow type allows the classification of data flows with the same characteristics, transmitted from distinct ITS stations or to distinct destination nodes. However, in the common situation in which several applications are installed in a given ITS station unit, these applications are typically engaged in several data exchanges of distinct nature (different flow types). There could consequently exist multiple ongoing data flows of different natures, competing for the same ITS station resources.

5.3 ITS-S communication profiles

In general, an ITS station supports multiple protocols and functionalities (ITS-S capabilities) within each of the ITS station layers: in the ITS-S facilities layer (e.g. the communication handler specified in ISO 17423:2018, ITS-S application processes for CAM[24] and DENM[25],...), various types of ITS-S networking and transport layer protocols (IPv6[8], FNETP [21], GeoNetworking[26],...) and various types and instances of access technologies (communication interfaces[14]).

Available protocols and access technologies can be combined in various ways to transfer data to the destination. A collection of protocols used to transfer data to a destination is referred to as the communication profile (ITS-SCP).

The communication profile indicates the protocol stack, i.e. the protocols at the ITS station facilities layer, the ITS station networking and transport layer, and ITS station access technologies layer that are used for a given data flow.

Several communication profiles could exist to reach a given destination. Some communication profiles may not be appropriate to reach a given destination if the communication end points do not support a compatible set of protocols.

5.4 ITS-S paths

An ITS-S path as defined in ISO 21217:2014 starts at its source node and ends up at a destination node. There may be zero or more intermediate nodes in the ITS-S path between the source node and the destination node.

However, the ITS-S path towards a destination node goes through “selectable communication nodes” that are pre-determined according to the peer nodes engaged in the communication. These “selectable communication nodes” are referred to as the ‘ITS-S anchor nodes’ (respectively the ‘ITS-S ingress anchor node’ and the ‘ITS-S egress anchor node’) and form the entry and exit end points of a controllable path segment (‘ITS-S anchor segment’). This is illustrated in [Figure 2](#).

NOTE 1 The CI, the ITS-S ingress anchor node and the ITS-S egress anchor node are the selectable parts of the path. The CI is the starting point of the ITS-S path. The ITS-S ingress anchor node is the first selectable communication node on the path to which the packets are forwarded, whereas the egress ITS-S anchor is the last selectable communication node.

NOTE 2 For groupcast communication, there are multiple destinations but the packets transmitted to a group are not duplicated before reaching the ITS-S egress anchor node, hence all destination nodes are said to be reachable over the same path. The ITS-S egress anchor node can play the role of a rendez-vous point for IP-based multicast communications.

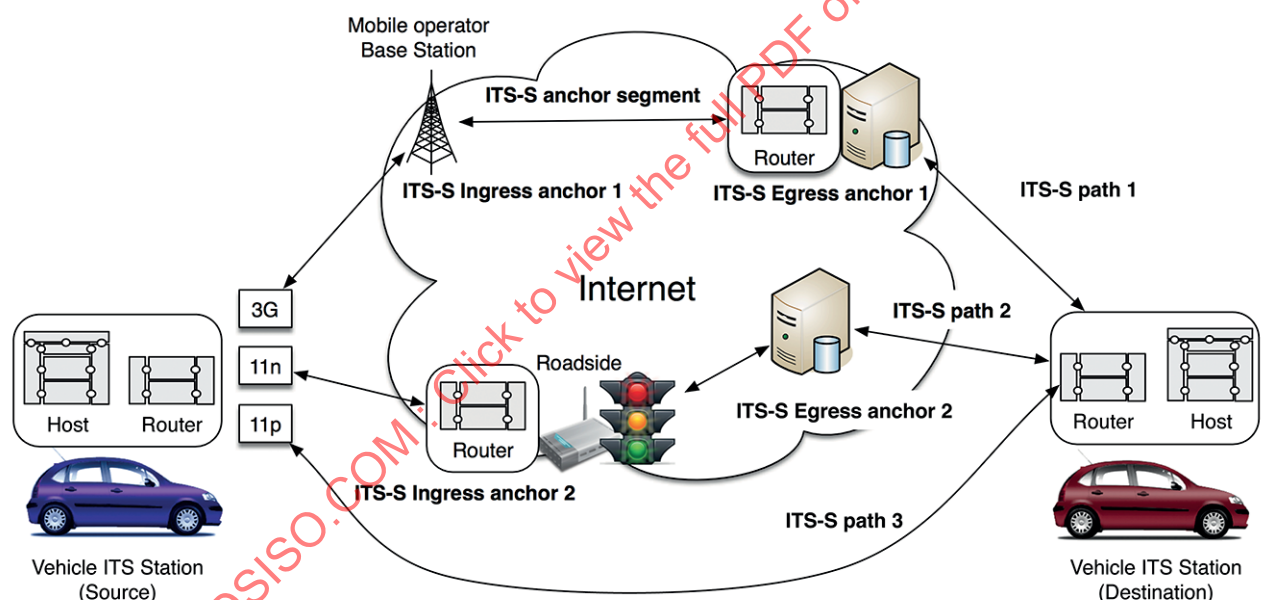


Figure 2 — Overview of the concept of ITS-S path and ITS-S anchor segment

In some circumstances, for example when the source node and the destination node are both located in the same local network (see ITS-S path 3 in [Figure 2](#)), the ingress and ITS-S egress anchor nodes are collapsed with the destination node.

- For Internet-based communications (see ITS-S path 1 and 2 in [Figure 2](#)), an ITS-S path goes through a communication interface (CI) of the source ITS-S. The ITS-S ingress anchor node is a node in the access network to which the ITS station is locally attached, and the ITS-S egress anchor node is a node in the Internet to which the ITS station is remotely attached. It finally reaches its destination node.
- For local ad hoc communications (see ITS-S path 3 in [Figure 2](#)), an ITS-S path goes through a CI of the source ITS-S. The ingress anchor, egress anchor and the destination node are identical.

The diversity of communication interfaces and ITS-S anchor nodes imply a multiplicity of ITS-S paths may be available to reach a given destination node. This happens:

- When multiple ITS-S ingress anchor nodes are reachable through the same communication interface, each of them typically located in the access network of distinct operators or located in different parts of the network when communication traffic is discriminated between road safety, traffic efficiency and infotainment types of services, or when multiple ITS-S ingress anchor nodes are reachable through distinct communication interfaces. Note that ITS-S ingress anchor nodes could be significantly distant in the topology of the communication network (e.g. the ITS-S ingress anchor node on an ITS-S path going through an 11p communication interface of a vehicle ITS station is likely on the roadside infrastructure whereas the ITS-S ingress anchor node on an ITS-S path going through the 3G communication interface is in the network of a cellular operator thus much further away).
- When a diversity of ITS-S egress anchor nodes from the same service operator are deployed in distinct geographic areas or when a diversity of ITS-S egress anchor nodes from distinct service operators provide similar or complementary services.

These ITS-S paths can take very different routes.

5.5 ITS-S capabilities

ITS-S capabilities are used to indicate protocols and functionalities that can be provided by a given ITS-S managed service entity. Each ITS-S capability provides a well-identified function, with some specific characteristics. Each ITS-S capability has a unique identifier. Well-known ITS-S capabilities may be recorded in a global registry. An ITS-S capability can be provided by several protocols or methods.

At the ITS-S networking and transport layer, examples of ITS-S capabilities in the IPv6 Networking ITS-S managed service entity (`mse-IPv6suite`) are the protocols providing network addressing (IPv6 Stateless Address AutoConfiguration), the protocol providing session continuity (IPv6 mobility support), the protocol providing encryption (IPsec). These ITS-S capabilities of the IPv6 Networking MSE are defined in ISO 21210.

ITS-S capabilities of the generic ITS-S managed service entity in the ITS-S facilities layer (`mse-GISFsuite`) are specified in ISO 17423:2018 (facilities service handler, content subscription handler, communication profile handler), in ISO/TS 21177 [21177] (security service) and ISO/TS 21176 [2] (position and time functionality).

5.6 Path and flow management

When there are multiple ITS-S flows and a diversity of communication profiles and ITS-S paths, it is useful to determine for each ITS-S flow:

- The most suitable ITS-S communication profile to transfer data to the destination. This determination is not only necessary for the appropriate use of resources at the sending ITS station, but is also necessary to ensure both communication end points use a compatible set of protocols.
- The most suitable ITS-S path for routing a given ITS-S flow. This determination is not only necessary to route the packets but also to map ITS-S flows to the ITS-S path that best meets the communication requirements of the ITS-S application processes installed on the ITS station.

The determination of the ITS-S path implies the selection of the communication interface, the ITS-S ingress anchor node and ITS-S egress anchor node as shown in [Figure 2](#).

Such determination is made by the ITS station management entity once it has gathered sufficient information on the following categories of information:

- Communication requirements of the applications installed on the ITS station that require communication resources of the ITS station (classified in operational, destination type, performance, monetary cost, energy cost, security, and protocol requirements as specified in ISO 17423:2018).

- Capabilities of all layers of the ITS station (functionalities, technologies and protocols supported by the ITS station, characteristics of available communication interfaces, etc.):
 - Supported ITS station facilities layer protocols (CAM[24], DENM[25], SPaT, MAP, CoAP[6], communication handler, service announcement, generic message handling, local dynamic map[3],...) and their parameters;
 - Supported ITS station network & transport layer protocols (UDP, TCP, FNETP[21], IPv6[8], 6LoWPAN[5], GeoNetworking/BTP[26], etc.), the functionalities they provide (broadcasting, multicasting, geocasting, mobility management, multihoming, etc.) and their parameters;
 - Supported ITS station access technologies layer protocols (IEEE 802.11(p)[13][27][28], infrared[12], satellite[23], 2G[10]/3G[11], LTE[2], IEEE 802.15.4[29],...), the functionalities they provide (short range communication, medium range communication, long range communication, ...) and their parameters;
- Capabilities of the access networks to which the ITS station is attached:
 - Network services provided by surrounding neighbour nodes (e.g. vehicle ITS station able to relay information to other vehicles, roadside ITS station providing Internet connectivity, etc.). The ITS station detects neighbour ITS stations and other legacy nodes through network services (neighbour discovery and other mechanisms including signalling protocols) and facilities services (CAM, DENM, SPaT, MAP, SAM, ...). For instance, among the services of neighbour ITS stations detected from network layer signalling protocols, a neighbour ITS station may provide a network access service allowing the ITS station to access the Internet while another may provide an anchor service;
 - Current network conditions: various metrics of an access technology (bandwidth, packet loss), status of link (set up, in use, ...), network load, reachability over that link (availability of Internet access);
- Capabilities of the peer communication end points as they must be able to support the same communication profiles;
- Capabilities of the ITS-S anchor nodes along the ITS-S path;
- Regulations and policies including local, national and regional rules (e.g. allowed access technologies and their transmission power; location privacy) and stakeholder rules (e.g. always prefer one access technology over another).

[Figure 3](#) illustrates the architectural components (building blocks and management data flows) of the ITS station management entity which are involved in the ITS-S path selection process. The same architecture applies to the communication profile selection process introduced in ISO 17423:2018.

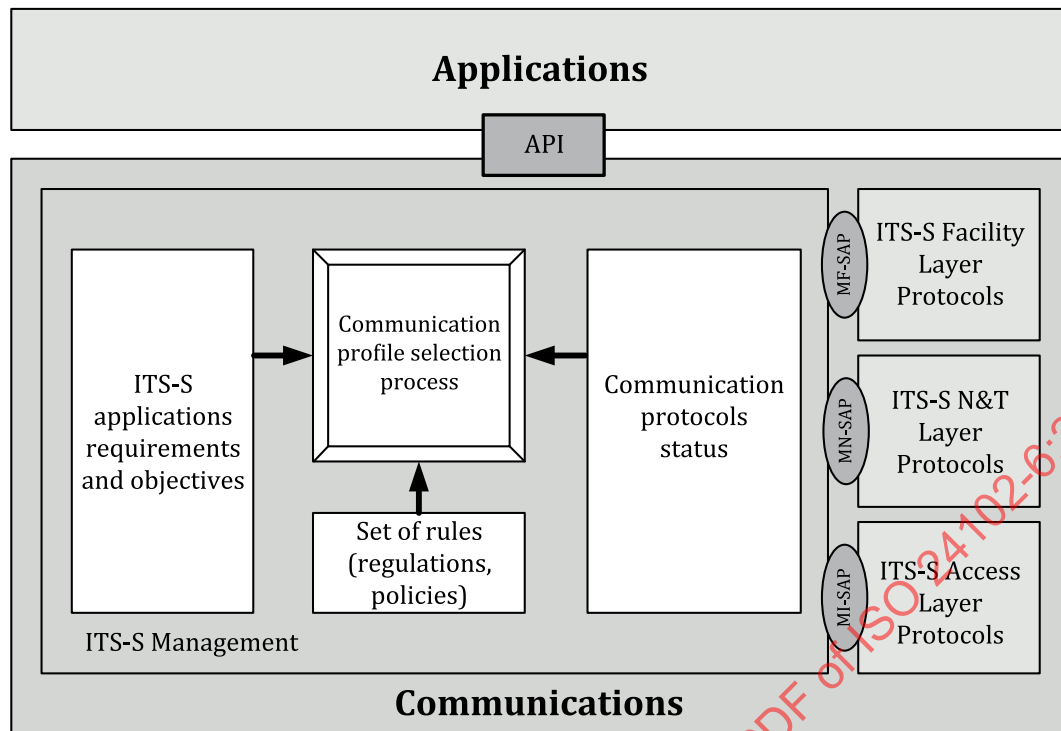


Figure 3 — Architecture of the communication profile and path selection [ISO 21217:2014]

NOTE In general, it cannot be ensured that the communication requirements will be met all along a particular ITS-S path as there can be no knowledge of the capabilities of all the nodes along the ITS-S path.

5.7 ITS station management functionalities

This document defines the following functionalities of the ITS “Station Management Entity” (SME) to determine available ITS-S paths and select the most appropriate one for each ITS-S flow.

- **ITS station capabilities management** is the process of ascertaining the capabilities of the ITS station (supported protocols or services and their functions, available communication interfaces and their characteristics) and which of them can be used at a given time.
- **Path management** is the process of determining ITS-S paths where packets can be routed. To do so, the SME must collect information from the ITS-S layers. In particular, it must determine the neighbour network nodes that could act as ITS-S ingress anchor nodes, their capabilities and the network services they provide (e.g. Internet access).
- **Flow management** is the process of keeping track of the ITS-S flows in the ITS station, including assigning and releasing the ITS-S flow identifiers.
- **Path selection** is the process of determining the most appropriate ITS-S path(s) from all the ITS-S paths available for a given ITS-S flow or a set of ITS-S flows of the same characteristics.
- **Communication profile selection** is the process of determining the most appropriate protocol stack for an ITS-S flow.

In order to determine the most appropriate ITS-S path for a given ITS-S flow, the SME must first have the most up-to-date view of all the available ITS-S paths and for how long they are able to survive. Keeping track of the available ITS-S paths requires gathering information from all ITS-S layers and maintaining accurate information.

The SME thus collects information from all the ITS-S layers and monitors the current state of the network (via the MN-SAP), the characteristics of the access technologies (via the MI-SAP), flow

requirements expressed by applications (via the MA-SAP) or the facilities (via the MF-SAP), and other information maintained locally in order to determine routing policies to be applied to ITS-S flows, given the flow requirements, the current status of the network and access technologies characteristics.

Once the determination is realized, the SME provides to all ITS-S layers the communication profile(s) (ITS-SCP) and the rules to be applied to a given ITS-S flow or set of ITS-S flows. This information can be updated dynamically.

NOTE The rationale for those functionalities is detailed in the deliverable D2.4 *Final System Specification* of the ITSSv6 project^[30] from which this document is largely derived.

5.8 ITS station management information tables

The SME collects and maintains information about ITS-S flows, ITS-S paths and ITS-S capabilities. This information can be maintained in the form of tables as illustrated on [Figure 4](#).

Parameters obtained through the M*-SAP are expressed to the SME in a protocol agnostic fashion so that mechanisms for path and flow management are performed identically and independently of the type of ITS station (vehicle, roadside, personal or central ITS stations), its capabilities (protocols and functionalities) and the type of implementation (distributed in several ITS-SCU or not).

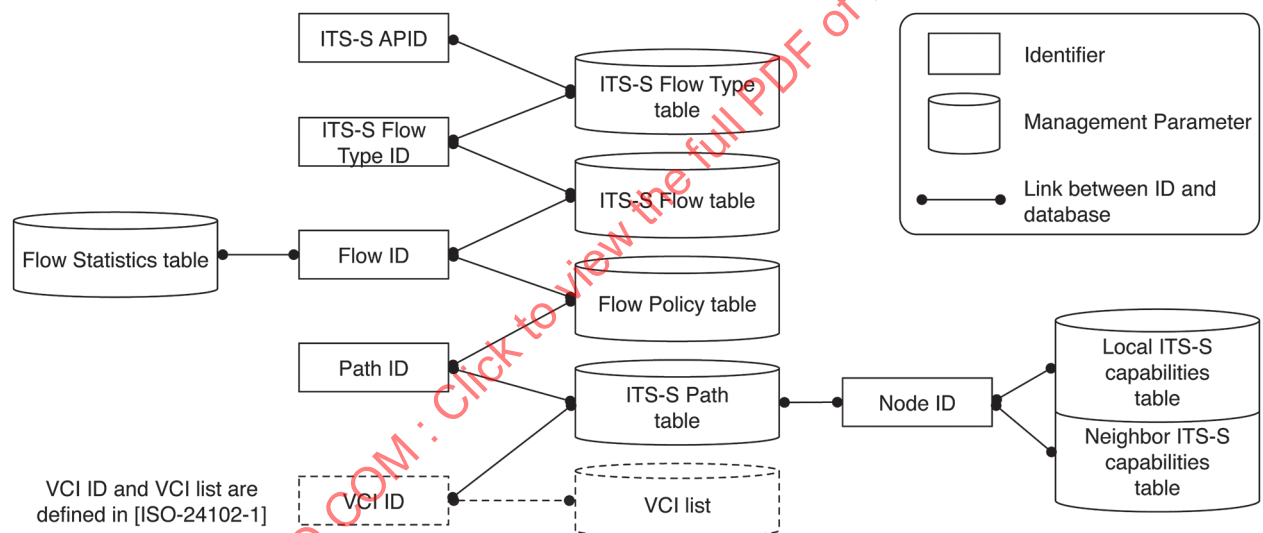


Figure 4 — Information maintained within the ITS station management entity

5.9 Interaction with ITS station layers

The interaction between the ITS “Station Management Entity” (SME) and the layers of the ITS station architecture, the ITS station application entity and the ITS station security entity is made through the management Service Access Points (SAP) of the ITS station (MI-SAP, MN-SAP, MF-SAP, MA-SAP, MS-SAP) specified in ISO 21217:2014 and in ISO 24102-3^[17] as follows.

- The interactions between the SME and ITS station application processes (ITS-S-APs) are realized through the MA-SAP using the MA-REQUEST service initiated by the ITS-S-APs, and the MA-COMMAND service initiated by the SME. These service primitives are specified in ISO 24102-3^[17], ISO 17423:2018 and ISO/TS 17429:2017 specify how related service primitive functions are handled by the ITS-S-APs.
- The interactions between the SME and the ITS “Station Facilities Layer” (SFL) are realized through the MF-SAP using the MF-REQUEST service initiated by the SFL to the SME and the MF-COMMAND service initiated by the SME. The request and confirm service primitives are specified

in ISO 24102-3[17]. ISO/TS 17429:2017 specifies how related service primitive functions are handled by the generic ITS-S managed service entity (*mse-GISFsuite*) of the SFL.

- The interactions between the SME and the ITS “Station Networking & Transport Layer” (SNTL) are realized through the MN-SAP using the MN-REQUEST service initiated by the SNTL, and the MN-COMMAND service initiated by the SME. The request and confirm service primitives are specified in ISO 24102-3[17]. ISO 21210[8] specifies how related service primitive functions are handled by the IPv6 Networking ITS-S Managed Service Entity of the SNTL (*mse-IPv6suite*) whereas ISO 29281-1[22] specifies how related service primitive functions are handled by the FNTTP ITS-S Managed Service Entity of the SNTL (*mse-FNTTPsuite*).

NOTE ISO 21210[8] is intended to be revised as Part 1[9] of a multi-part standard on IPv6.

- The interactions between the SME and the ITS “Station Access Layer” (SAL) are realized via the MI-SAP using the MI-REQUEST service initiated by the SAL, and the MI-COMMAND service initiated by the SME. The request and confirm service primitives are specified in ISO 24102-3[17], ISO 21218[14] and ISO 24102-1[15] specify how related service primitives are handled by Communication Interface ITS-S Managed Service Entity of the SAL (*mse-CISuite*).

Figure 5 shows the information flow between the SME and the ITS station layers.

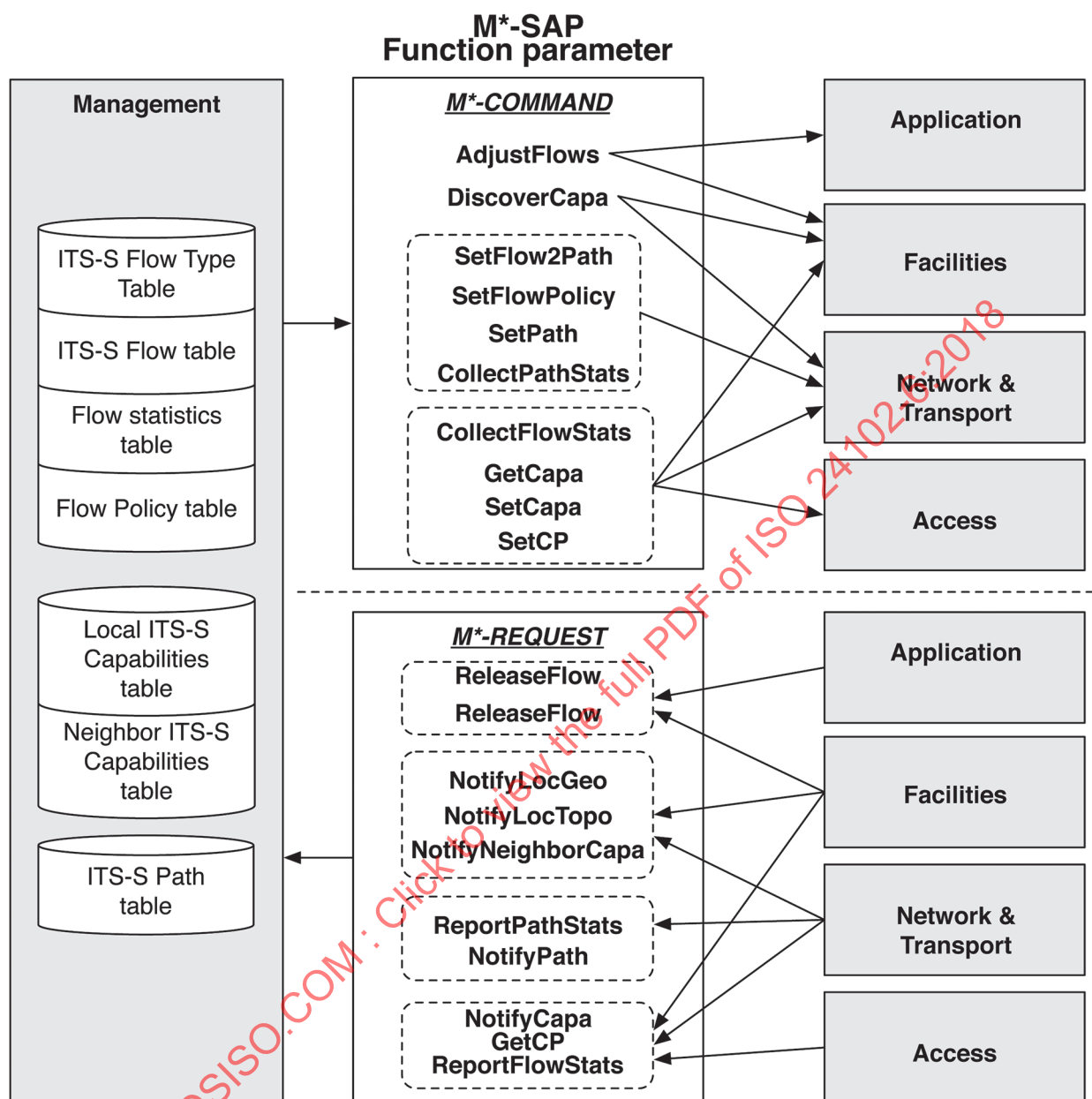


Figure 5 — Cross-layer information flow for path and flow management

6 Requirements for flow management and communication profile selection

6.1 ITS-S flow type parameters

Table 1 presents the list of parameters that are maintained by the SME for each ITS-S flow type known within the ITS-S. The method used to record ITS-S flow type information is implementation specific and is out of scope of this document. The parameters presented in Table 1 shall be of ASN.1 types specified in the normative Annex D.

Each ITS-S flow type is identified by an ITS-S flow type identifier (ITS-FlowTypeID) which shall be unique in the ITS station. Well-known flow types may be identified by a globally unique ITS-FlowTypeID assigned by a registry.

Table 1 — ITS-S flow type parameters maintained by the SME

ITS-S flow type parameters	ASN.1 type	Description
IITS-S-APID (key)	ITSSapiid	Identifier of an ITS-S application process (exactly one of possibly several instances of it in an ITS-SU). Originally specified in ISO 24102-1[15] with name ApplicationID; now specified in ISO 17419[1].
ITS-S RX/TX interface (key)	ITS-SapSsId	Sink or source of an ITS-S-AP. Specified in ISO 17419[1].
ITS-FlowTypeID	FlowTypeID	Identifier of the ITS-S flow type (if larger than 0, corresponds to a well-known ITS-S flow type which parameters are recorded in a registry). Specified in ISO 17419[1].
Priority	UserPriority	Requested priority to be applied to this ITS-S flow type. Specified in ISO 17419[1].
ServSecu	CapaInfos	List of security services (ITS-S capabilities) to be applied to packets of this ITS-S flow type. Necessary atomic operations are performed by the ITS station security entity (DataConfidentiality, DataIntegrity, NonRepudiation, SourceAuthentication, LocationPrivacy).
ServFac	CapaInfos	List of ITS station facilities layer services (ITS-S capabilities) to be applied to packets of this ITS-S flow type once or on a per packet basis.
ServCom	CapaInfos	List of ITS communication services (ITS-S capabilities) to be applied to packet of this ITS-S flow type once or on a per packet basis. (ContConnect, NxRepeat, etc.).
RcvPort	PortNumber	Specific port requested by the ITS-S-AP to receive
DstType/ CommunicationMode	DestinationType	Type of transmission (single receiver, group of receivers (multicast, broadcast), geographic area, etc.)
DstDomain	DestDomain	Domain of communication (ITS-S internal, local, Internet)
CommDistRequested	MinCommDistance	Minimum distance in meter to reach the next neighbour node. Specified in ISO 17423:2018.
Directivity	Directivity	Information about the required antenna aperture. Specified in ISO 21218[14].
Resilience	Resilience	Request to provide the appropriate means to increase the likelihood of proper delivery of messages. Specified in ISO 17423:2018 as CostObjective.
MinThroughput	DataRate	The required minimum average data rate. Specified in ISO 17423:2018 with reference to ISO 21218[14].
MinLatency	MaxLat	Maximum acceptable latency. Specified in ISO 17423:2018.
Duration	ExpFlowLifeTime	Expected duration of ITS-S flow. Specified in ISO 17423:2018.
CostMonetary	MediumCost	Maximum accepted monetary cost. Specified in ISO 17419.
MaxADU	MaxADU	The maximum ADU size requested by ITS-S-AP. Specified in ISO 17423:2018.
MaxFPDU	MaxFPDUonoFragmentation	The maximum FPDU size calculated by the SME on the basis of MaxADU.
PortNo	PortNumber	Port number provided by the ITS-S-AP

Table 1 (continued)

ITS-S flow type parameters	ASN.1 type	Description
ProtoTrans	CapaInfos	Identifier and associated parameters of the transport protocol (ITS-S capability), if requested by the ITS-S-AP
ProtoNet	CapaInfos	Identifier and associated parameters of the network protocol (ITS-S capability), if requested by the ITS-S-AP
ProtoAccessIDProtoNetInfo	CapaInfoIDCapaInfo	Identifier of the access technology (ITS-S capability), if requested by the ITS-S-AP Associated set of parameters specific to the requested network protocol
ProtoLogicalChannelTypeProtoAccessID	LogicalChannelTypeCapaInfoID	Identifier of the requested logical channel (CCH, SaCH, SCH, SfCH – see ISO 21217:2014 Section 8.2.3). Specified in ISO 17419[1]. Identifier of the access technology (ITS-S capability), if requested by the ITS-S-AP
ProtoLogicalChannelType	LogicalChannelType	Identifier of the requested logical channel (CCH, SaCH, SCH, SfCH – see ISO 21217:2014 Section 8.2.3). Specified in ISO 17419[1].

6.2 ITS-S flow parameters

Table 2 presents the list of parameters that are maintained by the SME for each ITS-S flow known within the ITS-S. The method used to record ITS-S flow information is implementation specific and is out of scope of this document. The parameters presented in Table 2 shall be of ASN.1 types specified in the normative Annex D.

Each ITS-S flow is identified by an ITS-S flow identifier (ITS-S-FlowID) which shall be unique in the ITS station.

Each entry shall contain an ITS-FlowTypeID allowing the retrieval of the list of communication requirements detailed in 6.1.

The destination fields are necessary to determine ITS-S paths allowing to reach a given destination.

Table 2 — ITS-S flow parameters maintained by the SME

Flow parameters	ASN.1 type	Description
ITS-S-FlowID (key)	FlowID	Identifier of the ITS-S flow
RegisStatus	FlowRegistrationStatus	Current status of this ITS-S flow (FLOW_REGISTERED, FLOW_ONGOING, FLOW_SUSPENDED)
RegisTime	FlowRegistrationTime	Time at which this flow was registered
ITS-FlowTypeID	FlowTypeID	Identifier of the corresponding ITS-S flow type (point to the list of communication requirements).
Priority	UserPriority	Priority of the ITS-S flow determined by the SME
DstType/CommunicationMode	DestinationType	Type of transmission (single receiver, group of receivers (multicast, broadcast), geographic area, etc.)

Table 2 (continued)

Flow parameters	ASN.1 type	Description
PathAvailability	PathFlowAvailability	Indicates either that there is no path currently selected for this flow (pathFlowNotSelected), or that there doesn't seem to be any path allowing transmission at full rate (pathFlowNotAny), or that there exists at least one clear path (pathFlowExistent)
PathID	PathID	Identifier of the ITS-S path currently selected for packets of this ITS-S flow
SrcAppID	ITSsapiid	Identifier of the source application
SrcNodeID	NodeID	Identifier of the source node
SrcPort	PortNumber	Source port of the ITS-NTPDU
DstAppID	ITSsapiid	Identifier of the destination application (varies according to communication mode)
DstID	DestinationID	Identifier of the destination. Various destination ID types are possible, and may be added in the future. Examples are web address, an IP address, an email address, a 48 bit MAC address, a geo-location.
DstNodeID	NodeID	Identifier of the destination node
DstPort	PortNumber	Destination port of the ITS-NTPDU
MaxFPDU	MaxFPDUnoFragmentation	The maximum FPDU size determined by the SME in order to avoid fragmentation of the packets given the protocols and services used for this flow.
ProtoTrans	CapaInfos	Identifier and associated parameters of the transport protocol (ITS-S capability) specifically selected for this ITS-S flow
ProtoNet	CapaInfos	Identifier and associated parameters of the network protocol (ITS-S capability) specifically selected for this ITS-S flow
ProtoAccess	CapaInfos	Identifier and associated parameters of the access technology protocol (capability) specifically selected for this ITS-S flow
ProtoAccessChannelParams	AccessChannelParameters	List of channel parameters
Stats	FlowStatisticsList	Set of statistics collected on this data flow (e.g. data rate, average/min/max Round Trip Time, packets per second, number of packets sent, number of acknowledgements received, number of negative acknowledgements received, etc.

6.3 ITS-S flow monitoring

Collecting statistics about ITS-S flows can provide useful information about the current network conditions and can help to adjust decisions on where to route packets. These statistics are reported by the ITS station layers in an arbitrary level of precision, and for a given ITS-S flow or for a set of ITS-S flows.

Whenever required, the SME shall use the `CollectFlowStats` command to request ITS-S Managed Service Entities at all ITS-S layers to start, stop, suspend, resume or immediately provide the collection of ITS-S flow statistics. This command is performed either for a single ITS-S flow when the value of `FlowID` is larger than 0, or for the entire set of flows.

When the action is set to `report`, the ITS-S Managed Service Entity shall use `CollectFlowStatsConf` to immediately provide ITS-S flow statistics upon reception of a the `CollectFlowStats` command from the SME. Otherwise, the ITS-S Managed Service Entity shall use `ReportFlowStats` to report ITS-S flow statistics asynchronously anytime after ITS-S flow statistics are collected.

Whenever a `ReportFlowStats` request or `CollectFlowStatsConf` confirmation is received, the ITS-S flow information maintained in the SME as indicated in 6.2 is updated for the corresponding ITS-S flow(s).

NOTE Statistics can be provided about flows for which there is no known registration (`FlowID`), i.e. entrant flows, or flows emitted from legacy applications that could not perform the registration operations specified in this document. Details are outside the scope of this version of this document.

6.4 Notification of a communication profile determination

Upon selection of a new ITS-SCP or modification of the ITS-SCP for the ITS-S flow identified by `FlowID`:

- The SME shall use the `AdjustFlows` command to notify the ITS-S-AP that recommended transmission parameters have been updated for the ITS-S flow identified by `FlowID`.

NOTE 1 This notification allows the ITS-S-AP to adapt its data transmission rate or data content quality according to the current network conditions. If this notification is ignored, the transmission can result into packet fragmentation, packet loss or packet delivery delay.

NOTE 2 The maximum ADU size depends on the MTU reduced by the size of all headers added at all ITS station layers. For example, for IP flows, the maximum ADU size takes into account the size of the IPv6 header and additional extension headers (e.g. security) or encapsulation headers (e.g. IPv4-IPv6 transition).

- The SME shall use the `SetCP` command with `SetCP.action` set to `action-startCreate` or `action-update` to notify the ITS-SCP associated to `FlowID` to relevant ITS-S Managed Service Entities.
- The SME shall inform the SNTL about the new ITS-S flow as specified in 9.3.
- The SME shall inform the SAL about the new ITS-S flow.

NOTE 3 Informing the different layers about the new communication profile determination is particularly useful for QoS management.

6.5 Processing request to provide communication profiles

- The ITS-S Managed Service Entity shall use the request `GetCP` to request the SME to provide ITS-SCPs.

Upon reception of a `GetCP` request from an ITS-S Managed Service Entity, the SME shall reply to the request using a `GetCpConf` confirmation containing the list of ITS-SCPs for a list of selected ITS-S flows maintained by the SME.

6.6 Processing flow statistic reports

Upon reception of a `ReportFlowStats` request from an ITS-S Managed Service Entity, the SME updates the information it maintains about ITS-S flows.

7 Requirements for flow registration

7.1 Processing ITS-S flow type registration from ITS-S-AP

Communication requirements are expressed for each ITS-S flow type (for each receive and transmit interface) either dynamically using the `ITS-S-Appl-Reg` request as specified in ISO 17423:2018, or statically for well-known or default ITS-S flow types. Well-known flow types may be registered in a global registry and are referenced by a unique `FlowTypeID` larger than 0.

For dynamic registration, an ITS-S-AP shall register with the SME its communication requirements for a given ITS-S flow type using the procedures specified in ISO 17423:2018 and ISO/TS 17429:2017.

Each ITS-S flow type registration contains a `FlowTypeID`. The value 0 is used to identify the case where the application is providing a set of communication requirements rather than a well-known `FlowTypeID`.

In case an ITS-S-AP presents a value of `FlowTypeID` larger than 0:

- If `FlowTypeID` is not known to the SME, the SME may contact the ITS-SCU-CMC specified in ISO 24102-2[16] in order to get an update of the well-known ITS-S flow type IDs.
- The SME assesses if the ITS-S-AP is authorized to transmit flows corresponding to `FlowTypeID` using the method detailed in 7.4.
- The SME assesses if it has the necessary ITS-S capabilities to support the communication requirements using the method detailed in 7.5.

If all checks are successful:

- The SME shall return `pfmOK`.
- The SME shall maintain a list of ITS-S-APs for which ITS-S flow types are identified as detailed in 6.1.

7.2 Processing RegisterFlow from ITS-S-AP

For each new destination where ADUs corresponding to a given 'ITS-S flow type' must be sent, the ITS-S-AP shall register its 'ITS-S flows' with the SME using the `RegisterFlow` request.

Upon reception of a `RegisterFlow` request from an ITS-S-AP:

- The SME checks whether it has previously recorded an ITS-`FlowTypeID` corresponding to the 2-tuple {ITS-S-`APID`, `TXInterfaceNo`}. If not, it shall return the error code `pfmTxNotRegistered` or `pfmAppNotRegistered`;
- The SME may check whether the ITS-S-AP is authorized to register ITS-S flows using the method detailed in 7.4. If not, it shall return the error code `pfmNotAuthorized`.

If all checks are successful:

- The SME shall allocate a `FlowID` and maintain a list of parameters as detailed in 6.2. `FlowRegistrationStatus` is set to `flowStatusRegistered`.
- The SME determines the ITS-SCP (communication profile) that best matches the communication requirements using the methods specified in 7.7.
- The SME checks whether an ITS-S path is available to route packets of this flow to the requested destination using the methods specified in 7.6.

- The SME shall acknowledge successful execution of the request with RegisterFlowConf containing the FlowID together with recommended communication parameters:
 - If no ITS-SCP can currently be determined, the SME shall return the error code pfmCpNotFound. This error code does not prevent the ITS-S-AP to transmit.
 - If no ITS-S path is currently available, the SME shall return the error code pfmDstCannotReach. This error code does not prevent the ITS-S AP to transmit though the destination cannot be reached.
- The SME shall notify the selected ITS-SCP to relevant ITS-S Managed Service Entities in all ITS-S layers using the methods specified in 6.4.

7.3 Processing ReleaseFlow request from ITS-S-AP

Upon reception of a ReleaseFlow request from the ITS-S-AP, the SME assesses the validity of the request. The SME shall reply with a PFMErrorsStatuspfmFlowInvalid if the FlowID does not exist.

The SME assesses if the ITS-S-AP is authorized to modify the flow status using the method detailed in 7.4.

If this assessment is successful:

- If the action is set to action-resume the SME sets the status of the corresponding ITS-S flow to flowStatusOngoing.
- If the action is set to action-suspend the SME sets the status of the corresponding ITS-S flow to flowStatusSuspended.
- If the action is set to action-release the SME may release all information corresponding to the ITS-S flow.
- The SME shall use the SetCP command with SetCP.action respectively set to action-resume or action-suspend or action-release to notify all relevant ITS-S Managed Service Entities about the change of status associated to FlowID.

7.4 Checking ITS-S-AP credentials

If the credentials presented by the ITS-S-AP are invalid, the SME shall return to the requesting ITS-S-AP the error code pfmNotAuthorized.

NOTE Methods to perform this determination are out of scope of this document.

7.5 Checking communication requirements

The set of parameters of the ITS-S flow type as specified in ISO 17423:2018 may include communication profile parameters (ITS-SCP), i.e. identifiers of specific communication protocols (ITS station networking and transport layer, ITS station facilities layer), the access technology and the channel (ITS station access technologies layer).

In general, the ITS-S-AP leaves the choice of the ITS-SCP to the SME. Leaving the determination of the ITS-SCP to the SME is more flexible, is future proof, eases interoperability and allows the SME to select the most appropriate ITS-SCP according to current network conditions and network load, and actual availability of the access technologies. It also allows the SME to change the ITS-SCP dynamically whenever the network conditions change.

The ITS-S-AP may nevertheless provide specific ITS-SCP parameters for one, more or all layers of the ITS station protocol stack. For example, the ITS-S-AP may request the use of a specific access technology (e.g. cellular) but not requesting any particular communication protocol. In another situation, the ITS-S-AP may request a complete protocol stack, e.g. FNETP/M5 or BTP/GeoNetworking/ITS-G5 or UDP/IPV6/11p for the exchanges between the roadside infrastructure and a vehicle.

The SME checks if the ITS-S-AP requested a specific ITS-SCP (communication profile). If so:

- The SME checks it has the appropriate ITS-S capability for each parameter of the ITS-SCP.
- If one of the mandatory ITS-SCP parameters is (voluntary) omitted, the SME determines if it has an appropriate ITS-S capability (communication protocol or technology) for each missing parameter, taking into consideration the provided ITS-SCP parameters.
- If the requested ITS-SCP cannot be supported, this procedure returns error code `pfmCpNotSupported`.

NOTE 1 When a requested ITS-SCP cannot be supported by the SME, the ITS-S-AP has an indication that it should request the SME to contact the host management centre (ITS-SCU configuration management centre) – ITS-SCU-CMC as specified in ISO 24102-2[16].

The SME checks it has the necessary ITS-S capabilities to support the communication requirements provided by the ITS-S-AP (available ITS-S capabilities are determined by the SME as specified in [Clause 10](#)):

- If no ITS-S capability can be found to support any of the communication requirements, the SME shall return the error code `pfmCapaNotSupported` indicating the list of ITS-S capabilities that cannot be supported.

NOTE 2 Since different ITS-S capabilities can be available in different deployment scenarios and new ITS-S capabilities can appear, the specification of the method to conduct this determination is out of scope of this document.

7.6 Checking ITS-S path availability

The SME checks whether an ITS-S path is available to reach the destination. If not, this procedure returns the error code `pfmDstCannotReach`.

NOTE 1 The error code `pfmDstCannotReach` is just an indication that at the current time the destination cannot be reached. This status could quickly change and doesn't prevent the ITS-S-AP to transmit packets.

NOTE 2 The specification of the methods for determining the availability of an ITS-S path is a competitive factor between stakeholders; as such it is out of scope of this document.

7.7 Communication profile determination

The SME checks if an ITS-SCP has already been determined (e.g. either by the ITS-S-AP at time of flow type registration, or statically by the SME).

- For all parameters of the ITS-SCP that are not already filled up, the SME determines the ITS-S capability that best meets the communication requirements, taking into consideration the destination, available ITS-S capabilities, available ITS-S paths and current network conditions.
- If no ITS-S capability can be determined for one or more parameters of the ITS-SCP, this procedure returns the error code `pfmCpNotFound`, indicating that no ITS-SCP can be immediately determined.

NOTE 1 The error code `pfmCpNotFound`, is just an indication that the current time the ITS-SCP cannot be determined. This status could quickly change and doesn't prevent the ITS-S-AP to transmit packets.

NOTE 2 The specification of the methods for determining the most appropriate ITS-SCP is a competitive factor between stakeholders; as such it is out of scope of this document. An example on how to select an ITS-SCP is presented in ISO 17423:2018, Annex 3.

As a result of a positive determination, all the necessary communication profile parameters of the ITS-S flow type identified by FlowID are filled up.

8 Requirements for path management

8.1 ITS-S path parameters

[Table 3](#) presents the list of parameters that is maintained by the SME to determine the available ITS-S paths. The method used to record ITS-S path information is implementation specific and is out of scope of this document. The parameters presented in [Table 3](#) shall be of ASN.1 types specified in the normative [Annex D](#).

Each ITS-S path is identified by an identifier (PathID) which shall be unique in the ITS station.

Detailed explanations about ITS-S path parameters are given in ITSSv6 D2.4[30].

Table 3 — ITS-S path parameters maintained by the SME

ITS-S path parameters	ASN.1 type	Description
PathID (key)	PathID	Identifier of the ITS-S path, unique within the ITS station.
MSE	MseID	Identifier of the ITS-S Managed Service Entity for which this information is valid
PathLinkID	Link-ID	Identifier of the VCI/CI where the ITS-S path starts from (LinkID). See ISO 24102-2 for details. This parameter is used to retrieve characteristics and other details about the CI.
PathNextHop	NodeID	Identifier of the next hop node from the ITS station
PathLocator	LocatorID	Identifier of the network topological location of the ITS-S in the communication network in which the ITS-S is currently attached to through this ITS-S path.
PathIngressAnchor	NodeID	Identifier of the ITS-S ingress anchor node (in IPv6, corresponds to the next hop)
PathEgressAnchor	NodeID	Identifier of the ITS-S egress anchor node
PathDestDomain	DestDomain	Indicates the domain of reachability along this ITS-S path (e.g. ITS-S internal, local, Internet)
PathStatus	PathStatus	Indicates the level of readiness for the ITS-S path: “being used” (128), “ready to be used” (64), “potentially ready” (32), “going to up” (8), “going to down” (4); “not available” (0)
PathCharacteristicsList	PathCharacteristicsList	List of metrics of the ITS-S path: Max size of the payload allowed on this ITS-S path, number of hops, monetary cost, reliability, propagation delay, number of hops to reach the destinations, level of security, reverse reachability, QoS, ...).
PathCapaList	PathCapabilityList	List of ITS-S capabilities applicable on this ITS-S path (e.g. IPsec on the tunnel, session continuity for host)
PathStatList	PathStatisticsList	List of statistics recorded about this ITS-S path: data rate, delay, number of hops, etc.

8.2 Topological and geographic position parameters

[Table 4](#) presents the list of parameters about the topological and geographical position of a node (self ITS-S and its neighbour nodes) that is maintained by the SME to determine the available ITS-S paths. The method used to record ITS-S path information is implementation specific and is out of scope of this document. The parameters presented in [Table 4](#) shall be of ASN.1 types specified in the normative [Annex D](#). All entries are uniquely identified by a node identifier.

The necessary information can be classified in three categories:

- General information about the node: The type of node, the role performed by the node, the ITS station type (e.g. vehicle ITS-S, roadside ITS-S) are information useful to determine the influence of the movement on the ITS-S paths managed by the ITS-S, while the node type is useful to qualify the ability of the node to relay packets not intended to itself.
- Topological information about the node, which indicates its location in the communication network topology. The ITS-S can be attached to multiple branches of the communication network (through one or several communication interfaces) and in multiple communication networks at the same time. This information is essential to determine available ITS-S paths. This category of information can be very dynamic for mobile ITS stations.
- Geographic information about the node: It includes the geographical position (latitude, longitude and altitude) and movement information (speed and direction). It is used to compute the distance to other nodes. This category of information is very dynamic for mobile ITS stations.

Table 4 — Topological and geographic information parameters maintained by the SME

ITS station parameters	ASN.1 type	Description
NodeID (key)	NodeID	Identifier of the ITS-SCUID or neighbour node. Preferably globally unique.
StationType	StationType	Type of ITS-SU mobile (0), fixed (1), infrastructure (2), vehicle (3), roadside (4), central (5), portable (6), unknown/not an ITS-SU (255)
NodeRole	NodeRole	Role performed by the node or ITS-SU: host, router, border router, access router, mobile router, anchor, etc.
.locatorList	LocatorIdList	List of all network topological location identifiers of the ITS-S in the communication networks to which the ITS-S is currently attached.
.latitude	Latitude	Latitude of the ITS-SU
.longitude	Longitude	Longitude of the ITS-S
.altitude	Altitude	Altitude of the ITS-S
.speed	Gs	Ground speed of the ITS-S
.heading	Tta	Heading of the ITS-S
.accuracy	PositionAccuracy	Accuracy indicator of the kinematic state of the ITS station
.timestamp	Time48IAT	Time when the corresponding kinematic state is recorded
.lifetime	TimeDurationValue	The expiration time of the corresponding geographical position entry. Value zero to indicate “unknown”

8.3 Collecting topological and geographical information

- Topological and geographical information maintained within the SME can be obtained by various means. The information can be requested by the SME to ITS-S Managed Service Entities within ITS-S layers (using M*-Command and M*-Request service primitives), the SME can access directly the information available at the ITS-S layers (using M*-Get and M*-Set service primitives) or can be inferred internally by the SME.

- Upon reception of a `NotifyLocTopo` or `NotifyLocGeo` request, the SME updates the information it maintains about the topological and geographical location of the ITS station and neighbour nodes.
- In addition to information collected from the ITS-S layers, the SME can determine internally some of the information corresponding to an ITS-S path. The path status could also be estimated internally from collected statistics.

8.4 Path management

- Whenever the SME concludes that an ITS-S path must be setup, removed or updated, the SME shall use the `SetPath` command to request relevant ITS-S Managed Service Entities in the ITS station networking and transport layer to execute an operation needed for path management (establishment of an ITS-S path, removal or change of the path parameters).
- Upon reception of a `SetPath` command from the SME, the ITS-S Managed Service Entity shall confirm the command by returning either `PFErrorStatuspfmOK` if the command is understood or an error status. It then performs the requested operation.
- Whenever the status of an ITS-S path is modified in an ITS-S Managed Service Entity, the ITS-S Managed Service Entity shall use the `NotifyPath` request to notify the SME about the change of status.
- Upon reception of a `NotifyPath` request from an ITS-S Managed Service Entity, the SME updates the information it maintains about the ITS-S path identified by `PathID` as indicated in the request:
 - If `PathID` doesn't correspond to an existing identifier, the SME shall discard the request. It may respond to the requesting ITS-S Managed Service Entities with an error.
 - If `PathID` contained in the request is `NULL`, the SME shall allocate an identifier unique within the ITS-S station and shall respond to the requesting ITS-S Managed Service Entities with a service primitive function `NotifyPathConf` containing the allocated `PathID`.

8.5 ITS-S path monitoring

Collecting statistics about ITS-S paths can provide useful information about the current network conditions and help to adjust decisions on where to route packets. These statistics are reported by the ITS station layers in an arbitrary level of precision, and for a given ITS-S path or for a set of ITS-S paths.

Whenever required, the SME shall use the `CollectPathStats` command to command ITS-S Managed Service Entities within the ITS-S networking and transport layer to start, stop, suspend, resume or immediately provide the collection of ITS-S path statistics. This command is performed either for a single ITS-S path when the value of `PathID` is larger than 0, or for the entire set of paths.

When the action is set to report, the ITS-S Managed Service Entity shall use `CollectPathStatsConf` to immediately provide ITS-S path statistics upon reception of a the `CollectPathStats` command from the SME. Otherwise, the ITS-S Managed Service Entity shall use `ReportPathStats` to report ITS-S path statistics asynchronously anytime after ITS-S path statistics are collected.

Whenever a `ReportPathStats` request or `CollectPathStatsConf` confirmation is received, the ITS-S path information maintained in the SME as indicated in [8.1](#) is updated for the corresponding ITS-S path(s).

8.6 Interface management

Whenever required, the SME uses the `SetCapa` command to instruct the relevant ITS-S Managed Service Entity to perform an action on a CI.

NOTE 1 When the action is set to start, the ITS-S Managed Service Entity is instructed (through the information contained in the field `capaInfos`) to perform a number of actions, depending on CI type and the destination domain (`DestDomain`) requested by the SME through this CI. These actions are necessary to determine if an ITS-S path is available to reach nodes in `DestDomain`. The ITS-S Managed Service Entity will report the result of each action (e.g. for IPv6, the successfulness of a link-local IPv6 address configuration will result in a report that link-local communications are possible).

NOTE 2 The CI is known by the ITS-S Managed Service Entity as an ITS-S capability, identified by an ITS-S capability identifier. The type of CI and other CI parameters (transmit power, etc.) are known from the LinkID (see ISO 21218).

9 Requirements for path selection

9.1 General requirements for path selection

The path selection process uses various types of information maintained in the SME to determine the most appropriate available ITS-S path to route packets for each ITS-S flow. The method used to realize this determination is out of scope of this document.

This determination may be made once whenever a new ITS-S flow is registered (see 7.2) or whenever the SME is notified that the status of the ITS-S Path selected for a given ITS-S Flow is changed.

The decisions shall be commanded to the relevant ITS-S Managed Service Entities within the SNTL using respectively commands `SetFlow2Path` and `SetFlowPolicy`.

9.2 Routing policies parameters

Table 5 presents the list of parameters that must be maintained by the SME for each routing policy determined by the SME. The method used to record this information is implementation specific and is out of scope of this document. The parameters presented in Table 5 shall be of ASN.1 types specified in the normative Annex D.

There could be multiple entries for the same ITS-S flow.

Table 5 — Flow routing policies maintained by the SME

Routing policy parameters	ASN.1 type	Description
ITS-S-FlowID (key)	FlowID	Identifier of the ITS-S flow
PathID	PathID	Identifier of the ITS-S path selected for the ITS-S flow
Priority	UserPriority	Preference of this policy over other routing policies applying to the same ITS-S flow (the highest value is the most preferred routing policy)

9.3 Notifying path selection

Whenever a new ITS-S path is selected for an ITS-S flow instead of an existing one, the SME shall use the `SetFlow2Path` command with `F2Paction` set to `modify` to notify the relevant ITS-S Managed Service Entities which ITS-S path must be used to forward packets of the ITS-S flow corresponding to ITS-S-FlowID.

Whenever an additional ITS-S path can be used for an ITS-S flow, the SME shall use the `SetFlow2Path` command which `F2Paction` set to `add` to notify the relevant ITS-S Managed Service Entities to add the entry corresponding to the 2-tuple identified by `FlowID` and `PathID`.

Whenever an ITS-S path should no longer be used for an ITS-S flow, the SME shall use the `SetFlow2Path` command which `F2Paction` set to `delete` to notify the relevant ITS-S Managed Service Entities to remove the entry corresponding to the 2-tuple identified by `FlowID` and `PathID`.

Whenever an ITS-S flow no longer exists, the SME shall use the `SetFlow2Path` command which `F2Paction` set to `flush` to notify the relevant ITS-S Managed Service Entities to remove the entries corresponding to the 2-tuple identified by `FlowID` and `PathID`.

NOTE 1 A given data flow can be routed to several interfaces, with a given level of preference (indicated to the SNTL using the `SetFlowPolicy` command).

NOTE 2 The specification of the methods for determining the most appropriate ITS-S path to route an ITS-S flow is a competitive factor between stakeholders; as such it is out of scope of this document.

9.4 Notifying routing policies

Whenever needed the SME may decide to update a routing policy (adding a new one, modifying or deleting an existing one, etc.). These policies are transmitted to the SNTL and must be applied to all packets of the same flow or the same set of flows.

The SME shall use `SetFlowPolicy` to command the relevant ITS-S Managed Service Entity of the ITS-S networking and transport layer to update the flow policy.

NOTE The specification of the methods for determining the priority of routing policies is a competitive factor between stakeholders; as such it is out of scope of this document.

10 Requirements for ITS-S capabilities management

This document specifies the methods necessary for the ITS “Station Management Entity” (SME) to activate the available ITS-S capabilities at each ITS station layer necessary for path and flow management. This document does not specify methods to decide which ITS-S capabilities have to be activated at each layer of the ITS-S nor under which conditions. This decision is left to developers according to deployment requirements.

10.1 Maintenance of ITS-S capabilities information

[Table 6](#) presents the list of parameters maintained by the SME about ITS-S capabilities (internal to the ITS-S or neighbour nodes). The method used to maintain this information is implementation specific and is out of scope of this document. The parameters presented in [Table 6](#) shall be of ASN.1 types specified in the normative [Annex D](#).

Table 6 — ITS-S capabilities parameters maintained by the SME

ITS-S capabilities parameters	ASN.1 type	Description
NodeID (key)	NodeID	Identifier of the ITS-SCUID or neighbour node. Preferably globally unique.
capaID (key)	CapaInfoID	Identifier of the ITS-S capability
mseID (key)	MseID	Identifier of the ITS-S Managed Service Entity offering this ITS-S capability
capaStatus	CapaStatus	Status of the ITS-S capability (<code>capaStatusAvailable</code> , <code>capaStatusSuspended</code> , <code>capaStatusStopped</code>),
capaInfos	CapaInfos	List of parameters of the ITS-S capability

10.2 Determination of internal ITS-S capabilities

At boot time or whenever required, the SME determines the ITS-S capabilities available at each layer. This can either be determined through static configuration or dynamically by requesting each layer to provide such information.

For dynamic determination, the SME shall use the `GetCapa` command to request a given ITS-S Managed Service Entity to provide the list of supported ITS-S capabilities.

Upon reception of a `GetCapa` command from the SME, the ITS-S Managed Service Entity shall use the `NotifyCapa` request to notify the SME the list of ITS-S capabilities it supports and their parameters.

Whenever the status of an ITS-S capability is changed, the `NotifyCapa` request shall be used from the relevant ITS-S Managed Service Entity to notify to the SME the changed status of the ITS-S capability.

The SME shall maintain a list of the ITS-S capabilities available at each ITS-S Managed Service Entity and update it upon reception of a `NotifyCapa` request.

NOTE From the point of view of the IPv6 Networking ITS-S Managed Service Entity (`mse-IPv6Suite`), a CI is seen as an ITS-S capability. A `SetCapa` with action set to `action-startCreate` means that the IPv6 Networking ITS-S Managed Service Entity will allocate an IPv6 link-local action and perform other actions such as IPv6 Neighbour Discovery etc. depending on the characteristics of the ITS-S capability.

Whenever required, the SME shall use `M*-Get` and `M*-Set` to directly access to information available at the ITS-S layers.

10.3 Determination of neighbour ITS-S capabilities

The SME shall maintain a list of the ITS-S capabilities available by each neighbour node and update it upon reception of a `NotifyNeighbourCapa` request.

Whenever required, the SME shall use the command `DiscoverNeighbourCapa` to request a given ITS-S Managed Service Entity to determine ITS-S capabilities available on neighbour nodes reachable through a given interface. Information maintained by the SME about neighbour nodes is updated accordingly.

Upon reception of a `DiscoverNeighbourCapa` command from the SME, or whenever an ITS-S Managed Service Entity discovers capabilities of neighbour nodes, the `NotifyNeighbourCapa` request shall be used by the ITS-S Managed Service Entity to notify to the SME known ITS-S capabilities offered by neighbour nodes.

10.4 Activating ITS-S capabilities in the ITS-S Managed Service Entity

The SME shall use the `SetCapa` command with action set to `action-startCreate` to instruct the relevant ITS-S Managed Service Entity to activate the execution of the ITS-S capability identified by `CapaInfoID`.

The ITS-S Managed Service Entity shall execute the action on the ITS-S capability indicated in the command and report the result of the action with an error status.

NOTE ITS-S capabilities to be activated include for instance "session continuity" in the IPv6 Networking ITS-S Managed Service Entity of the ITS-S networking and transport layer (see ISO 21210).

10.5 Suspending ITS-S capabilities in the ITS-S Managed Service Entity

The SME shall use the `SetCapa` command with action set to `action-suspend` to instruct the relevant ITS-S Managed Service Entity to suspend the execution of the ITS-S capability identified by `CapaInfoID`.

The ITS-S Managed Service Entity shall execute the action on the ITS-S capability indicated in the command and report the result of the action with an error status.

10.6 Resuming ITS-S capabilities in the ITS-S Managed Service Entity

The SME shall use the `SetCapa` command with action set to `action-resume` to instruct the relevant ITS-S Managed Service Entity to resume the execution of the ITS-S capability identified by `CapaInfoID`.

The ITS-S Managed Service Entity shall execute the action on the ITS-S capability indicated in the command and report the result of the action with an error status.

10.7 Reporting about ITS-S capabilities in the ITS-S Managed Service Entity

The SME shall use the `SetCapa` command with action set to `action-report` to instruct the relevant ITS-S Managed Service Entity to report the status of the ITS-S capability identified by `CapaInfoID`.

The ITS-S Managed Service Entity shall execute the action on the ITS-S capability indicated in the command and report the status and parameters of the requested ITS-S capability.

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Annex A (normative)

M*-COMMANDs from SME

A.1 General

The notation M*-COMMAND means either MA-COMMAND, or MF-COMMAND, or MN-COMMAND, or MI-COMMAND, or MS-COMMAND. This notation is used to indicate that COMMAND service primitive functions may identically apply for different management SAPs. See ISO 24102-3[17].

A.2 Overview

Table 7 presents a summary of M*-COMMANDs defined for path and flow management. ASN.1 types are presented for .request/.confirm service primitives. The detailed structure of M*-COMMANDs is presented in A.3 with ASN.1 details specified in Annex D.

Table 7 — M*-COMMANDs

COMMAND name	ASN.1 type	Description
AdjustFlows	.request AdjustFlows	See 6.4. Request the ITS-S-AP to adjust transmission parameters of one or several given ITS-S flow(s). Indications for up to 254 different flows can be presented simultaneously. This COMMAND is applicable in the MA-SAP and MF-SAP. Parameter details are presented in A.3.1.
	.confirm AdjustFlowsConf	The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. In this case, parts of the request (i.e. for a specific ITS-S-FlowID) that were processed successfully do not need to be confirmed. In case the request fails due to an unknown application and several ITS-S-FlowID values were presented, the COMMAND. confirm shall indicate ITS-S-FlowID = 0 (i.e. meaning “all ITS-S-FlowIDs”), and PFMerrorStatus = pfmAppNotRegistered. Parameter details are presented in A.3.1.
CollectFlowStats	.request CollectFlowStats	See 6.3. Request a given ITS-S Managed Service Entity to collect statistics about a given ITS-S flow or the complete set of ITS-S flows. This COMMAND is applicable in the MF-SAP, MN-SAP, and MI-SAP. Parameter details are presented in A.3.2.

Table 7 (continued)

COMMAND name	ASN.1 type	Description
	.confirm CollectFlowStatsConf	The request service primitive shall always be confirmed with the M*-COMMAND.confirm. In case no status information needs to be returned or an error occurred, the FlowStatusList shall be empty (size = 0). In case the request fails due to an unknown ITS-S-FlowID, the COMMAND.confirm shall indicate PFMerrorStatus = pfmFlowInvalid. Parameter details are presented in A.3.2.
CollectPathStats	.request CollectPathStats	See 8.5. Request a given ITS-S Managed Service Entity to collect statistics about a given ITS-S path or the complete set of ITS-S paths. This COMMAND is applicable in the MN-SAP. Parameter details are presented in A.3.3.
	.confirm CollectPathStatsConf	The request service primitive shall always be confirmed with the M*-COMMAND.confirm. In case no status information needs to be returned or an error occurred, the FlowStatusList shall be empty (size = 0). In case the request fails due to an unknown PathID, the COMMAND.confirm shall indicate PFMerrorStatus = pfmPathInvalid. Parameter details are presented in A.3.3.
DiscoverCapa	.request DiscoverNeighbourCapa .confirm DiscoverNeighbourCapaConf	See 10.3. Request from the SME to a given ITS-S Managed Service Entity to discover neighbour nodes able to provide network services (ITS-S capabilities provided by neighbour nodes). This COMMAND is applicable in the MN-SAP and MF-SAP. As the processing of this COMMAND.request may take quite long time, the result is provided asynchronously using the REQUEST.request NotifyNeighbourCapa. The request service primitive shall always be confirmed with an empty M*-COMMAND.confirm. Parameter details are presented in A.3.4.
GetCapa	.request GetCapa .confirm GetCapaConf	See 10.2. Request from the SME to a given ITS-S Managed Service Entity to provide the list of supported ITS-S capabilities. This COMMAND is applicable in the MF-SAP, MN-SAP, and MI-SAP. The result of this COMMAND.request is provided asynchronously using the REQUEST.request NotifyCapa. The request service primitive shall always be confirmed with an empty M*-COMMAND.confirm. Parameter details are presented in A.3.5.

Table 7 (continued)

COMMAND name	ASN.1 type	Description
SetCapa	.request: SetCapa	See 6.4 , 8.6 , 10.4 , 10.5 , 10.6 , 10.7 . Request a given ITS-S Managed Service Entity to perform an action on a given ITS-S capability. This COMMAND is applicable in the MF-SAP, MN-SAP, and MI-SAP. Parameter details are presented in A.3.6 .
	.confirm: SetCapaConf	The request service primitive shall always be confirmed. Parameter details are presented in A.3.6 .
SetCP	.request SetCP	See 6.4 Notify or modify the communication profile (ITS-SCP) selected for the transmission of packets of a given ITS-S flow. This COMMAND is applicable in the MF-SAP, MN-SAP and MI-SAP, Parameter details are presented in A.3.7 .
	.confirm SetCpConf	The request service primitive shall always be confirmed. Parameter details are presented in A.3.7 .
SetFlow2Path	.request SetFlow2Path	See 9.1 , 9.3 Link an ITS-S flow to an ITS-S path. This COMMAND is applicable in the MN-SAP. Parameter details are presented in A.3.8 .
	.confirm SetFlow2PathConf	The request service primitive shall always be confirmed. Parameter details are presented in A.3.8 .
SetFlowPolicy	.request SetFlowPolicy .confirm SetFlowPolicyConf	See 9.1 , 9.4 Notify to a given ITS-S Managed Service Entity of the ITS-S networking and transport layer the priority associated to an ITS-S flow. This COMMAND is applicable in the MN-SAP. Parameter details are presented in A.3.9 .
SetPath	.request SetPath	See 8.4 Request a given ITS-S Managed Service Entity of the ITS-S networking and transport layer to perform an action on an ITS-S path (establishment, removal of an ITS-S anchor segment, or change of the ITS-S anchor segment parameters) This COMMAND is applicable in the MN-SAP. Parameter details are presented in A.3.10 .
	.confirm SetPathConf	The request service primitive shall always be confirmed. Parameter details are presented in A.3.10 .

A.3 Details

A.3.1 AdjustFlows

Table 8 — M*-COMMAND.request for M*-COMMAND AdjustFlows

COMMAND.request	ASN.1 Type	Description
AdjustFlows	AdjustFlows	Notify the ITS-S-AP that it should adjust transmission parameters of one or several given ITS-S flow(s). This COMMAND is applicable in the MS-SAP and MF-SAP.
.itss-app	ITSSapiid	Identifier of the target ITS-S-AP
.flowInfos	AdjustFlowInfos	Indications for up to 254 different flows can be presented simultaneously.
AdjustFlow	AdjustFlow	
.flowID	FlowID	Identifier of ITS-S flow. The value zero of this INTEGER number is reserved to indicate any flow.
.params	TXparameters	List of recommended transmission parameters (packet rate, maximum ADU size, ...)
TXparameter	TXparameters	
.paramID	TXparameterID	Unique identifier of parameter type
.txParam	dependent on paramID	Parameter value

Table 9 — M*-COMMAND.confirm for M*-COMMAND AdjustFlows

COMMAND.confirm	ASN.1 Type	Description
AdjustFlows	AdjustFlowsConf	
.itss-app	ITSSapiid	Identifier of the target ITS-S-AP
.flowInfos	AdjustFlowStatuses	Indications for up to 255 different flow statuses can be presented simultaneously.
AdjustFlowStatus	AdjustFlowStatus	
.flowID	FlowID	Identifier of ITS-S flow.
.errCode	PFMerrorStatus	Error status code; see Annex C .

A.3.2 CollectFlowStats

Table 10 — M*-COMMAND.request for M*-COMMAND CollectFlowStats

COMMAND.request	ASN.1 Type	Description
CollectFlowStats	CollectFlowStats	Request a given ITS-S Managed Service Entity to collect statistics about a given ITS-S flow identified by ITS-S-FlowID or the complete set of ITS-S flows.
.mseID	MseID	ITS-S Managed Service Entity concerned by the command
.flowID	FlowID	Identifier of ITS-S flow. The value zero of this INTEGER number is reserved to indicate "all flows".
.action	CfsCpsAction	This INTEGER parameter has the following values — ping (0): Check whether collection of flow statistics is already active. No results shall be returned. — startCreate (1): Start collection of statistics after having performed first an implicit stop. — suspend (2): Stop collection without deleting the status, and shall return current result. — resume (4): Continue collecting statistics (applicable only after a previous suspend). No results shall be returned. — report (8): Return currently available results. — stop (255): Stop collection of statistics, return result, and delete status. Only applicable after a previous start.

Table 11 — M*-COMMAND.confirm for M*-COMMAND CollectFlowStats

COMMAND.confirm	ASN.1 Type	Description
CollectFlowStatsConf	CollectFlowStatsConf	If successful and action was to provide feedback, reply with statistics of the requested ITS-S flow (all ITS-S flows if ITS-S-FlowID was set to NULL)
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.flowID	FlowID	Identifier of the ITS-S flow (if NULL, means all flows)
.statList	FlowStatusList	List of statistics collected for each ITS-S flow (e.g. datarate, packet per second, packet loss, etc.)
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmFlowInvalid
FlowStatus	FlowStatus	Status of a single flow item
.itemID	FlowStatusTypeID	Unique item identifier
.itemStatus	depends on itemID	Status value of item

A.3.3 CollectPathStats

Table 12 — MN-COMMAND.request for MN-COMMAND CollectPathStats

COMMAND.request	ASN.1 Type	Description
CollectPathStats	CollectPathStats	Request a given ITS-S Managed Service Entity to collect statistics about a given ITS-S path or the complete set of ITS-S paths.
.mseID	MseID	ITS-S Managed Service Entity concerned by the command
.pathID	PathID	Identifier of the ITS-S path (if NULL, means all ITS-S paths)
.action	CfsCpsAction	This INTEGER parameter has the following values — ping (0): Check whether collection of flow statistics is already active. No results shall be returned. — startCreate (1): Start collection of statistics after having performed first an implicit stop. — suspend (2): Stop collection without deleting the status, and shall return current result. — resume (4): Continue collecting statistics (applicable only after a previous suspend). No results shall be returned. — report (8): Return currently available results. — stop (255): Stop collection of statistics, return result, and delete status. Only applicable after a previous start.

Table 13 — M*-COMMAND.confirm for MN-COMMAND CollectPathStats

COMMAND.confirm	ASN.1 Type	Description
CollectPathStatsConf	CollectPathStatsConf	If successful and action was to provide feedback, reply with statistics of the requested ITS-S path (all ITS-S paths if PathID was set to NULL)
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.pathID	PathID	Identifier of the ITS-S flow (if NULL, means all flows)
.statList	PathStatisticsList	List of statistics collected for each ITS-S path (data rate, packet per second, pack loss, etc.)
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmPathInvalid

A.3.4 DiscoverCapa

Table 14 — M*-COMMAND.request for M*-COMMAND DiscoverCapa

COMMAND.request	ASN.1 Type	Description
DiscoverCapa	DiscoverNeighbourCapa	Request a given ITS-S Managed Service Entity of the ITS-S networking and transport layer to discover neighbour nodes able to provide network services (ITS-S capabilities provided by neighbour nodes)
.mseID	MseID	ITS-S Managed Service Entity concerned by the command
.localCIID	EUI64	Identifier of the CI on which ITS-S capabilities discovery must be performed; see ISO 21218-4. In case localCIID has the value "Distinct Null Identifier" (DNI), the action is performed on all CIs.
.neighbourCapaIdList	CapaIdList	List of ITS-S capabilities that the ITS-S Managed Service Entity is requested to discover (e.g. network services at the SNTL, like neighbour nodes able to provide DNS, Internet access, anchor function, gateway function, locator registration, address, ...). In case the size of this list is zero, all ITS-S capabilities provided by the neighbour node(s) reachable through the CI have to be reported.

A.3.5 GetCapa

Table 15 — M*-COMMAND.request for M*-COMMAND GetCapa

COMMAND.request	ASN.1 Type	Description
GetCapa	GetCapa	Request a given ITS-S Managed Service Entity to provide the list of supported ITS-S capabilities
.mseID	MseID	ITS-S Managed Service Entity initiating the report

A.3.6 SetCapa

Table 16 — M*-COMMAND.request for M*-COMMAND SetCapa

COMMAND.request	ASN.1 Type	Description
SetCapa	SetCapa	Request a given ITS-S Managed Service Entity to perform an action on a given ITS-S capability
.mseID	MseID	ITS-S Managed Service Entity concerned by the command
.capaID	MseCapability	Identifier of the target ITS-S capability
.capaAction	CfsCpsAction	This INTEGER parameter has the following values — startCreate (1): Start a capability. — suspend (2): Suspend a capability. — resume (4): Resume a capability. — report (8): Report a capability status together with available statistics. — update (16): Update a capability. — stop (255) Stop a capability.
.capaInfos	CapaInfos	Optional list of parameters specific to the ITS-S capability
CapaInfo	CapaInfo	
.infoID	CapaInfoID	
.infoValue	depends on infoID	

Table 17 — M*-COMMAND.confirm for M*-COMMAND SetCapa

COMMAND.confirm	ASN.1 Type	Description
SetCapa	SetCapaConf	In case the COMMAND was executed successfully, information about a given ITS-S capability is provided.
.mseID	MseID	Same as in related request.
.capaID	MseCapability	Same as in related request.
.capaStatus	CapaStatus	Status of the ITS-S of the capability. This INTEGER parameter has the following values — available (1). — suspended (2). — busy (3). — stopped (255)
.capaInfos	CapaInfos	Set of parameters specific to the requested ITS-S capability

A.3.7 SetCP

Table 18 — M*-COMMAND.request for M*-COMMAND SetCP

COMMAND.request	ASN.1 Type	Description
SetCP	SetCP	Notify or modify the communication profile (ITS-SCP) selected for the transmission of packets of a given ITS-S flow.
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.flowID	FlowID	Identifier of the ITS-S flow
.cpID	ITSprotocolStackID	Identifier of an ITS-SCP.
.action	CfsCpsAction	Action to be performed. This INTEGER parameter has the following values — startCreate (1). — suspend (2). — resume (4). — update (16). — delete (255).
.srcAP	ITSsapiid	Identifier of the source ITS-S application process
.dstType	DestinationType	Type of destination (unicast, groupcast)
.dstID	DestinationID	Identifier of the destination
.srcPort	PortNumber	
.dstPort	PortNumber	
.priority	UserPriority	Priority to be applied to this ITS-S flow
.protoSecInfo	CapaInfos	List of security services (ITS-S capabilities) to apply to packets of this ITS-S flow
.protoFacInfo	CapaInfos	List of facilities services (ITS-S capabilities) to apply to packets of this ITS-S flow. The service may be executed once (e.g. network address determination) or on a per-packet basis (e.g. time stamping).
.protoNetInfo	CapaInfos	Infos of the network protocol (ITS-S capability) to be used for this ITS-S flow (needed for address lookup)
.protoTransInfo	CapaInfos	Infos of the transport protocol (ITS-S capability) to be used for this ITS-S flow
.protoAccessInfo	CapaInfos	Infos of the access protocol (ITS-S capability) to be used for this flow
.portLocalDest	FacAddr	Facilities layer address as specified in ISO/TS 17429:2017.

Table 19 — M*-COMMAND.confirm for M*-COMMAND SetCP

COMMAND.confirm	ASN.1 Type	Description
SetCpConf	SetCpConf	Report about success or failure.
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.flowID	FlowID	As in related request
.errCode	PfMerrorStatus	Applicable error codes are: pfmOK, pfmFlowInvalid, pfmFail

A.3.8 SetFlow2Path

Table 20 — MN-COMMAND.request for MN-COMMAND SetFlow2Path

COMMAND.request	ASN.1 Type	Description
SetFlow2Path	SetFlow2Path	Notify a given ITS-S Managed Service Entity of the ITS-S networking and transport layer to route packets of a given ITS-S flow to a given ITS-S path
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.flowID	FlowID	Identifier of the ITS-S flow
.pathID	PathID	Identifier of the ITS-S path
.action	F2Paction	Action to be performed on the ITS-S flow (add / modify / delete / flush)

Table 21 — MN-COMMAND.confirm for MN-COMMAND SetFlow2Path

COMMAND.confirm	ASN.1 Type	Description
SetFlow2PathConf	SetFlow2PathConf	Report about success or failure.
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.flowID	FlowID	Identifier of the ITS-S flow
.pathID	PathID	Identifier of the ITS-S path
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmFlowInvalid, pfmFail, pfmPathInvalid, pfmPathUnAvailable

A.3.9 SetFlowPolicy

Table 22 — MN-COMMAND.request for MN-COMMAND SetFlowPolicy

COMMAND.request	ASN.1 Type	Description
SetFlowPolicy	SetFlowPolicy	Notify to a given ITS-S Managed Service Entity of the ITS-S networking and transport layer the priority associated to an ITS-S flow
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.flowID	FlowID	ITS-S flow identifier
.pathID	PathID	ITS-S path identifier
.action	F2Paction	Action to be performed on the flow policy (add / modify / delete / flush)
.priority	UserPriority	Priority of the policy (the highest priority value means the most preferred routing policy)

This command shall be confirmed with a MN-COMMAND.confirm carrying flowID and pathID and ErrStatus.

A.3.10 SetPath

Table 23 — MN-COMMAND.request for MN-COMMAND SetPath

COMMAND.request	ASN.1 Type	Description
SetPath	SetPath	Request a given ITS-S Managed Service Entity of the ITS-S networking and transport layer to perform an action on an ITS-S path (establishment, removal of an ITS-S anchor segment, or change of the ITS-S anchor segment parameters)
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.pathID	PathID	ITS-S path identifier associated to this ITS-S path
.pathLinkID	Link-ID	Identifier of the VCI/CI where the ITS-S path starts from (LinkID). See ISO 24102-2 for details.
.action	SPaction	Action to be performed on the ITS-S path (SET, REMOVE, UPDATE)
.pathIngressAnchor	NodeID	Identifier of the ITS-S ingress anchor node
.pathEgressAnchor	NodeID	Identifier of the ITS-S egress anchor node
.pathDestDomain	DestDomain	Indicates which parts of the network can be reached along this ITS-S path (e.g. ITS-S internal, local, Internet)

Table 24 — MN-COMMAND.confirm for MN-COMMAND SetPath

COMMAND.confirm	ASN.1 Type	Description
SetPathConf	SetPathConf	Report about success or failure.
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.pathID	PathID	Same as in related request.
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmFail, pfmPathInvalid, pfmPathUnavailable

Annex B (normative)

M*-REQUESTs to the SME

B.1 General

The notation M*-REQUEST means either MA-REQUEST, or MF-REQUEST, or MN-REQUEST, or MI-REQUEST, or MS-REQUEST. This notation is used to indicate that REQUEST service primitive functions may identically apply for different management SAPs. See ISO 24102-3[17].

B.2 Overview

Table 25 presents a summary of M*-REQUESTs defined for path and flow management. ASN.1 types are presented for .request/.confirm service primitives. The detailed structure of M*-REQUESTs is presented in B.3 with ASN.1 details specified in Annex D.

Table 25 — M*-REQUESTs

REQUEST name	ASN.1 type	Description
GetCP	.request GetCP	See 6.5, 6.6. GetCP is used by ITS-S managed service entities to request the SME to provide communication profiles (ITS-SCP) after reset of the by ITS-S managed service entities or failure of a component. This REQUEST is applicable in the MF-SAP, MN-SAP and MI-SAP. Parameter details are presented in B.3.1.
	.confirm GetCpConf	The request service primitive shall always be confirmed. Parameter details are presented in B.3.1.
NotifyCapa	.request NotifyCapa	See 10.2. NotifyCapa is used by the ITS-S managed service entities to notify the SME the list of ITS-S capabilities supported by the ITS-S layer. This REQUEST is applicable in the MF-SAP, MN-SAP, and MI-SAP.
	.confirm NotifyCapaConf	The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.2.

Table 25 (continued)

REQUEST name	ASN.1 type	Description
NotifyLocGeo	.request NotifyLocGeo .confirm NotifyLocGeoConf	See 8.3 NotifyLocGeo is used by the ITS-S managed service entities to notify to the SME the geographical location of a node. This REQUEST is applicable in the MN-SAP and MF-SAP. The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.3 .
NotifyLocTopo	.request NotifyLocTopo .confirm NotifyLocTopoConf	See 8.3 NotifyLocTopo is used by the ITS-S managed service entities to notify to the SME the network topological location of a node in a communication network (locator) This REQUEST is applicable in the MN-SAP and MF-SAP. The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.4 .
NotifyNeighbourCapa	.request NotifyNeighbourCapa .confirm NotifyNeighbourCapaConf	See 10.3 NotifyNeighbourCapa is used by the ITS-S managed service entities to notify to the SME the list of ITS-S capabilities supported by a neighbour node This REQUEST is applicable in the MN-SAP and MF-SAP. The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.5 .
NotifyPath	.request NotifyPath .confirm NotifyPathConf	See 8.4 . NotifyPath is used by the ITS-S managed service entities to notify to the SME the current status of an ITS-S path. This REQUEST is applicable in the MN-SAP. The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.6 .
RegisterFlow	.request RegisterFlow	See 7.2 . RegisterFlow is used by an ITS-S-AP to register an ITS-S flow. This REQUEST is applicable in the MA-SAP and MF-SAP. Parameter details are presented in B.3.7 .
	.confirm RegisterFlowConf	Parameter details are presented in B.3.7 .

Table 25 (continued)

REQUEST name	ASN.1 type	Description
ReleaseFlow	.request ReleaseFlow .confirm ReleaseFlowConf	See 7.3 ReleaseFlow is used by an ITS-S-AP to notify the SME that an ITS-S flow is no longer used. This REQUEST is applicable in the MA-SAP and MF-SAP. The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.8 .
ReportFlowStats	.request ReportFlowStats .confirm ReportFlowStatsConf	See 6.3 ReportFlowStats is used by the ITS-S managed service entities to provide statistics collected about ITS-S flows. This REQUEST is applicable in the MI-SAP, MN-SAP and MF-SAP. The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.9 .
ReportPathStats	.request ReportPathStats .confirm ReportPathStatsConf	See 8.5 ReportPathStats is used by the ITS-S managed service entities to provide statistics collected about ITS-S paths. This REQUEST is applicable in the MN-SAP. The request service primitive may be confirmed in case of successful processing of the whole request. The request service primitive shall be confirmed in case of failures processing the whole request. Parameter details are presented in B.3.10 .

B.3 Details

B.3.1 GetCP

ASN.1 types and values for the applicable function shall be as presented in [Table 26](#) with ASN.1 details specified in [Annex D](#).

Table 26 — M*-REQUEST.request for GetCP

REQUEST.request	ASN.1 Type	Description
GetCP	GetCP	Request from an ITS-S Managed Service Entity to the SME to provide ITS-SCPs
.mseID	MseID	ITS-S Managed Service Entity initiating the report

Table 27 — M*-REQUEST.confirm for GetCP

REQUEST.confirm	ASN.1 Type	Description
GetCPConf	GetCpConf	Reply from the SME to the ITS-S Managed Service Entity containing the ITS-SCP of ITS-S flows
.mseID	MseID	Identifier of ITS-S Managed Service Entity
.flowObject	FlowObjectList	List o ITS-SCPs identified by ITS-S-FlowIDs.
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmFail.

B.3.2 NotifyCapa

Table 28 — M*-REQUEST.request for NotifyCapa

REQUEST.request	ASN.1 Type	Description
NotifyCapa	NotifyCapa	Notify to the SME the list of ITS-S capabilities supported by the ITS-S Managed Service Entity
.mseID	MseID	ITS-S Managed Service Entity initiating the report
.mseCapabilities	CapaList	List of ITS-S capabilities supported by the ITS-S Managed Service Entity, containing capaID, capaStatus (status of the ITS-S of the capability (AVAILABLE, SUSPENDED, STOPPED), capaInfos (set of parameters for each ITS-S capability)

B.3.3 NotifyLocGeo

Table 29 — M*-REQUEST.request for NotifyLocGeo

REQUEST.request	ASN.1 Type	Description
NotiyLocGeo	NotifyLocGeo	Notify to the SME the geographical location of a node
.mseID	MseID	ITS-S Managed Service Entity initiating the report
.nodeID	NodeID	Identifier of the node for which the geographic location is reported
.nodeKinematicState	NodeKinematicState	latitude of the ITS-S
.lifetime	ExpirationTime	(optional) The expiration time of the corresponding geographical position entry
NodeKinematicState	NodeKinematicState	
.latitude	Latitude	Latitude
.longitude	Longitude	Longitude
.altitude	Altitude	Altitude
.speed	Gs	Ground speed
.heading	Tta	True track angle
.accuracy	PositionAccuracy	Three-dimensional position accuracy
.timestamp	Time48IAT	International Atomic Time

B.3.4 NotifyLocTopo

Table 30 — M*-REQUEST.request for NotifyLocTopo

REQUEST.request	ASN.1 Type	Description
NotifyLocTopo	NotifyLocTopo	Notify to the SME the network topological location of a node in a communication network (locator)
.mseID	MseID	ITS-S Managed Service Entity initiating the report
.nodeID	NodeID	Identifier of the node for which the locator (network topological location) is reported
.locator	LocatorIdList	List of network topological location identifiers of the node in the communication networks to which the node is currently attached.
LocatorID	LocatorID	
.locatorType	LocatorIdID	
.locator	Depends on .locatorType	

B.3.5 NotifyNeighbourCapa

Table 31 — M*-REQUEST.request for NotifyNeighbourCapa

REQUEST.request	ASN.1 Type	Description
NotifyNeighbourCapa	NotifyNeighbourCapa	Notify the SME the list of ITS-S capabilities supported by a neighbour node
.mseID	MseID	ITS-S Managed Service Entity initiating the notification
.nodeID	NodeID	Identifier of the neighbour node providing the ITS-S capabilities
.mseCapabilities	CapaList	List of ITS-S capabilities supported by the neighbour node, containing capaID, capaStatus (status of the ITS-S of the capability (AVAILABLE, SUSPENDED, STOPPED)), capaInfos (set of parameters for each ITS-S capability)

This request may be confirmed with an M*-REQUEST.confirm carrying only an ErrStatus.

B.3.6 NotifyPath

Table 32 — MN-REQUEST.request for NotifyPath

REQUEST.request	ASN.1 Type	Description
NotifyPath	NotifyPath	Notify to the SME the current status of an ITS-S path
.mseID	MseID	ITS-S Managed Service Entity initiating the notification
.pathID	PathID	ITS-S path identifier. Null when the ITS-S anchor segment is not set up yet.
.action	NPaction	Purpose of the request: — Notification of a new path (pathID is set to NULL in this case; will be allocated by SME) — Notification of a status change — Notification of a reachability change (destDomain) — Notification of capabilities change — Notification of metrics change — Notification of statistics

Table 32 (continued)

REQUEST.request	ASN.1 Type	Description
.localCIID	EUI64	Permanent ID of the local CI of the link.
.remoteCIID	EUI64	Dynamic ID of the remote CI of the link.
.locator	LocatorID	Identifier of the network topological location of the ITS-S in the communication network in which the ITS-S is currently attached to through this ITS-S path. Parameter required when “action” is set to “new path”. Could be used in other situations for debugging purposes.
.pathIngressAnchor	NodeID	Identifier of the ITS-S ingress anchor node on the ITS-S path
.pathEgressAnchor	NodeID	Identifier of the ITS-S egress anchor node on the ITS-S path
.status	PathStatus	Status of the ITS-S path: not available (0), being used (128), ready to be used (64), potentially ready (32), going to up (4), going to down (8)
.destdomain	DestDomain	Indicates which parts of the network can be reached along this ITS-S path (e.g. ITS-S internal, local, Internet). Parameter required when “action” is set to “new path”; can be NULL if not known yet (e.g. path under construction). Could be used in other situations for debugging purposes.
.capalDList	PathCapabilityList	List of identifiers of ITS-S capabilities supported on the ITS-S path: reverse reachability for host, session continuity for host, reachability for network, session continuity for network, multicasting, GeoCasting, encryption, etc.
.metricList	PathCharacteristicsList	List of metrics of the ITS-S path: Max size of the payload allowed on this ITS-S path, number of hops, monetary cost, level of reliability, level of QoS, etc.
.statisticsList	PathStatisticsList	List of statistics collected on this ITS-S path: data rate, end-to-end delay, jitter, packet loss, etc.

This request is confirmed with a MN-REQUEST.confirm containing a PathID and an ErrStatus.

B.3.7 RegisterFlow

Table 33 — M*-REQUEST.request for RegisterFlow

REQUEST.request	ASN.1 Type	Description
RegisterFlow	RegisterFlow	Request from the ITS-S-AP to the SME to register an ITS-S flow
.itss-app	ITSSapiid	Identifier of the requesting ITS-S-AP
.txInterfaceNo	ITSappProcSinkSourceNo	Identifier of the transmission interface as defined in ISO 17419[1].
.destID	DestinationID	Identifier of the destination (type varies; could be a URL, an IP address, an email address, a 48 bit MAC address, a geo-location)
.destInfo	DestinationType	Set of information including the type of destination (single, group, broadcast, GeoArea, TopoArea)
.credentials	OCTET STRING	Credentials to assess the ITS-S-AP is authorized to perform this action

Table 34 — M*-REQUEST.confirm for RegisterFlow

REQUEST.confirm	ASN.1 Type	Description
RegisterFlowConf	RegisterFlowConf	Notification from the SME to the ITS-S-AP the results of the ITS-S flow registration
.itss-app	ITSSapiid	Same as in related request.
.flowID	FlowID	Identifier of ITS-S flow
.txInterfaceNo	ITSappProcSinkSourceNo	Same as in related request.
.params	TXparameters	Set of recommended transmission parameters (maximum packet rate, maximum ADU size,...) - used by the ITS-S-AP to adjust its transmission.
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmFail, pfmTxNotRegistered, pfmAppNotRegistered, pfmNotAuthorized, pfmCpNotFound, pfmDstCannotReach.

B.3.8 ReleaseFlow

Table 35 — M*-REQUEST.request for ReleaseFlow

REQUEST.request	ASN.1 Type	Description
ReleaseFlow	ReleaseFlow	Information from the ITS-S-AP to the SME that an ITS-S flow is not longer used, is suspended, or is resumed.
.itss-app	ITSSapiid	Identifier of the requesting ITS-S-AP (for debugging purposes)
.flowID	FlowID	Identifier of the ITS-S flow
.action	CfsCpsAction	Action to be performed. This INTEGER parameter could have the following values: action-release, action-suspend or action-resume.
.credentials	OCTET STRING	Credentials to assess the ITS-S-AP is authorized to perform this action. An empty string indicates that authorization cannot be assessed.

This request may be confirmed with an M*-REQUEST.confirm carrying only an ErrStatus.

B.3.9 ReportFlowStats

Table 36 — M*-REQUEST.request for ReportFlowStats

REQUEST.request	ASN.1 Type	Description
ReportFlowStats	ReportFlowStats	Provide to the SME statistics collected about ITS-S flows
.mseID	MseID	ITS-S Managed Service Entity initiating the report
.flowID	FlowID	Identifier of the ITS-S flow
.pathID	PathID	ITS-S path currently used for packets corresponding to the ITS-S flow identified by FlowID. NULL if reported from the ITS-S facilities layer.
.flowStats	FlowStatisticsList	Set of statistics collected for each ITS-S flow (number of packets sent, number of acknowledgements received, number of negative acknowledgements received, transmission rate, etc.)

Table 36 (continued)

REQUEST.request	ASN.1 Type	Description
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmPathUnavailable, pfmPathCongested, pfmFlowInvalid.
FlowStatistics	FlowStatistics	
.statType	FlowStatisticsTypeID	Identifier of type if statistical item
.statistics	Depends on .statType	Statistical item

This request may be confirmed with an M*-REQUEST.confirm carrying only an ErrStatus.

B.3.10 ReportPathStats

Table 37 — MN-REQUEST.request for ReportPathStats

REQUEST.request	ASN.1 Type	Description
ReportPathStats	ReportPathStats	Provide to the SME statistics collected about ITS-S paths
.mseID	MseID	ITS-S Managed Service Entity initiating the report
.pathID	PathID	Identifier of the ITS-S flow
.pathStats	PathStatisticsList	Set of statistics collected for each ITS-S path (number of packets sent, available bandwidth, quantity of data transmitted, propagation delay, transmission rate, etc.)
.errCode	PFMerrorStatus	Applicable error codes are: pfmOK, pfmPathInvalid, pfmPathUnavailable

Annex C (normative)

PFM error codes

Error codes used in the COMMAND and REQUEST service primitives for “Path and Flow Management” (PFM) are presented in [Table 38](#). PFM error codes are of ASN.1 type PFMErrorStatus specified in [Annex D](#).

Table 38 — PFM error codes

ASN.1 value	Description
pfmOK = 0	Success of the operation
pfmFail = 1	Failure of the operation
pfmFlowInvalid = 2	No registration corresponding to the ITS-S flow
pfmPathInvalid = 3	No ITS-S path corresponding to PathID
pfmPathUnavailable = 4	ITS-S path currently unavailable
pfmCapaNotSupported = 5	The indicated capability is not supported
pfmCpNotFound = 6	No communication profile can be found for this flow type
pfmCpNotSupported = 7	The requested communication profile cannot be supported for this flow type
pfmDstCannotReach = 8	Cannot reach the destination (ITS-FSDU cannot be transmitted)
pfmNotAuthorized = 9	The requesting ITSS-AP is not authorized to perform such action (the authorization material presented is not correct)
pfmTxNotRegistered = 10	TXInterfaceNo (ISO 17423:2018) is not registered
pfmAppNotRegistered = 11	The indicated ITS-S Application Process is not registered
pfmMseNotExistent = 12	The indicated ITS-S Managed Service Entity does not exist
pfmPathCongested = 13	The indicated ITS-S path is congested
pfmCpNotAvailable = 14	Communication profile is not available
pfmUnknownFailure = 255	An unknown failure occurred

Annex D (normative)

ASN-1 modules

D.1 Overview

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

— **ITSpfm2** { iso (1) standard (0) calm-management (24102) pfm (6) asnm-1 (1) version2(2) }

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

D.2 Module ITSpfm

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[1], ISO 21218[14], ISO 24102-1[15], ISO 24102-3[7], ISO 29281-1[21], ISO 17423:2018.

Unaligned packed encoding rules (PER) as specified in ISO/IEC 8825-2[24] shall be applied for this ASN.1 module.

```
ITSpfm2 { iso (1) standard (0) calm-management (24102) pfm (6) asnm-1 (1) version2(2) }

DEFINITIONS AUTOMATIC TAGS::=BEGIN

IMPORTS

-- C-ITS Data Dictionary in DIS 17419
NullType, EUI64, UserPriority, Time48IAT, MACAddress, Latitude, Longitude, Altitude,
TimeUnit, PortNumber, TimeDurationValue, EUI64MAC48, IPv6Address, MediumCost FROM
CITSdataDictionary1 {iso(1) standard(0) cits-applMgmt (17419) dataDictionary (1) version1
(1)}

-- DIS 17419
ITSatt, ITssapiid, FlowTypeID, ITS-SapSsId, ITSappProcSinkSourceNo, ITSprotocolStackID,
LogicalChannelType, ITS-scuId FROM CITSapplMgmtApplReg {iso(1) standard(0) cits-applMgmt
(17419) applRegistry (2) version2 (2)}

-- DIS 17423
DestinationType, DestDomain, MaxADU, MinCommDistance, Resilience, MaxLat, ExpFlowLifeTime
FROM CITSapplReq2 {iso(1) standard(0) cits-applReq (17423) asnm-1 (1) version2 (2)}

-- ISO 17429
FacAddr FROM ITSitssf { iso (1) standard (0) itssf (17429) asnm-1 (1) version1(1) }

-- DIS 21218 (planned for 2017) and ISO 21218
Link-ID, I-Param, Directivity, DataRate, Tta, Gs FROM ITSllsap {iso(1) standard(0)
calm-ll-sap(21218) asnm-1 (1) version2 (2)}

-- DIS 24102-1 (planned for 2017) and ISO 24102-1
StationType FROM ITSmanagement {iso (1) standard (0) calm-management (24102) local (1)
asnm-1 (1) version2 (2)}

;

-- End of IMPORTS
```

-- Types**-- Objects used internally****-- Path object**

PathObjectList ::= SEQUENCE OF PathObject

```
PathObject ::= SEQUENCE {
    pathID          PathID,
    ci              Link-ID,
    nextHop         NodeID,
    locator         LocatorID,
    ingressAnchor   NodeID,
    egressAnchor    NodeID,
    destDomain      DestDomain,
    status          PathStatus,
    metrics         PathMetrics,
    capabilities    PathCapabilityList,
    statistics      PathStatisticsList
} -- See Table 3
```

-- Flow Object

FlowObjectList ::= SEQUENCE OF FlowObject

```
FlowObject ::= SEQUENCE {
    flowID          FlowID,
    regStatus       FlowRegistrationStatus,
    regTime         FlowRegistrationTime,
    flowType        FlowTypeID,
    priority        UserPriority,
    commMode        DestinationType,
    pathAvailability PathFlowAvailability,
    pathID          PathID,
    srcAppID        ITSSapiid,
    srcNodeID       NodeID,
    srcPort         PortNumber,
    destAppID        FacAddr, -- Facility layer destAddress 17429
    destID          DestinationID,
    destNodeID      NodeID,
    destPort        PortNumber,
    maxFDPDU        MaxFDPDUorFragmentation,
    protoTransInfo  CapaInfo,
    protoNetInfo    CapaInfo,
    protoAccessInfo CapaInfo,
    lch             LogicalChannelType,
    protoAccessCHparams AccessChannelParameters,
    statistics      FlowStatisticsList
} -- See Table 2
```

-- General types

```
NodeRole ::= INTEGER {
    host      (1),
    router    (2),
    borderRouter (3),
    accessRouter (4),
    mobileRouter (5),
    anchor    (6),
    unknown   (255)
} (0..255)
```

```
PositionAccuracy ::= SEQUENCE{
    lat    Accuracy, -- in lateral direction
    lon    Accuracy, -- in longitudinal direction
    alt    Accuracy -- in altitude direction
}
```

```
Accuracy ::= INTEGER{
    unknown          (0), -- unknown
    fiveCentimeters (1), -- in 5cm units
    bigger           (255) -- bigger than 12,7 meters
}
```

```
} (0..255)
```

```
PathID ::= INTEGER {
    unknown          (0)
} (0..65535)
```

```
PathStatus ::= INTEGER {
    pathStatusNotAvailable      (0),
    pathStatusGoingUp           (4),
    pathStatusGoingDown        (8),
    pathStatusPotentiallyReady (32),
    pathStatusReady             (64),
    pathStatusUsed              (128)
} (0..255)
```

-- PathMetrics CLASS

```
PATH-METRICS ::= CLASS {
    &id          PathMetricsID UNIQUE,
    &Type
}
WITH SYNTAX {&Type SELECTED BY &id}
```

```
PathMetrics ::= SEQUENCE {
    metricsType  PATH-METRICS.&id({PathMetricsTypes}),
    metrics      PATH-METRICS.&Type({PathMetricsTypes}){@.metricsType}
}
```

```
PathMetricsMaxFPDU ::= MaxFPDUonoFragmentation -- minimum MTU 2 octet Int
PathMetricsNumbHops ::= NumberOfHops
```

```
NumberOfHops ::= INTEGER(0..255) --number of hops used 1 octet Int
```

-- End of PathCharacteristics CLASS

```
PathCapabilityList ::= SEQUENCE SIZE (0..255) OF PathCapability
```

```
PathStatisticsList ::= SEQUENCE SIZE (0..255) OF PathStatistics
```

-- PathStatistics CLASS

```
PATH-STATISTICS ::= CLASS {
    &id          PathStatisticsTypeID UNIQUE,
    &Type
}
WITH SYNTAX {&Type SELECTED BY &id}
```

```
PathStatistics ::= SEQUENCE {
    statType  PATH-STATISTICS.&id({PathStatisticsTypes}),
    statistics PATH-STATISTICS.&Type({PathStatisticsTypes}){@.statType}
}
```

```
PathStatNumbHops ::= NumberOfHops
```

-- End of PathStatistics CLASS

```
FlowID ::= INTEGER {
    anyFlow      (0) -- the value zero is reserved to indicate any flow
} (0..65535)
```

```
FlowRegistrationStatus ::= INTEGER {
    flowStatusRegistered (1),
    flowStatusOngoing    (2),
    flowStatusSuspended  (128)
} (0..255)
```

```
FlowRegistrationTime ::= Time48IAT
```

```

PathFlowAvailability ::= INTEGER {
    pathFlowNotSelected (0),
    pathFlowExistent    (1),
    pathFlowNotAny       (128)
} (0..255)

MaxFPDUnoFragmentation ::= INTEGER(0..65535)

AccessChannelParameters ::= SEQUENCE (SIZE(0..255)) OF I-Param

FlowStatisticsList ::= SEQUENCE (SIZE(0..255)) OF FlowStatistics

-- FlowStatistics CLASS

FLOW-STATISTICS ::= CLASS {
    &id          FlowStatisticsTypeID UNIQUE,
    &Type
}
WITH SYNTAX {&Type SELECTED BY &id}

FlowStatistics ::= SEQUENCE {
    statType      FLOW-STATISTICS.&id({FlowStatisticsTypes}),
    statistics     FLOW-STATISTICS.&Type({FlowStatisticsTypes}){@.statType}
}

FlowStatisticsAvgRTT ::= RoundTripTime

RoundTripTime ::= INTEGER{
    unknown          (0),
    oneMilliSecond   (1),
    larger            (65535)
} (0 .. 65535)

-- End of FlowStatistics CLASS

Txparameters ::= SEQUENCE (SIZE(0..255)) OF Txparameter

-- Txparameter CLASS

TX-PARAMETER ::= CLASS {
    &id          TxparameterID UNIQUE,
    &Type
}
WITH SYNTAX {&Type SELECTED BY &id}

Txparameter ::= SEQUENCE{
    paramID       TX-PARAMETER.&id({TxParameterTypes}),
    txParam       TX-PARAMETER.&Type({TxParameterTypes}){@.paramID}
}

TxParamMaxFPDUnoFragmentation ::= MaxFPDUnoFragmentation

-- End of Txparameter CLASS

PFMErrorStatus ::= INTEGER{
    pfmOK          (0),
    pfmFail         (1),
    pfmFlowInvalid  (2),
    pfmPathInvalid  (3),
    pfmPathUnavailable (4),
    pfmCapaNotSupported (5),
    pfmCpNotFound   (6),
    pfmCpNotSupported (7),
    pfmDstCannotReach (8),
    pfmNotAuthorized (9),
    pfmTxNotRegistered (10),
    pfmAppNotRegistered (11),
    pfmMseNotExistent (12),
    pfmPathCongested (13),
    pfmCpNotAvailable (14),

```

```

        pfmUnknownFailure      (255)
    } (0..255)

```

```

CfsCpsAction ::= INTEGER{
    action-ping           (0),
    action-startCreate    (1),
    action-suspend        (2),
    action-resume         (4),
    action-report         (8),
    action-update         (16),
    action-stopDelete     (255)
} (0..255)

```

-- DestinationID CLASS

```

DESTINATION-ID ::= CLASS {
    &id          DestinationIdTypeID UNIQUE,
    &Type
}
WITH SYNTAX {&Type SELECTED BY &id}

```

```

DestinationID ::= SEQUENCE{
    destTypeID      DESTINATION-ID.&id({DestinationIDTypes}),
    address         DESTINATION-ID.&Type({DestinationIDTypes}{@.destTypeID})
}

```

```

DestinationIdIPv6 ::= IPv6Address

```

```

DestinationIdMAC48 ::= MACAddress

```

```

DestinationIdEui64MAC48 ::= EUI64MAC48

```

```

-- DestinationIdGeoLoc ::=

```

```

DestinationIdURL ::= UTF8String

```

```

DestinationIdMail ::= UTF8String

```

```

DestinationIdDomainName ::= UTF8String -- e.g. gatewayID.car_maker.com

```

```

-- Added for eCall on 2017-02-08 - used in SIP

```

```

DestinationIdURN ::= UTF8String

```

-- End of DestinationID CLASS

-- NodeID CLASS

```

NODE-ID ::= CLASS {
    &id          NodeIdTypeID UNIQUE,
    &Type
}
WITH SYNTAX {&Type SELECTED BY &id}

```

```

NodeID ::= SEQUENCE{
    nodeTypeID      NODE-ID.&id({NodeIdTypes}),
    nodeID          NODE-ID.&Type({NodeIdTypes}{@.nodeTypeID})
}

```

```

NodeIdITSscuID ::= ITS-scuId

```

```

NodeIdIPv6Node ::= IPv6Address

```

```

NodeIdMac48 ::= MACAddress

```

```

NodeIdeui64MAC48 ::= EUI64MAC48

```

-- End of NodeID CLASS

-- COMMANDS --

-- Objects General

-- An object may apply to more than one M*-SAP

-- AdjustFlows

```

AdjustFlows ::= SEQUENCE{
    itss-app      ITSsapiid,
    flowInfos     AdjustFlowInfos
} -- service primitive function

```

```

AdjustFlowInfos ::= SEQUENCE (SIZE(0..255)) OF AdjustFlow

```

```

AdjustFlow ::= SEQUENCE {
    flowID FlowID,
    params TXparameters
}

AdjustFlowsConf ::= SEQUENCE {
    itss-app ITssapiid,
    flowInfos AdjustFlowStatuses
} -- service primitive function

AdjustFlowStatuses ::= SEQUENCE (SIZE(0..255)) OF AdjustFlowStatus

AdjustFlowStatus ::= SEQUENCE {
    flowID FlowID,
    errCode PFMerrorStatus
}

-- CollectFlowStats
CollectFlowStats ::= SEQUENCE {
    mseID MseID,
    flowID FlowID,
    action CfsCpsAction
}

CollectFlowStatsConf ::= SEQUENCE {
    mseID MseID,
    flowID FlowID, -- as provided in .request
    statList FlowStatusList, -- empty in case of failure or nothing
    -- requested
    errCode PFMerrorStatus
}

FlowStatusList ::= SEQUENCE (SIZE(0..255)) OF FlowStatus

-- FlowStatus CLASS

FLOW-STATUS ::= CLASS {
    &id FlowStatusTypeID UNIQUE,
    &Type
}
WITH SYNTAX {&Type SELECTED BY &id}

FlowStatus ::= SEQUENCE {
    itemID FLOW-STATUS.&id({FlowStatusTypes}),
    itemStatus FLOW-STATUS.&Type({FlowStatusTypes}){@.itemID}
}

FlowStatAvgDataRate ::= DataRate

-- End of FlowStatus CLASS

-- CollectPathStats
CollectPathStats ::= SEQUENCE {
    mseID MseID,
    pathID PathID,
    action CfsCpsAction
}

CollectPathStatsConf ::= SEQUENCE {
    mseID MseID,
    pathID PathID, -- as provided in .request
    statList PathStatisticsList, -- empty in case of failure or nothing requested
    errCode PFMerrorStatus
}

-- DiscoverCapa
DiscoverNeighborCapa ::= SEQUENCE {
    mseID MseID,
    localCIID EUI64, -- optional or set to NULL for MF-SAP
    neighborCapaIdList CapaIdList
}

```